
Sequoyah Nuclear Plant Unit 2

Sequoyah Nuclear Plant (SQN)

Nuclear Regulatory Commission (NRC) Meeting Regarding SQN Unit 2
Source/Intermediate Range Detector

September 28, 2026

Agenda

- Introduction
- Background
- Repair/Replacement Considerations
- Potential Event Scenarios
- Potential Technical Specification Changes
- Compensatory Measures
- Safety Analysis
- Precedent
- Path Forward

Introduction

- Purpose of the meeting is to inform the NRC of a potential issue with the SQN Unit 2 source range detector. The detector is currently operable but in a degraded condition.
- SQN Unit 2 is currently scheduled to start the Cycle 27 refueling outage on October 2, 2026, and defueling the vessel is tentatively scheduled to commence at noon eastern daylight time (EDT) on October 7, 2026. Core reload tentatively starts at 1300 EDT on October 18, 2026.
- Replacement of the degraded detector assembly is currently scheduled for the Cycle 27 refueling outage (repair is not an option as discussed later).
- This presentation describes the circumstances leading to the degraded detector assembly, repair/replacement considerations, potential SQN Unit 2 Technical Specification (TS) changes, safety assessment for operating with one source range and intermediate range detector assembly, proposed compensatory measures, and tentative schedule going forward.

Background

- SQN has two Thermo-Fisher Gamma-Metrics source and intermediate range neutron flux detectors, Channel I (N31 and N35) and Channel II (N32 and N36). The detectors are dual-chamber unguarded fission chamber detectors with two identical fission chambers.
- One fission chamber provides a signal to source range pre-amplifier A3 and the other to source/intermediate range pre-amplifier A4 (See Figure 1).
- One of the fission chambers for the Unit 2 N32/N36 detector is showing early signs of degradation at a location internal to the detector. This is causing intermittent negative effects to the signal-to-noise ratio of source range Channel N32.

Background (cont'd)

- The SQN Unit 2 Channel II detector assembly has a degraded internal cable that is located inside the overall Channel II detector assembly (Figure 1).
- The degradation of the fission chamber was located inside the detector assembly using time domain reflectometry (TDR) testing, as shown in Figure 2.
- TVA implemented a modification (T-mod) that disconnected the cable from the degraded fission chamber inside the wide range amplifier (WRA) enclosure that is located outside reactor containment. The modification allows the 2N32/36 detector assembly to provide both source and intermediate range indication using one of two fission chambers.

Figure 1 - T-mod disconnects 1 of 2 fission chambers inside 2N32/36 WRA enclosure

