ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNIT 3

PROPOSED TECHNICAL SPECIFICATIONS (TS) CHANGE TS-398
DESCRIPTION AND EVALUATION OF THE PROPOSED CHANGE

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I. DESCRIPTION OF THE PROPOSED TS CHANGE

TVA is requesting changes to the Unit 3 TS to include provisions for enabling the Oscillation Power Range Monitor (OPRM) Upscale trip function in the Average Power Range Monitor (APRM). The APRM is part of the Power Range Neutron Monitoring (PRNM) system. 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.

The PRNM upgrade was installed on BFN Unit 3 during the Fall 1998 refueling outage. TS changes supporting the PRNM installation were proposed in References 1 and 2, and were approved for Unit 3 by the NRC on September 3, 1998 (Reference 3). The PRNM upgrade uses General Electric (GE) Nuclear Measurement Analysis and Control (NUMAC) components. Its OPRM trip function implements the long-term stability solution designated as Option III in References 4 and 5. As described in References 1 and 2, the OPRM trip function is operated in the "indicate only" mode for one cycle following installation and enabled for the following fuel cycles. The OPRM trip function was enabled on Unit 2 during the recent refueling outage this Spring.

Provided below is a description of each requested TS change. The requested changes are based on examples presented in NUMAC PRNM Retrofit Plus Option III Stability Trip Function (Reference 6) which was approved by the NRC in Reference 7.

PROPOSED CHANGES TO TS

The proposed changes to incorporate provisions for enabling the OPRM Upscale trip function on Unit 3 are as follows:

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

The Required 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. The revised Note reads as follows (deleted words are shown with ~~strikethrough~~, and changed or added words are shown in ***bolded italics***):

-----------------NOTE---------------------
Not applicable for Functions 2.a, 2.b, 2.c,~~-or~~ 2.d, *or 2.f.*

In Condition B, the Note is revised to say that Condition B is also not applicable for new Function 2.f.

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

New Condition I and Condition J, together with Required Actions and Completion Times are added to the LCO Required Actions table. The new entries read as follows:

CONDITION		REQUIRED ACTION		COMPLETION TIME
I.	As required by Required Action D.1 and referenced in Table 3.3.1.1-1.	I.1	Initiate alternate method to detect and suppress thermal hydraulic instability oscillations.	12 hours
		<u>AND</u>		
		I.2	Restore required channels to OPERABLE.	120 days
J.	Required Action and associated Completion Time of Condition I not met.	J.1	Be in Mode 2.	4 hours

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

A new Surveillance, SR 3.3.1.1.17, is added to the Surveillance Requirements table. The new table entry reads as follows:

SURVEILLANCE		FREQUENCY
SR 3.3.1.1.17	Verify OPRM is not bypassed when APRM Simulated Thermal Power is $\geq$ 25% and recirculation drive flow is < 60% of rated recirculation drive flow.	24 months

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

New APRM Function 2.f, the OPRM Upscale trip function, together with Applicable Modes, Required Channels, Conditions Referenced, Surveillance Requirements and Allowable Value are added to Table 3.3.1.1-1. The new entry reads as follows:

FUNCTION	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER TRIP SYSTEM	CONDITIONS REFERENCED FROM REQUIRED ACTION D.1	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE
2. Average Power Range Monitors (continued)					
f. OPRM Upscale	1	3(b)	I	SR 3.3.1.1.1 SR 3.3.1.1.7 SR 3.3.1.1.13 SR 3.3.1.1.16 SR 3.3.1.1.17	NA

5. 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 reads as follows (deleted words are shown with ~~strikethrough~~):

> Two recirculation loops with matched flows shall be in operation.~~with core flow as a function of THERMAL POWER outside Regions I and II and the Operation Not Permitted Region of Figure 3.4.1-1.~~
>
> <u>OR</u>
>
> One recirculation loop may be in operation~~with core flow as a function of THERMAL POWER outside Regions I and II and the Operation Not Permitted Region of Figure 3.4.1-1 and~~ provided the following limits are applied when the associated LCO is applicable:
>
> a. LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)," single loop operation limits specified in the COLR;
>
> b. LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)," single loop operation limits specified in the COLR;
>
> c. LCO 3.3.1.1, "Reactor Protection System (RPS) Instrumentation," Function 2.b (Average Power Range Monitors Flow Biased Simulated Thermal Power - High), Allowable Value of Table 3.3.1.1-1 is reset for single loop operation;

6. Page 3.4-2, LCO 3.4.1, Recirculation Loops Operating

In the Required 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. The changed Required Actions table reads as follows (deleted words are shown with ~~strikethrough~~, and changed or added words are shown in ***bolded italics***):

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
~~A. Reactor operation with core flow as a function of THERMAL POWER inside of Region I of Figure 3.4.1-1.~~	~~A.1 Place mode switch in the shutdown position.~~	~~Immediately~~
~~B. Reactor operation with core flow as a function of THERMAL POWER inside of Region II of Figure 3.4.1-1.~~	~~B.1 Place mode switch in the shutdown position.~~ ~~AND~~ ~~B.2 Exit Region II.~~	~~Immediately upon discovery of thermal hydraulic instability~~ ~~2 hours~~
A. Requirements of the LCO not met. ~~for reasons other than A or B.~~	***A.***1 Satisfy the requirements of the LCO.	24 hours
B. Required Action and associated Completion Time of Conditions ~~B or C~~ ***A*** not met. <u>OR</u> No recirculation loops in operation. ~~while in MODES 2.~~	***B.***1 Be in Mode 3.	12 hours
~~E. No recirculation loops in operation while in MODE 1.~~	~~E.1 Place mode switch in the shutdown position.~~	~~Immediately~~

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

Surveillance SR 3.4.1.2 to verify that the reactor is outside of Region I and II of Figure 3.4.1-1, and its associated Frequency are deleted in their entirety.

