Situation and Gap Analysis of SNF Transportation after Interim Storage in Germany

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INMM Spent Fuel Management Seminar
Outline

1. Introduction
2. Legal Framework – Transport & Storage
3. Gap Analysis / Lessons Learned / Consequences
4. Quo Vadis
5. Experience on Transport Preparation after Storage
Concept of Dry Interim Storage for SNF and HLW in Germany

- according to German Reactor Safety Commission (RSK) guidelines 2012

- accident safe dual purpose metal casks with
  - Transport Approval Certificate
  - two independent sealed barriere lids
  - permanent monitoring of cask tightness

- storage period **up to 40 years**
Design Approval Procedure (Transport)

Approval Certificate

- for transport on public routes
- at time of storage placement
- over storage time

Type B(U) Certificate

Package Design Approval Procedure

according IAEA Regulations and Domestic Guidelines
Design Approval Certificate (Transport)

Acc. 1985 & 1996 Edition of the IAEA Regulations

Certificate is valid up to 5 years

“Cask Loaded and Stored”

- exclusion of further manufacturing
- cask loaded and placed in storage
- intervals of maintenance and updating the PDSR determined

Acc. 1985 & 1996 Edition of the IAEA Regulations up to 10 years

“Cask Loaded and Stored”

- exclusion of further manufacturing
- cask loaded and placed in storage
- intervals of maintenance and updating the PDSR determined

Transport Package design *well known* over storage period

- *constantly care* of the safety cases incl. documents concerning compliance to the regulations
- Transport possible at any time
Licensing for Dry Interim Storage

- according to Safety Guidelines for Dry Interim Storage of Irradiated Fuel Assemblies by the German Reactor Safety Commission

- consideration of storage operation condition

- *mechanical accident scenarios* different to transport conditions (handling without impact limiters)

- *long term performance* of all components (*up to 40 years*)

- stored casks have to be *transportable at any time* during storage
Tests and Inspections for Transport after Storage

‘Pure’ Transport Packaging: after unloading, all sections accessible

System of Periodic Inspections

Transport after Storage: accessible package sections

System of Specific Tests and Inspections

- visual inspections,
- load testing,
- replacement of components

check of the containment system

- check of the pressure monitoring system,
- lid screws (tightening torque),
- leak-tightness

measurements

- verification of shielding effectiveness
Gap Analysis / Lessons Learned / Consequences
Gap Analysis

- **periodic safety inspection** and **aging management procedure** is going to be implemented (related to storage & transport)

- extension of transport regulatory requirements for Dual Purpose Casks

Consideration of **aged materials & components**

long term behavior of material, components & inventory

**under transport conditions**

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40 years  

- Long term behavior **Storage Cask**

One time transport  

- Behavior of aged components **Transport Cask**
Gap Analysis & Lessons learned

What is necessary for SNF transports in future?
Requirement: **Provide solvable situation for future generations!**

transport under special arrangement vs. re-packing vs.
constructional strengthening (e.g. overpack) vs.
**valid transport approval certificate**

Present Concept in Germany

Aging management of knowledge about transport cask
incl. safety methods and analysis

Maintenance of the PDSR of the transport cask
Consequences from PDSR Review Process

Package description and manufacturing (if applicable)

✓ feedback and experience out of manufacturing of the packaging
✓ improvements of specifications, drawings, and parts list
✓ Reflection of document status and practical experience
✓ Allowance of manufacturing of components in far future, e.g. impact limiter

Package operation

✓ Operation of the package generates feedback
✓ operation and maintenance manual of the package need to be revised periodically

Examples:

Standards are changing periodically. Test procedure during re-inspections might be revised.

How transports are performed is changing over the time. Operating procedure for stowage of the cask on the transport vehicle might be revised.

Equipment is changed. What kind of canopy is used for a future transport?
Consequences from PDSR Review Process

Safety Analysis of Package Design

✓ Over recent decades requirements of transport regulations were stable
✓ Safety demonstration methods (analysis methods) are changing over decades
✓ Periodically revision of standards & guidelines
✓ New results of experimental investigations, e.g. friction coefficients

→ safety cases might to be revised

Simplified Approach  Numerical Approach
Consequences from PDSR Review Process

What can be done, if new methods show safety margins are not sufficient?

- safety of the package has to be enhanced
- improvement of components, e.g. impact limiter design

Example: Improvement of Package Impact Limiter Design design

![Diagram of improved impact limiter design compared to old design]

- improved impact limiter design
- old impact limiter design
- containment system (cask body with bolted and sealed lids)
- impact limiter tensioning (e.g. bars)
Aging Management

knowledge, experience, documents, analysis, long term behavior, ...

R&D Aging (long term behavior) of material and components
gaskets, package under regulatory tests, spent fuel behavior

Regulatory Work

IAEA Working Group – Safety Case for Dual Purpose Casks