U.S. Nuclear Waste Technical Review Board

Staff Briefing Document

Framework for the Technical Workshop on the Impacts of Dry-Storage Canister Designs on the Future Handling, Storage, Transportation, and Geologic Disposal of Spent Nuclear Fuel in the United States

Washington, DC
November 18–19, 2013

1 Background

Following discharge from a nuclear reactor, "spent" nuclear fuel (SNF)[1] continues to generate heat. Initially, nuclear power utilities allow the SNF to cool in water-filled pools at the nuclear utility sites. When these pools approach their licensed capacity, most utilities transfer enough SNF that has cooled sufficiently into large dry-storage canister systems to create space to accommodate additional SNF discharges from continued operation of the nuclear power plants. In order to minimize the economic and operational impacts of transferring SNF to dry-storage systems, nuclear utilities have worked with storage system vendors to maximize the capacity of the storage systems. Consequently, most of the dry-storage canisters in use at utility sites today exceed the size, weight, and/or heat-load limits for repository concepts that have been developed to date.

The design of the dry-storage canisters used by utilities could have major impacts on future SNF handling, storage, transportation, and disposal operations, as well as the scope of a centralized interim storage facility, should one be constructed, and the design of a repository for disposal of SNF. Unless the canisters can be directly disposed of in a geologic repository, the SNF they contain will need to be repackaged into disposal canisters before emplacement in a repository. Repackaging the SNF into smaller capacity, low-heat output containers would have significant implications for the waste management system. For example, repackaging the SNF may be a lengthy process and could impact operational schedules at the utility sites, at a consolidated storage facility, or at the repository, depending on where repackaging is performed. SNF repackaging also could involve extensive SNF assembly handling operations that could result in additional radiation exposure to workers and increase the potential for fuel damage, and possibly generate a large volume of low-level waste that will require disposal. In addition, at utilities where the SNF pool has been decommissioned, construction of a pool or dry-transfer facility may be necessary if repackaging is needed to be done at the utility site.

Direct disposal of the large, high heat output dry-storage canisters also could have significant impacts. For example, the large size and high heat output of the canisters could affect the types of geologic environments that may be considered, increase the amount of engineering necessary for a geologic repository, compromise the integrity of engineered (e.g., backfill) or geologic barriers (e.g., clay repository), increase the uncertainty of dose predictions, and impact repository operations and retrieval options.

1.1 Dry-Storage Systems

The workshop presentations and discussions will reference different types of SNF containers. The names and functions of the different containers are defined in Table 1 and are discussed in more detail in the following sections.

There are two basic types of dry-storage systems in use: 1) dry-storage casks and 2) dry-storage canisters. In both cases, some systems are licensed for storage only, some are licensed for both storage and transportation, and it is possible that some of those that are currently licensed for storage only could also

[1] The term "spent nuclear fuel," as used in this report, has the same meaning as the term "used nuclear fuel" the U.S. Department of Energy (DOE) typically employs.

Table 1. Container Types and Their Functions

Name	Function
Container	Any type of sealed cylindrical vessel that provided containment for SNF. Dry-storage canisters, disposal containers, dry-storage casks, etc. are referred to generically as containers.
Disposal Container	A sealed cylindrical vessel that provides containment and is designed for emplacement in a repository. A disposal container may contain bare SNF assemblies or one or more storage canisters, transportation or multi-purpose containers and may provide radiation shielding according to the design of the repository.
Dry-storage canister	A thin-walled cylindrical vessel, typically fabricated from stainless steel, that provides containment for SNF. For storage, a dry-storage canister is loaded into a storage overpack or modular storage bunker to provide the necessary radiation shielding. Some dry-storage canisters may be able to be transported when loaded into transportation overpacks to provide the necessary radiation shielding.
Dry-storage cask	A thick-walled cylindrical vessel, typically fabricated from stainless steel that provides both containment and shielding for storage of SNF assemblies. Some dry-storage casks can be transported.
Dry-storage system	A generic term for a dry-storage cask or a dry-storage canister in a storage overpack or a bunker.
Overpack	A thick-walled cylinder that provides radiation shielding for a canister containing SNF. Overpacks for storage are typically fabricated from concrete. Overpacks for transportation are typically fabricated from stainless steel.
Standardized Transportation-Aging-Disposal Canister (STAD)	A standardized multi-purpose thin-walled canister, or range of canisters with different capacities, being considered by DOE to introduce flexibility and economy in the management of SNF. Different overpacks would be used for storage and transportation and, possibly, disposal.
Transportation cask	A thick-walled container typically fabricated from stainless steel that provides radiation shielding during transportation for a canister containing SNF or bare SNF assemblies.

be licensed for transportation. In addition, it might be possible to design multi-purpose casks or containers that could be used for dry storage, transportation, and geological disposal of SNF. These systems are described in the following sections.

1.1.1 Dry-Storage Systems Designs

1.1.1.1 Dry-Storage Casks

Dry-storage casks are cylindrical vessels used for SNF storage. They are typically made of stainless steel, with walls approximately 8 inches thick, neutron shielding approximately 6 inches thick, and have internal baskets to support the SNF assemblies. The dry-storage casks provide both containment and radiation shielding and are typically stored vertically. Casks that also can be used for transportation are transported in a horizontal orientation by rail. Depending on the repository design, these casks may not be acceptable for direct disposal in a geologic repository. Figure 1 shows a typical dry-storage cask design.

