GNS’ experience in the long-term storage at dry interim storage facilities in Ahaus and Gorleben

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GNS’ experience in the long-term storage

- The storage facilities Ahaus (TBL-A) and Gorleben (TBL-G) for spent fuel and high-level waste
- The CASTOR® casks for spent fuel and high-level waste
- Licensing procedures for TBL-A and TBL-G
- Storage experience of GNS (main issues)
  - Pressure switch
  - Dose at TBL-G fence
  - Cask approval procedure
  - In-service inspection
- Summary
The storage facilities for spent fuel and high-level waste

**Building dimensions:**
- 200 m length
- 40 m width
- 22 m height
- 20 to 50 cm wall thickness

**Natural-draught cooling:**
- Cooling in- and outlets are open or closed, depending on the heat load

**Handling and monitoring equipment:**
- 140 t/10 t gantry crane
- Cask monitoring system
- γ/n dose rate system
- Fire alarm system

**Storage areas:**
- Ahaus: 2 storage areas with 210 spaces
- Gorleben: 420 storage spaces
Interim storage facility Ahaus (TBL-A) - aerial view

Western storage area for the interim storage of low-level waste (licensed according to § 7 StrlSchV)

Eastern storage area for the interim storage of MTR- and LWR-fuel assemblies (licensed according to § 6 AtG)
Interim storage facility Ahaus (TBL-A)

Western storage area:
10-year storage of operational waste

Licensed inventory:
- Heavy metal: 3900 Mg
- Activity: $2 \times 10^{20}$ Bq
- Heat load: 17 MW

Stored casks:
- 6 casks with LWR-fuel assemblies
  - 3 CASTOR® V/19
  - 3 CASTOR® V/52
- 305 CASTOR® THTR/AVR casks with HTR-fuel assemblies
- 18 CASTOR® MTR2 casks with MTR-fuel assemblies

Eastern storage area:
LWR-, HTR- and MTR-fuel element casks
Interim storage facility Gorleben (TBL-G) - aerial view

- Pilot conditioning plant (PKA) for the conditioning of high-level waste and fuel assemblies for final disposal (licensed according to § 7 AtG)
- Interim storage of high-level waste and LWR-fuel assemblies (licensed according to § 6 AtG)
- Interim storage facility (ALG) for the storage of low-level and intermediate-level waste (licensed according to § 7 StrlSchV)
Interim storage facility Gorleben (TBL-G)

Stored casks:
- 108 casks with vitrified reprocessing waste
  - 74 CASTOR® HAW 20/28 CG, 21 CASTOR® HAW28M, 12 TN85 and 1 TS28 V
- 5 casks with LWR-fuel assemblies
  - 3 CASTOR® V/19, 1 CASTOR® Ic and 1 CASTOR® IIa

Licensed inventory:
- Heavy metal: 3800 Mg
- Activity: $2 \cdot 10^{20}$ Bq
- Heat load: 16 MW
The CASTOR® cask

Cask for transport and interim storage of spent fuel and high-level waste

- The key for the German protection concept for interim storage is the massive metallic cask with its protection functions and protection targets:
  - Safe containment of radioactive material
  - Safe removal of decay heat
  - Safe compliance with subcriticality
  - Prevention of unnecessary radiation exposure
Licensing procedures for TBL-A and TBL-G

- First storage license according to § 6 AtG was granted in 1983 for TBL-G and in 1987 for TBL-A
- In the mid-1990s:
  Replacement by new licenses, valid for a period of 40 years
- Additional license (§ 7 StrlSchV) for TBL-Ahaus in 2009
  - 10-year storage of low-level (LLW) and intermediate-level (ILW) operational waste in the western storage area
  - during this decade no storage of fuel elements
Current licensing procedures for TBL-A and TBL-G

- Further applications for new inventories (e.g. additional reprocessing waste or MTR-fuel assemblies) or new cask types are under examination
- The new licensing procedures always comply with the current state of the art of science and technology
  - e.g. extensive considerations within the accident analyses and the mechanical proofs
- Application for a new crane in TBL-Ahaus according to KTA 3902, section 4.3
- Application for the storage of operational LLW and ILW in the storage area of TBL-Gorleben
- Application of construction measures for security purposes
- Usual duration of licensing procedures: ~ 3 to 6 years
Additional regulatory requirements – PSR and ageing

