



PATRAM2013

Session Title: Package Design:
Aging Management - Long-term Storage and
Containment

Presentation Title:
Assessment Feedback on Material Compatibility and
Determination of Material Parameters
for Transport Packages Used as Dual Purpose SNF and HLW Casks

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**ASSESSMENT FEEDBACK ON MATERIAL COMPATIBILITY
AND DETERMINATION OF MATERIAL PARAMETERS
FOR TRANSPORT PACKAGES USED AS
DUAL PURPOSE SNF AND HLW CASKS**

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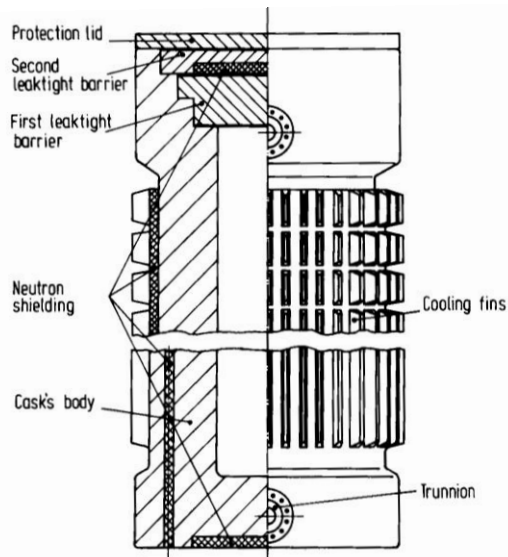
- (1) Introduction**
- (2) Effect of Operational Factors on Material Compatibility and Material Data**
- (3) Operational Phases and their Specific Features for the Compatibility of Materials**
- (4) Advice for Verification Concept for Material Compatibility**
- (5) Advice for Verification Concept for Material Design Data**
- (6) Conclusions**

Starting point:

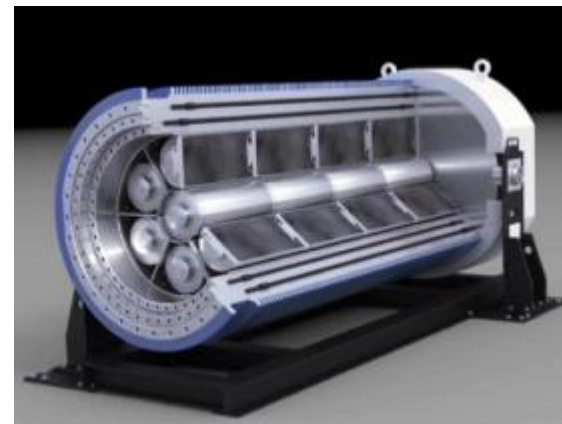
IAEA SSR-6, § 614: The materials of the packaging and any components or structures shall be physically and chemically compatible with each other and with the radioactive contents. Account shall be taken of their behaviour under irradiation.

Focus on:

Dual Purpose Casks with Spent Nuclear Fuel (SNF)

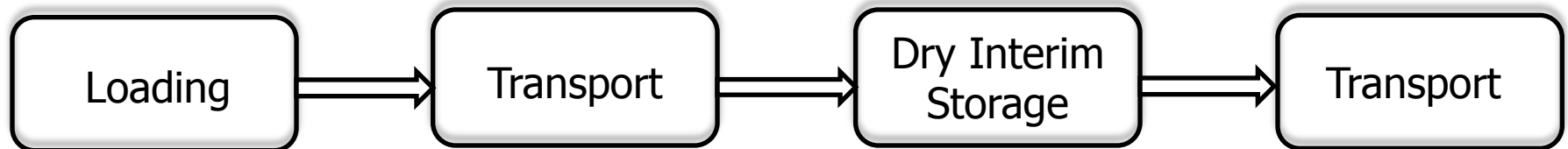
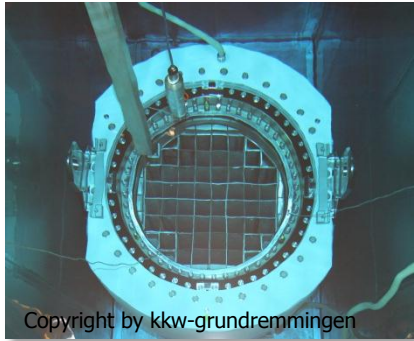