1.1.1.2 Dry-Storage Canisters

Dry-storage canisters are cylindrical vessels, typically made of stainless steel, with walls approximately ½ inches thick and with internal baskets that support the SNF assemblies. The canisters provide containment but only limited radiation shielding. The canisters are loaded into thick-walled metal or concrete overpacks that provide radiation shielding during storage. They are transferred to thick-walled metal overpacks that provide shielding for transportation. Dry-storage canisters in transportation overpacks are typically transported in a horizontal orientation by rail. Depending on the repository design, the dry-storage canisters may not be acceptable for disposal.

For storage, canisters in concrete or metal overpacks are typically placed vertically on a concrete storage pad, as shown in Figures 2 and 3. Alternatively, canisters may be inserted horizontally into a concrete bunker that provides the radiation shielding, as shown in Figure 4.

1.1.1.3 Standardized Transportation-Aging-Disposal Canisters

The use of standardized canisters for storing, transporting, and disposing of SNF has some obvious advantages in reducing the range of canister sizes, weights, and designs that need to be accommodated in

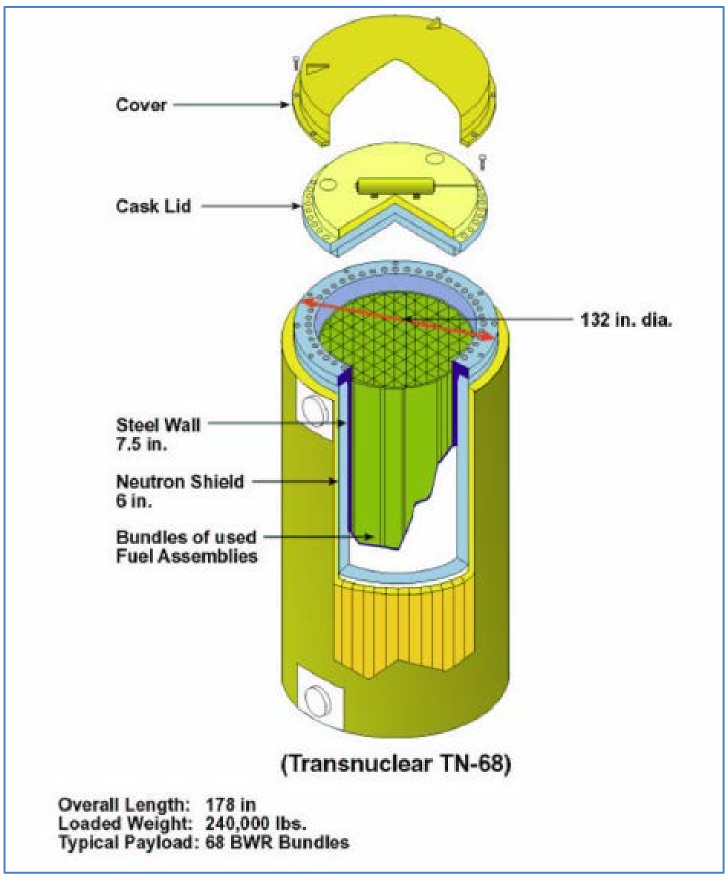


Figure 1. Typical Dry-Storage Cask
(NRC 2011)

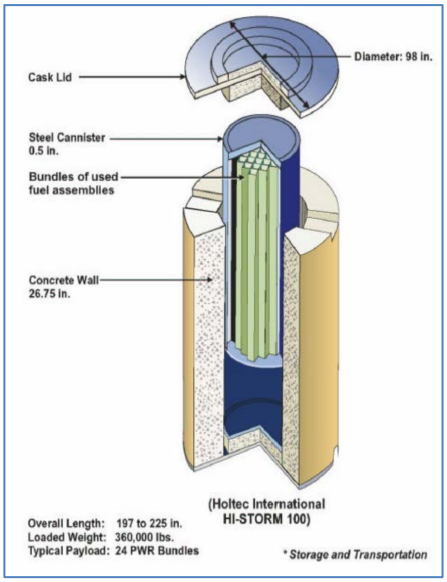


Figure 2. Vertical Concrete Overpack (NRC 2011)

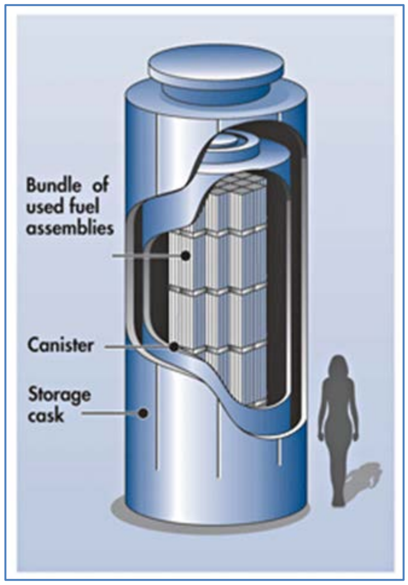


Figure 3. Vertical Metal Overpack (NRC 2013)

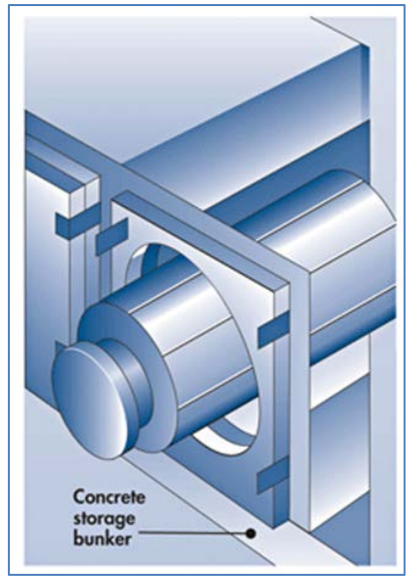


Figure 4. Horizontal Concrete Bunker (NRC 2013)

facilities involved in managing and disposing of SNF. Consequently, the U.S. Department of Energy (DOE) has in the past considered standardized canisters for SNF management and recently has contracted with teams led by AREVA and Energy Solutions to develop initial concepts for the use of standard transportation-aging-disposal canisters (STADs).

