





# Transport and Storage Considerations for Management of Used Fuel

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# Management of Used Fuel



- ▶ **Options selected to manage Used Fuel determine what issues will need to be addressed**
- ▶ **Basic Options**
  - ◆ **Store**
  - ◆ **Recycle**
  - ◆ **Disposal (Future)**
- ▶ **Each management option has unique requirements and challenges**
- ▶ **AREVA/TN Inc has been involved in all aspects of transport, storage, recycling and disposal of used fuel**

# On-Site Fuel Management Options



## ▶ On-Site wet storage

- ◆ Typical short term storage in fuel pools
- ◆ Re-racking is common
- ◆ Least expensive approach until fuel pool is full

## ▶ On-Site Dry storage

- ◆ Many Examples
- ◆ Over 50,000 fuel assemblies dry stored in the US



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# Off Site Fuel Management Options

- ▶ **Site-to-Site Transport and then Storage**
  - ◆ Used sparingly to take advantage of larger fuel pools
  - ◆ Oconee to McGuire (US)
  - ◆ Brunswick and Robinson to Shearon Harris (US)
- ▶ **Site-to-Central Storage Facility**
  - ◆ Early shipments to central wet storage facility (US)
  - ◆ Leibstadt to Zwiilag (Switzerland)
  - ◆ Other locations



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# Recycle and Disposal Fuel Management Options



## ▶ Transport to Lag Storage

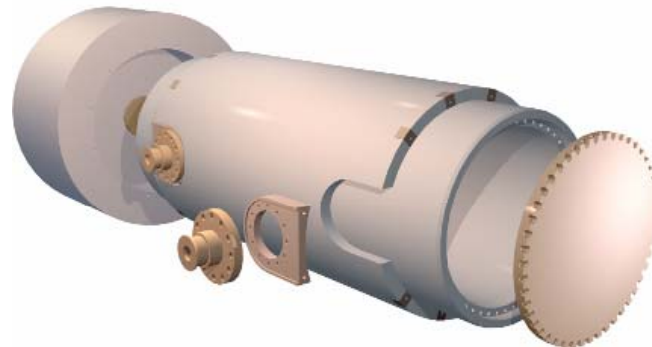
- ◆ Can be either wet or dry
- ◆ Can support both recycle and disposal
- ◆ Yucca Mountain approach

## ▶ Site-to-Recycle

- ◆ Recycling Facility

## ▶ Site-to-Disposal

- ◆ Yucca Mountain
- ◆ Future



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# Management Issues with Used Fuel Storage



- ▶ **Issues can be grouped into three areas**
  - ◆ **Transport now**
  - ◆ **Store**
    - Wet and Dry
    - Short term and Extended
  - ◆ **Transport later**
- ▶ **All options require some level of Transport**
- ▶ **Some of the issues are common to both Storage and Transport**

# Transport Now



- ▶ **Regulations are well defined**
- ▶ **The issues are limited to a small window of time**
- ▶ **Issues can be addressed at the time of transport package licensing**
- ▶ **Approaches to safety and security evaluations are reasonably clear**
  - ◆ **Package Safety (Structural, thermal, criticality, shielding, containment)**
  - ◆ **Package Security**
  - ◆ **IAEA standards**
  - ◆ **Package license/CoC**
  - ◆ **Local validation of package for transport**
- ▶ **Transportation community share information**



# Store First



## ▶ Wet Storage

- ◆ Pool capacity
- ◆ Re-racking of pool
- ◆ Materials issues
- ◆ Water Chemistry
- ◆ Security

## ▶ Short to Intermediate Term Dry Storage

- ◆ Rules fairly well established at time of storage
- ◆ Containment/confinement
- ◆ Materials issues
- ◆ Payload issues
- ◆ Natural phenomena protection
- ◆ Security Requirements

## ▶ Extended Term Dry Storage

- ◆ All of the short to intermediate term issues
- ◆ Change in regulations
- ◆ Inspection/verification
- ◆ Materials Aging
- ◆ Material properties data and analytical methods for safety evaluations

# Transport Later



- ▶ **Dual Purpose (Transportation aspects)**
  - ◆ Subject to changes in transportation regulations
  - ◆ Evolution of knowledge
  - ◆ Political pressures
  - ◆ Etc.
- ▶ **Revalidation or upgrades difficult**
  - ◆ Regulation differences between storage and transport
  - ◆ Transport casks built in the 1980s no longer meet current requirements
  - ◆ Testing to different requirements during fabrication (containment/thermal and shielding material testing)
  - ◆ MP187 able to meet requirements but restricted to 13kW (MP197HB now at 32kW with thermal test required)
- ▶ **Counting on transport in the future carries a level of risk**