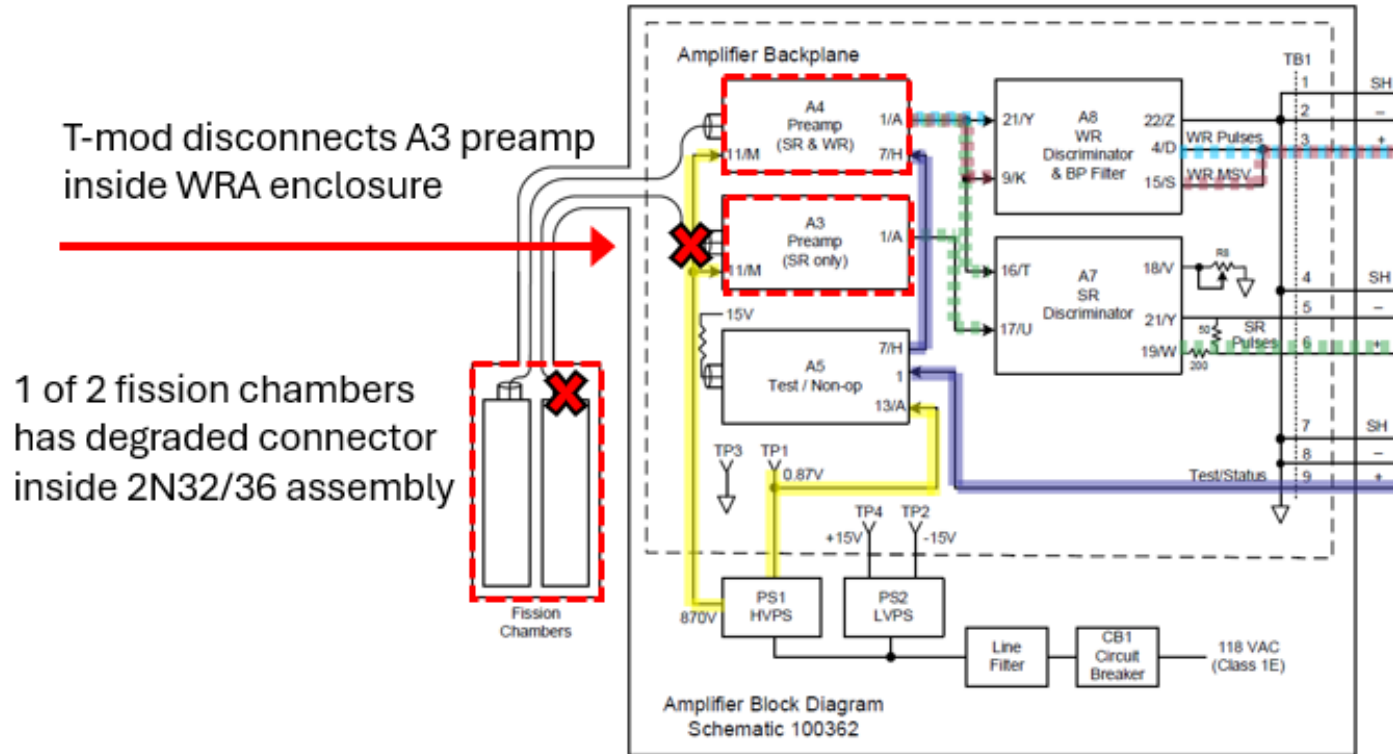


Figure 2 - TDR plot of 2N32 cable shows impedance change