At this point, there is no defined timescale for fully developing the STAD concept or introducing STADs into service. However, the STAD is a useful concept as a basis for considering the implications of using a system that allows SNF to be loaded at a utility site into a canister without the need to be repackaged for transportation or repository disposal.

1.1.2 Dry-Storage Systems Inventory

Table 2 shows the dry-storage system inventory as of December 2011. At that time, over 1,400 dry-storage systems were in use in the United States in 25 U.S. Nuclear Regulatory Commission (NRC) approved dry-storage canister/cask designs.

SNF assemblies are currently stored at independent spent fuel storage installations (ISFSIs) located at 54 utility sites, including facilities that use dry-storage systems for SNF from nuclear power plants as well as other storage systems. Figure 5 shows the current ISFSI locations.

2 Factors Affecting the Need to Repackage

Some of the dry-storage canisters currently in use were not designed for transportation and none were designed for disposal. Although some of the canisters may meet the requirements for transportation, and the DOE currently is assessing the possibility of direct disposal of dry-storage canisters in a geologic repository, it is likely that some of the current inventory of SNF stored in large dry-storage canisters will

Table 2. Dry-Storage Systems in Use as of December 2011
(Williams 2011)

Vendor	Name	Number of Systems (As of 12/2011)
Fuel Solutions	W150	8
	VSC-24	58
TN (including NUHOMS)	24PT1,24PT4, 24PT	68
	7P, 12T, 24P, 24PHB, 32P, 52B	258
	24PTH, 32PT, 32PTH, 61BT,61BTH	263
	TN-68	53
	TN-40	29
NAC	MPC-26, MPC-36	59
	UMS-24	204
HOLTEC	MPC-24, MPC-32, MPC-68, MPC-80	439
Total		1,439

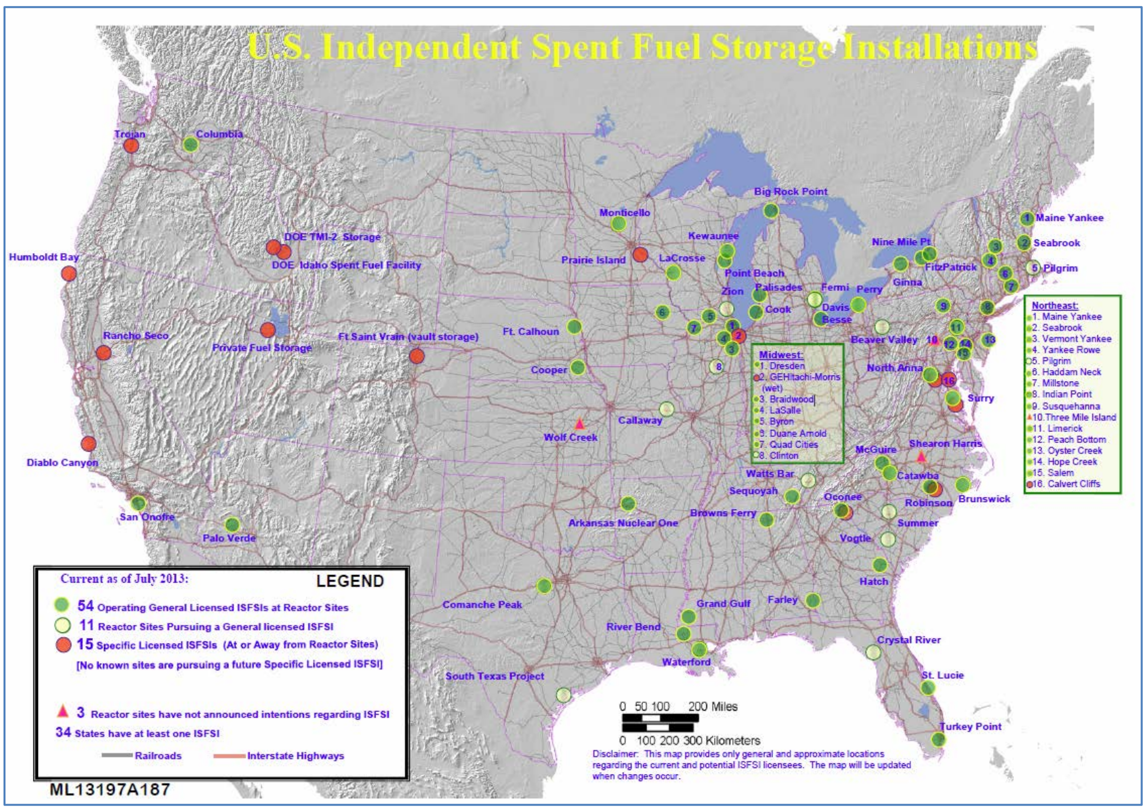


Figure 5. U.S. Independent Spent Fuel Storage Installations
(NRC 2013)

need to be repackaged into alternative containers for transportation and/or for disposal. Some of the factors that could make it necessary to repackage the SNF include the following:

