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PWR ZINC INJECTION EXPERIENCE AT FARLEY UNIT 2

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Objectives: To investigate the effects of zinc injection in a PWR. Previous work has shown that low concentrations of zinc in the primary coolant could reduce out-of-core exposure rates and primary water stress corrosion cracking (PWSCC) of Alloy 600. A cooperative program was undertaken by EPRI and the Westinghouse Owners Group to evaluate the effectiveness of zinc in mitigating Alloy 600 PWSCC and radiation fields. The demonstration program of zinc addition at Farley-2 included pre- and post-zinc measurements on radiation dose rates, PWSCC of steam generator tubes, fuel cladding oxide growth and fuel crud analysis as well as chemistry and radiochemistry monitoring.

Comments: At Farley-2, zinc was added as natural zinc acetate after 190 days into cycle 10. The coolant zinc concentration was maintained in a range of 35-45 ppb for approximately nine months. At the end of cycle 10, evaluations were made of cladding oxide growth, fuel deposit landings and composition, radiation rates and PWSCC of steam generator tubes.

Visual examination of fuel at the end of cycle 10 showed a uniform black deposit over the full length of the fuel assemblies including bottom nozzles and grids. A chemical analysis of the deposit showed that it consisted primarily of nickel ferrite and nickel or nickel oxide. Eddy current examination of fuel rods resulted in greater than expected zirconium oxide thickness measurement compared to measurements made at the end of cycle 9. A definitive root cause of the observed increase in the zirconium oxide thickness has not been established. The possible biasing effect from a ferromagnetic deposit on eddy current oxide measurement was investigated as a potential reason for the measured oxide thickness. This type of effect has been observed on BWR fuel exposed to zinc and hydrogen water chemistry.

Remarks: Measurements of radiation dose rates after cycle 10 with zinc addition showed a reduction of 25-30% at steam generator channel heads and 20% at the main coolant piping compared to cycle 9 without zinc injection. Unit 2 operates under the modified PWR primary chemistry control (pH, Li, B) and its Nuclear Fuel bundle design has zinc grid straps instead of Inconel. These factors, along with zinc addition, contribute to dose resuction. The relative effect of each factor is being reviewed by Westinghouse and Southern Nuclear. Zinc-65 was less than 10% of the radioisotope mix and only a minor contributor to the radiation fields. Oxide characterization from pulled steam generator tubes showed the oxide film was conditioned similar to oxides that showed PWSCC benefits in laboratory testing. The result of the PWSCC and dose rates were consistent with expectations based on prior work.

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References: Rickersten, D., "PWR Zinc injection Experience at Farley Unit 2," Proceedings, EPRI Radiation Field Control and Chemical Decontamination Seminar, Tampa, Florida, November 1995, EPRI Distribution Center, P.O.Box 23205, Pleasant Hill, CA 94532.

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