8. 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.

9. Page B 3.3-9, Bases Section 3.3.1.1, RPS Instrumentation

In the Applicable Safety Analyses Bases for Average Power Range Monitor, changes are made to reflect addition of the new OPRM Upscale trip function. After the changes, the Average Power Range Monitor description reads as follows (deleted words are shown with ~~strikethrough~~, and changed or added words are shown in ***bolded italics***):

> The APRM channels provide the primary indication of neutron flux within the core and respond almost instantaneously to neutron flux increases. The APRM channels receive input signals from the local power range monitors (LPRMs) within the reactor core to provide an indication of the power distribution and local power changes. The APRM channels average these LPRM signals to provide a continuous indication of average reactor power from a few percent to greater than RTP. ***Each APRM also includes an Oscillation Power Range Monitor (OPRM) Upscale Function which monitors small groups of LPRM signals to detect thermal-hydraulic instabilities.***
>
> The APRM System is divided into four APRM channels and four 2-out-of-4 voter channels. Each APRM channel provides inputs to each of the four voter channels. The four voter channels are divided into two groups of two each, with each group of two providing inputs to one RPS trip system. The system is designed to allow one APRM channel, but no voter channels, to be bypassed. A trip from any one unbypassed APRM will result in a "half trip" in all four of the voter channels, but no trip inputs to either RPS trip system. ***APRM trip Functions 2.a, 2.b, 2.c, and 2.d are voted independently from OPRM Upscale Function 2.f. Therefore, any Function 2.a, 2.b, 2.c, or 2.d*** ~~A~~ trip from any two unbypassed APRM channels will result in a full trip in each of the four voter channels, which in turn results in two trip inputs to each RPS trip system logic channel (A1, A2, B1, or B2). ***Similarly, a Function 2.f trip from any two unbypassed APRM channels will result in a full trip from each of the four voter channels.*** Three of the four APRM channels and all four voter channels are required to be OPERABLE to ensure that no single failure will preclude a scram on a valid signal. In addition, to provide adequate coverage of the entire core, consistent with the design bases for the

APRM Functions *2.a, 2.b and 2.c*, at least twenty (20) LPRM inputs, with at least three (3) LPRM inputs from each of the four axial levels at which the LPRMs are located, must be operable for each APRM channel. ***For the OPRM Upscale Function 2.f, LPRMs are assigned to "cells" with either 3 or 4 detectors, with a total of 33 "cells" assigned to each OPRM channel. A minimum of 23 cells, each with a minimum of 2 LPRMs must be OPERABLE for the OPRM Upscale Function 2.f to be OPERABLE.***

10. Page B 3.3-14, Bases Section 3.3.1.1, RPS Instrumentation

In the Applicable Safety Analyses Bases for APRM Function 2.d. Average Power Range Monitor - Inop, an editorial change is made. The words "non-bypassed APRM channels" are revised to say "unbypassed APRM channels."

11. Page B 3.3-15, Bases Section 3.3.1.1, RPS Instrumentation

In the Applicable Safety Analyses Bases for APRM Function 2.e. 2-Out-Of-4 Voter, the phrase "including the OPRM Upscale Function" is added into the first sentence of the section. See the mark-up for placement.

A new paragraph is also added to describe the independence of OPRM Upscale, Function 2.f from APRM Functions 2.a, 2.b, and 2.c and to discuss considerations that may go into declaring voter Function 2.e inoperable. See the mark-up for placement. The new paragraph reads as follows:

> The 2-Out-Of-4 Voter Function votes APRM Functions 2.a, 2.b, 2.c, and 2.d independently of Function 2.f. The voter also includes separate outputs to RPS for the two independently voted sets of Functions, each of which is redundant (four total outputs). The voter Function 2.e must be declared inoperable if any of its functionality is inoperable. However, due to the independent voting of APRM trips, and the redundancy of outputs, there may be conditions where the voter Function 2.e is inoperable, but trip capability for one or more of the other APRM Functions through that voter is still maintained. This may be considered when determining the condition of other APRM Functions resulting from partial inoperability of the Voter Function 2.e.

12. Page B 3.3-15, Bases Section 3.3.1.1, RPS Instrumentation

In the Applicable Safety Analyses Bases a new section, 2.f. Oscillation Power Range Monitor (OPRM) Upscale is added to describe the new OPRM Upscale trip function. The new section reads as follows:

2.f. Oscillation Power Range Monitor (OPRM) Upscale

The OPRM Upscale Function provides compliance with GDC 10 and GDC 12, thereby providing protection from exceeding the fuel MCPR safety limit (SL) due to anticipated thermal-hydraulic power oscillations.

References 13, 14 and 15 describe three algorithms for detecting thermal-hydraulic instability related neutron flux oscillations: the period based detection algorithm, the amplitude based algorithm, and the growth rate algorithm. All three are implemented in the OPRM Upscale Function, but the safety analysis takes credit only for the period based detection algorithm. The remaining algorithms provide defense in depth and additional protection against unanticipated oscillations. OPRM Upscale Function OPERABILITY for Technical Specification purposes is based only on the period based detection algorithm.

The OPRM Upscale Function receives input signals from the local power range monitors (LPRMs) within the reactor core, which are combined into "cells" for evaluation of the OPRM algorithms.