- *Heat emitted by the dry-storage canisters* – The large-capacity, dry-storage canisters produce considerable heat. However, keeping repository temperatures low can protect buffer material, reduce the corrosion rates of engineered barrier materials, and simplify the understanding of thermo-mechanical and chemical processes in the repository. If the repository design requires a lower host rock temperature, the SNF in large high-heat dry-storage canisters likely would need to be repackaged into smaller capacity disposal containers or allowed to "cool" (radioactively decay), possibly for several decades.

- *Radiation level of dry-storage canisters* – Title 10 of the U.S. Code of Federal Regulations (10 CFR) Part 71.47 places limits on the radiation level at any point on the surface of or 2 meters from the surface of a cask used to transport SNF. Whether or not a transportation cask containing a large dry-storage canister meets the radiation level limit will depend on the characteristics of the SNF and the number of fuel assemblies in the canister. It is possible, therefore, that the total radiation from the SNF assemblies in some canisters would be too high for these canisters to be loaded into transportation casks without exceeding the radiation limits.

- *Canister criticality control* – Inconsistencies exist in both the requirements and the methods used to address criticality control throughout the fuel cycle. Therefore, repackaging SNF assemblies into containers that meet criticality requirements for transportation or disposal may be necessary.

- *Material degradation of dry-storage canisters and/or SNF assemblies* – 10 CFR Part 71.55 requires that a package used for the shipment of fissile material must be designed and constructed, and its contents limited, such that under normal conditions of transport, the geometric form of the package contents would not be substantially altered. This requirement ensures that the contents of the canister do not reconfigure into a more reactive geometry during transportation. In 2013, DOE, in collaboration with the Electric Power Research Institute (EPRI), has initiated a program to evaluate the effects of long-term dry storage on dry-storage canisters and SNF assemblies, including high-burnup SNF assemblies. If the results of these studies indicate that either the dry-storage canister or the SNF assemblies have degraded, or their mechanical properties have changed, to a point that is outside the original specification on which the certificate of compliance for the transportation cask was based, repackaging of the SNF assemblies may be required before transport off the utility site.

- *Size of disposal containers* – The ability to emplace waste in a repository, including transporting the disposal containers from the surface to the repository depth, and emplacing them in a repository drift in different orientations (i.e., vertical or horizontal), could be affected by the size of the disposal container. The ability to retrieve the wastes, if necessary, also could be affected by the disposal container size.

3 Workshop Objectives

The Board, with participation by DOE, NRC, the nuclear industry, and other affected and interested groups and individuals, is holding a workshop to explore the impacts of dry-storage container designs on the future handling, storage, transportation, and geologic disposal of SNF in the U.S. The primary purpose of the workshop is to objectively identify and record the potential technical issues associated with (1) the repackaging of SNF from large dry-storage canisters into smaller containers for transport or disposal and (2) the direct disposal of SNF in large dry-storage canisters in a geologic repository.

4 Workshop Format

The workshop is scheduled to begin at 1:00 p.m. on Monday, November 18, 2013, and to continue at 8:00 a.m. on Tuesday, November 19, 2013. The workshop agenda is available in a separate handout.

During the first afternoon of the workshop, the DOE Assistant Secretary for Nuclear Energy and the NRC Chairman will give their respective perspectives on the importance of addressing the impacts on the waste management system of dry-storage container designs. There also will be technical presentations on the types, sizes, and numbers of dry-storage containers currently in use at nuclear power plant sites, the technical implications of repackaging SNF, and the technical implications of direct disposal of large dry-storage canisters in a deep geologic repository. A presentation also will be made by a representative of DBE Technology, GmbH, which is a German company that has been involved in developing the German repository program and has considered the implications of direct disposal of SNF in large dry-storage canisters as well as smaller disposal containers.

On the morning of the second day, two concurrent breakout sessions will be held to allow extensive discussion of issues that could impact future handling, storage, transportation, and disposal of commercial SNF and SNF managed by DOE. Introductory statements on relevant issues will be made by a nuclear industry representative and by a representative of a non-governmental organization that is independent of the nuclear industry. If time permits, other participants also will have the opportunity to present short prepared statements.

