

Retrieving waste from the Asse salt mine – facts and challenges

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Content

- **Radioactive waste disposal in Germany – history and present status**
- The „Asse“ history
- „Lex Asse“
- Consequences of the decision for retrieving the waste
- Some conclusions

Nuclear waste disposal in Germany

Heat generating waste:

- 1961 German Nuclear Commission decides to dispose radioactive waste in deep geological formations and recommends salt deposits; research programmes initiated;
- 1977 Initiation of a licensing procedure for the Gorleben site (HLW repository)
- 1986 Chernobyl accident**
- 2000 „Gorleben-Moratorium“
- 2002 German government decides nuclear phase-out
- 2010 Termination of the „Gorleben Moratorium“; Decision for NPP life time extension
- 2011 Fukushima accident; Shut down of 8 oldest NPPs; decision of an accelerated nuclear phase-out until 2022**
- 2013 **Site selection act** (Gorleben not any more the reference site for a HLW repository)
- 2014-2016 Commission for the disposal of high level radioactive waste
- 2014/2016 Foundation of a new regulator (BfE) and a new implementor organisation (BGE)**



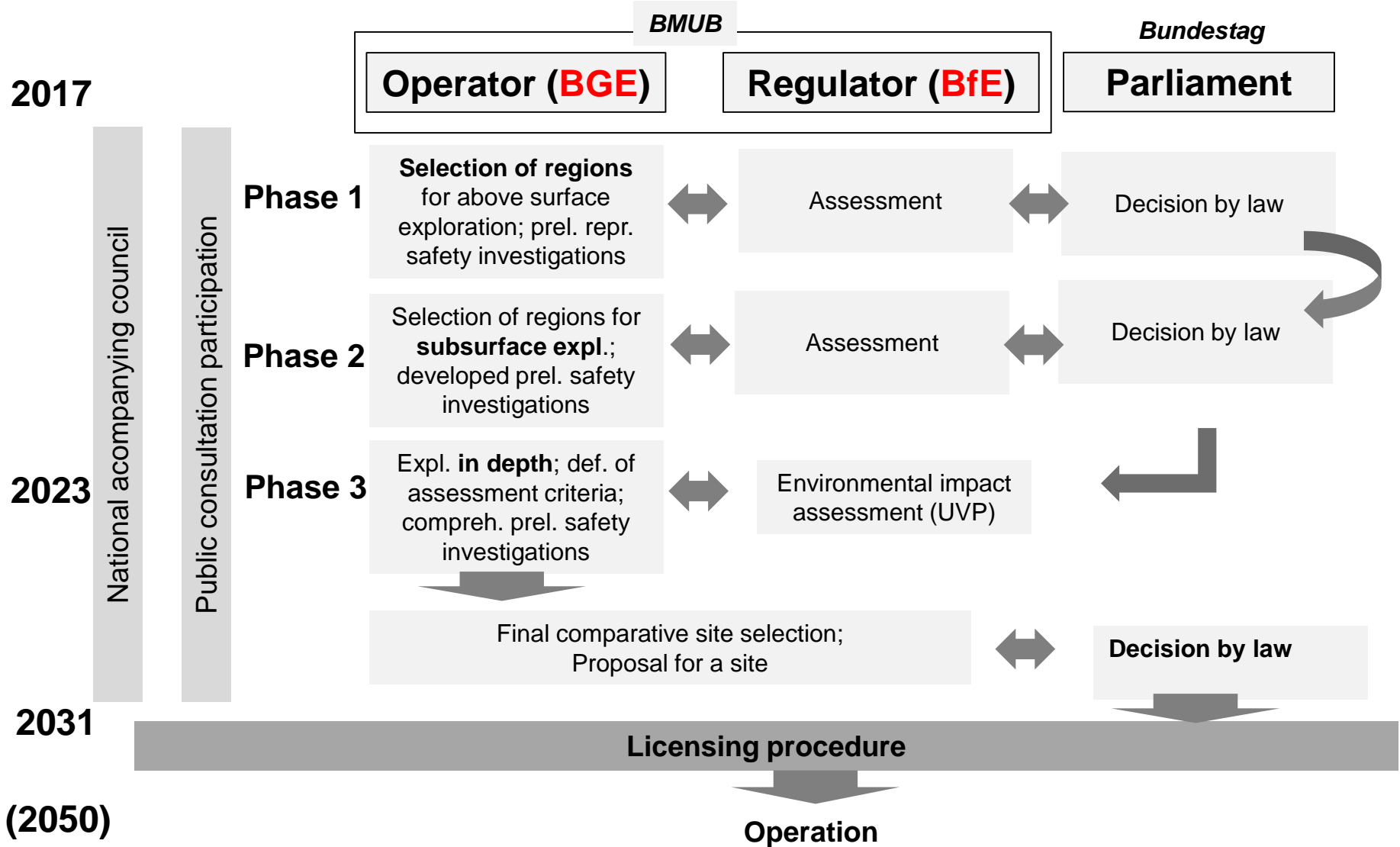
Nuclear waste disposal in Germany

Site selection act (2013/2017) passed within a broad political consensus

- Site selection in a **science-based, participative, transparent, self examining and learning process.**
- Radioactive waste disposal in a **mined repository in a deep geological formation**
- Consideration of rock salt, argillaceous rock and crystalline rock as possible host rocks („**white map of Germany**“)
- Provision of a **retrievability option** during the operation of the repository and the possibility to retrieve the waste for up to 500 years after closure of the mine