Dual Purpose Casks with High Level Waste (HLW)



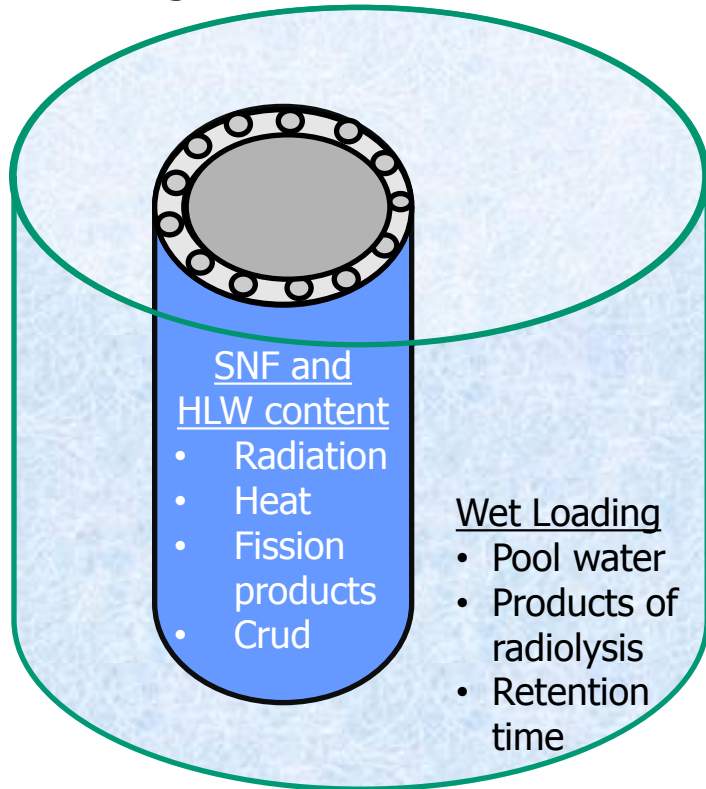
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Operational phases to be considered for the assessment of material compatibility and variation of material properties



- From these operational phases one can derive boundary conditions for the analysis of chemical and physical compatibility of a single material and of materials/components among each other.
- Probable forms of metal corrosion as well as degradation phenomena of materials/components, connecting elements and radioactive content occurring due to radiation and/or heat have to be analyzed for cask design.

Loading



Transport



Environment

- Water
- Humidity
- UV-Radiation
- Temperature
- Atmospheric pollution

➤ **Changes of a material/component structure can be generated, like**

- Corrosion of metals in liquid environment
- Enclosure of hydrogen
- Changes in the lattice structure of metals
- Cross-linking and degradation of polymers
- Aging effects of shock absorbing materials

Wet Loading

- **Each single material** and the **contacted materials** have to be analyzed regarding their corrosion behavior.
- Contact of **Aluminum with stainless steel** → Critical for Basket design → Anodization of aluminum components could considerably reduce contact corrosion.
- **Corrodible surfaces of the cask cavity** are normally coated. The coat has to be tested regarding porosity and surface and galvanic corrosion with the contacted materials.
- **Trunnions** should be tighten on the cask body in such a way that an entry of water could be excluded.
- **Seals** of underwater attached lids have to be investigated in detail.

