—Summary—

DEPLETED URANIUM DIOXIDE WASTE PACKAGES FOR SPENT NUCLEAR FUEL

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Depleted uranium dioxide (DUO_2) waste packages (WPs) for spent nuclear fuel (SNF) are being investigated to (1) reduce radionuclide releases from WPs, (2) decrease the potential for repository nuclear criticality events, and (3) provide a means to beneficially use excess DU. The DUO_2 is being considered for use as a fill for all void spaces in the WP—including SNF coolant channels—and as a component of a cermet WP. Cermets are a mechanism to create a strong ductile form of DUO_2. The cermet, contains 40 to 65 vol % DUO_2 embedded in steel, substitutes for the steel components (shell and basket) of the WP. The cermet WP includes an outer non-cermet layer of a more corrosion-resistant alloy such as C-22.

Conceptually, the DUO_2 WP with SNF is similar to a small (100-ton) uranium ore deposit containing uranitite (UO_2). The same mechanisms that have preserved uranitite for long periods of time in areas of oxidizing groundwater are expected to preserve UO_2 in SNF and thus delay the release of those radionuclides trapped in the fuel pellets. The WP materials of construction are chosen for geochemical reasons.

Mechanisms for delayed release of radionuclides include the following: elimination of void space to prevent early WP collapse with failure of radionuclide release barriers (outer corrosion resistant metal layer, diffusion barriers, etc.), maintenance of chemically reducing conditions within the WP by preferential oxidation of DUO_2 and steel, saturation of fluids in the WP with DU, reduced fluid flow (air, oxidizing groundwater) inside the WP from plugging of void spaces by the oxidation products of iron and DUO_2, sorption and ion exchange of selected radionuclides (neptunium, etc.) on hydrated DU oxides, and long-term buildup of uranium silicate surfaces. The expected behavior is described and compared with that of natural uranium ore deposits in similar environments.