BNL ALARA CENTER

Processes and Practices Related to Occupational Dose

ID: 61

ZINC IN REACTOR WATER OR ZINC INJECTION (BWRS)

Keywords: ZINC INJECTION; CONTAMINATION PREVENTION; OPERATIONAL AND CHEMISTRY CONTROLS; COBALT; REACTOR COLLANT; CHEMISTRY; WASTE; CONDENSATE PRE-FILTERS; GEZIP

Description:

Studies have shown an inverse correlation between the concentration of zinc in the primary water of BWR plants and the dose rate due to cobalt plate out on steam pipes. In addition, laboratory studies have shown that injections of zinc into the primary water of test loops tends to inhibit the deposition of cobalt on pipe surfaces. Based on these studies, zinc addition is expected to reduce cobalt-60 buildup by a factor of about 3.5 in typical plants. Laboratory studies have also shown that this is true for both normal water chemistry and hydrogen water chemistry in primary systems. In addition to lower levels of cobalt-60 deposition on internal piping, there is also a reduced cobalt inventory to be processed through the rad-waste system. Activation of zinc tends to counteract the reductions due to cobalt, however, zinc has a lower half-life and the quantities produced are somewhat less than cobalt-60. Therefore, a net reduction of both dose rates and rad waste quantities has been achieved.

A commerical system for injecting zinc has been developed by the General Electric Company and has been tested at the Hope Creek plant beginning in October 1986. Initial testing at Hope Creek encountered some difficulties due to fairly high concentrations of iron in the primary system. This problem was alleviated through the addition of condensate pre-filters which made possible operation of the system with lower concentration of zinc injection. As of December 1988 the system is working very satisfactorily and has resulted in significantly lower dose rates throughout the plant than would have been experienced without the zinc injection.

Other plants that are utilizing zinc injection are Nine Mile Point-2, Millstone-1, and Liebstadt in Switzerland. The measured dose rates at these U.S. plants are as follows:

Plant	EFPY	Avg. Dose Rate (mR/h)
Hope Creek	0.75	58
Hope Creek	1.81	111
Nine Mile Point-2	0.45	24
Millstone-1	1.57 (with Zn)	89

This compares favourably with non zinc plants which average 300 mR/h. One side effect worth noting was the significant release of Zn-65 from the fuel deposits to the reactor water at the first refueling outage at Hope Creek. Moreover, the Reactor Water Clean Up (RWCU) system was also not available at the time and this amplified the effect significantly. Although outage spiking of soluble species is a common occurrence in BWRs the amount of this release made it unique. In response Northeast Utilities planned their refueling outage very carefully for Milstone-1 and ensured that RWCU system would remain in service during key stages of the shutdown process to minimize the effects of such an occurence. Based on the good outage results achieved at Milstone-1, it is believed that outage spiking of Zn-65 in high iron plants can be controlled with good outage planning and should not impact outage tasks or lengthen schedules.

References and Selected Abstracts:

1. Hudson, M.J.B., Marble, W.J., Vannoy, T.W., and Lovell, J.R., "Gezip Zinc Injection used at Hope Creek and Millstone," Nuclear Engineering International, October 1987, pp. 26-27.

ABSTRACT. With GEZIP (General Electric Zinc Injection Passivation), zinc is injected into reactor cooling water in order to control the buildup of radiation fields. The technique was used for the first fuel cycle at Hope Creek and -- following tests to confirm the absence of adverse effects in a mature reactor -- at Millstone 1.

2. Marble, W.J., BWR Radiation-Field Control using Zinc Injection Passivation, EPRI Report NP-4474, March 1986. (Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.)

ABSTRACT. Correlations between BWR radiation buildup and reactor water ionic zinc were identified and reported in the project interim report. This report presents the sucessful results of controlled laboratory tests which verify that the continuous presence of ionic zinc inhibits the corrosion of stainless steel and consequently limits the buildup of Co-60 by measured factors of 3 to 20. The current state of mechanistic understanding is discussed, as well as the results of qualification testing to ensure that intentional addition of ionic zinc will not aggravate stress corrosion cracking of primary system materials nor will it cause problems for the nuclear fuel. Additionally, a review of existing data on the impact of Zn-65 on pipe dose rates and radwaste shipments for BWRs shows that zinc addition to control radiation buildup will have only a small effect on these peripheral issues.

3. Wood, C.J., Techniques for Reducing Radiation Field In Nuclear Power Plant," Radiation Protection Management, September/October 1987, pp. 37-62.

4. Wood, C., "Advance in Water Chemistry to Reduce Radiation Fields," Nuclear News, July 1988, pp. 79-80, 82 and 84.

5. Johnson C.P., et. al., "Collective Radiation Exposure Task Force Report: Hope Creek Generating Station," April, 1987, p. 63.