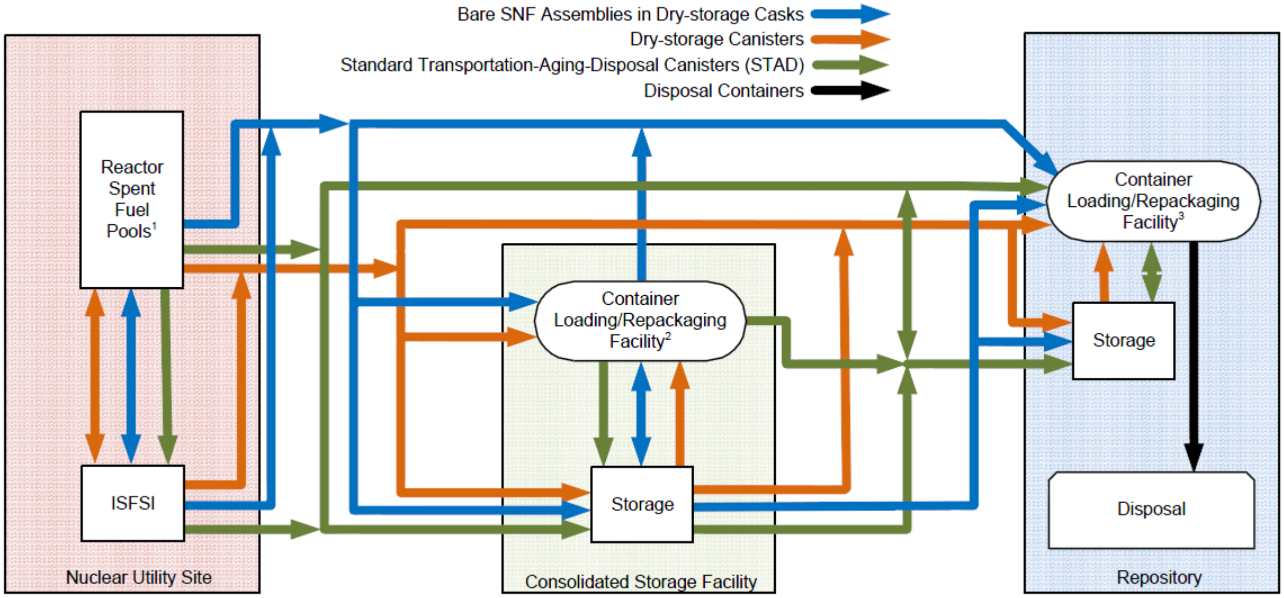
During the afternoon of the second day, there will be a plenary session where the outcomes of the breakout sessions will be summarized. Participants will also discuss factors such as the interdependencies of the issues and whether non-technical factors could affect the resolution or timeframe for their resolution. Although it is not intended that actions will be identified at the workshop, these “take away” points may be included in a Board report on the outcomes of the workshop.

A final comment session for meeting participants and attendees will close out the workshop.

5 Workshop Breakout Sessions

The concurrent breakout sessions will identify issues associated with the two main approaches to SNF management: (1) repackaging the SNF that is in dry-storage canisters into small-capacity, low-heat output containers and (2) direct geologic disposal of the dry-storage canisters. Two techniques (material flow paths and interaction matrices) will be used to analyze issues that may arise at each operational stage as well as issues that may arise because of the interactions between the different operational stages.

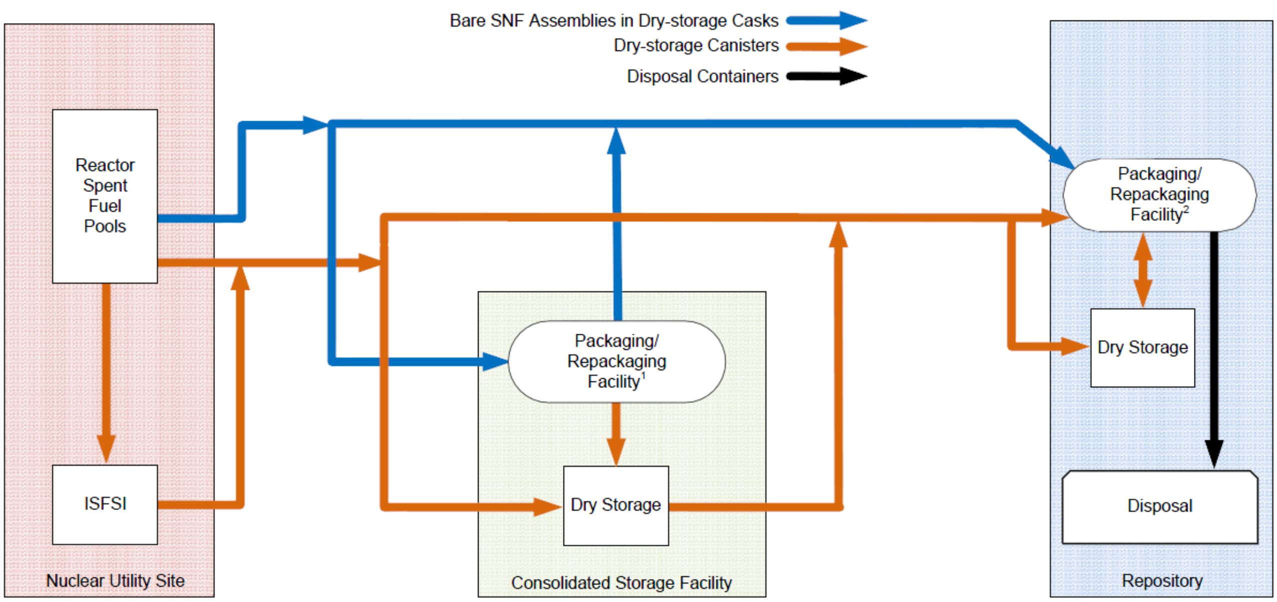
First, potential material flow paths — from the time the SNF assemblies are moved from the reactor to the fuel pool through disposal — will be used to identify the SNF management activities that could occur at each type of facility (i.e., nuclear utility site, consolidated storage facility, and repository) and to identify where and how movement of SNF between the facilities could occur. The potential material flow paths for the two breakout sessions are shown in Figures 6 and 7. These figures depict the movement of SNF within a nuclear utility site (light orange box on the left), consolidated storage facility (light green box in the middle), and repository (light blue box on the right), as well as transportation from one facility to another (arrows between colored boxes). Figures 6 and 7 use a different color for (1) each type of container that is being used to store SNF at nuclear utility sites, (2) each type of container that will



General Notes:
- All arrows outside the shaded facility boxes represent transportation operations.
- There are some dry-storage casks at utility sites that contain bare SNF assemblies which can be loaded into STADs at the utility site, Consolidated Storage Facility, or Repository; or loaded into disposal containers at the repository.

