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Aging Management Solutions to Ensures Safety of Extended Dry Fuel Storage

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Outline

- Introduction: Sustainable fuel management
- Fuel inventories
- Status of License Renewal
- What is an Aging Management
- Industry Challenges
- Aging Management program
- Conclusions

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Introduction
The management of used nuclear fuel is sustainable if it:

- Covers all the steps of used fuel management until final disposal, in accordance with an acceptable, practical plan
- Proves to be feasible with an acceptable impact level
- Includes a realistic and balanced financing plan
- Does not impose undue burdens on future generations

Deep disposal with a safe and acceptable route

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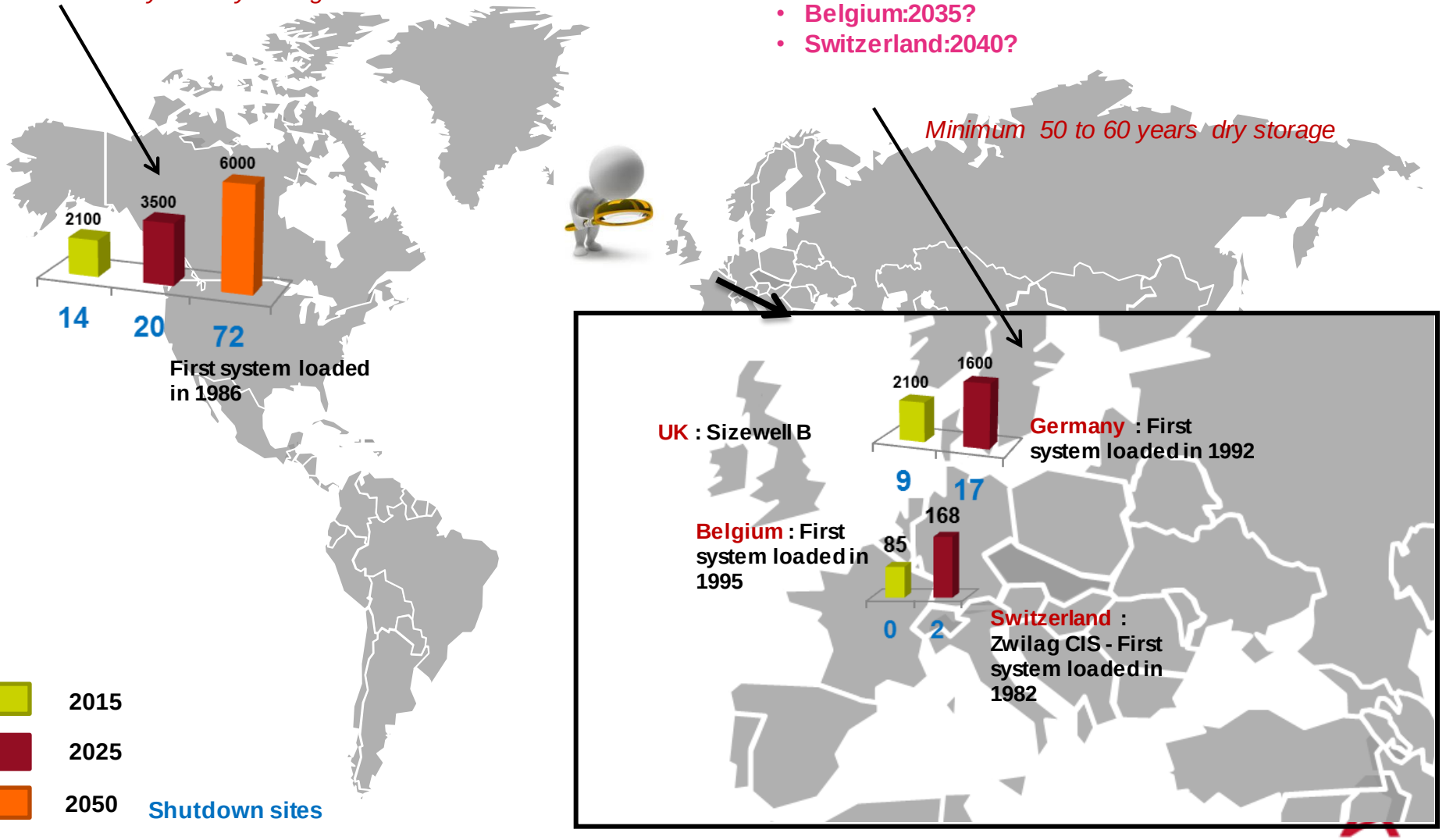
Fuel Inventories
Dry Storage Evolution 2015 – 2025 – 2050

Repository 2048?