The OPRM Upscale Function is required to be OPERABLE when the plant is in a region of power-flow operation where anticipated events could lead to thermal-hydraulic instability and related neutron flux oscillations. Within this region, the automatic trip is enabled when THERMAL POWER, as indicated by the APRM Simulated Thermal Power, is ≥ 25% RTP and reactor core flow, as indicated by recirculation drive flow is < 60% of rated flow, the operating region where actual thermal-hydraulic oscillations may occur. Requiring the OPRM Upscale Function to be OPERABLE in Mode 1 provides consistency with operability requirements for other APRM functions and assures that the OPRM Upscale Function is OPERABLE whenever reactor power could increase into the region of concern without operator action.

An OPRM Upscale trip is issued from an APRM channel when the period based detection algorithm in that channel detects oscillatory changes in the neutron flux, indicated by the combined signals of the LPRM detectors in a cell, with period confirmations and relative cell amplitude exceeding specified setpoints. One or more cells in a channel exceeding the trip conditions will result in a channel trip. An OPRM Upscale trip is also issued from the channel if either the growth rate or amplitude based algorithms detect growing oscillatory changes in the neutron flux for one or more cells in that channel.

Three of the four channels are required to be OPERABLE. Each channel is capable of detecting thermal-hydraulic instabilities, by detecting the related neutron flux oscillations, and issuing a trip signal before the MCPR SL is exceeded. There is no allowable value for this function.

13. Page B 3.3-30, Bases Section 3.3.1.1, RPS Instrumentation

In the Required Actions Bases under the description of Actions A.1 and A.2, a sentence is revised to note that Action A.2 also is not applicable for APRM Function 2.f, the OPRM Upscale trip function. The revised sentence reads as follows (deleted words are shown with ~~strikethrough~~, and changed or added words are shown in ***bolded italics***):

> As noted, Action A.2 is not applicable for APRM Functions 2.a, 2.b, 2.c,~~-and~~ 2.d, ***or 2f.***

14. Pages B 3.3-32, Bases Section 3.3.1.1, RPS Instrumentation

In the Required Actions Bases under the description of Actions B.1 and B.2, a paragraph is revised to note that Condition B also in not applicable for APRM Function 2.f, the OPRM Upscale trip function. The revised paragraph reads as follows (deleted words are shown with ~~strikethrough~~, and changed or added words are shown in ***bolded italics***):

> As noted, Condition B is not applicable for APRM Functions 2.a, 2.b, 2.c,~~-and~~ 2.d, ***or 2.f.*** Inoperability of an APRM channel affects both trip systems and is not associated with a specific trip system as are the APRM 2-out-of-4 voter and other non-APRM channels for which Condition B applies. For an inoperable APRM channel, Required Action A.1 must be satisfied, and is the only action (other than restoring operability) that will restore capability to accommodate a single failure. Inoperability of ***a Function in*** more than one required APRM channel results in loss of trip capability ***for that Function*** and entry into Condition C, as well as entry into Condition A for each channel. Because Conditions A and C provide Required Actions that are appropriate for the inoperability of APRM Functions 2.a, 2.b, 2.c, ~~and~~ 2.d, ***or 2.f,*** and these functions are not associated with specific trip systems as are the APRM 2-out-of-4 voter and other non-APRM channels, Condition B does not apply.

15. Page B 3.3-34, Bases Section 3.3.1.1, RPS Instrumentation

In the Required Actions Bases the existing discussion of Actions E.1, F.1, and G.1 is made applicable for new action J.1 by adding "J.1" into the into the heading of this discussion. No other changes to the existing discussion are made.

16. Page B 3.3-35, Bases Section 3.3.1.1, RPS Instrumentation

In the Required Actions Bases two new paragraphs are added to discuss new Actions I.1 and I.2. The new paragraphs read as follows:

<u>I.1</u>

If OPRM Upscale trip capability is not maintained, Condition I exists. Reference 12 justified use of alternate methods to detect and suppress oscillations for a limited period of time. The alternate methods are procedurally established consistent with the guidelines identified in Reference 17 requiring manual operator action to scram the plant if certain predefined events occur. The 12 hour allowed action time is based on engineering judgment to allow orderly transition to the alternate methods while limiting the period of time during which no automatic or alternate detect and suppress trip capability is formally in place. Based on the small probability of an instability event occurring at all, the 12 hours is judged to be reasonable.

<u>I.2</u>

The alternate method to detect and suppress oscillations implemented in accordance with I.1 was evaluated (Reference 12) based on use up to 120 days only. The evaluation, based on engineering judgment, concluded that the likelihood of an instability event that could not be adequately handled by the alternate methods during this 120 day period was negligibly small. The 120 day period is intended to be an outside limit to allow for the case where design changes or extensive analysis might be required to understand or correct some unanticipated characteristic of the instability detection algorithms or equipment. This action is not intended and was not evaluated as a routine alternative to returning failed or inoperable equipment to OPERABLE status. Correction of routine equipment failure or inoperability is expected to normally be accomplished within the completion times allowed for Actions for Conditions A and B.

17. Page B 3.3-44, Bases Section 3.3.1.1, SR 3.3.1.1.14

In the last paragraph describing the LOGIC SYSTEM FUNCTIONAL TEST, the words "and OPRM" are added. See the mark-up for placement.

18. Page B 3.3-45, Bases Section 3.3.1.1, RPS Instrumentation

In the Surveillance Requirements Bases a new discussion of SR 3.3.1.1.17 is added. The new discussion reads as follows:

SR 3.3.1.1.17

This SR ensures that scrams initiated from OPRM Upscale Function (Function 2.f) will not be inadvertently bypassed when THERMAL POWER, as indicated by the APRM Simulated Thermal Power, is ≥ 25% RTP and core flow, as indicated by recirculation drive flow, is < 60% rated core flow. This normally involves confirming the bypass setpoints. Adequate margins for the instrument setpoint methodologies are incorporated into the actual setpoint. The actual surveillance ensures that the OPRM Upscale Function is enabled (not bypassed) for the correct values of APRM Simulated Thermal Power and recirculation drive flow. Other surveillances ensure that the APRM Simulated Thermal Power and recirculation flow properly correlate with THERMAL POWER and core flow respectively.