Footnotes:
1. Utility fuel pools can be used to transfer SNF assemblies from a dry-storage canister or dry-storage cask to STADs or dry-storage cask into a STAD or disposal container, if the disposal container is transportable .
2. The Container Loading/Repackaging Facility at the Consolidated Storage Facility can be used to transfer bare SNF assemblies or SNF assemblies in a dry-storage canister to STADs.
3. The Canister Loading/Repackaging Facility at the Repository can be used to transfer bare SNF assemblies or SNF assemblies in a dry-storage cask or dry-storage canister into a STAD or disposal container, or load a STAD into a disposal container.

Figure 6. Breakout Session 1- Implications of Repackaging SNF for Transportation or Disposal, Potential Material Flow Paths



General Notes:
- All arrows outside the shaded facility boxes represent transportation operations.
- There are some dry-storage casks at utility sites that contain bare SNF assemblies which can be transferred into a canister at the utility site, Consolidated Storage Facility, or Repository; or directly into a disposal container at the repository.

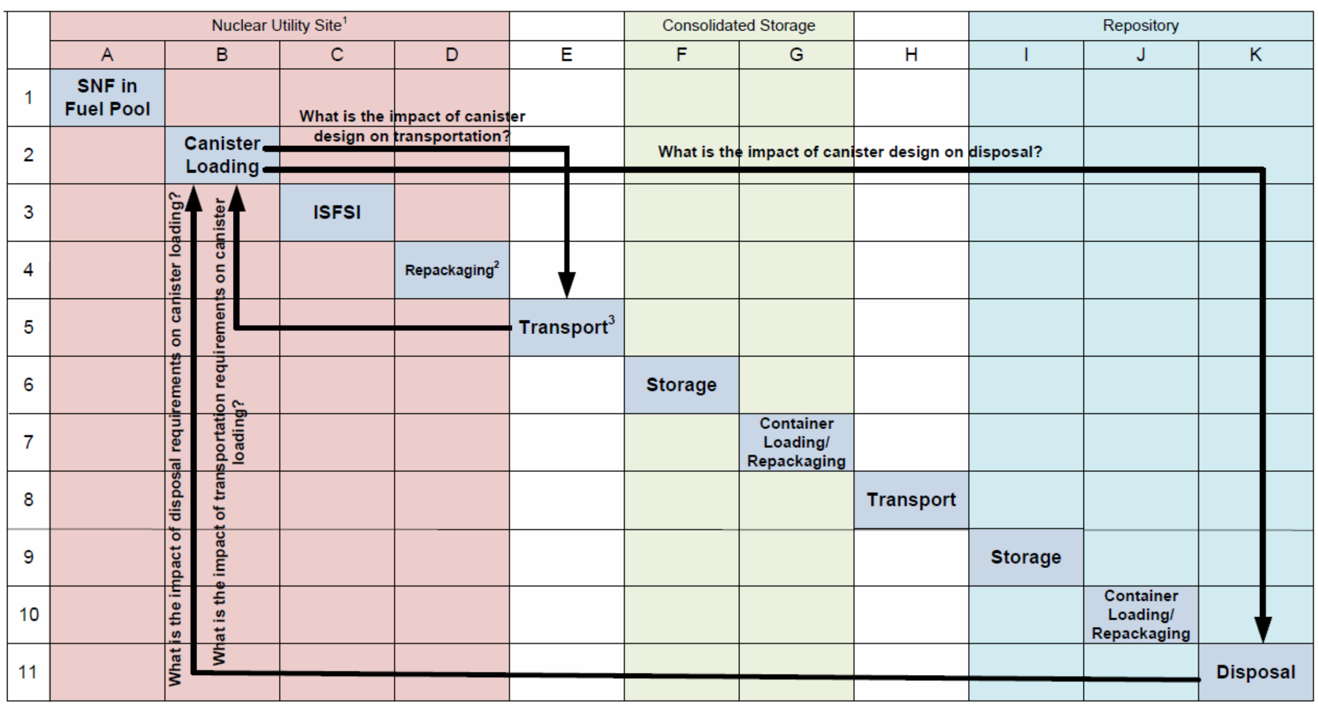
Footnotes:
1. The Packing/Repackaging Facility at the Consolidated Storage Facility can be used to transfer bare SNF assemblies from a dry-storage cask into a dry-storage canister.
2. The Packing/Repackaging Facility at the Repository can be used to transfer bare SNF assemblies from a dry-storage cask into a dry-storage canister or disposal container.

Figure 7. Breakout Session 2-Implications of Direct Disposal of Large Dry-Storage Canisters, Potential Material Flow Paths

be used for transportation and disposal, and (3) the pathways for SNF movement between the different SNF management facilities.

