COMPATIBILITY OF REQUIREMENTS FOR
STORAGE AND TRANSPORTATION OF SPENT NUCLEAR FUEL
(Retrievability, Cladding Integrity, and Safe Handling)

The purpose of this summary is to present information on the background and current U.S. Nuclear Regulatory Commission (NRC) staff considerations on this topic. This summary does not represent an official agency position or present an interpretation of the NRC requirements.

*The NRC staff is conducting a review of the regulatory framework for spent fuel storage and transportation to identify potential enhancements to the efficiency and effectiveness of its licensing and inspection programs. This review is being conducted as part of the project plan more fully described in COMSECY-10-0007, "Project Plan for the Regulatory Program Review to Support Extended Storage and Transportation of Spent Nuclear Fuel" (*Agencywide Documents Access and Management System (ADAMS) *Accession No. ML101390216). The staff will solicit stakeholder input in identifying enhancements to the current licensing and inspection programs at the August 16-17, 2012, public meeting, "Meeting to Obtain Stakeholder Feedback on Improvements in the Licensing and Inspection Programs for Spent Fuel Storage and Transportation Under 10 CFR Parts 71 and 72" (http://www.nrc.gov/waste/spent-fuel-storage/public-involvement.html). NRC staff will use the information obtained from this meeting, and future opportunities for stakeholder input, to inform the staff in its regulatory review.*

BACKGROUND:

Regulations for packaging and transport of spent nuclear fuel are set forth in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71, while requirements for storage of spent nuclear fuel are set forth in 10 CFR Part 72. Because these regulatory schemes are separate, there is no requirement that licensed and loaded storage casks also meet the transportation requirements in 10 CFR Part 71. Integration of storage and transport regulations could enable a more predictable transition from storage to transport by potentially minimizing future handling of spent fuel and uncertainty as to whether loaded storage casks may be transported from the storage location. As part of its evaluation of integration and compatibility between storage and transportation regulations, the U.S. Nuclear Regulatory Commission (NRC) staff is reviewing its policies, regulations, guidance, and technical needs in several key areas, such as: (1) retrievability, cladding integrity, and safe handling of spent fuel; (2) criticality safety features and requirements for spent fuel transportation; and (3) aging management and qualification of dual-purpose canisters and components after long-term storage.

The NRC staff is reviewing the potential policy issues and requirements related to retrievability, cladding integrity, and safe handling of spent fuel as the lead issue for evaluating compatibility of storage and transportation regulations. Spent fuel cladding is the first fission product barrier and is often relied upon for retrievability, safe handling of spent fuel, and criticality safety during storage and transportation. Additionally, 10 CFR 72.122(h)(1) requires that spent fuel cladding be protected during storage against degradation that leads to gross ruptures or the fuel must be otherwise confined to facilitate its removal from storage. The "License and Certificate of Compliance Terms" final rulemaking (76 FR 8872; February 16, 2011), extending the term of an independent spent fuel storage installation license to 40 years, was consistent with the conclusions of the research program at the Idaho National Laboratory that low burnup fuel would not degrade in storage for the longer storage duration. At this time, research does not exist to support similar conclusions for high burnup spent fuel.

The NRC requirements in 10 CFR 72.122(l) state that spent fuel storage systems should be designed to allow ready retrieval of spent fuel, high-level radioactive waste and reactor-related greater than class C waste for further processing or disposal. This requirement applies to both site-specific and general storage licensees. NRC's longstanding interpretation of this rule, as discussed in SECY-01-0076, "Retrievability of Spent Fuel from Dry Storage Casks" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML011020520) and Interim Staff Guidance No. 2, Revision 1, "Fuel Retrievability" (ADAMS Accession No. ML100550861) is that individual fuel assemblies should be retrievable after storage. Spent fuel assemblies that can be handled by normal means after storage (i.e., have not significantly degraded, or were placed in damaged fuel cans prior to dry storage) meet the retrievability requirements.

For transportation, the regulatory requirements in 10 CFR Part 71 that apply to all package types have been generally premised on the use of transportation packages that are periodically inspected and maintained while empty, loaded with contents within a few days to weeks before transportation, and whose contents are immediately unloaded at recipient facilities. However, currently loaded spent fuel casks will likely be sealed in dual-purpose canisters for several decades prior to shipment to a future repository.

