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Nuclear Fuels Storage & Transportation Planning Project
Office of Fuel Cycle Technologies
Nuclear Energy

Integrating Standardization into the Nuclear Waste Management System

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Nuclear Waste Technical Review Board
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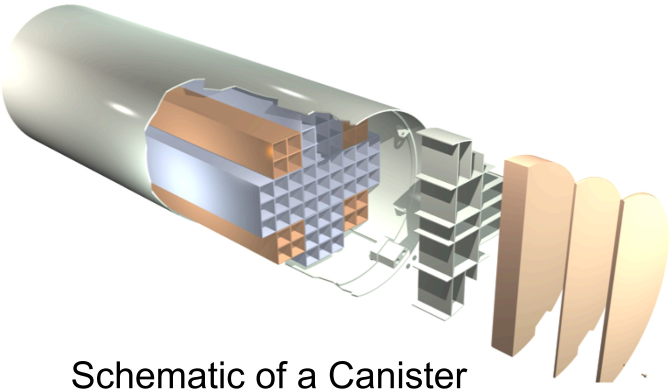
Caveat lector: Standard Contract between utilities and DOE (10 CFR 961)

- This is a technical presentation that does not take into account the contractual limitations under the Standard Contract
- Under the provisions of the Standard Contract, DOE does not consider spent fuel in canisters to be an acceptable waste form, absent a mutually agreed to contract modification

The current dry storage inventory is diverse

- **Once pools started to fill up (after re-racking), assemblies were moved to dry storage**
- **NRC has licensed 26 designs**
  - 5 storage-only casks
  - 21 storage and transportation dual purpose canisters (DPCs)
- **Many different canister sizes**
  - Length: 122.5 to 196 inches
  - Weight: 55,000 to 105,000 pounds
  - Storage may be horizontal or vertical
  - Maximum Capacities:
    - 7 to 37 PWR assemblies
    - 52 to 89 BWR assemblies
- **Three main vendors (each with own designs)**
  - NAC (12%), Transnuclear (38%), and Holtec (46%)