inside the detector

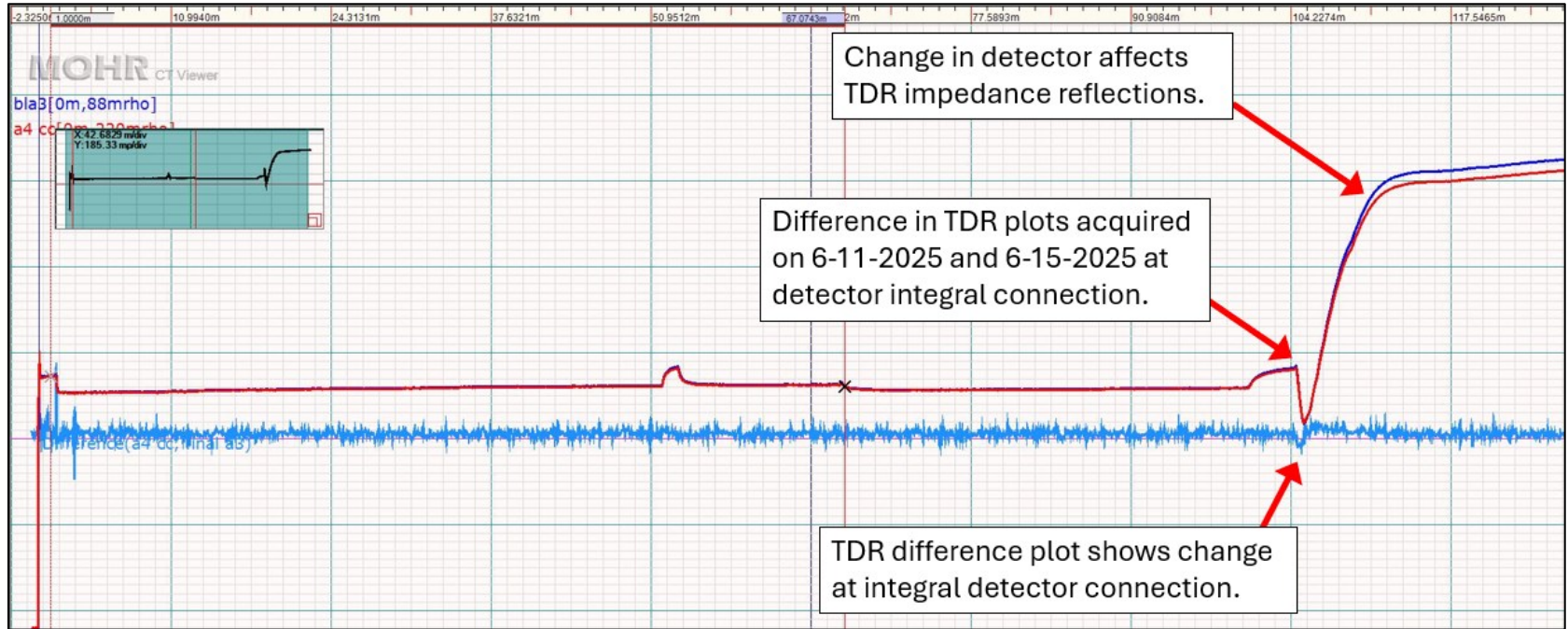
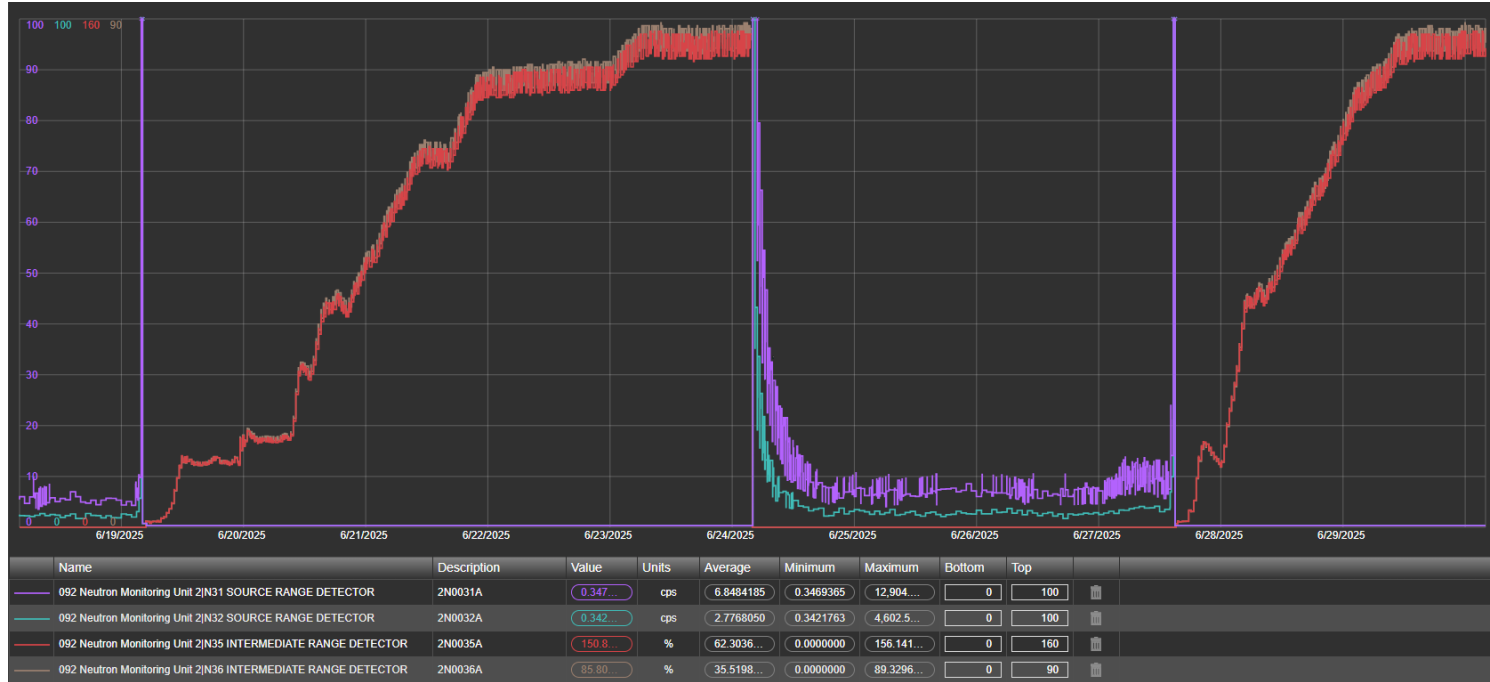