Nuclear waste disposal in Germany

Site selection process acc. to law (StandAG)



Nuclear waste disposal in Germany

Waste with negligible heat generation:

- ERAM** Operation **1971 – 1991** and **1994 – 1998**
(Morsleben) (37,000 m³; 6,600 radiation sources; $<6 \cdot 10^{14}$ Bq)
(Rock salt mine) **Decommissioning: Backfilling** (licensing approval under way)
- Asse II** Operation **1967 - 1978** → **Safety problems!**
(Rock salt mine) (125,787 drums; $2.5 \cdot 10^{15}$ Bq)*
 “Lex Asse” (2013): Selected option: Waste Retrieval (not before 2033)
- Konrad** Since **1975** examined to be a repository
(Iron ore mine) **1982 – 2002** Licensing procedure
 2007 Conversion of the mine to a repository
 Planned Operation: 202x (max. 303,000 m³)



* BfS, 2017

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History of the Asse II salt mine

- 1909-1964* mining of potash and sodium salt
(void volume after shut-down: 3.5 Mio m³)
- Since 1965* establishment of a research mine
(costs: 700,000 DM) for the demonstration
of disposal techniques in the abandoned
salt mine
- 1967-1978** disposal of LLW/ILW (125,787 drums)
operation as a repository **and**
an underground rock laboratory



The contemporary view

Sea disposal operation from 1946 to 1993

- 48 years of ocean disposal
- 140 PBq (1.4×10^{17} Bq)
- 140'000 tons of low-level radwaste

Sources: Calmet, D., IAEA Bulletin #4, 1989; IAEA, TEC-DOC 1105, 1999;
Kirsti-Liisa et al., IAEA Bulletin 2/1994
König L. A., Naturwissenschaften 70, 430-433, 1983

Features

Ocean disposal of radioactive waste: Status report

A number of studies are being done to more fully assess the impact of sea disposal

