PWR PRIMARY SYSTEM CHEMISTRY: EXPERIENCE WITH ELEVATED PH AT MILLSTONE POINT UNIT 3

Keywords: OPERATIONAL AND MAINTENANCE TECHNIQUES; RADIATION PROTECTION; REACTOR MATERIAL; WATER CHEMISTRY; FUEL

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Objectives: Earlier EPRI measurements of the solubility of simulated fuel crud, together with modeling of crud transport phenomena, led to the conclusion that a pH of 7.4 was superior to a pH of 6.9 for minimizing buildup of radiation fields. Operation of the Ringhals PWRs in Sweden and an earlier cycle of operation at Millstone-3 showed the benefit of operating at higher pH. However, additional data were deemed necessary to determine the effects of long-term operation at higher lithium hydroxide concentrations on the performance of plant components, especially Zircaloy-clad fuel rods.

The objectives are

1. To measure dose rates after operating for one fuel cycle to a terminal pH of 7.2 (following operation for one fuel cycle to a terminal pH of 7.4) and compare these values with other pertinent dose-rate data, and

2. To measure Zircaloy cladding oxide thickness and compare it with similar data obtained from the North Anna PWR.

Comments: Plant chemistry staff maintained the lithium concentration at 3.35 ± 0.15 ppm until the pH reached 7.2; the pH was then held constant until the end of the cycle. The project team then used visual examinations and an eddy current nondestructive evaluation technique to assess oxide buildup on selected fuel rods. Other tasks included dose-rate measurement at standard piping and steam generator locations as well as gamma spectrometry to determine radionuclide concentrations. Dose-rate measurement trends were analyzed using the contractor's CORA code. The beneficial effects of elevated pH operation on radiation fields at Millstone-3 persisted for a second cycle, even though the pH was held at 7.2, rather than the 7.4 value used in the previous cycle. This change halved the time that the unit operated at 3.35 ppm lithium. Operation with elevated lithium appeared to increase Zircaloy cladding corrosion, but the effects are impossible to quantify, given the extensive scatter in the data. Because of the anticipated length of the next fuel cycle, the utility decided to continue operating at a constant pH of 6.9 to minimize the exposure time with lithium concentrations greater than 2.2 ppm.

Remarks/Potential for dose limitation: The use of elevated pH for a second cycle of operation of the Millstone Point unit 3 PWR continued to reduce radiation-field buildup rates

significantly. Dose rates were about 15% lower than in plants operating under coordinated chemistry.

Comparison of the Millstone-3 oxide thickness data and the North Anna high-burnup oxide thickness data suggests that operation with elevated lithium may increase the corrosion rate of Zircaloy cladding. However, the large variation in oxide thickness measurements prevents one from drawing any firm conclusions. Higher pH operation had no observable effect on any other fuel-assembly components. Observed and CORA-calculated dose rates measured here and at the Swedish Ringhals-3 PWR are consistent. Component dose rates are about 15% lower for elevated coolant pH operation compared with operation under coordinated chemistry at a pH of 6.9.

References:

1. EPRI NP-7077, PWR Primary Water Chemistry Guidelines, Revision 2.

2. EPRI TR-100960, PWR Primary System Chemistry: Experience with Elevated pH at Millstone Point Unit 3, Progress Report Number 2, July 1992, 140 pages.

Duration: from: 1990 to: 1994 **Funding:** N/A

Status: Continuing **Last Update:** October 28, 1992