Second, an interaction matrix will be used as a convenient, traceable way to represent the SNF management system. An interaction matrix is a top-down approach that is used to ensure all aspects of the program are being considered, e.g., the features, events, and processes in performance assessments for high-level radioactive waste disposal. The main operational stages being modeled are listed and presented along the leading diagonal of the interaction matrix, with the start of the system in the upper left corner of the matrix. The interactions between the main operational stages are associated with the off-diagonal terms. Interactions can be forward (to the right along a row away from one operational stage on the leading diagonal and down to another operational stage on the leading diagonal) or backward (to the left along a row away from one operational stage on the leading diagonal and up to another operational stage on the leading diagonal). Interaction matrices can be used in this way to systematically and transparently identify the issues and interactions between the operational stages of the SNF management system.

The interaction matrix for the SNF management system is shown in Figure 8. To identify issues that may arise at different operational stages, it can be helpful to ask questions about the interaction. Two examples of interactions between operational stages of the SNF management systems, with example questions, are depicted in Figure 8. For the interaction between canister loading at a utility site and transportation of the SNF to a consolidated storage facility, there are both potential forward and backward interactions. A question to understand the potential issues associated with the forward interaction is, "What are the impacts of canister design on transportation of SNF from a nuclear utility site to a consolidated storage



Footnotes:
1. Before the fuel handling and fuel pool facilities are decommissioned.
2. If the plant fuel pool has been decommissioned, repackaging would require a temporary fuel pool or dry transfer facility
3. If dry-storage canisters do not meet the transportation requirements the canisters may need to be repackaged prior to transporting

Figure 8. Interaction Matrix

facility?" Issues associated with the answer to the question could be depicted in, or assigned to, "From Cell" B2 "To Cell" E5 of the interaction matrix. A question to understand the potential issues associated with the backward interaction is "What are the impacts of transportation requirements on the design of canisters loaded at nuclear utility sites?" Issues associated with the answer to the question could be depicted in, or assigned to, "From Cell" E5 "To Cell" B2 of the interaction matrix.

To facilitate capturing the issues identified during the breakout sessions, they will be recorded in tabular form in the manner shown in Table 3. For example, issues that arise from the impact of loading dry-storage containers at reactor sites on the subsequent transportation of SNF away from the site to a consolidated storage facility can be recorded in "From Cell" B2 "To Cell" E5. Also, potential issues that arise from the canister loading used at a nuclear utility facility on repository disposal of SNF can be recorded in cell "From Cell" B2 "To Cell" K11. Issues that arise from the impacts of disposal requirements on the loading of the canisters loaded at nuclear utility sites can be recorded in cell "From Cell" K11 "To Cell" B2. Similarly, issues that arise from the impacts of transportation requirements on the loading of the canisters at nuclear utility sites can be recorded in cell "From Cell" E5 "To Cell" B2, as appropriate. In addition, any issues identified by the participants that do not fit into the SNF management interaction framework, but that nevertheless could impact future SNF management activities, also will be recorded.

Together the material flow diagrams and the interaction matrices should allow workshop participants to identify the potential issues that impact the SNF management system by looking at both the types of containers (casks, canisters, etc.) that could be used at different operational stages and the interactions that may occur between the operational stages of the SNF management system. For example, the issues that arise in a particular interaction (e.g., impact of canister design used at a nuclear utility facility on transportation to a consolidated storage facility) could differ depending on whether dry storage casks or dry storage canisters are used at the nuclear utility site.

Table 3. Examples of Issues Identified by Interaction Between Components of the SNF Management System

Horizontal Evaluation

From Cell	To Cell	Potential Issue
B2	C3	•
	D4	•
	E5	• If credit for soluble boron is used in the criticality analysis during canister loading, the possibility exists that the canister may not meet the criticality requirements for transportation, as the analysis for transportation has to take account of the potential for the canister to become flooded with demineralized water. • Canisters may meet structural requirements for storage but not for transportation
	F6	•
	G7	•
	H8	•
	I9	•
	J10	•
	K11	• The dry-storage canister criticality control material is aluminum impregnated with boron. The corrosion rate of this material may not be acceptable for repository disposal.

Each breakout session will have a facilitator who will help focus the technical discussions and keep the sessions on schedule. Participants may stay in one of the breakout sessions for the complete duration or may move between sessions so they can derive the most benefit from their workshop participation. Two Board members in each session will serve as rapporteurs to record the main discussion points, which will be presented during the afternoon plenary session and will serve as the bases for a Board report on the outcomes of the workshop.

6 Workshop Results

The workshop, including the breakout sessions, will be transcribed. The transcript will be available after December 16, 2013, on the Board's website www.nwtrb.gov. Any documents submitted by workshop attendees or other interested organizations or individuals as input to the workshop also will be posted to the Board's website, as part of the record of the workshop.

Following the workshop, the Board will prepare a report recording the technical background and the issues that were raised. It also will record points raised during discussion of the "take-aways" and other relevant information, and may make observations determined by the Board to be appropriate in recording the outcomes of the workshop. This report will be posted on the Board's web site. Comments on the Board report provided by workshop participants and other interested parties also will be posted on the Board's website.

7 References

NRC. *Backgrounder on Dry Cask Storage of Spent Nuclear Fuel*. May 23, 2013. http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/dry-cask-storage.html (accessed September 4, 2013).