Transport

- **Residual amount of water** after drying has to be assessed regarding the corrosive and radiochemical effects to the components of the containment.
- The behavior of **chemical bonded water** on surfaces has to be evaluated under NTC, for instance in oxide layers.
- **Organic materials** → Change of its structure has to be considered.
- **Release of volatile gas** has to be taken into account for material compatibility issues and in design assessment.
- Access of **rainwater** → a special importance has the area between lid side shock absorber and lid.

Dry interim storage and following transport

- **Expected:** Aging effects at metal and elastomeric seals, polymer shielding components, at screws, springs, damping material and spent fuel assemblies.
- **Main point for transport:** Compliance of design parameters and safety cases with package characteristics during and after interim storage.
- **Possible:** Inspections of external state of package (e. g. visual inspection, surface crack and overload test) on components which are well accessible like cask body, outer lid, trunnions and shock absorbers.
- **Normally not intended:** Inspection of cask cavity → it is mandatory to know the state of not accessible components (lids, screws, seals, cask cavity), the basket, the shielding and radioactive content.

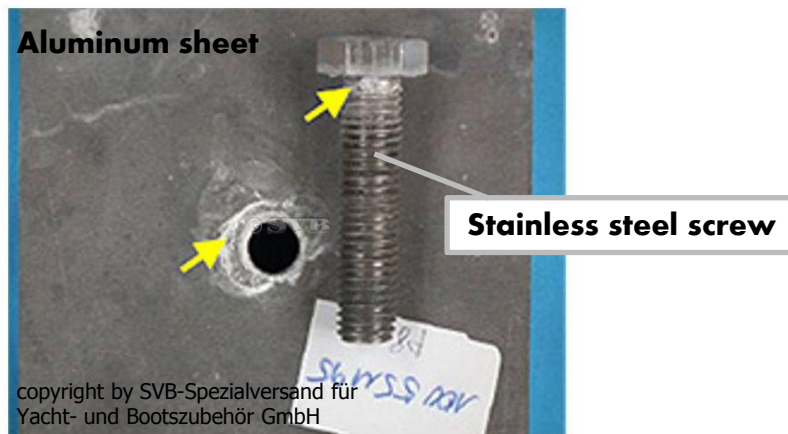
Examples for galvanic corrosion



Picture 1

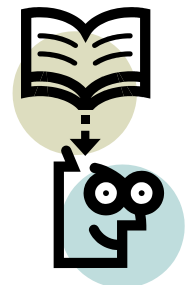


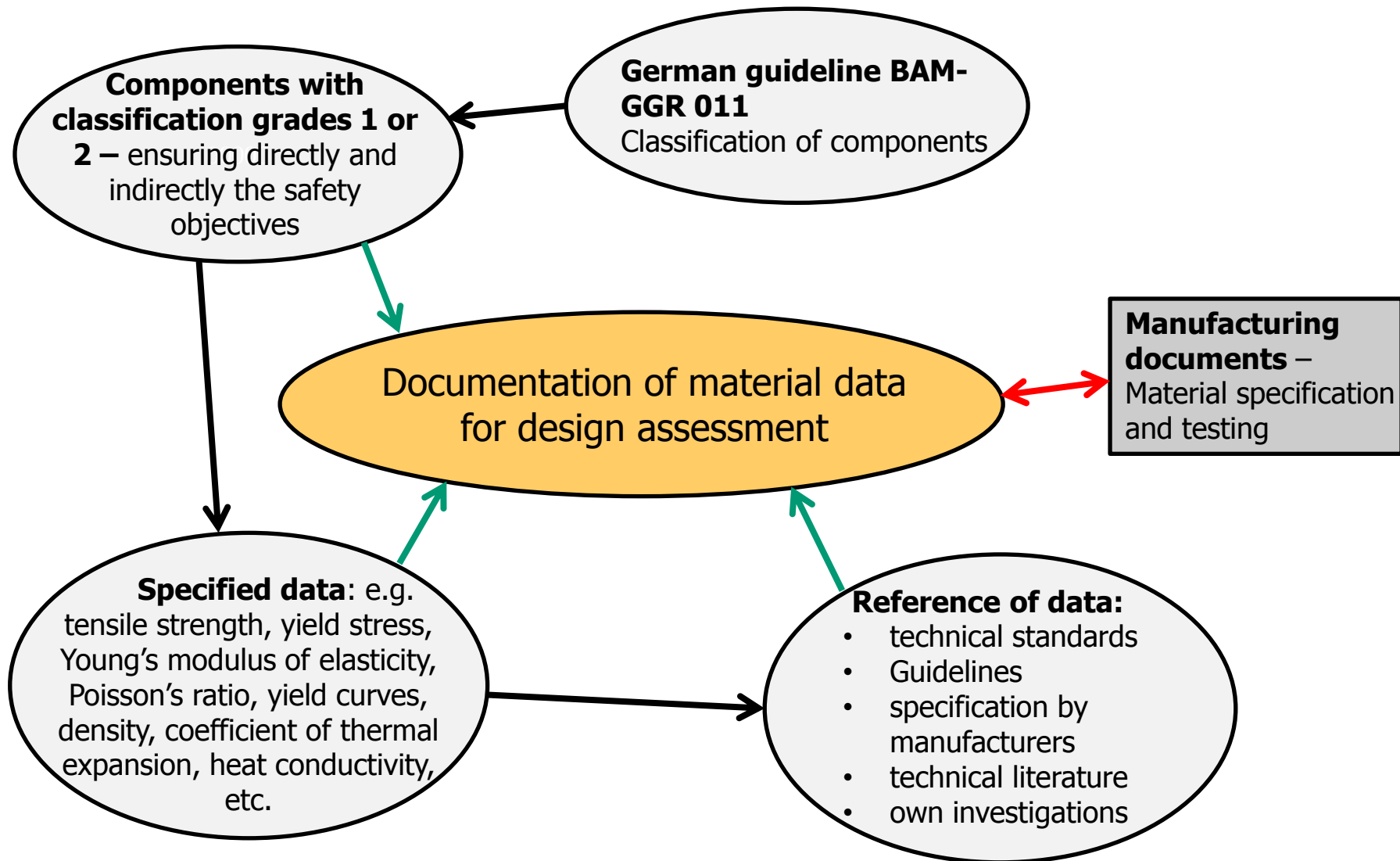
Picture 2



Picture 3

- The applicant has to demonstrate in SAR that under operating loads and exposures the package remain in compliance with transport package design approval certificate.
- The applicant should provide a joint report or separate reports about material compatibility and aging effects.