Part 71 does not contain explicit requirements for retrievability or cladding integrity. The regulations in 10 CFR 71.43(d) require, in part, that the package must be constructed of materials that assure there will be no significant chemical, galvanic, or other reaction among package contents. Section 71.55 specifies several criticality requirements, including showing that the geometric form of the package contents would not be substantially altered during the tests for normal conditions of transportation. The integrity of spent fuel is often relied upon for geometry control in transportation criticality analyses, but sealed canisters that have been in storage prior to being transported cannot be readily inspected to ensure the proper geometry for transportation.

ISSUE DESCRIPTION:

Most spent fuel being removed from operating reactors today is high burnup fuel (fuel with peak rod average burnup greater than 45,000 MWd/MTU is considered high burnup fuel). Most inventory remaining in spent fuel pools is high burnup fuel, therefore the nuclear industry continues to seek certification of storage and transportation for high burnup fuel. The NRC staff has been seeking additional information on the material properties of high burnup spent fuel to determine whether the material properties change sufficiently to affect the retrievability of spent fuel to comply with the storage and transport requirements. Currently available data on the material properties indicates that high burnup cladding becomes embrittled below certain temperature ranges and when certain hydrogen concentrations exist; therefore, it is unclear whether these assemblies would retain sufficient structural integrity during storage to maintain retrievability, or their structural integrity during subsequent transportation. In addition, given the changes in national policy on managing the backend of the fuel cycle, staff is assuming: (1) longer storage durations than originally anticipated; (2) continued uncertainties with how the fuel and storage systems will perform over longer periods of time; and (3) continued uncertainty on how fuel will need to be handled and perform at yet-to-be-specified receipt facilities, potential centralized storage facilities, and/or permanent repositories after transportation.

Spent fuel transportation regulations do not contain any explicit retrievability or cladding integrity requirements. Staff is evaluating whether storage and transport regulations should have consistent retrievability and cladding integrity requirements. Additionally, given the uncertainty with high burnup fuel cladding material properties, the staff is evaluating its retrievability and

cladding integrity requirements for spent fuel storage. Staff is also evaluating alternative approaches to licensing and certification of high burnup fuel for storage and transportation based on the fact that licensees may not be able to show that the cladding will remain intact during storage or transport. Staff has established acceptance criteria for demonstrating moderator exclusion and burnup credit, and staff continues to evaluate expanded approaches in these areas on a case-by-case basis.

The embrittlement and degradation of some high burnup claddings in inert storage environments could be inevitable over a long period. However, industry has not developed significant data on actual high burnup cladding behavior after reactor operations nor established associated confirmatory performance programs. If licensees are unable to demonstrate that fuel assemblies maintain their structural integrity such that the fuel cladding degradation during storage would not lead to gross ruptures, then under the current licensing and certification approach, canning or other mitigating strategies may be needed to ensure retrievability of high burnup fuel assemblies. If cladding integrity can be demonstrated during storage, but not during subsequent transportation, then, either the fuel would need to be repackaged before transportation or its transport package should be certified to transport damaged spent fuel.

Alternatively, if NRC were to move to a canister-based retrievability policy, then certification of storage and transportation systems would need to consider the performance of systems with credible spent fuel reconfigurations while in storage and transportation. This may require additional effort to address technical issues such as the mechanics of credible reconfigurations, moderator exclusion approaches, burnup credit analyses, aging management of external barriers, and/or the capabilities of recipient facilities to safely handle fuel during unloading of the systems.

CONSIDERATIONS:

In reviewing its policy on cladding integrity and retrievability and evaluating options going forward, staff is considering:

- revising the storage regulations and guidance to address confinement of fuel failures (e.g. canning), fuel assembly-based retrievability, and canister-based retrievability;

- revising the transportation regulations and guidance to address cladding integrity and maintain safe handling of spent fuel; and

- revising regulations and guidance to address concurrent certification of spent fuel storage and transportation systems in order to provide greater assurance that spent fuel placed into long-term storage technologies can be readily transported.

In evaluating potential options, the staff will consider, in part:

- the importance of maintaining fuel assembly integrity for flexibility in ultimate disposition;

- the importance of maintaining cladding integrity as a primary fission product barrier for safe handling during the backend of the nuclear fuel cycle; and

- operational considerations, including associated risks and cost-benefits (e.g., cost and worker dose to either repackage spent fuel or can high burnup fuel assemblies).