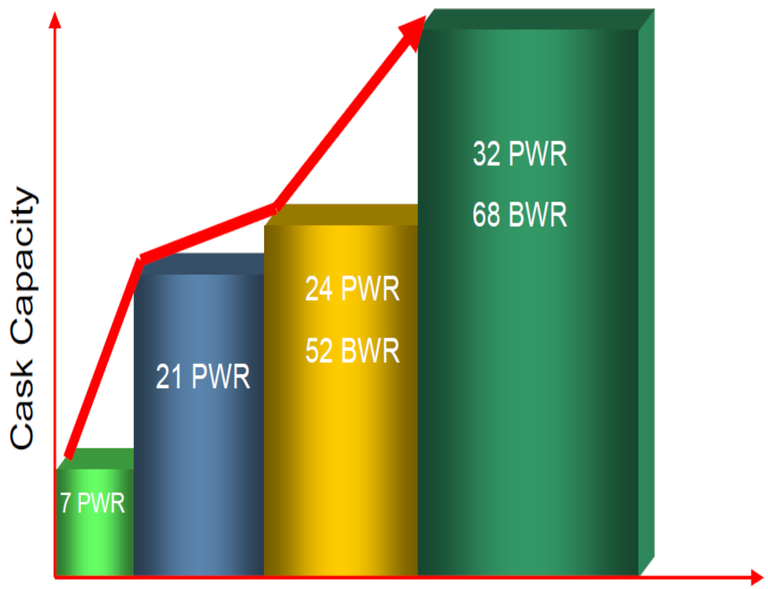
Schematic of a Canister

Horizontal storage

Vertical storage

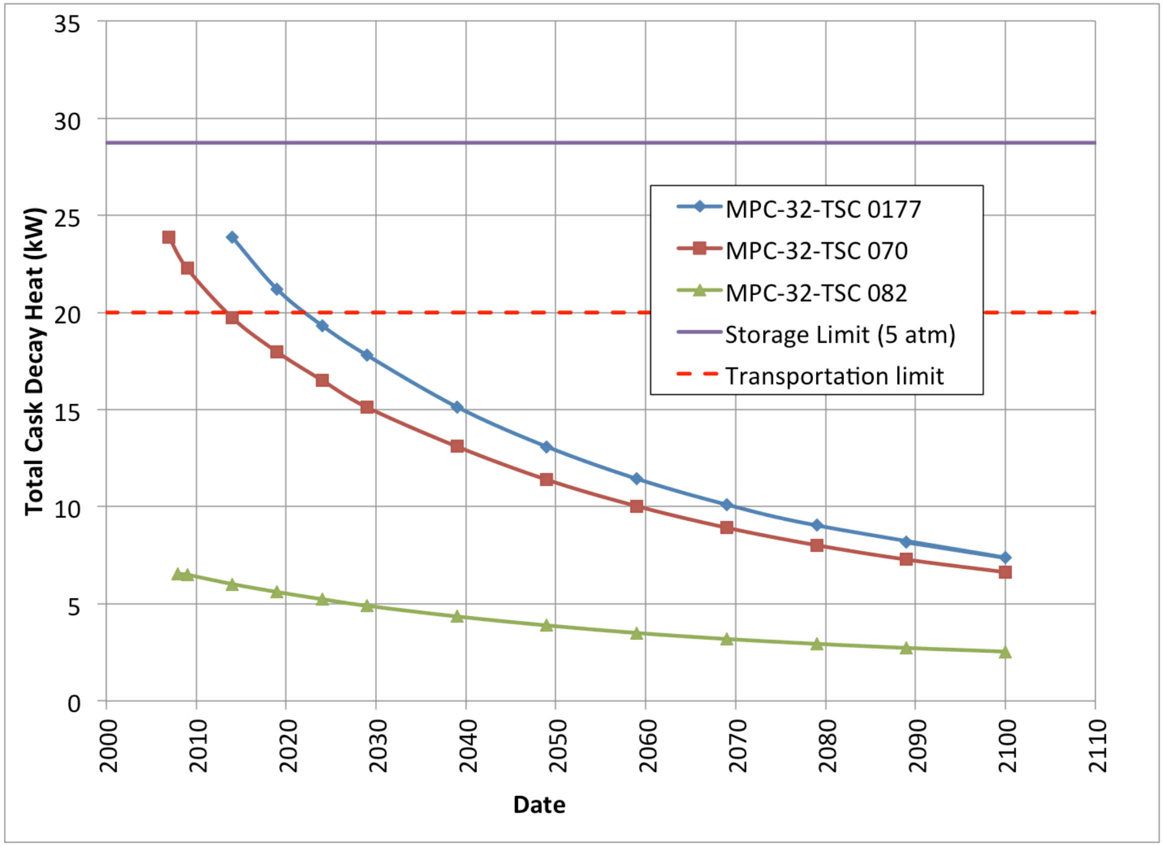
The current dry storage inventory is diverse because there is no integrated waste management system

- **Each utility makes site-specific dry storage decisions**
  - Dependent on cost, dose, and operations at each site
- **There is no recognition of disposal in our current system**
  - As a result, the utilities are optimizing on storage (not transportation or disposal)
  - This has resulted in larger and larger DPCs



Thermal loads in dry storage are problematic to an integrated waste management system

- Large DPCs may not be transportable for many years due to lower heat load limits, as compared to storage



Examples of actual casks loaded at Sequoyah – a few of the casks will not meet the transportation limit until ~10 years after loading

Large DPCs may increase the cost of the waste management system

- **Large DPCs may not be transportable for many years due to lower heat load limits, as compared to storage**
- **Increasing dry storage in DPCs increases the extra cost in the system**
  - Cost to purchase DPCs (that are not part of the final solution)
  - Cost to load DPCs and then re-package assemblies in “disposable canisters”
  - Cost to dispose of DPCs as low level waste
  - If the assemblies could be loaded in the “disposable canisters” initially, these extra costs could be avoided