- ESK published a recommendations for periodic safety reviews (PSR) in 2010 and for ageing management in 2012.
- TBL-Gorleben was selected for a 2-year test phase.
- The test phase was accompanied by the Federal Ministry for the Environment and by the experts (GRS and Öko-Institut).
- The results of the test PSR were handed over to the supervisory authority in May 2013, main results are:
  - constant optimisation based on long-term experience
  - extreme robustness of the casks
  - a safe operation is granted after 18 years
- The ageing management for TBL-G is currently in process and will be finished by the end of 2014.
Additional regulatory requirements – PSR and ageing

- A workshop with the Federal Ministry for the Environment, ESK, the supervisory authorities, GNS and the German utilities, was held in 2013

⇒ Summary of the PSR and ageing-management recommendation in one document:

“ESK guidelines for the performance of periodic safety reviews and on technical ageing management for storage facilities for spent fuel and heat-generating radioactive waste”, dated March 13, 2014
Licensing procedures for TBL-A and TBL-G

Relevant supplementary regulations

NB A 6: 3-month-reports on:
- Dose-rate measurements
- Personal doses
- Balance of radioactive inventory
- In-service inspections of facility equipment
- Essential operational occurrences (e.g. pressure switch events)

NB A 8: Annual dose at the fence

NB A 17: Valid cask approval certificate for all stored cask types over the storage period

NB A 21: Temperature measurements of the concrete structures of the facility

NB A 23: The operating manual, work instructions and test procedures must be adapted on the basis of loading and storage experiences

NB A 28: 10-year inspection of the casks

_reporting to the authority shows no safety relevant aspects (to be discussed hereafter)
Storage experience of GNS – the pressure switch

- Experience of more than a 13,000-year lifetime
- All in all ~ 1200 casks were equipped with pressure switches
- GNS records all data of pressure switch events and analyses these data

⇒ Constant optimizations performed, e.g.
  - Improvement of the welding process for the main membrane
  - Improvement of the ceramic leader transactions
  - Enlargement of the screw-head pressure loaded area

Five events in TBL-G:
- One defect of the weld seam of the main switch
- Three times: failure of the connector between the switch and the main computer
- The last event is currently under investigation

Conclusion:
⇒ In case of proper handling no failure of a sealing barrier has occurred so far
⇒ The principle of self-monitoring has proved to be effective
Storage experience of GNS – dose at TBL-G fence

Dose at the fence [mSv/a]

Licensed dose limit 0.3 mSv/a

Natural Neutron-Dose: 0.05 … 0.08 mSv/a

Number of casks stored in TBL-G

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Storage experience of GNS – cask approval procedures

- A Supplementary regulation requires a valid cask approval certificate for all stored casks at any time
  - Cask approval certificates are typically limited to three or five years (in a few exceptional cases up to 10 years)
  - All in all twelve approval certificates must constantly be prolonged, with the safety analysis always complying with the current state of technology
  - Experience of several prolongations:
    - Modification of impact limiters or even of cask components

- Storage operator’s view, searching for a balanced solution
  - e. g. by granting the cask approval certificate for the storage duration
  - or a supplementary regulation in the storage license could determine an atomic monitoring
    - This monitoring shall grant that solid evidence of a specific risk is recognized and should focus on transport after storage
Storage experience of GNS – in-service inspections

- In 2001/2002 the supplementary regulation NB A 28 required a 10-year inspection
  - GNS introduced new provisions for the long-term preservation against negative external influences (e.g. humidity)
  - sealing process of all stored casks in 2002

- Inspections after 10 years of storage on CASTOR® HAW 20/28 CG in 2012:
  - two small findings at the cooling fins (damage of surface painting)
  - points with corrosion of minor importance
  - one point of air bubbles inside a silicone seam
    - no rework was necessary

- In case of a CASTOR® V cask minor findings required a repair of the coating
GNS has a vast operational experience in the dry interim storage
  - of spent fuel assemblies
  - and high-level waste from reprocessing

From the mid-1990s, 442 casks have been stored in TBL-A and TBL-G

The cask itself is an essential safety feature in this system

The 10-year inspection and also the periodic safety review have proved the high safety level of the interim storage

All casks stored to date have a valid cask approval certificate which is constantly being prolonged

In this view it is suggested to obtain a cask approval certificate which is valid for the complete storage time or an atomic monitoring
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