



# Aging Management in Dry Spent Fuel Cask Storage

**BAM**

**Bundesanstalt für Materialforschung und –prüfung  
(Federal Institute for Materials Research and Testing)**

**Holger Völzke, Anton Erhard**

## **Outline:**

- I. Regulatory Framework on Aging Management in the Nuclear Field
- II. Technical Issues in Terms of Cask Storage Installations
- III. Developments in Regulatory and Technical Guidance



# I. Regulatory Framework on Aging Management in the Nuclear Field

## European guidance in spent fuel and radioactive waste management



### EU Nuclear Safety Directive

**COUNCIL DIRECTIVE 2011/70/EURATOM**

**of 19 July 2011**

**establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste**



***WENRA** is a network of Chief Regulators of EU countries with nuclear power plants and Switzerland as well as of other interested European countries which have been granted observer status.*

**WORKING GROUP ON WASTE AND DECOMMISSIONING (WGWD)**

**WASTE AND SPENT FUEL STORAGE SAFETY REFERENCE LEVELS REPORT** (version 2.1 February 2011)



## WASTE AND SPENT FUEL STORAGE SAFETY REFERENCE LEVELS REPORT

<i>Part II.</i>	16
1. Safety area: Safety management	18
1.1. Safety issue: Responsibility	18
1.2. Safety issue: Organizational structure	19
1.3. Safety issue: Management system	20
1.4. Safety issue: Record keeping	21
2. Safety area: Design	23
2.1. Safety issue: Storage facility design requirements	23
2.2. Safety issue: Handling and retrieval requirements	27
3. Safety Area: Operation	29
3.1. Safety issue: Conduct of Operation	29
3.2. Safety issue: Emergency Preparedness	29
3.3. Safety issue: Operational Experience Feedback	31
3.4. Safety issue: Operation facility modification	32
3.5. Safety issue: Maintenance, periodic testing and inspection	32
3.6. Safety issue: Specific contingency plans	33
3.7. Safety issue: Requirements for acceptance of waste and spent fuel packages and unpackaged spent fuel elements	34
4. Safety area: Safety verification	36
4.1. Safety issue: Contents and updating of the safety case	36
4.2. Safety issue: Periodic safety review	37



WENRA:

**WASTE AND SPENT FUEL  
STORAGE SAFETY REFERENCE  
LEVELS REPORT**

**Ageing**

General process in which characteristics of a structure, system or component gradually change with time or use.

**Ageing degradation**

Ageing effects that could impair the ability of a structure, system or component to function within its design limits .

**Ageing management**

Engineering, operations and maintenance actions to control within acceptable limits the ageing degradation of structures, systems and components.

Chapter 3.5:

**S-44: A maintenance, periodic testing and inspection program shall be conducted according to written procedures in order to ensure that SSCs are able to function in accordance with the design intents and safety requirements.**

**S-47: The maintenance, periodic testing and inspection programs shall be reviewed at regular intervals to incorporate the lessons learned from experience.**

**S-48: The licensee shall develop an inspection program for the verification of the continuing compliance of waste and spent fuel packages or unpackaged spent fuel stored with the limits specified in the safety case to ensure continued functionality of safety features on which safety case is based. This program shall address:**

- the required environmental conditions within the storage facility,
- the state of waste and spent fuel packages or unpackaged spent fuel elements.



## **Aging management guidance** (recent documents with relevance to German spent fuel cask storage)



IAEA Safety Standards  
**Ageing Management for Nuclear Power Plants**  
**Safety Guide No. NS-G-2.12**  
Vienna, 2009

**Storage of Spent Fuel**  
**DRAFT SAFETY GUIDE DS371**  
**IAEA Safety Standards Series No. SSG-15 (to be published)**



**Safety Standards** of the  
Nuclear Safety Standards Commission (KTA)  
**KTA 1403 (2010-11)**  
**Ageing Management in Nuclear Power Plants**  
(Alterungsmanagement in Kernkraftwerken)