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Standardization is a method to introduce integration

Opportunities for standardizations

- **Storage overpacks**
  - Single vertical storage overpack for all canisters
  - One vertical and one horizontal overpack for all canisters
  - One overpack for each canister vendor
  - Potential benefits:
    - Simplified operations at an interim storage facility or repository aging pad
- **Transportation overpacks**
  - Single overpack for all canisters
  - Single overpack for each canister vendor
  - Potential benefits:
    - Simplified receiving operations at any waste facility
    - Simplified rail car design and operations
    - Reduced overpack inventory needs

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Opportunities for standardizations

- **Complete canister system**
  - Canister, overpacks, and ancillary equipment

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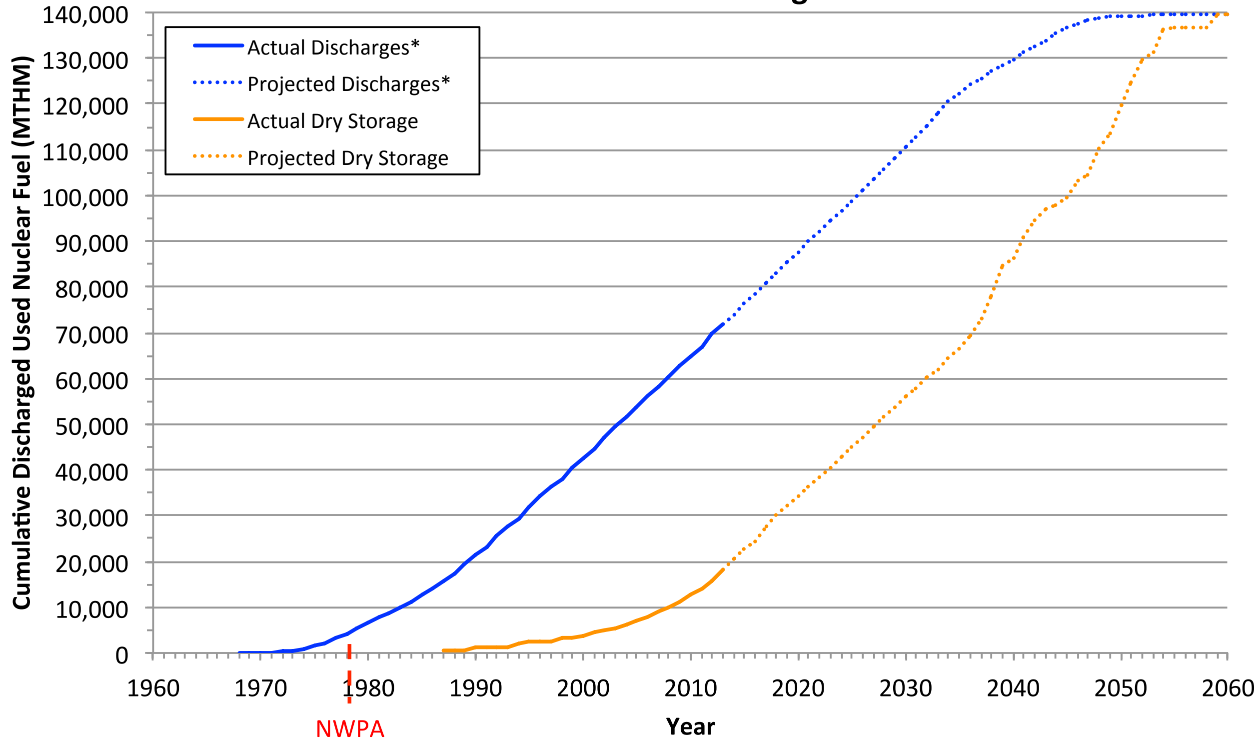
Opportunities for standardizations