Minimum 62 years dry storage

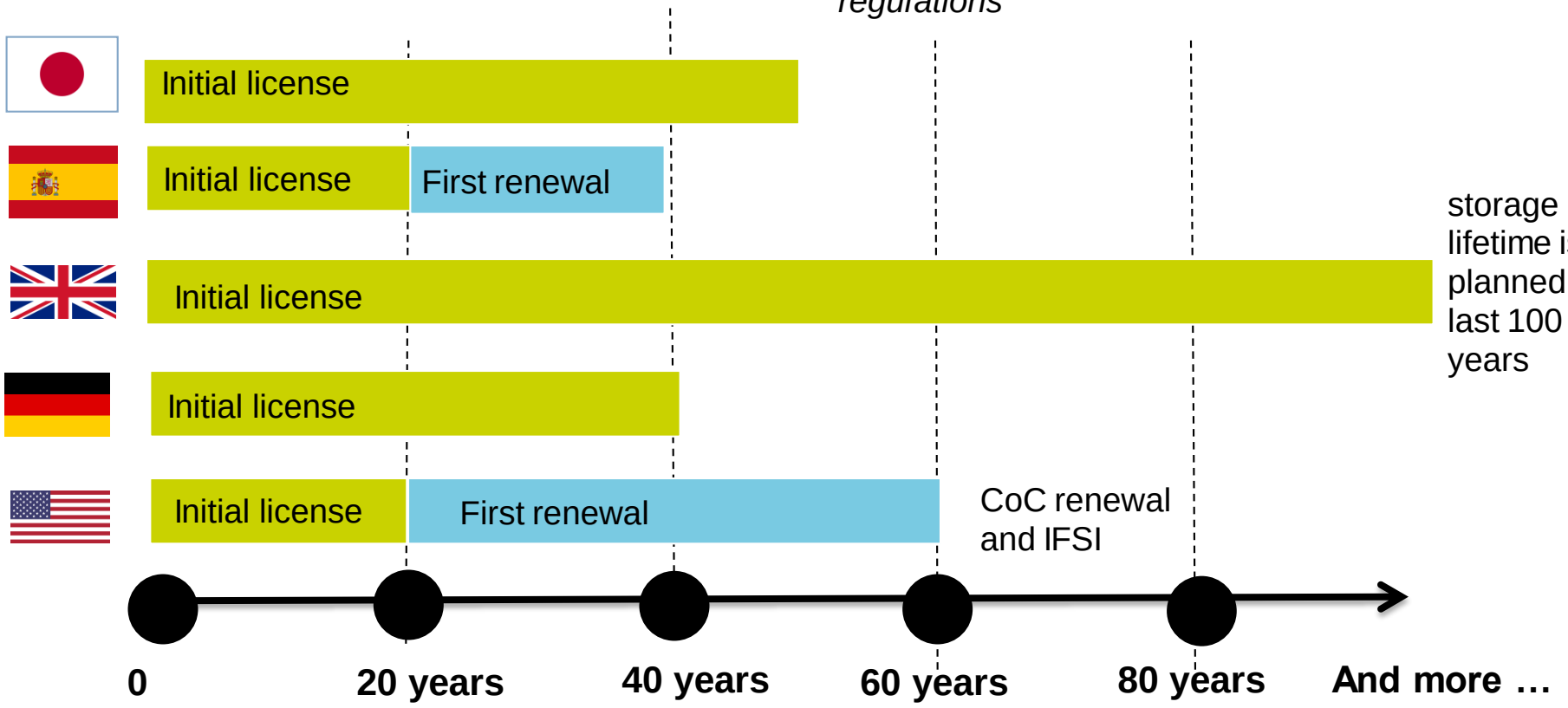
Repositories
- **Germany: 2025?**
- **Belgium:2035?**
- **Switzerland:2040?**

Minimum 50 to 60 years dry storage



Dry storage licenses period and renewals

Only US and Spain regulations issue initial license with the ability to apply for extension after initial period. Other countries have not yet upgraded their regulations



US: First Need to Renew Licenses

USA – Overview Process for Renewal

- Licensee renewal process in NUREG-1927
- Both ISFSIs License renewal (General and Site Specific) are conditioned by the Dry Storage System Certificate of Compliance Renewal
- "Pragmatic" renewal process based on demonstrations and "Learning Aging management":
  - **Safety demonstrations for critical components**
  - **Rely on future results of on-going tests and studies**
  - **Inspections**

Learning Aging Management

TN with oldest systems has successfully renewed licenses (+40 Years)

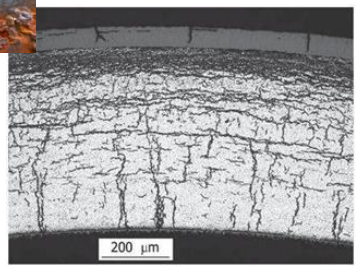
What is an Aging Management of dry storage casks?