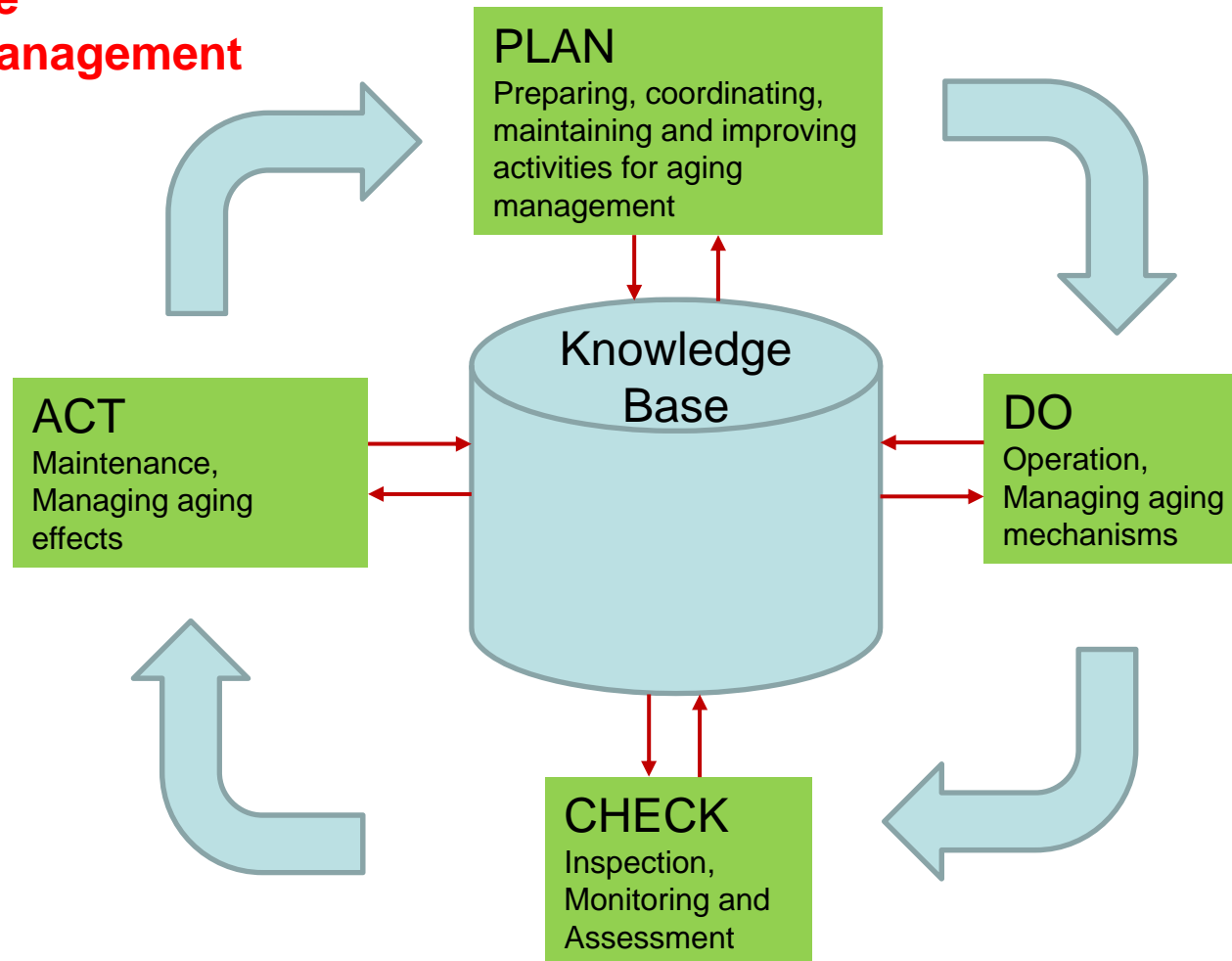


**ENSI Swiss Federal Nuclear Safety Inspectorate**  
**ENSI-B01 Alterungsüberwachung – Richtlinie für schweizerische Kernanlagen**  
**(Ageing Management – Guideline for Swiss Nuclear Installations)**



## II. Technical Issues in Terms of Cask Storage Installations

### PDCA cycle of aging management





**Aging management**

**Program for monitoring and maintaining safety related equipment with the goal to control age-related degradation and prevent equipment failures caused by ageing.**



**Identification and categorization of safety functions and related components in “active” (with external operational support) or “passive” (with inherent safety functions).**

**Dry cask storage has only passive safety functions with regard to safe enclosure, sub-criticality, shielding and decay-heat removal**

**Key elements:**

- Understanding and knowledge of aging-related damage mechanisms
- Predictive models to extrapolate behaviour of systems, structures or components up to a defined time
- Qualified methods for detection and surveillance of ageing degradation
- Qualified mitigation, repair and replacements measures
- Availability of a technical service and knowledge base.