- **Complete canister system**
  - Canister, overpacks, and ancillary equipment
- **Potential benefits:**
  - Reduced overall system cost, mainly from avoidance of extra costs and operational efficiencies
  - Increased flexibility and/or reduced sensitivity to future decisions and/or changes to waste management requirements
  - Simplification in waste handling and licensing at an interim storage, repackaging, or reprocessing facility and/or repository
    - Less ancillary equipment and associated procedures and training
  - Reduced uncertainties associated with waste acceptance and system performance
  - Minimized repackaging requirements and associated costs and dose effects

Delaying standardization will reduce the benefits

- **At some point, most of the fuel is in DPCs and the majority of extra costs are unavoidable**



Source: *Based on actual discharge data as reported on RW-859s through 12/31/2002 and projected discharges, in this case for 100 license renewals

Amount of Fuel in Dry Storage

2012: ~20,000 MTHM

2025: ~50,000 MTHM

2035: ~70,000 MTHM

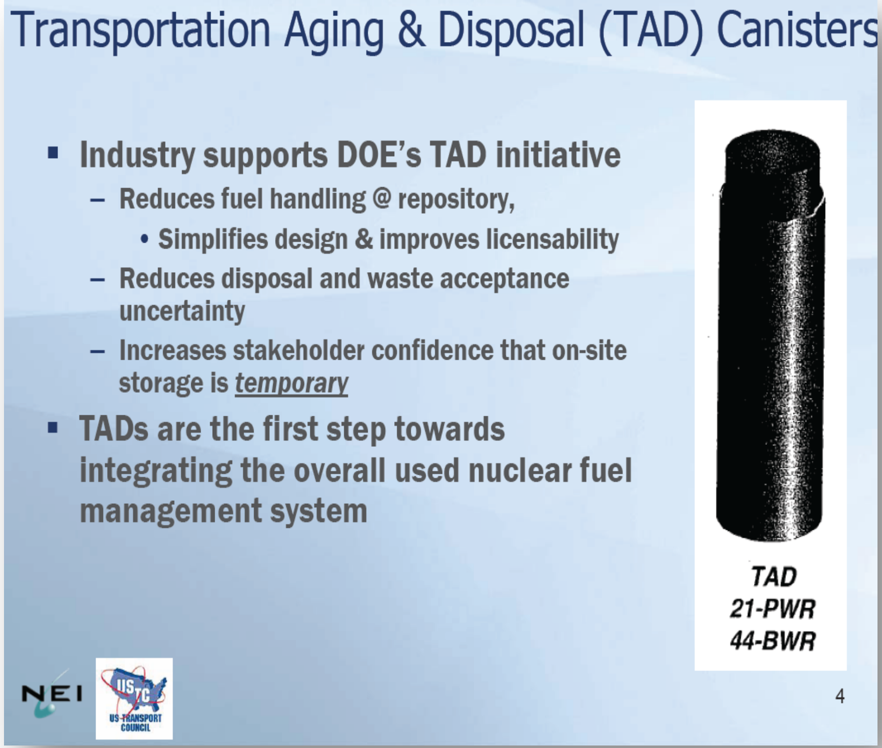
2048: ~110,000 MTHM

The when and where of standardization is important

- **There is reduced return on investment if the time frame to incorporate standardization is delayed**
  - Unfortunately, without disposal requirements, it is a challenge to design and incorporate a waste package function with certainty
- **Where to incorporate standardization**
  - Operating Reactors
    - Must minimize impact on current “assembly throughput”
  - Shut-down Reactors
    - Some extra cost
  - At an interim storage facility or repository
    - Significant extra cost if all fuel is in DPCs
    - Bare fuel transportation directly from the reactor pools could mitigate this risk

Previous efforts recognized and pursued benefits of standardization

- **In the 1990s, the US DOE contemplated a waste management system that included a multi-purpose canister and consolidated interim storage as part of an integrated waste management system**
- **In the late 2000s, the use of Transportation, Aging, and Disposal (TAD) Canisters was seen as a way to integrate storage at independent spent fuel storage installations (ISFSI), transportation, and disposal**



NEI NWTRB September 2007 Presentation

These previous efforts had the advantage of a known geologic setting for a repository