- Corrosion rate has to be determined for the chemical and electrochemical corrosion of metals.
- Components which are not accessible or removable have to be assessed regarding corrosion and aging effects for the postulated service life.
- Additional tests, inspections and measures in view of a final transport after dry interim storage period are expected especially regarding the assessment of aging effects. These measures have to be implemented in procedures of periodic inspections.





Qualification of materials and components

- For materials and components with no data available from literature investigation programs (qualification program) have to be carried out. Three main categories:

Already referenced material in technical standards, guidelines, *but*

Material or components

not sufficiently referenced with specific values for the application

e. g. *wood, metals at high and low temperature*

not sufficiently referenced with specific values in consideration of long term thermal and/or radiation loads

e. g. *polymers, precipitation hardening aluminum alloys*

manufactured by new and/or very sophisticated processes, which have to be supervised,

e. g. *stainless steels alloyed with boron, composite materials, polymers, seals*

For safety assessment of dual purpose SNF or HLW casks BAM needs

- a report or separate reports about material compatibility and degradation effects under consideration of the operational scenarios. This implies the consideration of all relevant degradation mechanism, like corrosion, aging etc. by the assessment under transport conditions.
- a documentation of all relevant material properties considering the applicable operational conditions. Necessary qualification programs has to be created and approved by BAM.

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Thank you for your attention!