MODELING OF MOLECULAR AND PARTICULATE TRANSPORT IN DRY SPENT NUCLEAR FUEL CANISTERS

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ABSTRACT

There are two important phenomena associated with the depressurization of a dry spent nuclear fuel canister after the formation of a through-wall pinhole breach. The first phenomenon is the release from the canister of any radioactivity that might have become suspended within the fill gas and the second is the transport of oxygen into the canister (leading to oxidation of cladding and any exposed fuel) after pressure equilibrium has been reached. In order to better quantify the effects associated with these phenomena, several models have been constructed. The first of these models determines the depressurization time of a breached canister in which no particles are suspended in the fill gas. The second model tracks the possible transport of fission gases and helium produced from alpha decay through nano-scale pathways within the spent fuel located in the canister. The third model expands the first model to track any suspended particle release from the canister and to monitor particle deposition within the breach (along with the associated flow area blockage). The fourth model uses Monte Carlo methods to remove several limitations of the third model, including particle deposition patterns, effects of particle size, and breach geometry. The results generated by these models provide a better understanding of the time-dependent behavior of a spent fuel canister that has developed a microscopic through-wall breach and may prove to be useful tools in the future monitoring and handling of spent fuel canisters.