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Current Motivation for Standardization

- **Blue Ribbon Commission (BRC) final report**
  - *"…DOE should begin laying the groundwork for…improving the overall integration of storage as a planned part of the waste management system without further delay. Specific steps that DOE could take in the near term include:…*
    Working with nuclear utilities, the nuclear industry, and other stakeholders to promote the better integration of storage into the waste management system, including standardization of dry cask storage systems."
- **Nuclear Energy Advisory Committee: June 13, 2013 report**
  - *"A new standardized storage, transport and disposal canister design should be developed for the large amount of used fuel still in cooling pools …"*
- **Nuclear Waste Technical Review Board: June 30, 2011 report**
  - *"Future programs should consider the TAD* [transportation, aging, and disposal] *canister concept carefully because of its potential safety, handling, system-simplification, and cost advantages. However, the programs should ensure that the sizes of the canisters are compatible with fuel dimensions and the sizes of dual-purpose canisters."*

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Recent Arguments against Standardization

- **NEI: October 31, 2011 letter to the BRC**
  - *"We do not agree that standardization will necessarily improve the waste management system and reduce overall system costs….We do not think that dry cask storage systems can be standardized until the requirements for the disposal waste package are specified…We recommend that the subcommittee provide a recommendation that a new waste management organization strive to dispose of the existing canisters before designing a new standardized canister."*
- **EPRI: July 1, 2011 letter to the BRC**
  - *"EPRI disagrees that the case for "standardizing" dry storage systems has strengthened. Useful "standardization" can only be done with details of the storage and disposal designs in hand. … Thus, given there are no details on the requirements for a disposal canister, what is the basis for selecting a "standardized" storage system? In summary, until there is adequate confidence that the details of both the consolidated storage and disposal systems are in hand, EPRI recommends that the current industry approach of independently selecting storage and transportation systems be maintained."*

Input solicited and received from industry

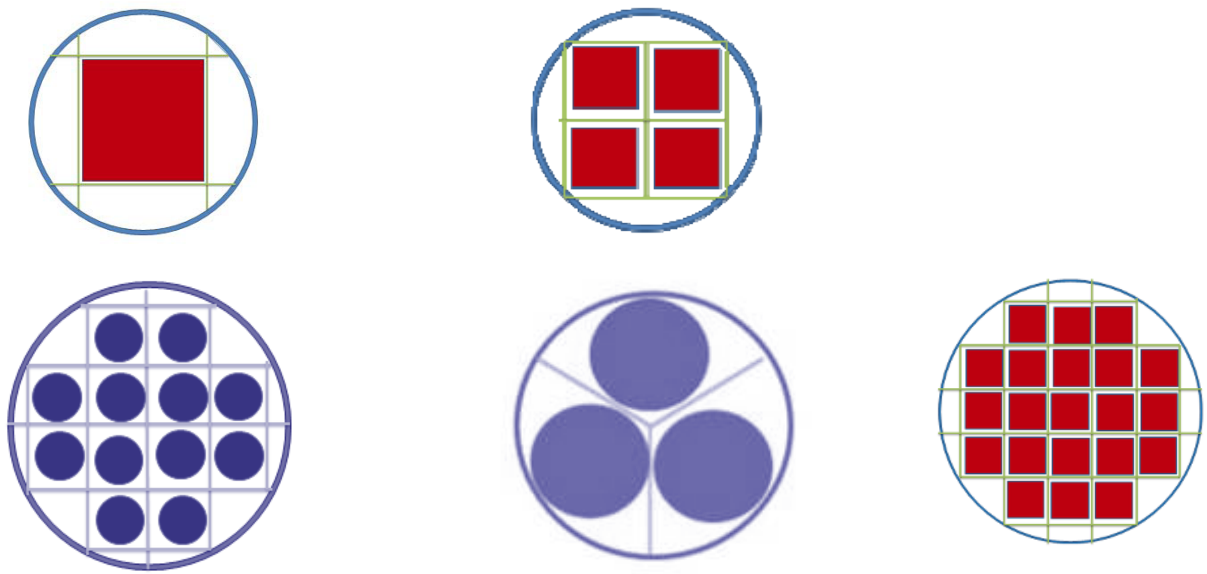
- **In FY13, the NFST asked industry Advisory and Assistance contractors to provide technical ideas and recommendations, supported by evaluation/analysis, on approaches to better integrate Standardized Transportation, Aging, and Disposal (STAD) canister concepts into the waste management system**
- **Two contracts awarded:**
  - AREVA-led team
  - Energy*Solutions*-led team
- **Each team developed design concepts for a STAD/family of STADs with the help of various utilities and cask designers**
- **Each team performed system analyses**