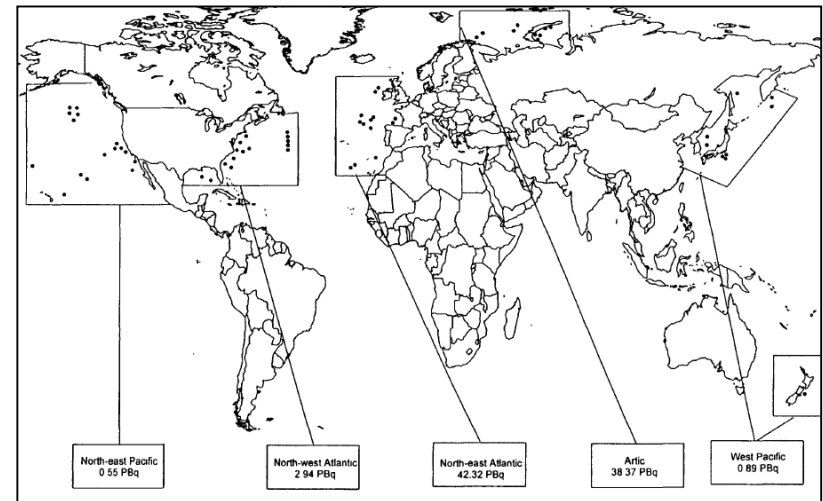
by Dominique P. Calmet

For hundreds of years, the seas have been used as a place to dispose of wastes resulting from human activities. Although no high-level radioactive waste (HLW) has been disposed of into the sea, variable amounts of packaged low-level radioactive waste (LLW) have been dumped at more than 50 sites in the northern part of the Atlantic and Pacific Oceans.* In 1946, the first sea dumping operation took place at a site in the North East Pacific Ocean, about 80 kilometres off the coast of California. The last known dumping operation was in 1982, at a site about 550 kilometres off the European continental shelf in the Atlantic Ocean. (See map.)

*Between these two dates, an estimated 63 PBq



National and international programmes have improved knowledge about the potential impact of deep sea disposal of radioactive waste. Shown here, about to be submerged, is a new type of "sediment cores" to sample the 30 upper metres of seabed sediment. (Credit: CEA/DPT)



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- Since 1991** increasing inflow of brine from the
Southern flank

- Since 1994** reports on contaminated brines (³H, ¹³⁷Cs)