Figure 3 - SQN Unit 2 source and intermediate range during start up and shut down cycles



Repair/Replacement Considerations

- The Unit 2 Channel II detector assembly includes the two fission chambers in one canister and integral mineral insulated metal cable of sufficient length to reach from the ex-core detector well to a junction box located inside reactor containment.
- This cable length is defined as 171 feet and discussions with the detector vendor have determined that this is the longest source/intermediate range cable length in the industry. Therefore, any industry spare detectors will not be suitable for replacement of the detector assembly.
- The vendor has also stated that lengthening a short cable by adding additional junction boxes or splices is not possible.

Repair/Replacement Considerations (cont'd)

- A spare detector assembly was acquired in 1989 (Figure 4). Preliminary testing this year including insulation resistance, TDR and capacitance indicate this is a viable source/intermediate range detector assembly.
- Industry operating experience and vendor recommendations indicates there is risk inherent in manipulating the detector assembly and integral cable during installation. If the cable exceeds the bend radius and is kinked, then the entire detector assembly is made inoperable which includes both the source and intermediate range indication functions.
- A new replacement detector assembly has been ordered from the vendor, but it has a long lead time and will not arrive before completion of the Unit 2 Cycle 27 refueling outage.

Figure 4 - Spare 2N32/36 detector assembly acquired in 1989



Potential Event Scenarios

1. Replacement of the degraded detector assembly cannot occur until core empty is achieved in the Cycle 27 refueling outage. In the event that replacement of the degraded detector assembly is not successful or fails during refueling, it would be declared inoperable, and NRC approval would be needed for a temporary change to SQN Unit 2 TS 3.9.3, Required Action A.1 to allow core alterations to continue with an inoperable source range monitor.
2. Additionally, TVA would not be able to start-up for SQN Unit 2 Cycle 28 with an inoperable detector assembly. Therefore, NRC approval would be needed to multiple SQN Unit 2 TS (discussed later) to allow operation during Cycle 28 and subsequent core offload during the Cycle 28 refueling outage with an inoperable source range and intermediate range monitors.

Potential SQN Unit 2 TS Changes

- The following slides are potential TS changes to allow core alterations during the upcoming Cycle 27 refueling outage with an inoperable source range monitor (Event Scenario 1).

Potential Technical Specification Changes

The potential changes are to allow Core Alterations during the SQN Unit 2 Cycle 27 refueling outage with an inoperable source range monitor

Nuclear Instrumentation
3.9.3

3.9.3 Nuclear Instrumentation

LCO 3.9.3 Two source range neutron flux monitors shall be OPERABLE.

APPLICABILITY: MODE 6.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One source range neutron flux monitor inoperable.	A.1 -----NOTE----- During the Unit 2 Cycle 27 refueling outage only, CORE ALTERATIONS are allowed with one source range neutron flux monitor inoperable. ----- Suspend CORE ALTERATIONS. <u>AND</u>	Immediately
	A.2 Suspend operations that would cause introduction of coolant into the RCS with boron concentration less than required to meet the boron concentration of LCO 3.9.1.	Immediately
	A.3 -----NOTE----- Only applicable during the Unit 2 Cycle 27 refueling outage with one source range neutron flux monitor inoperable. -----	
	Perform SR 3.9.1.1	Once per 4 hours

Potential Technical Specification Changes

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Two source range neutron flux monitors inoperable.	B.1 Initiate action to restore one source range neutron flux monitor to OPERABLE status.	Immediately
	<u>AND</u>	
	B.2 Perform SR 3.9.1.1.	Once per 12 hours
	<u>AND</u>	
	B.3 -----NOTE----- Only applicable during the Unit 2 Cycle 27 refueling outage with one source range neutron flux monitor inoperable. ----- Perform Required Actions A.1 and A.2	Immediately

Potential SQN Unit 2 TS Changes

- The following slides are potential TS changes to allow operation during Cycle 28, and the Cycle 28 refueling outage with an inoperable source range monitor and intermediate range monitor (Event Scenario 2).

