Dual Purpose Casks in Dry Storage in Switzerland

DPC Workshop, 20th May 2014

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ENSI
Outline

• Start of dry storage in CH
• Dry storage in CH today
• Future challenges
• DPC approach
Start of interim dry storage in Switzerland: first loading in 1983

• In 1983 loading at Paul Scherrer Institute (PSI), Würenlingen, Switzerland
• Cask: CASTOR Ic-Diorit
• Content: Research reactor fuel
  – Activity: 27.9 PBq
  – Heat load: 2.6 kW
  – Pu-239: 4829 g
  – Pu-241: 189 g

Figure: ZWILAG/PSI
Safety demonstrations for CASTOR Ic

Physical tests for CASTOR Ic family:
- Drop tests
- Drop tests at -40°C
- Pool fire test
- Aircraft crash test

Figures: BAM
Transfers of CASTOR Ic-Diorit

• Removal from storage area at PSI in 1985: from Diorit building to «location 26» (waste building)
• Transfer to central interim storage facility (ZZL) in 2004: «Road transport» of a few hundred metres under special arrangement
• Repetition of leak test in ZZL after transport: $6.2 \times 10^{-9} \text{ Pa} \cdot \text{m}^3/\text{s}$ at primary lid  
  $\rightarrow$ slightly lower than 1983

Figure: PSI
Today: different storage concepts in Switzerland

<table>
<thead>
<tr>
<th>NPP</th>
<th>Transport</th>
<th>Storage Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load transport cask</td>
<td>Transport</td>
<td>Unload transport cask / load DPC (hot cell operation)</td>
</tr>
<tr>
<td>Wet storage pool</td>
<td>Transport (later)</td>
<td>Store DPC (still required)</td>
</tr>
<tr>
<td>Load DPC</td>
<td>On-site transfer</td>
<td>On-site storage</td>
</tr>
<tr>
<td>Load DPC</td>
<td>Transport</td>
<td>Store DPC in central facility</td>
</tr>
</tbody>
</table>

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ENSI
## Dry storage of DPCs in CH

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>Operational license for ZZL (central interim storage facility in CH)</td>
</tr>
<tr>
<td>2001</td>
<td>HAW 20/28 CG (HAW) and TN97L (SFA) stored in ZZL</td>
</tr>
<tr>
<td>2002</td>
<td>TN24G (SFA) stored in ZZL</td>
</tr>
<tr>
<td>2004</td>
<td>TN81CH (HAW), TN24BH and CASTOR Diorit (SFA) stored in ZZL</td>
</tr>
<tr>
<td>2005</td>
<td>TN52L (SFA) stored in ZZL</td>
</tr>
<tr>
<td>2007</td>
<td>TN24BH/L (SFA) stored in ZZL</td>
</tr>
<tr>
<td>2008</td>
<td>Operational approval for ZWIBEZ (on-site storage facility at KKB) TN24GB (SFA) stored in ZWIBEZ</td>
</tr>
<tr>
<td>2014</td>
<td>HAW28M (HAW) expected to be stored</td>
</tr>
</tbody>
</table>
DPC in Swiss storage facilities

Current quantity of stored packages in ZZL/ZWIBEZ

<table>
<thead>
<tr>
<th>Design/Typ</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>TN24G/GB</td>
<td>9 (5 at ZWIBEZ)</td>
</tr>
<tr>
<td>TN24BH/BHL</td>
<td>14</td>
</tr>
<tr>
<td>TN97L</td>
<td>9</td>
</tr>
<tr>
<td>TN52L</td>
<td>1</td>
</tr>
<tr>
<td>TN81CH</td>
<td>6</td>
</tr>
<tr>
<td>HAW20/28CG</td>
<td>5</td>
</tr>
<tr>
<td>Castor I-c-Diorit</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>

Storage hall for material with high activities (Figure: ZWILAG)

34 x spent fuel + 11 x high active waste
Cask monitoring at ZZL/ZWIBEZ

Permanent monitoring:
- Leak tightness for every cask individually
- Temperature and dose for the storage hall
- Additionally periodical temperature and dose rate measurements for single casks

Results:
- No findings or abnormalities
- Only exchange of some pressure switches
Past, current and future loadings