AREVA's recommendations

- ***"Carry forward three canister options (one small* [1 PWR/2 BWR], *one medium* [4 PWR/9 BWR], *and one large* [21 PWR/44 BWR]*) to the conceptual and preliminary design phases"***
  - Keep options open because repository characteristics are unknown

Canister

Handling Frame and Overpack

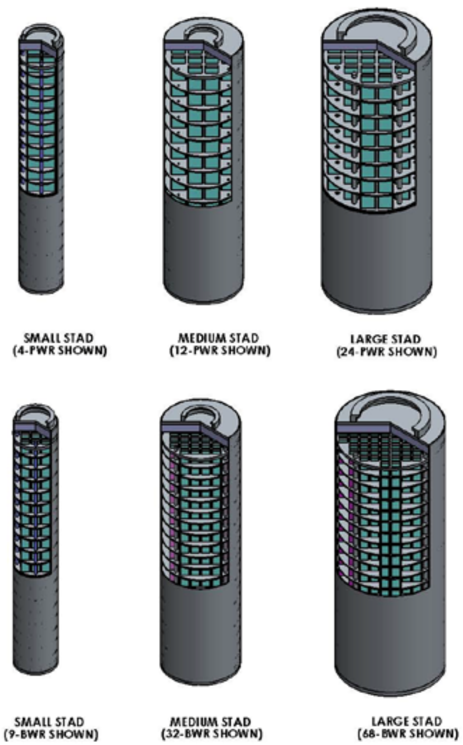


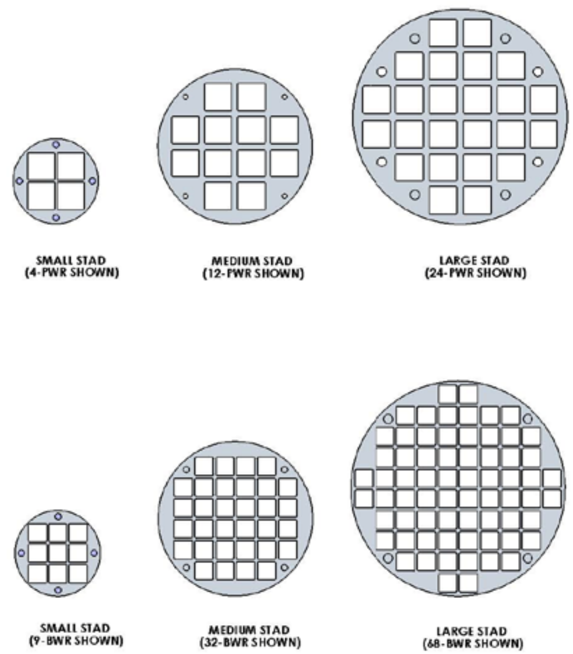
1 PWR
2 BWR

4 PWR
9 BWR

Energy*Solutions*' recommendations

- ***"Until the repository is selected, maintain a multi-STAD canister approach comprising of a small (*4 PWR/9 BWR*), medium (*12 PWR/32 BWR*) and large (*24 PWR/68 BWR*) configuration"***
  - Similar to AREVA but all sizes are larger





