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Processes and Practices Related to Occupational Dose

ID: 24

HYDROGEN WATER CHEMISTRY FOR BWRs

Keywords: HYDROGEN WATER CHEMISTRY; OPERATIONAL AND CHEMISTRY CONTROL; HYDROGEN; REACTOR COOLANT CHEMISTRY; IGSCC; INTERGRANULAR STRESS CORROSION CRACKING; COBALT-60; BWRs; PIPES; WATER CHEMISTRY

Description:

Both laboratory and in-plant studies have shown that injection of hydrogen into BWR feedwater mitigates intergranular stress-corrosion cracking of austenitic stainless steel piping in BWRs which results in costly plant outages and large collective doses (typically 1,000-2,000 person-rem per pipe replacement). Operation with hydrogen water chemistry does cause increased radiation levels throughout the plant due to transport of nitrogen-16, but has been shown to reduce and even prevent IGSCC. The Dresden 2 reactor began operation using hydrogen water chemistry (HWC) in 1983. With the continuing successful trials of hydrogen injection as a means of controlling intergranular stress corrosion cracking, small-scale tests have been done at other BWRs. These studies a wide plant-to-plant variation in the hydrogen concentration needed. The radiological impact of HWC was evaluated at Dresden 2 by measuring the dose rates in the turbine building and plant environs during operation and with and without hydrogen addition. Personnel exposures were estimated and compared with regulatory limits.

During an 18-month fuel cycle test at Dresden 2, radiation build-up measurements showed that the cobalt-60 concentration on reactor piping walls showed an increase of 14% which was consistent with observed increases in cobalt-60 concentrations in the coolant (EPRI NP-4470M). The radiological impact of hydrogen water chemistry at Dresden is minor. However, the impact is site specific and other BWRs may be more severely affected. The long-term costs and benefits, both monetary and dose saving, resulting from hydrogen water chemistry are continuing to be evaluated at a number of plants.

References and Selected Abstracts:

1. Jones, R.L., Wood, C.J., Cowan, R.L. Head, R.A. Linn, C.C., and Wong T.L., "Hydrogen Injection Mini-Tests Completed at Eight U.S. BWRs," Nuclear Engineering International, August/September 1987, pp. 25-26.
2. Zimmer, Anstine, L.D., and Burley, E.L. "Radiological Effects of Hydrogen Water Chemistry, EPRI Report NP-4011, May 1985. (Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.)
3. "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations: 1987 Revision: Special Report." EPRI Report, NP-5283-SR-A, 1987. (Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.)

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ABSTRACT. The Boiling Water Reactor (BWR) Owner's Groups initially submitted the draft "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations" to the Director, NRC Office of Nuclear Reactor Regulation (NRR) on October 12, 1985. This staff's initial review indicated that the storage and use of large quantities of liquid hydrogen on a plant size raises the concern of potentially new and different accidents from those previously considered and evaluated as part of the licensing process. A revised version of the "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations" was submitted to NRC for review (Neils, January 27, 1986), and the staff requested additional information concerning review of this submittal (Hulman, May 8, 1986). Another revision of the Guidelines (hereafter referred to as the Guidelines) incorporating responses to the staff's request for additional information was submitted (Neils, December 5, 1986) and is the basis for the review. The electrolytic option that generates hydrogen and oxygen at the rate used in the process is not considered a storage option.

(Also see EPRI NP-4470-M)

4. Johnson, C.P. et al., "Collective Radiation Exposure Task Force Report: Hope Creek Generating Station," April 1987, p. 72.
5. Ljungberg, L., "Material Behavior in Hydrogen Water Chemistry in the Ringals-1 BWR," EPRI Report NP-3992M, May 1985. (Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.)