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Williams, J. "Compatibility of Commercial Storage Containers with the Waste Management System." January 9, 2012 NWTRB Meeting, Arlington, Virginia. http://www.nwtrb.gov/meetings/2012/jan/williams.pdf (accessed September 4, 2013)

Acronyms and Glossary of Terms

Abbreviations and Acronyms

Acronyms	**Description**
Board	U.S. Nuclear Waste Technical Review Board
DOE	U.S. Department of Energy
EPRI	Electric Power Research Institute
GWd/MTU	gigawatt-days per metric tons uranium
ISFSI	independent spent fuel storage installations
mrem/hr	milliroentgen equivalent in man per hour
NRC	U.S. Nuclear Regulatory Commission
NUREG	U.S. Nuclear Regulatory Commission Regulation
NUWASTE	Nuclear Waste Assessment System for Technical Evaluation
NWTRB	U.S. Nuclear Waste Technical Review Board
SNF	spent nuclear fuel
STAD	standardized transportation-aging-disposal container

Glossary of Terms

actinide	The series of elements encompassing the 15 metallic chemical elements with atomic numbers from 89 to 103, actinium through lawrencium
buffer material	A material placed around the disposal container that retards the movement of water.
burnup	A measure of reactor fuel consumption expressed as the percentage of the fuel atoms that have undergone fission, or the amount of energy produced per unit weight of fresh fuel
burnup credit	The reduction in assembly reactivity as a result of assembly use in power reactors. Changes in the assembly isotopic composition during reactor operation results in the reduction of the net fissile content, the build-up of actinides and fission products, and, where applicable, the reduction of burnable absorber concentration.
container	Any type of sealed cylindrical vessel that provided containment for SNF. Dry-storage canisters, disposal containers, dry-storage casks, etc. are referred to generically as containers.
containment	A structure or component that prevents the release of radioactive material to the environment.
criticality	The condition in which a fissile material can sustain a nuclear reaction. Criticality occurs when the number of neutrons present in one generation equals the number of neutrons in the previous generation.
disposal container	A sealed cylindrical vessel that provides containment and is designed for emplacement in a repository. A disposal container may contain bare SNF assemblies or one or more storage canisters, transportation or multi-purpose containers and may provide radiation shielding according to the design of the repository.
dry-storage canister	A thin-walled cylindrical vessel, typically fabricated from stainless steel, that provides containment for SNF. For storage, a dry-storage canister is loaded into a storage overpack or modular storage bunker to provide the necessary radiation shielding. Some dry-storage canisters may be able to be transported when loaded into transportation overpacks to provide the necessary radiation shielding.

dry-storage cask	A thick-walled cylindrical vessel, typically fabricated from stainless steel that provides both containment and shielding for storage of SNF assemblies. Some dry-storage casks can be transported.
dry-storage system	A generic term used to refer either to a dry-storage cask or to a dry-storage canister in a storage overpack or a bunker.
enrichment	The process of increasing the weight percent of 235U contained in the assembly
exclusive use	The sole use by a single consignor of a conveyance for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee
fission products	Fission products are the result of fission by a heavy atomic nucleus. Typically a heavy nucleus such uranium or plutonium undergoes fission by absorbing a neutron and dividing into nuclei of lower mass. The fission process also yields additional neutrons, gammas, betas, and neutrinos. Recoverable energy is released in the form of kinetic energy of the fission fragments and neutrons, and gammas.
geologic repository	A facility for disposing of radioactive waste in excavated geologic media, including surface and subsurface areas of operation and the adjacent part of the natural setting.
high-level waste	Highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in concentrations above levels specified in regulations. Any other highly radioactive material that NRC, consistent with existing law, determines permanent isolation by disposal in a geologic repository.
k_{eff}	Effective neutron multiplication factor — In an assembly containing fissile material, k_{eff} is the ratio of the number of neutrons in one generation compared to the number of neutrons in the previous generation, or alternatively, the average number of neutrons from one fission that causes another fission. It follows that $k_{eff} = 1$, if the system is critical; $k_{eff} < 1$, if the system is subcritical; $k_{eff} > 1$, if the system is supercritical
NUREG	U.S. Nuclear Regulatory Commission Regulation

overpack	A thick-walled cylinder that provides radiation shielding for a canister containing SNF. Overpacks for storage are typically fabricated from concrete. Overpacks for transportation are typically fabricated from stainless steel.
reactivity	A measure of the state of a reactor in relation to where it would be if it were in a critical state. Reactivity is positive when a reactor is supercritical, zero at criticality, and negative when the reactor is subcritical. Reactivity is the fractional change in the effective multiplication factor, k_{eff}, or $(k_{eff} - 1)/k_{eff}$, or $\Delta k/k$.
repackaging facility	A facility that contains a wet pool and/or dry transfer station that is used to repackage the SNF.
shielding	A structure or component that blocks radiation and reduces the radiation level.
spent nuclear fuel	Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by chemical reprocessing.
standardized transportation-aging-disposal canister (STAD)	A new standardized multi-purpose thin-walled canister, or range of canisters with different capacities, being considered by DOE to introduce flexibility and economy in the management of SNF. Different overpacks would be used for storage and transportation and, possibly, disposal.
transfer station	A component located inside the repackaging facility that is used to transfer the SNF.
waste stream	The number and characteristics (type, initial enrichment, and burnup) of SNF assemblies discharged from the U.S. nuclear power plants each year.
transportation cask	A thick-walled container typically fabricated from stainless steel that provides radiation shielding during transportation for a canister containing SNF or bare SNR assemblies.