If any bypass setpoint is nonconservative (i.e., the OPRM Upscale Function is bypassed when APRM Simulated Thermal Power ≥ 25% and recirculation drive flow < 60% rated), then the affected channel is considered inoperable for the OPRM Upscale Function. Alternatively, the bypass setpoint may be adjusted to place the channel in a conservative condition (unbypass). If placed in the unbypassed condition, this SR is met and the channel is considered OPERABLE.

The Frequency of 24 months is based on engineering judgment and reliability of the components.

19. Page B 3.3-46, Bases Section 3.3.1.1, RPS Instrumentation

The following new references are added to the list of References:

13. NEDO-31960-A, "BWR Owners' Group Long-Term Stability Solutions Licensing Methodology," November 1995.
14. NEDO-31960-A, Supplement 1, "BWR Owners' Group Long-Term Stability Solutions Licensing Methodology," November 1995.
15. NEDO-32465-A, "BWR Owners' Group Long-Term Stability Detect and Suppress Solutions Licensing Basis Methodology and Reload Applications," August 1996.
16. NEDC-32410P-A, Supplement 1, "Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function," August 1996.

17. Letter, L.A. England (BWROG) to M.J Virgilio, "BWR Owners' Group Guidelines for Stability Interim Corrective Action," June 6, 1994.

20. Page B 3.4-4 and -5, Bases Section 3.4.1, Recirculation Loops Operating

In the Applicable Safety Analyses Bases the following discussion of power oscillations and required operator actions is deleted:

Safety analyses performed for FSAR Chapter 14 implicitly assume core conditions are stable. However, at the high power/low flow corner of the power flow map, an increased probability for limit cycle oscillations exists (Ref. 3) depending on combinations of operating conditions (e.g., power shape, bundle power, and bundle flow). Generic evaluations indicate that when regional power oscillations become detectable on the APRMs, the safety margin may be insufficient under some operating conditions to ensure actions taken to respond to the APRMs signals would prevent violation of the MCPR Safety Limit (Ref. 4). NRC Generic Letter 86-02 (Ref. 5) addressed stability calculation methodology and stated that due to uncertainties, 10 CFR 50, Appendix A, General Design Criteria (GDC) 10 and 12 could not be met using analytic procedures on a BWR 4 design. However, Reference 5 concluded that operating limitations which provide for the detection (by monitoring neutron flux noise levels) and suppression of flux oscillations in operating regions of potential instability consistent with the recommendations of Reference 3 are acceptable to demonstrate compliance with GDC 10 and 12. The NRC concluded that regions of potential instability could occur at calculated decay rations of 0.8 or greater by the General Electric methodology.

Stability tests at operating BWRs were reviewed to determine a generic region of the power/flow map in which surveillance of neutron flux noise levels should be performed. A conservative decay ratio was chosen as the basis for determining the generic region for surveillance to account for plant to plant variability of decay ratio with core and fuel designs. This decay ratio also helps ensure sufficient margin to an instability occurrence is maintained. The generic region has been determined to be bounded by the 80% rod line and the 50% core flow line. BFN conservatively implements this generic region with the "Operation Not Permitted" Region and Regions I and II of Figure 3.4.1-1. This conforms to Reference 3 recommendations. Operation is permitted in Region II provided neutron flux noise levels are verified to be within limits. The reactor mode switch must be placed in the shutdown position (an immediate scram is required) if Region I is entered.

21. Page B 3.4-5a, Bases Section 3.4.1, Recirculation Loops Operating

In the LCO Bases the following sentence is deleted:

> In addition, the core flow expressed as a function of THERMAL POWER must be outside Regions I and II and the Operation Not Permitted Region of Figure 3.4.1-1.

22. Page B 3.4-6 and -7, Bases Section 3.4.1, Recirculation Loops Operating

In the Required Actions Bases discussion of Actions A.1, B.1 and B.2 are deleted. These deleted discussions, related to potential occurrence of thermal hydraulic instability, currently read as follows:

> <u>A.1</u>
>
> The minimum margin to the onset of thermal hydraulic instability occurs when the plant is in Region I of Figure 3.4.1-1. Therefore, the reactor mode switch is required to be placed in the shutdown position upon entry into this region. This action is considered sufficient to preclude core oscillations which could challenge the MCPR safety limit.
>
> <u>B.1 and B.2</u>
>
> Immediate action is required to exit Region II of Figure 3.4.1-1 upon entry by control rod insertion or flow increase. The 2 hour Completion Time for exiting the region is acceptable because it minimizes the risk while allowing time to exit the region without challenging plant systems. Because the probability of thermal hydraulic oscillations is lower and the margin to the MCPR safety limit is greater in Region II than in Region I, placing the mode switch in the shutdown position upon entry into the region is not necessary. The mode switch must be placed in the shutdown position if evidence of thermal hydraulic instability is observed. Formal surveillances are not performed while exiting Region II since delaying exit for surveillance is undesirable.
>
> One or more of the following conditions is an indication of reactor instability induced power oscillations when operating in or near the identified regions:
>
> 1. A sustained increase in APRM and/or LPRM peak-to-peak signal noise level, reaching two or more times its initial level at reduced core flow conditions. Any noticeable increase in noise level warrants closer monitoring of the LPRM signals.

The increased noise occurs with a characteristic period of less than 3 seconds.

