—Summary—

RETHINKING MULTIPURPOSE SPENT NUCLEAR FUEL CANISTERS

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In the 1980s, the concept of a multipurpose canister for storage, transport, and disposal of spent nuclear fuel (SNF) was investigated by the Yucca Mountain Project (YMP). The concept, as it might be implemented today, includes the following components: (1) the SNF is loaded into a multipurpose canister at the reactor; (2) the loaded canister functions as a dry-storage cask at the reactor site; (3) the canister with a transportation overpack is used to transport the SNF to the repository; and (4) at the repository the transport overpack is replaced with a repository overpack that allows the canister and overpack to function together as a repository waste package. There are several variants of the concept. The multipurpose canister makes it unnecessary to purchase separate storage, transport, and disposal packages for SNF. Furthermore, no transfer of SNF between storage, transport, and disposal packages is required. Recent events suggest that the concept should be reconsidered and may be a very attractive option.

- *YMP licensing.* The YMP examined multipurpose packages and determined that they had potential economic and safety advantages. However, multipurpose canisters were not adopted because the requirements for the repository waste package were not well understood or defined at that time. The waste package design has undergone many modifications as research and development improves the understanding of repository behavior. Additional waste package design changes may occur during the licensing process. Consequently, a multipurpose canister cannot be used for the first 10 to 20 thousand tons of SNF that will be in storage before the Yucca Mountain Repository is licensed because the existing storage systems are incompatible with the expected canister design. However, when the repository is licensed, the specific requirements will be known and defined. At that time (probably within this decade), it will become feasible to design and use a multipurpose canister for the 40,000+ tons of SNF that will be generated after the repository license is issued. Thus, multipurpose canisters should be considered as part of a second-generation waste package system.

- *Physical protection.* The destruction of the World Trade Center in New York City has resulted in a reevaluation of security requirements. Multipurpose canisters may offer significant economic advantages over competing methods for storage of SNF—with high levels of protection against sabotage. Such canisters are designed for transportation and, by design, (1) limit the SNF inventory at risk during any event to that of the cask capacity, (2) have totally passive cooling systems, (3) have robust walls that prevent consequences in most potential accident and sabotage scenarios, and (4) have extreme resistance to fire—the cause of the collapse of the World Trade Center towers. In a storage mode, fire duration from large aircraft impacts can be easily limited by sloping the storage yards to drain liquid fuels away from storage casks to burn pits (standard refinery practice to limit fire damage). In Germany, metal casks have been successfully tested against aircraft collisions by firing heavy metal poles (the size of jet engine rotors—the strongest and most damaging component in an aircraft) at very-high speeds into storage and transport casks.

Several alternative system designs for a multipurpose canister exist. One option is for the canister to provide the basket, shielding, and primary protection for the SNF. During shipment, a transportation overpack would be used to meet specific transport requirements. At the repository, a repository overpack would replace the transport overpack to provide a long-term corrosion-resistant barrier. The current Yucca Mountain waste package consists of an inner package and an exterior, 2-cm-thick exterior package of corrosion-resistant C-22 metal (a nickel alloy). The exterior package is designed to ensure package integrity for thousands of years. The same approach is applicable to a multipurpose canister where the inner package is the multipurpose canister and the outer package would be made of corrosion-resistant C-22.

Major advances have been made in cask design since the earlier studies on multipurpose canisters. An example of an advanced concept is a multipurpose canister whose shield body is made of a cermet consisting of depleted uranium dioxide (DUO_2) embedded in steel. This material provides several potential advantages:

- *Weight.* When using a cermet of DUO_2 and steel, the shielding thicknesses and cask weights are significantly less than for pure steel. Thus, there are fewer reactor and transport handling constraints. The cermet provides better gamma shielding (higher density) and better neutron shielding.

- *Regulatory and repository acceptance*. The repository and the U.S. Nuclear Regulatory Commission impose requirements on any multipurpose canister that is part of the waste package system. No organics, no cement, and no Resource Conservation and Recovery Act materials (such as lead) may be used. The canister must exhibit appropriate geochemistry, and uranium (if used), should be in oxide form. Regulatory and repository considerations make it unlikely that uranium metal would be acceptable in a multipurpose canister that was a component of a repository waste package system.

- *Repository performance*. The DUO_2 in the cermet reduces the potential for long-term nuclear criticality in the repository and is expected to lower the long-term radionuclide release rate from the SNF.

- *Use of excess materials*. Large quantities of excess depleted uranium (>500,000 tons) are available as well as large quantities of recycled carbon, stainless, and high-nickel steel from decommissioned nuclear facilities.

Various constraints and tradeoffs are associated with the use of a multipurpose canister. To maximize benefits, some changes in repository design would be required. The key constraints and tradeoffs should be examined in the context of current and future storage, transport, and repository requirements.