**Supporting R&D**

*References:*

*Erhard, Völzke, et al. / PATRAM 2010  
A. Blahoianu, et al. / NEA News 27/No.1 2009*



CASTOR® V cask design by GNS

### Dry Interim Cask Storage

- Cask inventory
- Cask structure and components
- Storage facility with buildings and technical equipment



Interim storage Gorleben (GNS)

#### Replaceable components, e.g.:

- Cover lid and screws
- Secondary lid and screws
- Trunnions
- Pressure gauge
- Cask handling equipment

#### Not replaceable components, e.g.:

- Cask inventory (spent fuel)
- Cask body
- Basket
- Neutron shielding polymers in boreholes
- Storage building





## First case of lifetime extension for cask storage in Germany:

Jülich AVR fuel storage facility:  
152 Castor THTR/AVR casks



*Expiration of the 20 year storage license: June 30, 2013*

### Options:

- Extension of the Jülich storage license
- **Transportation to another storage facility**



### Consequence:

Cask safety evaluation for shipping to the Ahaus storage facility and a new storage application for additional 20 years.

### Issues arising:

- Evaluation of ageing effects
- Selected inspections to verify e. g. leak tightness, lid screw pre-stresses
- Updated safety assessments considering current state-of-the-art





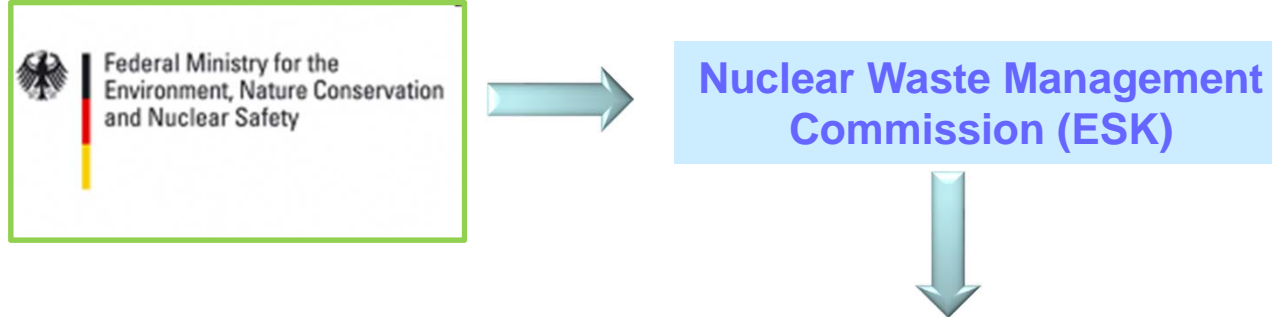
### III. Developments in Regulatory and Technical Guidance

#### Initial situation:

- Existing guidance and experience in aging management for nuclear power plants
- Existing 40 year operation licenses for interim storage facilities
- Operation experience for about 20 years under continuous supervision by responsible authorities

#### Current needs:

- Completion of technical guidance with regard to periodic safety inspection and aging management for dry interim cask storage
- Consideration of recent regulatory framework from IAEA, EU and WENRA



## Periodic Safety Review Guidelines for Interim Storage Facilities for Spent Fuel and Heat-Generating Radioactive Waste in Casks

### Main goals:

- ❖ Documentation and evaluation of operational experience and changes with respect to the level of safety, integrity of operation and dose minimisation.
- ❖ Updated safety evaluation under consideration of the state-of-the-art of science and technology and with respect to:
  - Safe and reliable continuation of operation.
  - Consequences of aging mechanisms on all relevant storage components like building structures, handling equipment, casks and cask inventories.
  - Adherence of safety requirements with respect to cask handling and transportation after storage.
- ❖ Derivation of conclusions and provisions for further operations.

