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Disposal of Spent Nuclear Fuel in Dual-Purpose and Multi-Purpose Canisters

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Abstract

Commercial spent nuclear fuel (SNF) is accumulating in dry storage canisters in the U.S. at 2,000 metric tons (MT) per year. Most of these welded, sealed canisters can be used for transport, hence they are called dual-purpose canisters (DPCs). By 2035 approximately half of all SNF in the U.S. will be stored in DPCs. Unless these can be disposed of directly, they will be cut open and the SNF re-packaged.

DPC design has changed since they came into use 20 years ago: they are larger and use various means to control criticality. Changes have occurred in parallel with advances in thermal and criticality analyses. Disposal has not been a factor, and current designs use aluminum-based materials for neutron absorption that would degrade rapidly once flooded, in the disposal environment.

Disposability of SNF canisters depends on safety strategies to ensure waste isolation, with sufficient heat dissipation and criticality control. Over thousands of years waste packages will eventually be damaged by corrosion and flooded with groundwater, leading to possible criticality. A framework for canister disposability shows how programs in several countries have proceeded, and it also suggests what options are available as alternatives to DPCs.

Direct disposal of DPCs is under study in the U.S., viewed as part of a diverse fuel management system that will eventually switch to loading MPCs. Nearly all DPCs loaded before this switch could be directly disposed of depending on the geologic setting selected. Direct disposal options have been developed for salt, crystalline and sedimentary host media. Salt and crystalline rock offer superior thermal properties, while flooding with chloride brine (in a salt repository) could eliminate the possibility of criticality.

The advantages of storage canisters suitable for disposal include simpler SNF management, lower cost, less waste (e.g., DPC hulls), and less worker exposure. Estimated savings in the U.S. depend on when such measures are introduced, but timely implementation could save at least $10B. Disposal of SNF in larger packages would allow additional savings in disposal costs. The outlook for deploying MPCs depends on progress in disposal planning, and cooperation of the nuclear utilities, vendors, and government.

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