2. LPRM and or APRM upscale and/or downscale annunciators that alarm with a characteristic period of less than 3 seconds.

23. Page B 3.4-7 and -8, Bases Section 3.4.1, Recirculation Loops Operating

In the Required Actions Bases the Action C.1 is relabeled "A.1".

24. Page B 3.4-8, Bases Section 3.4.1, Recirculation Loops Operating

In the Required Actions Bases the Action D.1 is relabeled "B.1," and the first sentence of the discussion is revised to make the action applicable in MODE 1. After revision, the sentence reads as follows (deleted words are shown with ~~strikethrough~~, and changed or added words are shown in ***bolded italics***):

> With no recirculation loops in operation while in MODE***S 1 or*** 2 or the Required Action and associated Completion Time of Condition ***A*** ~~or C~~ not met, the plant must be brought to a MODE in which the LCO does not apply.

25. Page B 3.4-9, Bases Section 3.4.1, Recirculation Loops Operating

In the Required Actions Bases the description of Action E.1 is deleted in its entirety. Before deletion, this discussion read as follows:

> <u>E.1</u>
>
> With the reactor in MODE 1 and no recirculation pumps operating, the reactor mode switch must be placed in the shutdown position immediately. An immediate scram is required since BFN does not have effective automatic scram protection for regional oscillations. This requirement was implemented to comply with Reference 4.

26. Page B 3.4-10, Bases Section 3.4.1, Recirculation Loops Operating

In the Surveillance Requirements Bases the description of SR 3.4.1.2 is deleted in its entirety. Before deletion, this discussion read as follows:

> <u>SR 3.4.1.2</u>
>
> This SR ensures the reactor THERMAL POWER and core flow are within appropriate parameter limits to prevent uncontrolled power oscillations. At low recirculation flows and high reactor power, the reactor exhibits increased susceptibility to thermal hydraulic instability. Figure 3.4.1-1 is based on guidance provided in

Reference 3, which is used to respond to operation in these conditions. Performance immediately after any increase of more than 5% RTP while initial core flow is < 50% of rated and immediately after any decrease of more than 10% rated core flow while initial thermal power is > 40% of rated is adequate to detect power oscillations that could lead to thermal hydraulic instability.

27. Page B 3.4-10, Bases Section 3.4.1, Recirculation Loops Operating

In the References for this Bases, References 3, 4, and 5 are deleted, and the reference numbers are designated as "Deleted." Before this change, References 3, 4, and 5 read as follows:

3. GE Service Information Letter No. 380, "BWR Core Thermal Hydraulic Stability," Revision 1, February 10, 1984.

4. NRC Bulletin 88-07, "Power Oscillations in Boiling Water Reactors (BWRs)," Supplement 1, December 30, 1988.

5. NRC Generic Letter 86-02, "Technical Resolution of Generic Issue B-19, Thermal Hydraulic Stability," January 22, 1986.

II. REASON FOR THE PROPOSED CHANGE

In response to Generic Letter 94-02, "Thermal-Hydraulic Instabilities in Boiling Water Reactors" (Reference 9), TVA selected Boiling Water Reactor Owners Group (BWROG) Stability Option III as the long-term stability solution for BFN. Implementation of Option III provides compliance with 10 CFR 50 Appendix A, GDC 10, and GDC 12 by providing protection from exceeding the fuel MCPR safety limit due to anticipated thermal-hydraulic power oscillations. Option III detects core instabilities and provides a reactor scram signal to the RPS.

As a platform to implement the Option III stability solution, TVA elected to replace the power range portion of the original BFN Neutron Monitoring System with a GE NUMAC PRNM retrofit design. The NUMAC PRNM equipment was installed on BFN Unit 3 during its Fall 1998 refueling outage. The same modification was installed on Unit 2 during the Fall 1997 refueling outage.

The NUMAC PRNM equipment implements Option III by use of an OPRM Upscale trip function. As discussed in References 1 and 2, the OPRM function is operated in the "indicate only" mode during each unit's first cycle of operation, and the stability trip function enabled for the subsequent fuel cycles.

In this submittal, TVA is providing the TS changes required to enable the OPRM Upscale trip function for Unit 3. The TS changes are based on example TS mark-ups proposed by GE in NEDC-32410P, Supplement 1, "Nuclear Measurement Analysis and Control

Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function," May 1996 (Reference 6), which was reviewed by the NRC and approved in Reference 7. The TS changes provide appropriate operability requirements, limiting conditions for operation, surveillance requirements, and bases discussions for the enabled OPRM Upscale trip function. In addition, the proposed changes delete certain existing stability monitoring restrictions on core flow as a function of thermal power. These restrictions were initially implemented as an interim solution to potential thermal-hydraulic stability related power oscillations. With implementation of the OPRM Upscale trip function, which automatically detects and suppresses thermal-hydraulic stability related power oscillations by automatic reactor scram action, these interim restrictions are no longer required.

III. SAFETY ANALYSIS

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 safety limit could be challenged.

Stability Long Term Solution Option III, described in References 4 and 5, consists of hardware and software that provides for reliable automatic detection and suppression of stability related power oscillations. The Option III hardware automatically initiates control rod insertion (scram) to terminate the power oscillation while it is still small. The combination of hardware, software, and system setpoints will provide protection against violation of the MCPR safety limit for oscillations.

Descriptions of the stability detect and suppress methodology and of the Option III solution were provided for NRC review in References 4 and 5. NRC acceptance of the concepts and associated recommendations are contained in the NRC Safety Evaluation Report dated July 12, 1993 (Reference 15). Specific hardware/software designs and related example TS changes were provided by GE for NRC review in References 6 and 16. NRC Safety Evaluation Reports contained in References 7 and 17 document acceptance of these designs and of the example TS changes.