Potential Technical Specification Changes

The potential changes are to allow operation during Cycle 28 with an inoperable source range monitor and intermediate range monitor

RTS Instrumentation
3.3.1

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
E. One channel inoperable.	-----NOTE----- The inoperable channel may be bypassed for up to 12 hours for surveillance testing of other channels. ----- E.1 Place channel in trip.	72 hours <u>OR</u> In accordance with the Risk Informed Completion Time Program
F. One Intermediate Range Neutron Flux channel inoperable.	-----NOTE----- With one Intermediate Range Neutron Flux channel inoperable, Required Actions F.1 and F.2 do not apply during the Unit 2 Cycle 28 Modes of Operation as specified in Table 3.3.1-1. ----- F.1 Reduce THERMAL POWER to < P-6. <u>OR</u> F.2 Increase THERMAL POWER to > P-10.	24 hours 24 hours

Potential Technical Specification Changes

H. One Source Range
Neutron Flux channel
inoperable.

H.1

-----NOTES-----

1. Limited plant cooldown or boron dilution is allowed provided the change is accounted for in the calculated SDM.
2. With one Source Range Neutron Flux channel inoperable, Required Action H.1 does not apply during the Unit 2 Cycle 28 Modes of Operation as specified in Table 3.3.1-1.

Suspend operations involving positive reactivity additions.

Immediately

Potential Technical Specification Changes

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
J. One Source Range Neutron Flux channel inoperable.	-----NOTE----- With one Source Range Neutron Flux channel inoperable, Required Actions J.1, J.2.1, and J.2.2 do not apply during the Unit 2 Cycle 28 Modes of Operation as specified in Table 3.3.1-1. ----- J.1 Restore channel to OPERABLE status. <u>OR</u> J.2.1 Initiate action to fully insert all rods. <u>AND</u> J.2.2 Place the Rod Control System in a condition incapable of rod withdrawal.	48 hours 48 hours 49 hours

Potential Technical Specification Changes

Table 3.3.3-1 (page 2 of 2)
Post Accident Monitoring Instrumentation

FUNCTION		REQUIRED CHANNELS	CONDITION REFERENCED FROM REQUIRED ACTION G.1
15.	Reactor Vessel Level Instrumentation		
a.	Dynamic Range	2	I
b.	Lower Range	2	I
c.	Upper Range	2	I
16.	Containment Area Radiation Monitors		
a.	Upper Compartment	1	I
b.	Lower Compartment	1	I
17.	Neutron Flux		
a.	Source Range	2 ^{(c)(g)}	H
b.	Intermediate Range	2 ^(g)	H
18.	ERCW to AFW Valve Position		
a.	Motor Driven Pumps	2 ^(d)	H
b.	Turbine Driven Pump	2 ^(d)	H
19.	Containment Isolation Valve Position	2 per penetration flowpath ^{(e)(f)}	H

(c) Source Range outputs may be disabled above the P-6 (Block of Source Range Reactor Trip) setpoint.

(d) A channel consists of two valve position indicators associated with the in-series valves in a single suction line.

(e) Not required for isolation valves whose associated penetration is isolated by at least one closed and deactivated automatic valve, closed manual valve, blind flange, or check valve with flow through the valve secured.

(f) Only one position indication channel is required for penetration flow paths with only one installed control room indication channel.

(g) During Cycle 28 operation, with either: 1) one Source Range Neutron Flux channel inoperable or 2) one Intermediate Range Neutron Flux channel inoperable, or 3) one Source Range Neutron Flux channel inoperable and one Intermediate Range Neutron Flux channel inoperable, Required Actions H.1 and H.2 do not apply.

Potential Technical Specification Changes

3.3 INSTRUMENTATION

3.3.4 Remote Shutdown Monitoring Instrumentation

LCO 3.3.4 The Remote Shutdown Monitoring Instrumentation Functions shall be OPERABLE.

APPLICABILITY: MODES 1, 2, and 3.

ACTIONS

-----NOTE-----
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more required Functions inoperable.	-----NOTE----- With one source range neutron flux channel inoperable, Required Action A.1 does not apply for the source range function during Unit 2 Cycle 28. ----- A.1 Restore required Function(s) to OPERABLE status.	30 days

Potential Technical Specification Changes

Nuclear Instrumentation
3.9.3

3.9 REFUELING OPERATIONS

3.9.3 Nuclear Instrumentation

LCO 3.9.3 Two source range neutron flux monitors shall be OPERABLE.