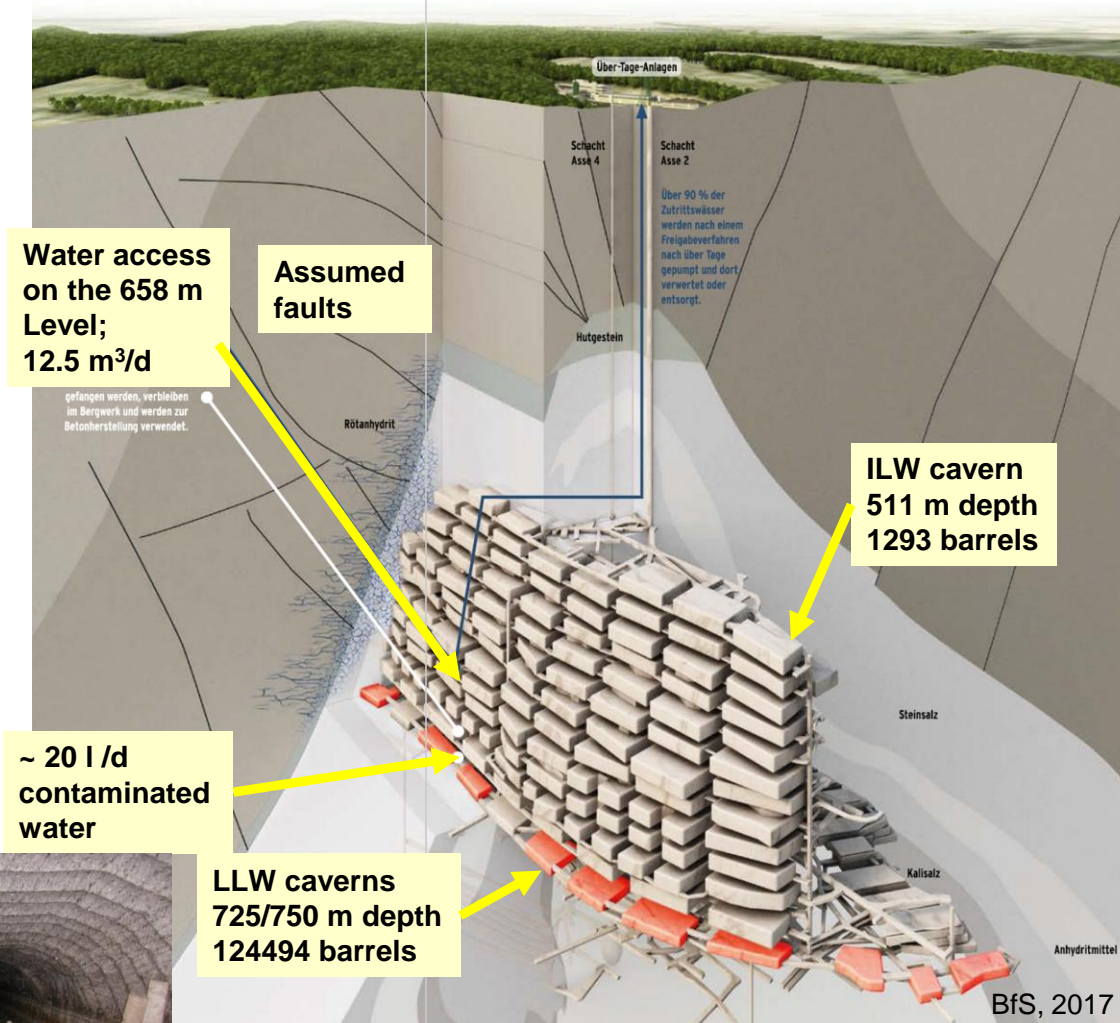
- 2007 Monitoring group (A2B) (civil society)

- 2008 Article in local newspaper
"Wasser im Asse-Endlager radioaktiv belastet"



(www.asse.bund.de)

