N216. Demonstration of Elevated pH

A demonstration of elevated pH at Millstone Unit 3 yielded results consistent with earlier experience at Swedish Ringhals units. This demonstration began shortly after the start of cycle 2. Reactor coolant system lithium was maintained at 3.35 ± 0.15 ppm until pH=7.4 and this pH was then held constant until the end of the cycle. The beneficial effects on radiation fields were significant; channel head fields decreased by 10% and piping fields increased by 30%. This compares with predicted increases of 33 and 100%, respectively, for a typical Westinghouse-designed plant operating at pH 6.9. Measured fuel cladding oxide thicknesses were somewhat greater than expected. Accordingly, Northeast Utilities limited exposure times at elevated lithium concentrations during cycle 3 by operating at a constant 3.35 ± 0.15 ppm lithium by about a factor of two. Dose rates measured after cycle 3 were about 15% lower than in plants operating under coordinated chemistry at a pH 6.9. Oxide thicknesses after operation with elevated lithium continued to be higher than found at similar plants operating at lower pH. Because of the high variability in oxide thickness measurements, it was concluded that the observations could not be conclusively attributed to operation with elevated lithium, though most plants operating on elevated lithium for extended periods show oxide thickness values greater than expected. An analysis of the Millstone 3 and high burnup oxide thickness data from North Anna is in progress to see if the effect of high lithium operation on fuel corrosion can be more precisely determined.

Clearer insight into the benefits from operating above pH 6.9 is expected to come from new PWRs where no inventory of Co-60 is present. Four U.S. plants have operated with modified coolant pH since startup, using an initial pH of 6.9 until 2.2 ppm lithium is reached, then hold constant lithium until pH 7.4 is reached. Channel head dose rates in these four units average 4.2 R/hr after about 1 effective full power year of operation. This compares to an average channel head dose rate of 6.4 R/hr in PWRs with similar design features that operated since startup at pH 6.9. Using an empirical correlation between dose rates and exposures, the dose rate reduction from operation with modified coolant chemistry leads to an anticipated savings of 66 person-rem per typical outage. Due to the limited time operating at lithium >2.2 ppm, accelerated fuel corrosion or primary side cracking of Alloy 600 is not expected to be a concern.

In conclusion, operation at $pH_{(t)}$ >6.9 is imperative to reduce shutdown radiation fields. Operation in the elevated lithium chemistry regime with $pH_{(t)}$ 7.4, achieved by lithium concentrations of 3.5 ppm is effective but requires a fuels surveillance program to ensure that accelerated Zircaloy cladding corrosion does not occur. Early results from plants that started up with modified chemistry where the bulk of the operation is at a lithium concentration of 2.2 ppm show about a 30% reduction in dose rates compared with similar plants operating at pH 6.9. Such operation should minimize concerns about the possibility of accelerated Zircaloy cladding corrosion or primary side cracking of Alloy 600 steam generator tubing.

Taken from, "Demonstration of Elevated pH," Howard Ocken. Radiation Control News, No. 15, September 1992 (EPRI, 3412 Hillview Avenue, Palo Alto, CA 94303).