The TS changes proposed in this submittal are based on the examples presented in Reference 6. Evaluation of each of the proposed changes is provided below.

In TS 3.3.1.1, an existing note is modified to state that Required Action A.2 and Condition B are not applicable for the new OPRM Upscale trip function, 2.f. Required Action A.2, "Place associated trip system in trip," is not applicable to the OPRM Upscale trip function because the OPRM provides signals to both RPS trip systems. Condition B is not applicable for the OPRM Upscale trip function because loss of more than one of the three required OPRM channel results in loss of OPRM scram capability and entry to Condition C.

In TS 3.3.1.1, new Conditions I and J, including Required Actions and Completion times are added. Condition I allows an alternate method to detect and suppress thermal-hydraulic instability. Because the OPRM Upscale trip is a new Function, it is remotely possible that experience may reveal some problem with the algorithm and/or implementation. The contingent alternate method will meet the requirements of the BWROG Interim Corrective Actions (ICAs) outlined in the letter to the NRC dated June 6, 1994 (Reference 18). The inclusion of the proposed Action Statement pre-plans for such a contingency with an established alternate method within 12 hours and requires OPRM OPERABILITY to be restored within 120 day. If Condition I is not met, Condition J requires the plant to be in MODE 2, a safe power level below the regions of potential instability.

In TS 3.3.1.1, Table 3.3.1.1-1, RPS Instrumentation, a new Function 2.f, OPRM Upscale, is added. In support of this new Function a new Surveillance Requirement, SR 3.3.1.1.17 is added into the Surveillance Requirements table of TS 3.3.1.1. Related Bases Section 3.3.1.1 is also revised.

Hardware to implement the OPRM Upscale trip, Function 2.f, is housed in the same chassis as the APRM trip functions, and the OPRM Upscale trip is considered a sub-function of the APRM System. Only the period based detect and suppress algorithm is used as the basis for the safety analysis for the OPRM Upscale trip function. The other two algorithms, amplitude based and growth based, discussed in the TS Bases provide defense in depth, will cause a trip, but are not required for OPRM Upscale OPERABILITY.

Because of the integrated nature of 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 which cause an APRM Inop signal also cause an OPRM Inop signal, and vice versa). However, unlike the APRM trips, the OPRM Upscale trip is voted separately 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 2-Out-Of-4 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 2-Out-Of-4 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 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.

Independent of the APRM/OPRM Inop logic, which originates in the APRM channel, a loss of communication from an APRM channel to a voter channel will result in both the APRM and OPRM voting logic in the 2-Out-Of-4 Voter channel declaring the inputs from that APRM channel inoperative. This condition is alarmed via the 2-Out-Of-4 Voter self-test diagnostics. A loss of communication may be the result of either a hardware failure (affects input to one or more voters) or a loss of power to the APRM channel (affects inputs to all voters). Loss of power to the 2-Out-Of-4 Voter channel will result in immediate RPS trip outputs from that voter channel.

Combining the OPRM trip voting and the APRM trip voting into a single 2-Out-Of-4 Voter function simplifies overall operation and the decision-making process, because most conditions affecting OPERABILITY of the voter channel will affect both the APRM trip voting and the OPRM trip voting. However, the final voting and output relays from the voter for these two functions are different. In addition, the output relays for each function are redundant (i.e., two relay outputs for the APRM trips and two additional relays for the OPRM Upscale trip). Even though there is only one voter channel for both the APRM and OPRM trips, the LCO clock will start as soon as any portion of a voter channel is determined to be inoperable.

Consistent with the APRM Neutron Flux - High function, the OPRM Upscale function is required only when the plant is operating in the Run Mode (MODE 1). In addition, the OPRM Upscale is bypassed automatically when THERMAL POWER is below 25% RTP (as indicated by APRM Simulated Thermal Power) or with core flow above 60% rated (as indicated by recirculation drive flow). In the regions below 25% RTP and above 60% rated core flow, thermal-hydraulic instabilities are not considered credible. The 25% RTP provides additional margin from the nominal 30% RTP OPRM scram enable setpoint recommended in NEDO-32465-A (Reference 14).

Identified events (e.g. recirculation pump trips or run-backs) can change flow to less than 60% without operator action. Other events (e.g., loss of feedwater heaters) can take the plant from a power less than 25% RTP to a power greater than 25% RTP without operator action. Therefore, even though the OPRM Upscale trip is bypassed above 60% flow and below 25% RTP, the function must be OPERABLE so that if one of the identified events occurs, the OPRM Upscale trip capability is immediately available without operator action. Requiring OPRM OPERABILITY in MODE 1 provides adequate margin to cover the operating region where oscillations may occur as well as the operating regions from which the plant might enter the potential instability region without operator action.

The outputs of the OPRM channels are shared by each RPS trip system via the independent 2-Out-Of-4 Voter channels. Any two of the four OPRM channels and one of the 2-Out-Of-4 Voter channels in each RPS trip system are required to function for the OPRM Upscale trip function to be accomplished. Therefore, a minimum of three OPRM channels assures at least two OPRM channels can provide trip inputs to the 2-Out-Of-4 Voter channels, even the event of a single OPRM channel failure. The minimum of two 2-Out-Of-4 Voter channels per RPS trip system assures at least one voter channel will be OPERABLE per RPS trip system, even in the event of a single voter channel failure.

The 2-Out-Of-4 logic module is designed for simplicity to assure high reliability and to detect loss of input signals from the OPRM channels. This feature, combined with the highly reliable digital electronics implementing the OPRM Upscale trip function and the on-line automatic self-test functions, assures the four-channel OPRM configuration will provide reliability, relative to the safety trip functions, equal to or greater than the current APRM system. This level of reliability is adequate for the OPRM Upscale trip function.