APPLICABILITY: MODE 6.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One source range neutron flux monitor inoperable.	A.1 -----NOTE----- During the Unit 2 Cycle 28 refueling outage only, CORE ALTERATIONS are allowed with one source range neutron flux monitor inoperable or until the inoperable source range monitor is restored to OPERABLE status. ----- Suspend CORE ALTERATIONS.	Immediately
	<u>AND</u> A.2 Suspend operations that would cause introduction of coolant into the RCS with boron concentration less than required to meet the boron concentration of LCO 3.9.1.	Immediately
	A.3 -----NOTE----- Only applicable during the Unit 2 Cycle 28 refueling outage with one source range neutron flux monitor inoperable. ----- Perform SR 3.9.1.1	Once per 4 hours

Potential Technical Specification Changes

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Two source range neutron flux monitors inoperable.	B.1 Initiate action to restore one source range neutron flux monitor to OPERABLE status.	Immediately
	<u>AND</u>	
	B.2 Perform SR 3.9.1.1.	Once per 12 hours
	<u>AND</u>	
	B.3 -----NOTE----- Only applicable during the Unit 2 Cycle 28 refueling outage with one source range neutron flux monitor inoperable. ----- Perform Required Actions A.1 and A.2	Immediately

Compensatory Measures

The following compensatory measures will be implemented to provide an additional defense-in-depth in the event that SQN Unit 2 is required to operate with only source range/intermediate range monitor:

- As shown in the potential TS changes, TVA would perform additional boron concentration sampling of the RCS every 4 hours to ensure that a boron dilution event was not occurring.
- Additionally, TS 3.9.2 ensures valve combinations used to isolate unborated water sources are secured in the closed position during Mode 6.
- Additional compensatory measures are being evaluated including additional monitoring of the remaining operable source range/intermediate range monitor.

Safety Analysis

- The source and intermediate range flux instruments provide inputs to alarms, rod stops, and reactor trips for events producing high neutron flux at low power levels. They are provided to mitigate the bank withdrawal from subcritical and boron dilution events. However, only boron dilution accident analyses credit these functions (Mode 2 boron dilution credits the source range high flux trip).
- TS 3.9.3 requires source range instrumentation for the detection of a boron dilution during refueling or an inadvertent misloading event; however, neither of these events are explicitly analyzed with credit for the source range equipment as both events are considered precluded by other administrative and TS controls (e.g., TS 3.9.1 and 3.9.2)
- TS 3.9.3 (applicable to Mode 6 only) changes have no safety analysis impacts.
- Ascending beyond Mode 6 for Cycle 28 with one source range neutron flux monitor inoperable would result in a loss of redundancy of the source and intermediate range instrument functions for boron dilution events and post accident monitoring.

Precedent

The following license amendments addressed refueling or operation with an inoperable source range monitor:

- NRC letter to Vistra Operations Company LLC, “Davis Besse Nuclear Power Station, Unit No. 1 - Issuance of Amendment No. 308 Re: Source Range Neutron Flux Channel Inoperable (Emergency Circumstances) (EPID L-2026-LLA-0130),” dated August 17, 2025 (ML25229A002)
- NRC letter to Tennessee Valley Authority, “Regional Waiver of Compliance, Inoperable Source Range Monitors (TAC 76360) - Sequoyah Nuclear Plant, Unit 1,” dated March 27, 1990 (ML20033G008)
- NRC letter to Nuclear Power Generation for the Diablo Canyon Power Plant, Units 1 and 2, “Issuance of Amendments (TAC Nos. 74496 and 74497),” dated October 30, 1989 (ML022330553)

Path Forward

- No NRC action is required at this time, but TVA would appreciate NRC feedback on this presentation either verbally or in writing.
- In the event, that SQN Unit 2 experiences an issue with source range and intermediate range detectors during the Cycle 27 refueling outage, that results in declaring these detectors inoperable, TVA would most likely pursue enforcement discretion (including an emergency license amendment request) as described in the potential event scenarios.
- TVA will keep the NRC Project Manager and Resident Inspector informed as to any further status updates.



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