N92. Techniques For Dose Reduction

There are three aspects of radiation field control corresponding to the processes involved in activation, transport, and deposition of cobalt containing wear and corrosion products in primary systems.

Reducing The Source

Requires the cobalt impurity level be minimized in structural alloys used to fabricate reactor components and substituting cobalt-free hardfacing alloys for the cobalt-based ones typically used in nuclear valves and other components requiring superior wear resistance. Low cobalt Inconel 690 tubing has been specified for use in replacement steam generators. Zircaloy grids in place of Inconel in PWR fuel assemblies is reducing cobalt-60 inventories. Alternatives to cobalt-based alloys are used successfully in the pins and rollers of BWR control blades in flow control valves. EPRI-sponsored research lead to the development of wear-resistant, iron-based hardfacing alloys, called NOREM.

Controlling Transport And Activation

Good water chemistry is essential for minimizing the formation and release of corrosion products into reactor water. There is a strong correlation between absence of radiation hot spots in crud traps in BWRs and good water chemistry. Parts per billion concentrations of zinc in BWR reactor water reduces release of soluble corrosion products and inhibits the subsequent deposition of cobalt 60. This has led to the use of zinc injection at 8 BWR plants. Radiation field buildup is reduced by about 50%, and early problems with zinc-65 activity have been overcome. Studies are in progress to determine feasibility of zinc injection in PWRs. For PWRs, pH control is essential to avoid activation of corrosion products as a result of in-core deposition. Steam generator fields at plants using closely controlled, elevated pH are 1.5 to 3 times lower than with standard chemistry. Current research has the objective of determining how far the pH can be increased without impairing the integrity of fuel cladding and steam generator tubing. A demonstration of elevated pH using 3.5 ppm lithium is in progress at the Millstone 3 plant. Results from the first cycle of operation with elevated lithium (the plant's second cycle) show that radiation fields in the primary system piping increased by an average of 11% and those in the channel head decreased by 3% compared to the first cycle of operation. Typically, at this stage of a plant's life, an increase of 25 to 30% would be expected. Millstone 3 lies at the lower end of the range of fields in Westinghouse plants.

Controlling Out-Of-Core Deposition

Preconditioning of primary system surfaces, either before plant start-up or before installation replacement components, can reduce the deposition rate of activated corrosion products.
There are two main methods of preconditioning: surface modification by mechanical or electrochemical polishing and chemical pre-oxidation to develop a passive oxide film before the surface is exposed to reactor coolant.

Taken From: "Getting Exposures Down at U.S. Plants," Christopher J. Wood, Nuclear Engineering International, May 1991, p. 16.