Because the OPRM Upscale trip function is implemented using the same equipment as the APRM trip functions, equipment reliability is also the same. Except for new Surveillance SR 3.3.1.1.17, the OPRM Upscale Surveillance Requirements -- Channel Check, LPRM Calibration, Channel Calibration, and Channel Functional Test -- are the same as for the APRM flux trip functions. The expected demand for the OPRM Upscale trip function is equal to or less than the demand for the APRM flux trip functions. Therefore, the OPRM Upscale Surveillance Requirements are adequate.

A new SR 3.3.1.1.17 is added to provide verification that the OPRM Upscale trip is enabled when APRM Simulated Thermal Power is $\geq$ 25% and recirculation flow is < 60% rated flow. The OPRM auto-enable region is determined by Simulated Thermal Power and drive flow setpoints in the APRM channels. Even though these setpoints are unlikely to change once set, periodic confirmation is appropriate. Other Surveillances verify the relationships between reactor thermal power and APRM Simulated Thermal Power, and between core flow and recirculation flow are within acceptable tolerances. The combined Surveillances ensure the OPRM Upscale trip function is enabled in the intended region on the plant power/flow map. The 24 months maximum surveillance frequency is based on engineering judgment and the fact that the actual values are stored digitally, with no drift. Any hardware failures affecting the Simulated Thermal Power and recirculation drive flow setpoints will likely be detected by the automatic self-test functions.

Based on the above discussion, adding the OPRM Upscale Function to the TS is reasonable and consistent with instability detect and suppress objectives.

In conjunction with the changes which support adding the OPRM Upscale Function to TS, certain restrictions on operation in regions of potential thermal-hydraulic instability are deleted. Figure 3.4.1-1, Thermal Power Versus Core Flow Stability Regions, which was originally placed in custom TS by Amendment 174 to DPR-52 and Amendment 179 to DPR-68 (see References 10, 11, 12 and 13) and carried forth with the issuance of Improved TS is deleted. Addition of this figure in TS, together with associated restrictions and required actions, was done to implement requirements of NRC Bulletin 88-07, Supplement 1 (Reference 19). Figure 3.4.1-1, together with associated restrictions and required actions, provided ICAs while the BWROG worked with GE and NRC to develop a long-term resolution to stability concerns.

The ICAs required verification that the reactor is operating outside of Region I and II of Figure 3.4.1-1, and that corrective actions be taken if operation within either of these regions should occur:

1. If operation inside Region I occurs, an immediate manual scram is required by placing the mode switch in the shutdown position.

2. If operation inside Region II occurs, immediate action to exit Region II is required, and a manual scram is required immediately upon discovery of thermal hydraulic instability.

3. With no recirculation loops in operation while in MODE 1 (resulting in entry to either Region I or Region II), an immediate manual scram is required by placing the mode switch in the shutdown position.

With the OPRM Upscale trip function enabled, the stability long term solution will be fully implemented, and the ICAs are no longer required. The OPRM will detect and automatically suppress any significant core wide or regional power oscillations over the region of the power-to-flow map included in Regions I and II of Figure 3.4.1-1. This automatic function provides more reliable protection that the three requirements proposed for deletion. Deletion of these requirements, together with their associated Bases discussions, will permit BFN to have the ability to manually insert control rods and restart a recirculation pump (instead of shutting down immediately) following a recirculation pump trip. During such recovery activities, the OPRM will provide reliable automatic monitoring for potential thermal hydraulic stability related power oscillations and will immediately and automatically generate a reactor scram before any unacceptable power oscillations can occur.

Based on the above discussion, deletion of the stability related ICAs is reasonable and acceptable, and is consistent with and supported by implementation of the OPRM Upscale trip function.

IV. NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

TVA has concluded that operation of BFN Unit 3 in accordance with the proposed change to the TS does not involve a significant hazards consideration. TVA's conclusion is based on its evaluation, in accordance with 10 CFR 50.91(a)(1), of the three standards set forth in 10 CFR 50.92(c).

A. The proposed amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated.

The proposed amendment is to enable the OPRM Upscale trip function which is contained in the previously installed PRNM equipment. Enabling the OPRM hardware provides the long term stability solution required by Generic Letter 94-02. This hardware incorporates the Option III detect and suppress solution reviewed and approved by the NRC in NEDO-31960, "BWROG Long Term Stability Solutions Licensing Methodology." The OPRM is designed to meet all requirements of GDC 10 and 12 by automatically detecting and suppressing design basis thermal-hydraulic power oscillations prior to violating the fuel MCPR Safety Limit. The OPRM system provides this protection in the region of the power-to-flow map where instabilities can occur, including the region where ICAs previously restricted operation because of stability concerns. Thus, the ICA restrictions on plant operations are deleted from the TS, including region avoidance and the requirement for the operator to manually scram the reactor with no recirculation loops operating. Operation at high core powers with low core flows may cause a slight, but not significant, increase in the probability that an instability can occur. This slight increase is acceptable because subsequent to the automatic detection of a design basis instability, the OPRM Upscale trip provides an automatic scram signal to the RPS which is faster protection than the operator initiated manual scram required by the current ICAs. Because of this rapid automatic action, the consequences of an instability event are not increased as a result of the installation of the OPRM system because it eliminates operator actions.

Based on the above discussion, the proposed amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated.