*Draft agreed in Nov. 2010*

*Two year test phase with two selected storage facilities has started in 2011*



Currently under development in addition to Periodic Safety Review Guidelines:

## Recommendations by ESK on

*Final Draft agreed in Jan. 2012*

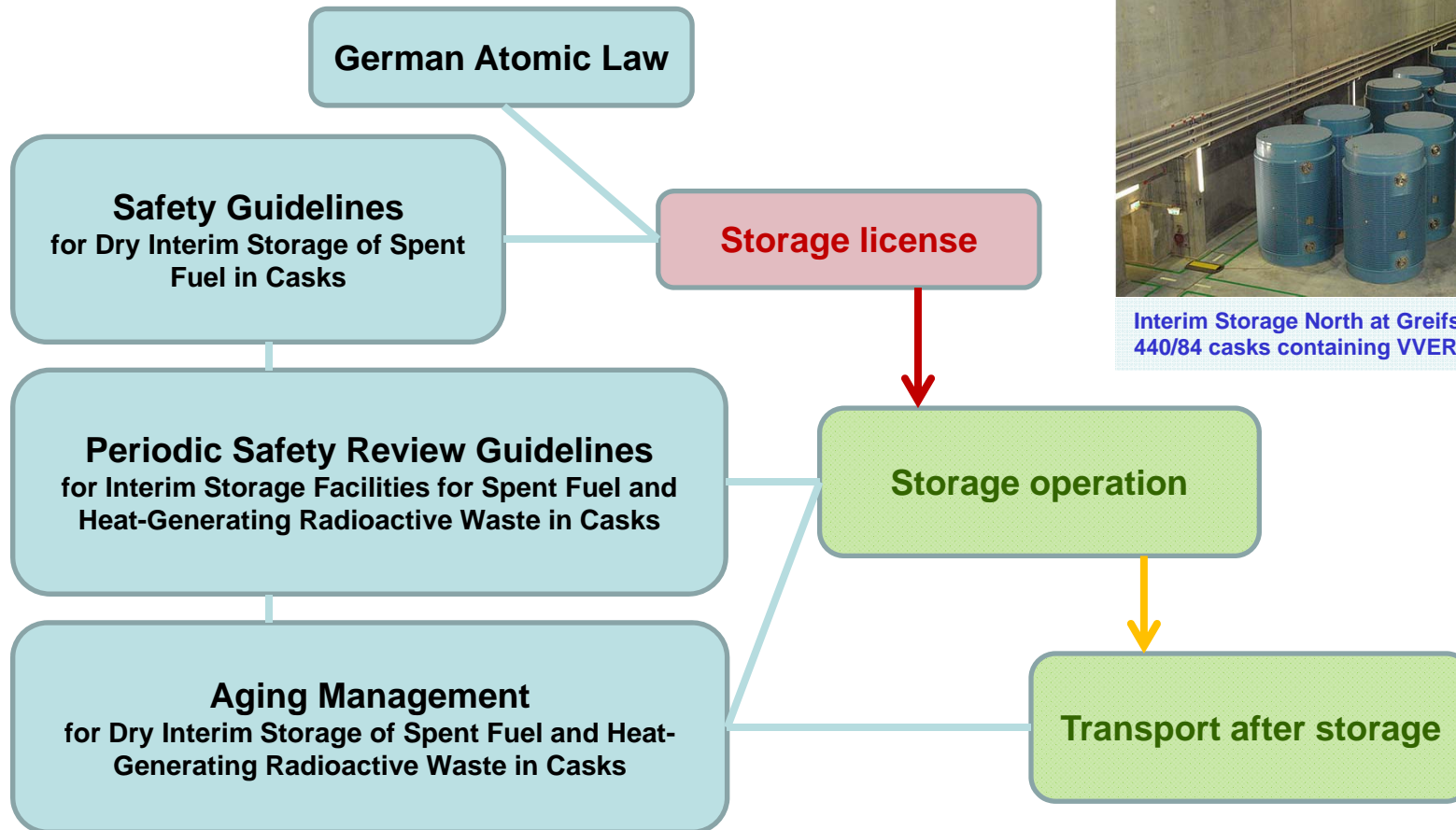
# Aging Management for Dry Interim Storage of Spent Fuel and Heat-Generating Radioactive Waste in Casks

### Chapters:

- Basics, Goals
- Approach to the technical aging management
  - Planning
  - Implementation
  - Documentation
  - Assessment
- Requirements for the monitoring concept
  - Casks (accessible regions; not accessible regions)
  - Storage building
  - Other technical equipment (fire protection, crane, cask monitoring installations,
- Non-technical aging
  - Long-term personnel management
  - Long-term documentation and knowledge management
  - Long-term operation management (safety management, electronic data processing systems)



## Concept for dry interim storage aging management



Interim Storage North at Greifswald with CASTOR 440/84 casks containing VVER fuel (photo: EWN)



## Aging management approach for extended storage periods