# How is the risk managed



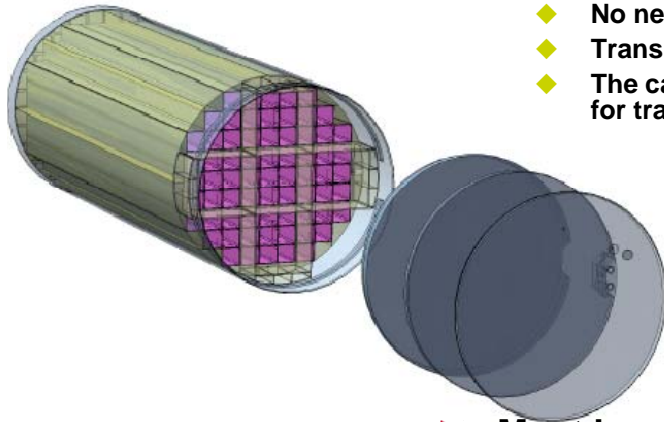
- ▶ **Minimize the length of time in storage**
- ▶ **Upgrade Dual Purpose system to stay current with current transport requirements if possible or practical**
- ▶ **Transportation under a one time exemption**
- ▶ **Use of different over-packs for storage and transportation (US, Switzerland, Spain, UK etc.)**
- ▶ **Flexibility and versatility in design (Transportation aspects)**

# Design Flexibility and Versatility Canister Solution



## ▶ Canister Solution

- ◆ Canister is dual purpose - meets the current storage and transport regulations
- ◆ Can be stored in a licensed storage over-pack and transported in an existing licensed transport cask
- ◆ If transport regulations change then future transport casks can accommodate these canisters as a payload
- ◆ No need to unload or open up the canisters
- ◆ Transport cask is the containment boundary
- ◆ The canister is also a containment boundary but no credit is taken for this containment for transportation



- ▶ Must be opened to recycle
- ▶ May need to be opened for future disposal depending on the repository requirements
- ▶ Methods have been demonstrated for easily opening welded canister
- ▶ Transnuclear has designed the TAD canister which is compatible with the disposal requirements mandated by DOE

# Design Flexibility and Versatility Transport and Dual Purpose

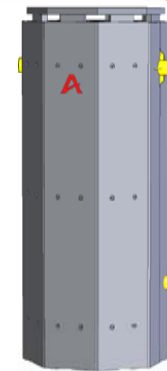
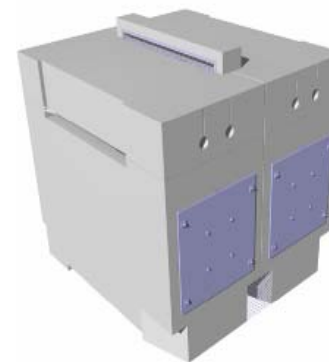
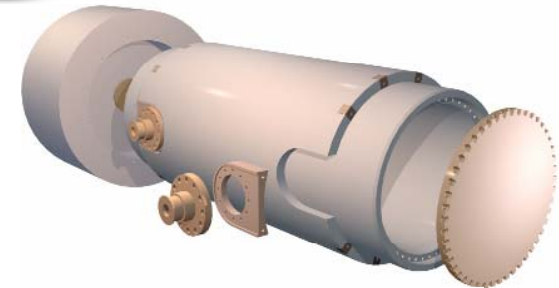
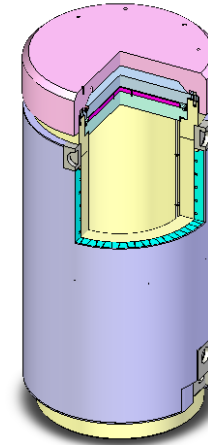


▶ **TN DUO (introduced in another session)**

- ◆ Dual Purpose
- ◆ Bare fuel cask
- ◆ Compatible with Recycling Facility

▶ **MP197HB (introduced in another session)**

- ◆ Transport only
- ◆ Canister as a payload
- ◆ Compatible with Recycling Facility
- ◆ Able to transport canisters that are stored vertically or horizontally
- ◆ Directly compatible with NUHOMS<sup>®</sup> Concrete Storage Systems
- ◆ Directly compatible with TN NOVA<sup>®</sup> Metal Storage Systems

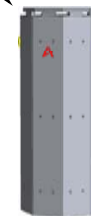
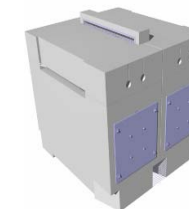
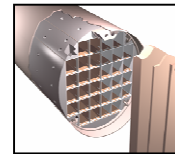
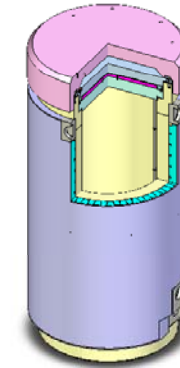


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# Conclusion



- ▶ If no other lesson is to be learned, the history in the used fuel storage and transportation industry guarantees change will occur
- ▶ Increase of knowledge will occur which will impact regulations
- ▶ Political pressure will modify the current regulations both locally and globally
- ▶ Evolution of analysis methods and analytical and computational capabilities will cause evolution of the rigor required for qualification of packages
- ▶ Economics may drive designs and regulations toward an even more risk based approach
- ▶ Currently we are looking at
  - ◆ SCC
  - ◆ High burn-up fuel
  - ◆ 130 year + storage in some locations
  - ◆ Higher seismic requirements
  - ◆ Multiple impact drop scenarios
  - ◆ Burn-up credit



## ▶ Tomorrow ??

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