N217. Current Status of PWR Primary Coolant Chemistry in the U.S.

The first step in the buildup of radiation fields is the release of cobalt from surfaces contacting the primary coolant. Activation of Co^{60} requires incorporation of the released cobalt into the corrosion product deposits on the fuel. Variations in pH can significantly affect the transport of corrosion products around the primary circuit. Laboratory studies using magnetite to model the transport of corrosion products showed that operation oat a pH of at least 6.9 at 300°C corresponded to the temperature coefficient of solubility. This is the pH value at which corrosion products would tend to deposit on out-of-core surfaces, rather than the fuel, thereby reducing the formation of Co^{60}. Corrosion products are nickel ferrites of varying composition. Laboratory measurements of nickel ferrite solubilities showed that a pH of about 7.4 is required to obtain zero or positive temperature coefficients of solubility.

This has been confirmed by data obtained from experiments carried out at the Massachusetts Institute of Technology using an in-pile loop that simulates a PWR primary circuit, where reduced Co-60 was observed as the pH increased. Operation at pH 6.5 was found to be detrimental; pH 7.2 was significantly superior to 7.0, but only a small further improvement was observed at pH 7.5. However, long-term plant operation using lithium concentrations above 2.2 ppm to effect higher pH presents possible concerns about increased Zircaloy fuel cladding oxidation. Laboratory and loop tests show that lithium above 10 ppm increase Zircaloy corrosion rates. Thus, the desire to increase pH to reduce radiation fields must be weighed against possible degradation of the fuel cladding. Also, the effect of lithium on the stress corrosion cracking (PWSCC) of Alloy 600 steam generator tubing remains an open issue. Some laboratory data suggest that lithium >2.2 ppm reduces the time required to initiate PWSCC.

The *PWR Primary Water Chemistry Guidelines* (Revision 2) presents recommendations for optimizing primary chemistry. These recommendations, in order of priority are:

1. **Do not operate below $pH_{(t)}$ 6.9.**
2. **Perform a plant-specific fuel and materials review if operation above 2.2 ppm lithium is required, and decrease the lithium concentration to 2.2 ppm as soon as possible.**
3. **Maintain 2.2 ± 0.15 ppm lithium until the selected pH is reached.**
4. **Maintain the selected pH at ±0.15 ppm lithium.**
5. **Minimize fluctuations in pH.**

Taken from, "PWR Primary Coolant Chemistry -- Current Status in the United States," Howard Ocken. Radiation Control News, No. 15, September 1992. (EPRI, 3412 Hillview Avenue, Palo Alto, CA 94303)