Can you imagine this in 100 years?

With Extension of dry storage well beyond original license, risks to be mitigated

Industry's Challenges

- **Safety**
  - **Canister integrity**
    - Corrosion (higher in marine environment)
    - Chloride induced stress corrosion cracking: higher risk on canister weld
    - ➢ Loosing containment
  - **Fuel Integrity**
    - High Burn-up Fuel degradation
    - ➢ Criticality risk & Retrievability more complex
  - **Shielding performance**
    - Concrete degradation
    - ➢ Radiation risk
- **Data records/institutional controls**
  - **Loosing critical information**
  - **Difficulties to proceed to next steps** (transport and storage at repository or recycling)



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Aging Management Program

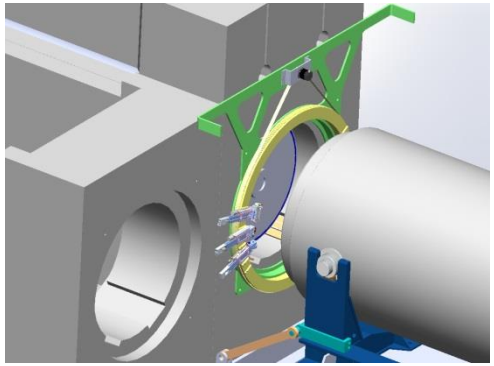
- **Three Main components**
  - **Inspection program**
  - **Monitoring program**
  - **Recovery program**

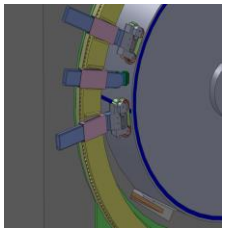
Low Risks with Extended Storage
However Birth of aging and Limited Operational Data
Need to Develop Robust Aging Management Program
and Recovery Plan

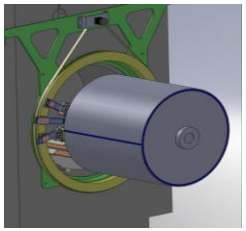
Inspection

Canister inspection

- NDE instruments are “plug-n’-play to the AM Tool
- NDE tools designed to read location of any surface defects found for easy repair

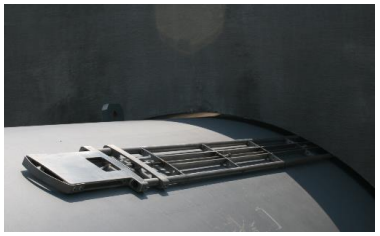


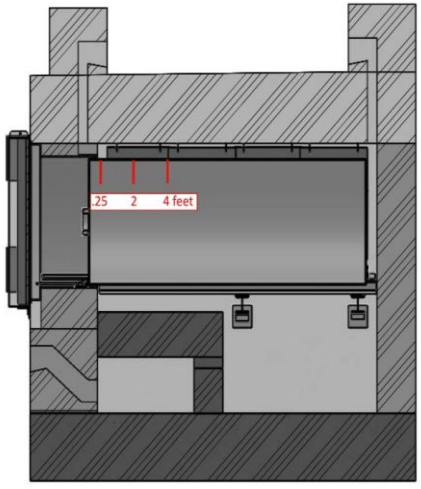




Canister welding inspection

- Whole system integrity checked quickly
- Ring travel – 100% access





SaltSensor Device tools

- Surface chloride concentration measurement

Inspection – Monitoring

- Periodic radiation and temperature monitoring
  - Direct measurement of the HSM or DSC temperatures
  - The HSM are built ready to receive thermocouple

- Visual inspection
  - System design allows complete accessibility of canister and module
  - Option by using high resolution video cameras
    - Concrete structures for cracking or coating for cask

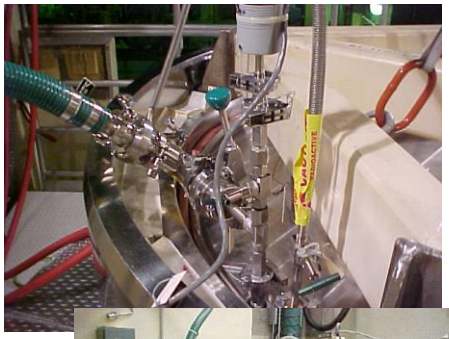
- Pressure Monitoring for dual purpose cask
  - Monitoring of interspace between inner & outer seals
  - Sensors control permanently the pressure