B. The proposed amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated.

The proposed amendment permits BFN to enable the OPRM power oscillation detect and suppress function provided in previously installed PRNM hardware, and it simultaneously deletes certain restrictions which preclude operation in regions of the power-to-flow map where oscillations potentially may occur. Enabling the OPRM Upscale trip function does not create any new system hardware interfaces nor create any new system interactions. Potential failures of the OPRM Upscale trip result either in failure to perform a mitigation action or in spurious initiation of a reactor scram. These failures would not create the possibility of a new or different kind of accident. Based on the above discussion, the proposed amendment does not create the

possibility of a new or different kind of accident from any accident previously evaluated.

C. <u>The proposed amendment does not involve a significant reduction in a margin of safety.</u>

The OPRM Upscale trip function implements BWROG Stability Option III, which was developed to meet the requirements of GDC 10 and GDC 12 by providing a hardware system that detects the presence of thermal-hydraulic instabilities and automatically initiates the necessary actions to suppress the oscillations prior to violating the MCPR Safety Limit. The NRC has reviewed and accepted the Option III methodology described in Licensing Topical Report NEDO-31960 and concluded this solution will provide the intended protection. Therefore, it is concluded that there will be no reduction in the margin of safety as defined in TS as a result of enabling the OPRM Upscale trip function and simultaneously removing the operating restrictions previously imposed by the ICAs.

Based on the above discussion, the proposed amendment does not involve a significant reduction in a margin of safety.

V. ENVIRONMENTAL IMPACT CONSIDERATION

The proposed change does not involve a significant hazards consideration, a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or a significant increase in individual or cumulative occupational radiation exposure. Therefore, the proposed change meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), an environmental assessment of the proposed change is not required.

VI. REFERENCES

1. Letter from TVA to NRC dated March 6, 1997, "Browns Ferry Nuclear Plant (BFN) - Units 1, 2, and 3 - Technical Specifications (TS) Change 353R1 - Power Range Neutron Monitor (PRNM) Upgrade with Implementation of Average Power Range Monitor (APRM) and Rod Block Monitor (RBM) TS (ARTS) Improvements and Maximum Extended Load Line Limit (MELLL) Analyses - Revision 1."

2. Letter from TVA to NRC dated April 11, 1997, "Browns Ferry Nuclear Plant (BFN) - Units 1, 2, and 3 - Technical Specifications (TS) Change 353S1 - Power Range Neutron Monitor (PRNM) Upgrade with Implementation of Average Power Range Monitor (APRM) and Rod Block Monitor (RBM) TS (ARTS) Improvements and Maximum Extended Load Line Limit (MELLL) Analyses - Supplement 1 - Improved Standard Technical Specifications (ISTS) Format."

3. Letter from NRC to TVA dated September 3, 1998, "Issuance of Amendment - Browns Ferry Nuclear Plant Unit 3 (TAC No. M92505) (TS-353)."

4. NEDO 31960, BWR Owners' Group Long-Term Stability Solutions Licensing Methodology, June 1991.

5. NEDO-31960, Supplement 1, BWR Owners' Group Long-Term Stability Solutions Licensing Methodology.

6. NEDC-32410P, Supplement 1, Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function, May 1996.

7. Letter from NRC to GE dated August 15, 1997, Licensing Topical Report NEDC-32410P, Supplement 1, Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC-PRNM) Retrofit Plus Option III Stability Trip Function (TAC No. M95746).

8. Letter from TVA to NRC dated June 2, 1997, Browns Ferry Nuclear Plant (BFN) - Units 1, 2, and 3 - Technical Specification (TS) 387 - Single Recirculation Loop Operation (SLO).

9. Generic Letter 94-02, "Long-Term Solutions and Upgrade of Interim Operating Recommendations for Thermal-Hydraulic Instabilities in Boiling Water Reactors, July 11, 1994.

10. Letter from TVA to NRC dated June 20, 1989, Browns Ferry Nuclear Plant (BFN) - TVA BFN Technical Specification No. 272 - Thermal-Hydraulic Stability Section 3.5/4.5-M.

11. Letter from NRC to TVA dated October 5, 1989, Technical Specification Changes Involving Thermal-Hydraulic Stability, Section 3.5/4.5-M (TAC 73435) (TS 272) - Browns Ferry Nuclear Plant, Unit 3.

12. Letter from TVA to NRC dated January 14, 1992, Browns Ferry Nuclear Plant (BFN) - TVA BFN Technical Specification (TS) No. 300 - Reactor Core Thermal-Hydraulic Stability.

13. Letter from NRC to TVA dated May 31, 1994, Issuance of Technical Specification Amendments for the Browns Ferry Nuclear Plant Units 1 and 3 (TAC Nos. M82650 and M82652) (TS-300)

14. NEDO-32465-A, Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications, August 1996.

15. Letter from NRC to BWROG dated July 12, 1993, Acceptance for Referencing of Topical Reports NEDO-31960 and NEDO-31960 Supplement 1, "BWR Owners Group Long-Term Stability Solutions Licensing Methodology" (TAC No. M75928)

16. NEDC-32410P-A, Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC-PRNM) Retrofit Plus Option III Stability Trip Function, October 1995

17. Letter from NRC to GE dated September 5, 1995, Acceptance of Licensing Topical Report NEDC-32410P, Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC-PRNM) Retrofit Plus Option III Stability Trip Function (TAC No. M90616).

18. Letter, LA England (BWROG) to MJ Virgilio, "BWR Owners' Group Guidelines for Stability Interim Corrective Action," June 6, 1994

19. NRC Bulletin 88-07, "Power Oscillations in Boiling Water Reactors (BWRs)," Supplement 1, December 30, 1988.

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNIT 3

PROPOSED TECHNICAL SPECIFICATION (TS) CHANGE TS-398
MARKED-UP PAGES

I. AFFECTED PAGE LIST

UNIT 3
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II. REVISED PAGES

See attached.