Browns Ferry Nuclear Plant

Pre-Submittal Meeting for Proposed License Amendment Request to Modify Technical Specification 3.3.2.1 Requirements for Rod Worth Minimizer

July 14, 2025

TVA TENNESSEE VALLEY AUTHORITY

Agenda

Introduction

Background

Description of the Proposed Change

Precedents

Conclusion

Schedule Milestones

Closing Remarks

Introduction

- Tennessee Valley Authority (TVA) is submitting a request for an amendment to Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68 for Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3.
- This proposed license amendment would modify BFN Technical Specification (TS) 3.3.2.1, “Control Rod Block Instrumentation,” regarding an inoperable rod worth minimizer (RWM). The proposed change would replace the current Required Action C.2.1.2 to verify that reactor startup with RWM inoperable has not been performed in the last calendar year with an action to verify that control rod coupling checks are performed for the first 12 control rods.
- Verification that control rod movement is in compliance with banked position withdrawal sequence (BPWS) by a second licensed operator or other qualified member of the technical staff is maintained in conjunction with the new proposed action.
- The proposed change would allow an unrestricted number of reactor startups with RWM inoperable.

Background

- The RWM is a subsystem of the plant process computer and functions as a backup to the operator during movement of control rods during reactor startup, shutdown, and low power level (<10% rated thermal power) control rod sequences.
- The use of RWM minimizes the consequences of a design basis control rod drop accident (CRDA) by enforcing pre-established control rod sequences in accordance with BPWS. The sequences are designed to maintain individual control rod worths such that the peak fuel enthalpy would remain below the specific energy design limit of 280 cal/g in the event of a CRDA. This ensures that the offsite dose consequences of a CRDA will be within the guidelines of 10 CFR 50.67, “Accident Source Term.”
- The RWM function is automatically bypassed at power levels greater than 10% rated thermal power, as there are sufficient void concentrations to preclude a CRDA exceeding 280 cal/g peak fuel enthalpy.

Background (cont.)

- At power levels less than 10% rated thermal power, the RWM may be manually bypassed by specific procedural control with verification by a second license operator (or qualified member of the technical staff) that the first operator is performing control rod movements in accordance with the BPWS.
- For continued rod movement with the RWM inoperable, TS 3.3.2.1 Condition C requires either suspension of control rod movement with the exception of a scram, or one of the following:
    - Verification that at least 12 control rods are withdrawn, and verification that control rod movement is in compliance with BPWS by a second licensed operator or other qualified member of the technical staff.
    - Verification that reactor startup with the RWM inoperable has not been performed in the last calendar year, and verification that control rod movement is in compliance with BPWS by a second licensed operator or other qualified member of the technical staff.

Background – Current TS 3.3.2.1 Condition C

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Rod worth minimizer (RWM) inoperable during reactor startup.	C.1 Suspend control rod movement except by scram.	Immediately
	OR	
	C.2.1.1 Verify ≥ 12 rods withdrawn.	Immediately
	OR	
	C.2.1.2 Verify by administrative methods that startup with RWM inoperable has not been performed in the last calendar year.	Immediately
	AND	
	C.2.2 Verify movement of control rods is in compliance with BPWS by a second operator or other qualified member of the technical staff.	During control rod movement

Description of the Proposed Change

- BFN TS 3.3.2.1 requires an operable RWM in Modes 1 and 2 while less than 10% rated thermal power and permits only one reactor startup per calendar year with the RWM inoperable.
- In the event that prolonged RWM issues are experienced, this overly restrictive constraint could result in a challenge to restarting the reactor even when the function of the RWM can be fulfilled by the use of a second licensed operator or qualified member of the technical staff.
- The proposed change to Required Action C.2.1.2 is to allow an unrestricted number of reactor startups with the RWM inoperable, provided that control rod coupling checks have been performed prior to a reactor restart.
- This change provides another layer of defense by breaking the sequence of events that would be required to lead to a CRDA, rendering this accident as unfeasible. Compliance with regulatory requirements is maintained, and existing margin of safety is maintained.

Description of the Proposed Change (cont.)

- TVA is proposing to modify BFN TS 3.3.2.1 Required Action C.2.1.2, which restricts reactor startup with an inoperable RWM to once per calendar year.
- The proposed method of minimizing the effects of a CRDA and maintaining acceptable rod worth will be the existing provisions in TS 3.3.2.1, as well as the utilization of existing plant procedures and prescribed control rod pattern templates.
- The function of the RWM to enforce adherence to the BPWS-compliant control rod sequences will continue to be manually fulfilled with the use of a second licensed operator or a qualified member of the technical staff, in accordance with Required Action C.2.2.