Mitigation

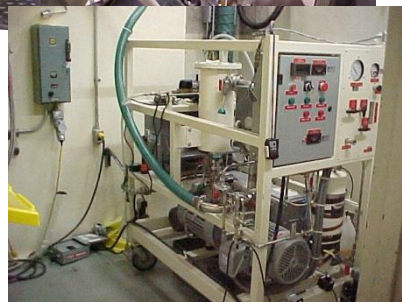
- Coating to prevent external corrosion of a carbon steel overpack component

- Cathodic protection systems used to minimize corrosion of metallic components embedded in concrete

- Adequate drying to prevent hydride reorientation in PWR high-burnup cladding alloys



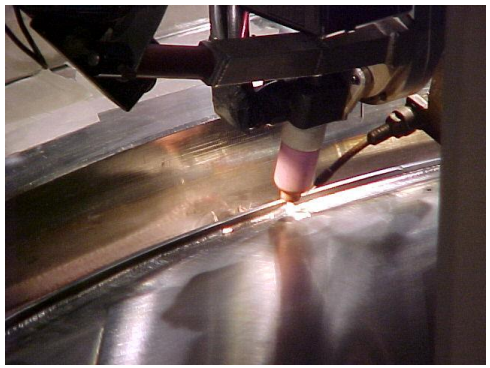
- Inert atmosphere of the cavity
  - Protection against corrosion for cask internals (basket) and fuel



- Fabrication techniques to mitigate corrosion
  - Selection of material not susceptible to SCC
  - Control stress

Remediation Recovery

- Cask coating repair
  - Qualification of coating on hot surface
  - No modification of storage system design

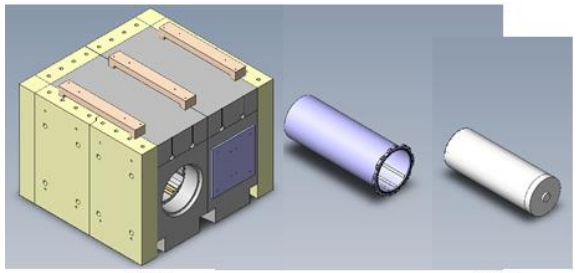


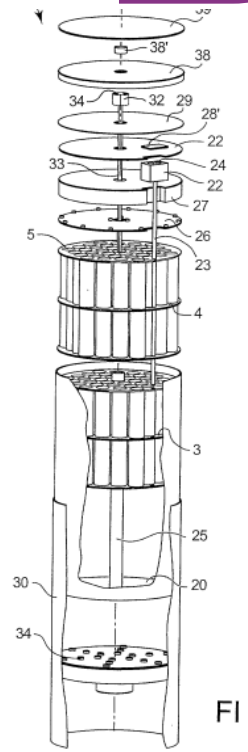
- Canister repair
  - Canister can be repaired by grinding to the root, if shallow, weld-repaired, if larger
  - Remote system, easy to use
  - No modification of the storage system required

- Canister Replacement
  - Canister always accessible and easily
  - If needed, canister could be removed using current transfer system
  - Overpack canister is bolted, sealed, and monitored
  - Transportation cask is used to move canister off-site

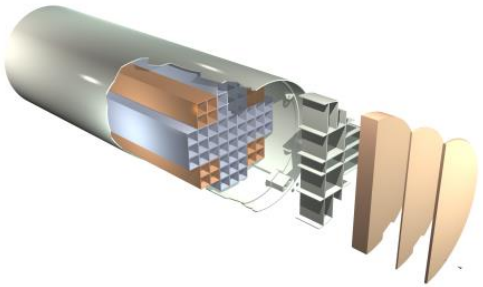
Innovative solutions

- Double Walled Canisters
  - System providing 2 independent containments: an inner canister where the fuel is loaded & an outer canister - Patents in France & in US
  - System comprising a standard DSC which contained the fuel and a liner housing this DSC in a storage module - Patents in France & in US





- SCC proof Canister
  - Resistant stainless steel Duplex instead of current Stainless Steel
  - Minor design change on the original NUHOMS® license and the full compatibility with the existing storage module or transport/transfer system



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Conclusion: Our mission

Provide Sustainable Cycle Solutions for optimized, long-term and responsible management of used fuel

Reduce risks
- Safety & security
- Environment impact
- Non proliferation

Increase value
- Economic value
- Fleet performance

Favor acceptability, public acceptance

Let's not forget that interim storage solutions are temporary

» **Responsible towards coming generations: Develop Geological Repository actively and minimize interim storage duration**

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Thank you for your Attention

Questions?

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