N250. PWR Primary Chemistry Update

The main primary chemistry issue continues to be the optimum pH for radiation control, minimum fuel cladding corrosion, and primary water stress corrosion cracking (PWSCC) of nickel-based alloys. Recent results from new plants commencing operation show that using a pH of 7.4 with a maximum lithium of 2.2 ppm reduces field buildup by 20-30%, compared to the pH 6.9 chemistry used in the recent past. French workers reported at a recent conference that the benefit of pH=7.2, tested at a few EDF plants, was not as great. Studies of the potential adverse side effects of lithium concentrations above 2.2 ppm are continuing in several countries. None of the individual fuel examinations after use of 3.5 ppm show a statistically significant effect on Zircaloy oxidation but taken together, preliminary assessments suggest an enhancement of 5-15%, which could be important when cladding oxide thickness is a limiting factor. A recent Japanese study of the effect of lithium on PWSCC confirmed earlier Westinghouse results that 3.5 ppm lithium reduced the time for cracking to initiate; however, 2.2 ppm lithium appeared superior to lower lithium concentrations, as was also indicated but not in a statistically significant way in earlier work. All these studies used reverse U-bend specimens, which are not ideal for evaluating a second-order effect such as chemistry in tests that are dominated by stress and metallurgical effects. These recent results support the modified pH chemistry strategy, using 2.2 ppm lithium and pH=7.4 for as much of the cycle as possible. This is consistent with the PWR Primary Water Chemistry Guidelines - Revision 2, which will remain in effect for the immediate future. In the longer term, zinc injection is a potentially attractive method for inhibiting PWSCC. As with hydrogen water chemistry in BWRs, zinc increased the time to initiate stress corrosion cracking in laboratory tests. These results justify further study, as the effect could be important for minimizing stress corrosion cracking in vessel head penetrations and steam generator tubing. By analogy with BWRs, zinc would be expected to reduce radiation buildup also. Unlike BWRs however, there is no plant experience of the effect of zinc on Zircaloy corrosion under PWR conditions; although no adverse effect is anticipated, fuel issues must be addressed using test reactors and a fuel surveillance program in the first plant demonstration.

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