Industry studies recognized the need to maximize assembly throughput

- **Currently, utilities have small windows (~few weeks a year) devoted to dry-cask loading campaigns**
- **Using current procedures, small canisters will take almost as long to load as larger canisters**
- **Impacting those windows could impact reactor operations**

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- **AREVA: *"Develop a business plan for the adoption of the STAD when the reactor enters D&D"***
- **Energy*Solutions*: *"Operating nuclear reactors should not be mandated to package their UNF into small or medium size STAD canisters…once an operating site is shutdown, the site operator will have flexibility for loading UNF from the spent fuel pool into STAD canisters*"**

Let’s change the conversation

- **Assembly throughput at the reactor sites is a key challenge**
  - Let’s work to address industry concerns
  - What types of innovation/research should be looked at?
    - Are there advanced/innovative canister designs?
    - Are the faster methods for welding and/or drying available?
    - Are there ways to do operations in parallel or reduce operational impacts inside the building?

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    - What are the system impacts if the disposal requirements change?

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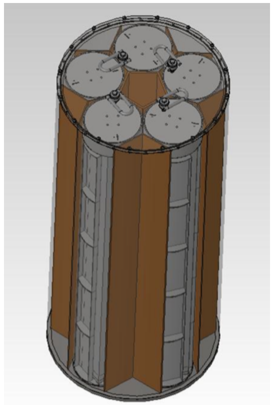
  - Let's work to quantify these risks
    - What are the system impacts if the disposal requirements change?
- **Status quo works now because we don't have an integrated system**
  - Let's lay the groundwork for a flexible, integrated system
  - Let's use this period of uncertainty to perform systematic analyses to form a basis for future decisions

There are a number of questions that could be answered



- **Canisters**
  - What are the performance requirements at a reactor and repository?
  - Are there innovative ideas for improving canister designs (or canister processes)?
- **Overpacks**
  - What are the cost/dose/operational benefits of standardized transportation or storage overpacks?
  - Are standardized overpacks technically feasible and licensable?
- **Timing**
  - When should canister systems and/or standardized overpacks be deployed?
- **Location**
  - Where should canister systems and overpacks be deployed?

There are a number of questions that could be answered

- **Total system impacts**
  - What is the operational effect of loading smaller canisters at reactors? Can this be mitigated?
  - How sensitive are the overall system costs to the
    - size of the canisters?
    - number of canisters that have to be transported?
    - cost of the canisters?
    - cost of the overpacks?
    - timing of standardization?
    - etc.
  - How beneficial is the avoidance of some/most repackaging?
  - How would a system with standardization be able to respond if the disposal requirements change?

Now is the time to address these questions

- **Current concerns**
  - Uncertain disposal requirements
  - Potential impacts to utilities
  - Debate over the basis and benefits of standardization
- **Path Forward – Perform quantitative assessment of relevant options to understand impact of current concerns**
  - Establish the basis for future policy decision making in regards to standardization
  - Compare different scenarios related to standardization
  - Specifically, these scenarios will include "what if we are wrong" scenarios
    - Example: What is the effect on the system if after 10 years of loading small canisters, it's determined that large canisters can be disposed?

Steps in a quantitative assessment of standardization

1. Assemble a standardization working group of subject matter experts
2. Develop a standardization assessment plan
   - Define which scenarios and key assumptions should be analyzed as well as assessment metrics
   - Assess and improve waste management systems analysis capabilities and tools relative to evaluating the relevant scenarios, including data requirements
   - Develop enveloping design requirements for potential disposal media and operational performance requirements and then initiate generic designs based on these requirements
   - Initiate activities that will improve the level of confidence in the information needed for assessment and/or target the challenges outlined in the plan
3. Execute the plan elements/activities including analyses and evaluations
4. Obtain external review by independent subject matter experts and key stakeholders
5. Finalize results that provide quantitative and qualitative comparisons of options to support decision making

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Successful conclusion of this activity will lay the groundwork for providing the basis for future policy decisions in regards to standardization and integration in the waste management system

Conclusion

- **A change to the waste management system would be a major policy decision**
  - It MUST have a firm basis

Questions