Description – Proposed TS 3.3.2.1 Condition C

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Rod worth minimizer (RWM) inoperable during reactor startup.	C.1 Suspend control rod movement except by scram.	Immediately
	OR	
	C.2.1.1 Verify ≥ 12 rods withdrawn.	Immediately
	OR	
	C.2.1.2 Verify control rod coupling checks are performed for first 12 rods.	Immediately
	AND	
	C.2.2 Verify movement of control rods is in compliance with BPWS by a second operator or other qualified member of the technical staff.	During control rod movement

Description – Technical Evaluation

- The RWM serves as a backup barrier to protect the reactor by preventing operators from moving an incorrect control rod. It is not intended to replace operator selection of control rod patterns but is simply to monitor and reinforce procedural adherence. The operator and pre-established control rod sequences serve as the first-line barrier in preventing the establishment of high worth control rods.
- Should the RWM become inoperable for any reason, the operator can maintain acceptable rod worth by adhering to plant procedures and prescribed BPWS-compliant control rod patterns and sequences when below 10% rated thermal power.
- In the years since the RWM operability requirements were added to the Standard Technical Specifications, continued studies of CRDA methodology and results have indicated a substantial reduction in enthalpy for a given rod worth as a result of better core geometry and moderator reactivity modeling. These results suggest that the CRDA probability is likely less than previously analyzed, and that the reliance on the RWM is outdated.

Description – Technical Evaluation (cont.)

- The CRDA postulates the de-coupling of a fully inserted control rod from its drive while remaining in the fully inserted position. The scenario then assumes the dropping of the rod results in a high local reactivity in a small region of the core. For large, loosely coupled cores, significant shifts in the spatial power generation are expected during the course of the excursion.
- Adherence to BPWS when reactor power is less than 10% rated thermal power limits the worth of the postulated dropped rod and ensure that the initial conditions of the CRDA analysis are not violated.
- The RWM does not mitigate or prevent a CRDA. This accident is mitigated by the average power range monitor, which generates a high flux scram signal to the reactor protection system, resulting in an automatic scram of the reactor.

Description – Technical Evaluation (cont.)

- Existing calculations demonstrate that no significant CRDA can occur above 10% rated thermal power due to increased voiding in the core, which flattens the flux profile surrounding a control rod. Therefore, the CRDA is not considered at higher power levels.
- The CRDA is not expected to occur during the lifetime of the plant (10^{-12} per reactor year) and is not modeled in the probabilistic risk assessment for BFN due to the specific system failures and personnel errors that would have to occur in the correct combination and sequence to present the reactivity required for a design basis CRDA.
- The proposed change to require control rod coupling checks for the first 12 control rods that are withdrawn upon a reactor startup breaks the chain of events required for a CRDA to occur, further decreasing the probability of occurrence.

Description – Technical Evaluation (cont.)

- The inadvertent operator-initiated withdrawal of a single control rod from the core is classified as a non-limiting transient event. The rod withdrawal error (RWE) at low power is categorized as an infrequent accident and is not considered credible during reactor startup or during low power ranges.
- The RWE accident, like a CRDA, is contingent upon specific failures occurring in a specific sequence: failure of the RWM, operator selecting an out-of-sequence rod with a high worth, and disregarding continuous alarm annunciations.
- In the event the RWM is inoperable during reactor startup, the RWE occurrence is precluded by a second licensed operator or qualified member of the technical staff verifying control rod movements comply with BPWS. The use of a second operator was found to be acceptable in development of the Improved Standard Technical Specifications.
- TVA has determined that neither the CRDA or RWE analyses are adversely impacted by the proposed amendment.

Precedents

- **Oyster Creek Nuclear Generating Station, Amendment No. 113 (ML011160423)**
  Temporary TS change to allow unlimited number of reactor startups without an operable RWM during operating Cycle 11.
- **James A. FitzPatrick Nuclear Power Plant, Amendment No. 358 (ML24313A147)**
  Temporary TS change to allow unlimited number of reactor startups without an operable RWM while compensatory measures are implemented, for a period of 6 weeks.

- The NRC found that the unlimited reactor startups authorized by the amendments could be conducted without endangering the health and safety of the public.

Conclusion

- TVA is proposing a change to BFN TS 3.3.2.1 Condition C which would allow an unrestricted number of reactor startups with an inoperable RWM, provided that coupling checks are performed on the first 12 control rods withdrawn and control rod movements are independently verified to be in compliance with BPWS requirements.
- The probability of a design basis CRDA or RWE accident are exceptionally low. Control rod coupling checks and the use of a second licensed operator or qualified member of technical staff to verify control rod movements fulfill the function of RWM to help prevent the occurrence of a CRDA or RWE at low power operation.
- The NRC has previously found that unlimited reactor startups with an inoperable RWM using compensatory measures and independent verification of control rod movement are acceptable to safe operation of the plant.

Schedule Milestones

- **July 14, 2025** Pre-Submittal Meeting with NRC
- **July 30, 2025** TVA submits LAR to NRC
- **September 2025** Acceptance of LAR for NRC review
- **July 2025** Issuance of BFN amendments
- **September 2026** Implementation of TS amendments at BFN


TVA
TENNESSEE
VALLEY
AUTHORITY