<table>
<thead>
<tr>
<th></th>
<th>CASTOR Ic-Diorit</th>
<th>TN24BH-L07</th>
<th>TN24BH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spent Fuel Assemblies</td>
<td>350 heavy water research reactor</td>
<td>69 light water power reactor</td>
<td>69</td>
</tr>
<tr>
<td>Activity</td>
<td>27.9 PBq</td>
<td>301.4 PBq</td>
<td>2909 PBq</td>
</tr>
<tr>
<td>Heat load</td>
<td>2.6 kW</td>
<td>27.8 kW</td>
<td>35.1 kW</td>
</tr>
<tr>
<td>Enrichement</td>
<td>0.7 % and 2.2 %</td>
<td>≈ 3.8 %</td>
<td>up to 5 %</td>
</tr>
<tr>
<td>Burn-up</td>
<td>1.5 .. 14 GWd/tU</td>
<td>≈ 50 GWd/tU</td>
<td>up to 80 GWd/tU for specific SFAs</td>
</tr>
<tr>
<td>Cooling time</td>
<td>0.5 years</td>
<td>7 .. 10 years</td>
<td>0.5 years for specific SFAs</td>
</tr>
</tbody>
</table>
Future challenges

More SFA with high-burn-up and high enrichment, mixed loadings, MOX

→ Applications for new cask designs
→ Aircraft crash tests

Figure: TNI
Aircraft crash test

Figures: Holtec International
Aircraft crash test

Figures: Holtec International
Requirements for DPC foreseen to be stored in Switzerland

- Requirements according to guideline ENSI-G05 issued April 2008 replacing guideline HSK-R-52 issued 2003:
  - Mechanical analyses
  - Lid system and weld joints
  - Subcriticality and dose limits
  - Ageing
  - Aircraft crash and earthquake event
  - Temperature limits for cask and building
  - Consideration of kerosine fire and covering of cask
  - Transportability and retrievability
  - Fabrication monitoring and documentation
Transport/storage approvals

Package design approvals
- Issued by the country of origin
- Validated in Switzerland
- Usually valid for five years
- Safety improvements in the transport point of view not in any case compatible to DPC storage requirements

Storage approvals for DPC
- Issued by Swiss CA (ENSI)
- Limited to the storage facility applied for
- Valid for whole storage period
- Periodical storage facility safety review (10 years)
Outcome of DPC working group

Documents

- Integrated safety case
- TRANSSSC/WASSC recommendations

Reactions

- TRANSSSC has started process to include ageing demonstrations in package requirements
- No further discussions in WASSC
Integrated DPC safety case

Storage PDSR

Transport PDSR

Demonstrations for ageing and transport after storage

PDSR = Package Design Safety Report
Swiss situation

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Transport PDSR

Storage PDSR

 Demonstrations for ageing and transport after storage

Country of origin approval

Storage country approval

Validation of storage country

Storage period

3-5 years

PDSR = Package Design Safety Report

Technical gap

3-5 years
TRANSSC proposal

- Transport PDSR
- Storage PDSR
- Demonstrations for ageing and transport after storage

**Country of origin approval**
- 3-5 years
- TRANSSC

**Storage country approval**
- 3-5 years

**Technical gap**

**Validation of storage country**

PDSR = Package Design Safety Report
Path forward

- Transport PDSR
- Storage PDSR
- Demonstrations for ageing and transport after storage

Country of origin approval

Storage country approval

Validation of storage country

PDSR = Package Design Safety Report

Storage period

>> 3-5 years

>> 3-5 years

PDSR = Package Design Safety Report
Transport and storage evaluation

Demonstrations for ageing and transport after storage

Demonstrations for ageing
• already considered during storage assessment (approved for storage period)
• but not with respect to transport conditions (approved for 3-5 years)

Transport after storage
• needs probably knowledge of DPC state at different stages of storage period
• definition of DPC state requires knowledge of storage conditions, including monitoring results, inspection findings, changes of storage situation
• transport after storage will usually be a national transport in the storage country
National approach

Transport PDSR

Demonstrations for ageing and transport after storage

Storage PDSR

Country of origin approval

Storage country approval

Full transport approval including transport after storage and necessary prolongations

PDSR = Package Design Safety Report
International approach

Transport PDSR

Demonstrations for ageing and transport after storage

Storage PDSR

Country of origin approval

PDSR = Package Design Safety Report

Storage country approval

Full transport approval including transport after storage and necessary prolongations

First validation of storage country
TRANSSC approach

TRANSSC approach does not seem to be appropriate to fulfil the needs of validating countries completely

• approach works rather on a national level
• transport/storage interface is not addressed sufficiently

→ Alternative approaches should be considered
for more information please visit:

www.ensi.ch
www.ifsn.ch

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