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Processes and Practices Related to Occupational Dose

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FUEL ROD CLEANING

Keywords: FUEL ROD CLEANING; FUEL; HIGH PRESSURE WATER DECONTAMINATION PROCESSES; ULTRA-HIGH PRESSURE WATER CLEANING SYSTEMS; AP-LOMI; AP-CAN DECON SOLVENT; FUEL ASSEMBLY REPAIR AND INSPECTION STATION; OPERATIONAL PRACTICE

Description:

Almost all radiation buildup in light water reactors is the result of deposition of activated corrosion and wear products in out-of-core areas. A significant quantity of corrosion and wear products are deposited on the fuel rods. Removing these corrosion products at each refueling outage eliminates a significant source of radioactivity and reduces plant radiation levels. Studies have been performed using non-chemical methods to decontaminate fuel rods. Ultrasonic cleaning and high-pressure water cleaning were identified as the two most promising nonchemical decontamination techniques.

High-pressure water decontamination processes use a high-pressure, low-volume pumps and array of spray nozzles to create a water-jet velocity of 400 ft/s to remove adhering corrosion products. Decontamination factors on the order of several hundred are expected when using high pressure water jets to clean fuel cladding surfaces.

Ultra-high-pressure water cleaning systems are similar to high-pressure systems but are capable of producing water steams with pressures between 20,000 and 60,000 psi. These systems are capable of removing tightly held contaminants, and by careful control of the water pressure, it may be possible to remove corrosion films without affecting the metal surfaces. Decontamination factors produced by the use of ultra-high pressure water lancing usually range from 200 to 500.

Another type of cleaning method which could be used to clean fuel rods is electrochemical decontamination or electropolishing. Here the item to be polished is immersed in an electrolyte filled reservoir and seves as the anode. One or more cathods are positioned around the object to be cleaned. The flow of electric current results in the adherent surface radioactivity being released into the electrolytic solution.

Electropolishing cleaning routinely produces decontamination factors in the range of 100 to 500, however, the disadvantage of the system is the need to neutralize the electrolyte prior to introduction into the radwaste system.

In conclusion, if only 20% of the crud is removed each time a new plant is refueled, radiation levels can be reduced by about 73%. The estimated cost to perform fuel element cleaning, assuming a combination of high-pressure water jetting and ultrasonics would be needed is estimated to be aproximately $200,000 to build the equipment; expendables would cost about $9,000 per cleaning; and disposal costs about $20,000.

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Toshiba has developed a Fuel Bundle Cleaner which is a device for removing radioactive crud depsited on fuel bundles. This cleaner is composed of a four part system. 1. Removal Tower - A tower is handling which contains 32 jet nozzles for cleaning the fuel bundle. 2. Crud Transfer Pump - A system to collect removed deposits of crud from the removal tower. 3. Spray Pump - Provides pressurized spray for 32 jet nozzles in the tower. 4. Filter - Extracts the crud removed from the Crud Transfer Pump.

References and Selected Abstracts:

1. Johnson, C.P., "Collective Radiation Exposure Task Force Report," Hope Creek Geneating Station, April 1987, pp. 84-85.

2. Wang, M.T., "Chemical Decontamination of BWR Fuel and Core Materials." EPRI-NP-58P2 Interim Report, June 1988.

ABSTRACT: Dilute chemical decontaminations using AP-LOMI and AP-CAN DECON solvent were performed on mill annealed, irradiated Type 304 stainless steel to evaluate its effect on surface corrosion and intergranual stress corrosion cracking (IGSCC). Constant extension rate tensile (CERT) specimens were fabricated from irradiated tie rod of a La Crosse control blade. Specimens were then mounted on the fuel channel wall of a spent fuel bundle. These specimens and spent fuel bundles were decontaminated in the spent fuel pool at Quad Cities Nuclear Power Plant. The decontaminated CERT specimens were then returned to the GE Vallecitos Nuclear Center for evaluation. The specimen surfaces were examined following CERT SCC testing in a simulted BWR coolant environment. All the testing and examinations were remotely conducted in the hot cell. The surface examinations provided an assessment of chemical attack, particularly intergranular attack (IGA) during the decontamination processing.

The CERT tests provided an assessment of any possible degradation of IGSCC resistance following decontamination. Results of post-decontamination evaluation indiated that neither the AP-LOMI nor AP-CAN DECON processes lead to any chemical attack or evidence of IGA.

Irradiation assisted IGSCC was observed on all of the specimens tested in water with 8 ppm dissolved oxygen. However, the two dilute chemical deontaminations did not affect IGSCC susceptibility.

3. Ocken, H., Walschot, W., "BWR Fuel Decontamination," EPRI Seminar on PWR Water Chemistry and Radiation Field Control, Proceedings Paper 14, March 16-18, 1988.

ABSTRACT: Decontamination of individual systems and components is now a common procedure to reduce radiation fields. However, decontamination of the entire primary system, including the fuel, is necessary to prevent recontamination by radionuclide release from the fuel during subsequent operation. It must first be established that chemical decontamination solvents can effectively remove radioactivity without damaging reactor core construction materials.

Two discharge BWR fuel bundles and higly irradiated Type 304 stainless steel specimens were decontaminated using the AP/CAN-DECOM and AP/LOMI solvents. The solvents were passed over the fuel bundles that were placed in a specially designed chamber. This on-site work took place at the Quad Cities site. Analysis of reagent samples during the decontamination, sipping tests, and visual examinations showed no evidence of bundle degradation. After analyzing the resins, the LLW was solidified in cement and shipped to Barnwell for disposal. The chemical analysis showed that AP/CAN-DECOM removed a total of 536 gm of metal containg 31 curies of activity, while the

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AP/LOMI process removed 456 gm of metal containing 106 curies. Iron was the principal metal removed - 420 gm in both cases. Approximately 90% of the activity was 60 Co. A large amount (-1000 curies) of 55 Fe (a pure x-ray emitter) was detected during the isotopic analysis of the waste resins and led to increased LLW disposal costs. additional information is being generated in a project with B&W that is performing destructive examinations of key bundle components. The examination of the stainless steel specimens showed neither decontamination solvent led to chemicaal attack or intergranular attack. Irradiation-assisted IGSCC was observed in CERT specimens tested in 8 ppm dissolved oxygen, but no deleterious effects wer attributed to the decontamination solvents.

4. Tucker, J.S., Sapyta, J.J., "Using FARIS For Assembly Clean-up and Debris Removal," Nuclar Engineering International, May 1990, pp. 60-62.

ABSTRACT: Debris is currently the commonly known cause of fuel failures in PWRs. Babcock & Wilcox is combatting this problem with Fuel Assembly Repair and Inspection Station (FARIS), a portable clean-up station, which has remotely interchangeable parts, so that it can be fully maintained without being removed from the fuel pool. FARIS can also be used for inspection, repair and oxide thickness measurements.