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Processes and Practices Related to Occupational Dose

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PASSIVATION OF PIPING IN LWRS

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Description:

The need for passivating new and decontaminated piping material was identified many years ago, for example when the bypass test loop at Dresden-1 was decontaminated and then radiation fields were found to increase rapidly upon restart.

Based on these and other observations, several pipe treatment methods were evaluated to identify a passivation process which would inhibit buildup of activity on new or decontaminated piping in BWRs. The successful methods were based on the formation of very thin, stable oxide film on the piping material. Optimum formation of the film was accomplished by passivating the pipe under carefully controlled conditions prior to exposure of the material to normal reactor coolant. The film thus formed protected the piping material from further oxidation and corrosion during reactor operation. It was also found that the passivation process could be further improved by providing a microscopically smooth, clean substrate surface for the film. Electropolishing was also found to be very effective, so that a complete passivation process should consist of electropolishing followed by oxide-film buildup on reactor system piping.

After extensive evaluation, the optimum passivation process was applied to the replacement piping of two BWRs and gamma scanning methods showed that the rate of radiation buildup was significantly reduced. The success of passivation in BWRs suggested similar benefits in PWR primary system. For example, the inner surfaces of SG channel heads and SG tubes are recognized as a major source of personnel exposure during maintenance work. Effective passivation which could reduce radiation buildup on these surfaces would be of real value in reducing radiation exposure at PWRs.

However, the chemistries of BWR and PWR primary systems are different, the former being based on pure water, the latter employing a reducing, chemically-controlled coolant. Nevertheless, an oxide film is always observed on PWR primary surfaces also. Consequently, a properly-formed, stable oxide film should also passivate the PWR materials against the uptake of radioactive species.

Specimens of SG material have been prepared by electropolishing and oxide passivation. These include Inconel-600 (tube material), Type 316 stainless steel (vessel material), and Type 308 stainless steel (weld-overlay material). The structure of surfaces and surface films has been examined Auger spectroscopy, x ray and other techniques. These tests show promise for retarding further oxidation of surfaces under exposure to normal PWR primary coolant. Plans for a full series of tests are underway. Discussions are in progress with organizations in Europe and Japan to develop suitable tests for exposing coupons to the primary water in an operating PWR and to conduct laboratory tests in simulated PWR conditions.

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ABSTRACT: Control of corrosion-product iron oxide transport in PWR steam condensate cycles depends on reduction of dissolved oxygen in high-purity makeup water systems. Makeup water is second only to condenser leakage as a source of dissolved oxygen.

A more direct method for maintaining oxygen concentrations near zero is installation of a fixed bed of material that removes oxygen from the water without significantly changing water, purity, temperature, or pressure. The following conclusions have emerged from this preliminary study of fixed bed oxygen removal processes: (1) Under the experimental conditions used three fixed bed oxygen removal processes were shown to be effective in reducing inlet oxygen values of 4-7 mgkg⁻¹ (ppm) to 10-60 ugkg⁻¹ (ppb). Evidence from other sources indicates that under optimum conditions final oxygen levels of <5 ugkg⁻¹ (ppb) will be achieved. (2) All three processes will probably contribute impurities, albeit at very low levels, to the water being treated. In view of the very high water quality demanded for PWR make-up, this will necessitate the use of a final ion-exchange stage which should reduce both ionic and particulate impurities. (3) It is considered that a system based upon the use of activated carbon for accelerating the hydrazine-oxygen reaction should be selected for further study in both laboratory and plant trials, its ease of use, its availability from many sources and its possible side benefits such as removal of organic impurities. The system is likely to be the cheapest of those considered. Problems in its use seem to center on its release of impurities, both ionic and particulate.