

February 27, 1998 LIC-98-0033

U. S. Nuclear Regulatory Commission ATTN: Document Control Desk Mail Station P1-137 Washington, DC 20555-0001

Reference: Docket No. 50-285

SUBJECT: Results of Investigation into Failures of Incore Detectors (TAC No. M95549)

In a meeting with the NRC staff on June 11, 1996, Omaha Public Power District (OPPD) discussed the current status of the incore detector failures, suspected failure mechanism, and plans to ensure operation through Cycle 16 at Fort Calhoun Station. Part of the plans discussed was completion of the Root Cause Task Force investigations, including testing of failed detectors.

The root cause analysis performed by ABB/Combustion Engineering has been completed. The failure mode for the incore detectors was identified as stress corrosion cracking (SCC) of the individual detector sheaths in the core region, with somewhat worse cracking in the vicinity of the rhodium wire. No single failure mechanism could be identified.

There were multiple causal factors which initiated SCC: these included:

- (1) The manufacturer changed to 10% cold working of starting material for individual detector sheaths.
- (2) The manufacturer changed annealing temperature from 1900°F to 1650°F.
- (3) Exterior and interior surfaces of the individual detector sheath material (as-swaged during manufacturing) exhibited numerous gouges and irregularities versus smooth surfaces for background detectors.
- (4) Impurities in the rhodium material contributed to the work hardening of the detector sheath in the rhodium area.





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(5) Normally occurring rhodium swelling introduced additional stresses into detector sheath material.

The detector sheath material being highly susceptible to SCC. coupled with increased stresses over the rhodium region and rhodium swelling. is postulated to have led to the premature breach of the detector sheath in the rhodium portion of the detector during Cycle 16 operation. Autoclave testing, metallurgical sample analysis, and hot cell examinations supported these conclusions.

As a result of these findings, improvements were implemented into the design of the new ICIs installed during the 1996 Refueling Outage. The improved design has resulted in greatly improved performance of the detectors during Cycle 17.

Please contact Marcus Guinn of my staff at 402-533-7277 if you have any questions.

Sincerely.

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TCM/tcm

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