—SUMMARY—

A Multifunction Cask for At-Reactor Storage of Short-Cooled Spent Fuel, Transport, and Disposal

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The spent nuclear fuel (SNF) system in the United States was designed with the assumptions that SNF would be stored for a few years in an at-reactor pool and then transported to reprocessing plants for recovery of fissile materials, that security would not be a major issue, and that the SNF burnups would be low. The system has evolved into a once-through fuel cycle with high-burnup SNF, long-term storage at the reactor sites, and major requirements for safeguards and security. The current system is expensive and requires multiple handling of SNF. Considering current requirements, no one would design the SNF management system as it presently exists. With changing requirements for SNF management and the potential for new reactor orders, it is time to ask whether a better SNF management could be designed. This paper describes one such alternative (Fig. 1), including the critical issue of storing short-cooled SNF at the reactor.

After reactor discharge and a short period of storage, SNF is placed in multifunction casks at the reactor and the casks are sealed. The shielded casks are used for at-reactor storage, transport, and geological disposal of SNF without ever being opened, thus minimizing SNF handling and remote operations. The multipurpose cask system disposes of all long-lived radionuclides from the fuel cycle: SNF and depleted uranium (DU). The cask is constructed of a cermet with DUO_2 particulates embedded in the steel. Because this cermet is a better shielding material than steel, the cask weighs less than a comparable steel cask, allowing increased cask capacity for a fixed weight limit. Cermets are the traditional material used in tank armor. The cask provides a sealed high-security SNF package.

Conflicting requirements for storage of short-cooled SNF, transport, and geological disposal of SNF are met by the use of cask overpacks. High-surface-area fins are required for a cask containing short-cooled SNF to remove decay heat and minimize SNF storage temperatures. A low-surface-area overpack of highly corrosion resistant materials is required to meet repository requirements (same as current system).

For existing and future reactors, strong incentives exist to minimize SNF handling and storage within the reactor facility. *To minimize such storage, cask cooling capabilities for short-cooled SNF must be maximized*. Inside the cask, heat from SNF is moved by (1) conduction through the basket structure and (2) circulation of inert gases from the SNF to the inner cask wall. On the outside cask wall, liquid-cooled natural-circulation bolt-on cooling fins provide highly efficient surface cooling with heat dumped to the air. The fins provide an almost uniform temperature over the entire surface of the cask body. The fins are similar to those used in electrical transformers and have much higher performance than the traditional solid fins typically used in cask storage. The use of circulating fluids inside and outside the cask maximizes the effective surface area of the cask body used for heat transfer (no cold zones with inefficient heat transfer) and minimizes the temperature drop across the cask body, thus maximizing cask

heat rejection capabilities while protecting the SNF with the full thickness of the cask body. While heat pipes and other devices can further improve cooling, such systems reduce security by penetrating the cask body. Bolt-on fins, a design feature of some existing casks, offer the advantage of being removable after the SNF decay heat has decreased. Removal of the fin reduces the cask size for shipping and results in a cask geometry that allows addition of an overpack at the repository. The paper describes the system, including the critical features for storage of short-cooled SNF in a multifunction cask designed for this application.

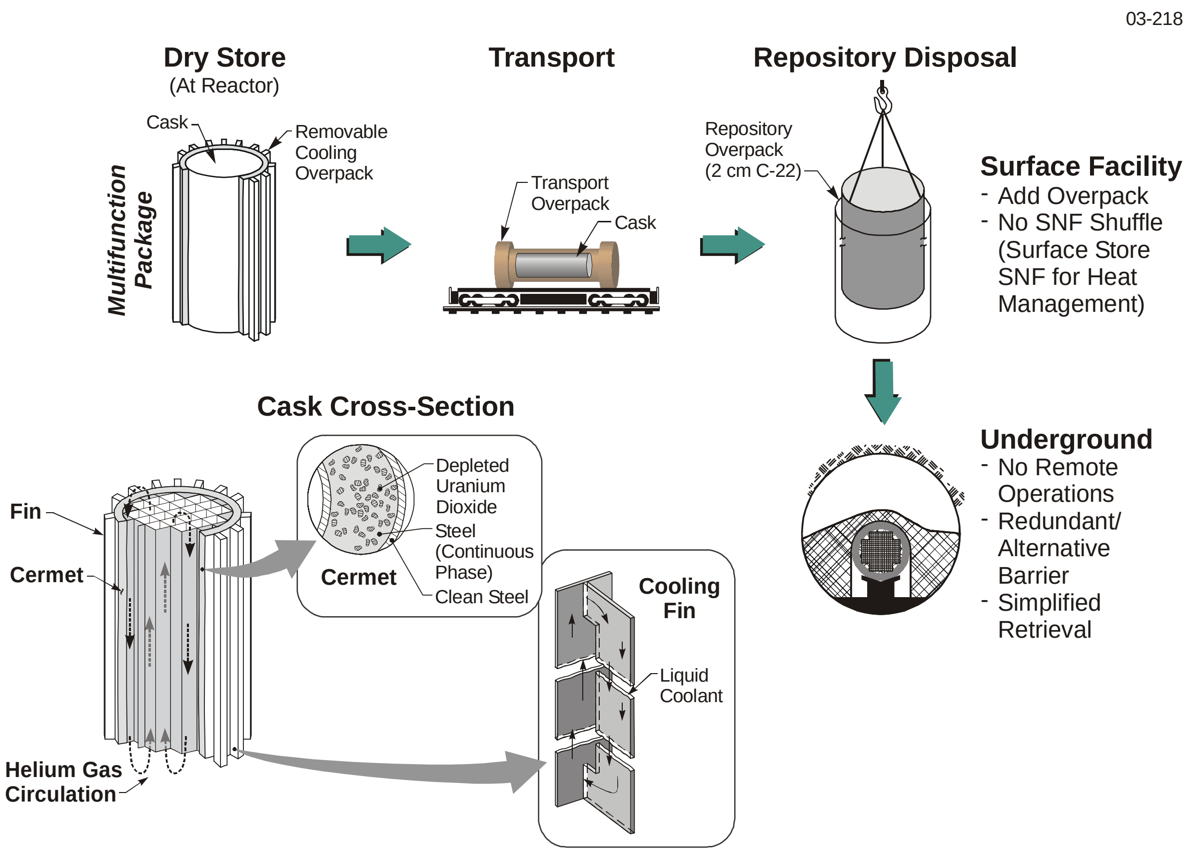

Fig. 1. DUO_2–Steel Cermet Multifunction Cask System.