History of the Asse salt mine



Water access on the 658 m Level; 12.5 m³/d

Assumed faults

ILW cavern 511 m depth 1293 barrels

~ 20 l/d contaminated water

LLW caverns 725/750 m depth 124494 barrels



BfS, 2017

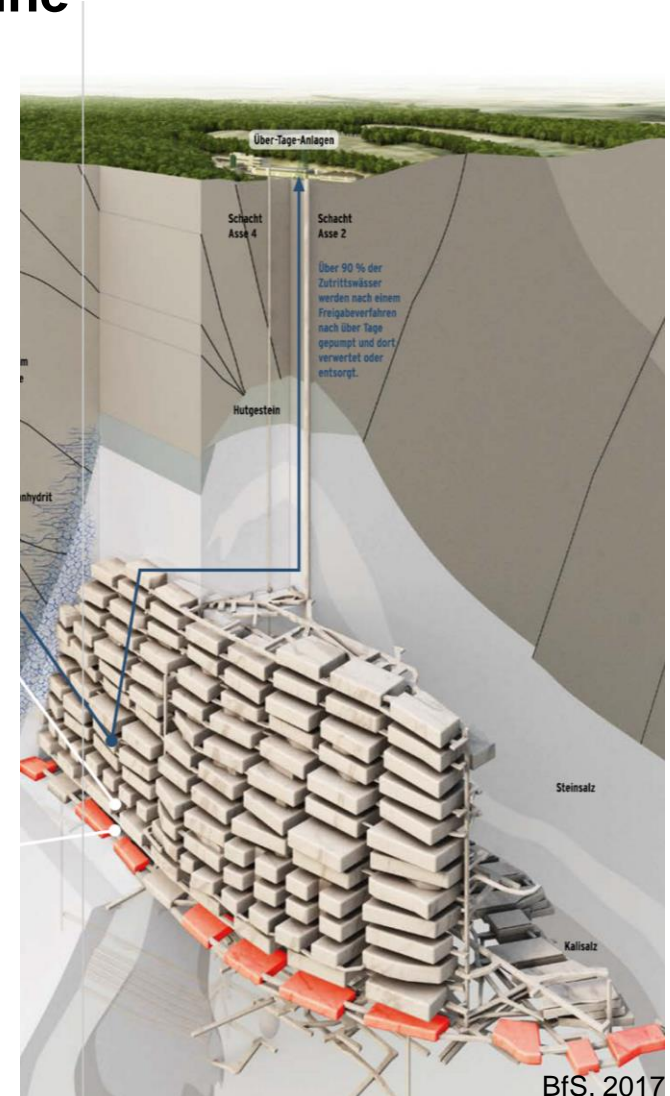
History of the Asse II salt mine

- 2008 Working group on the comparison of options (AGO)
- 2009 New operator: Federal office for radiation protection (BfS;
now BGE)
- Set up of a committee of inquiry (Bundestag)
- Comparison of remediation options (BfS)
- 2013 “Lex Asse”

History of the Asse II salt mine

Options for remediation of the ASSE II salt mine

- Suggested by the working group on the comparison of options, AGO, Feb. 2009
- Feasibility studies completed, October 2009
- Evaluation and presentation of results to the public by BfS, February 2010



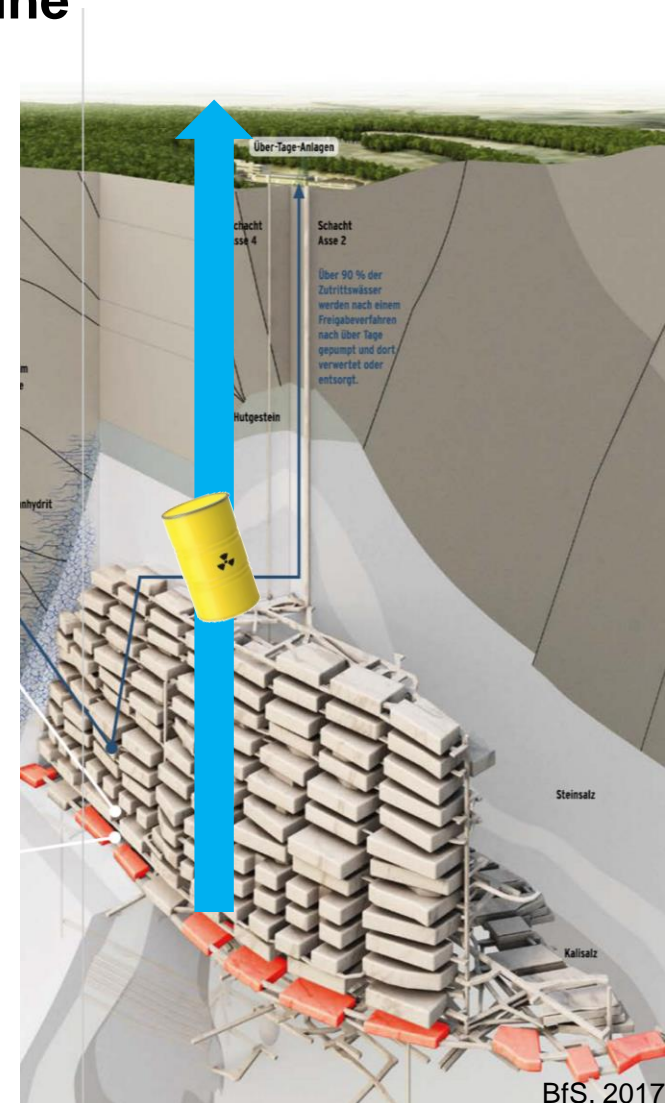
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Options:

- 1) Complete waste retrieval



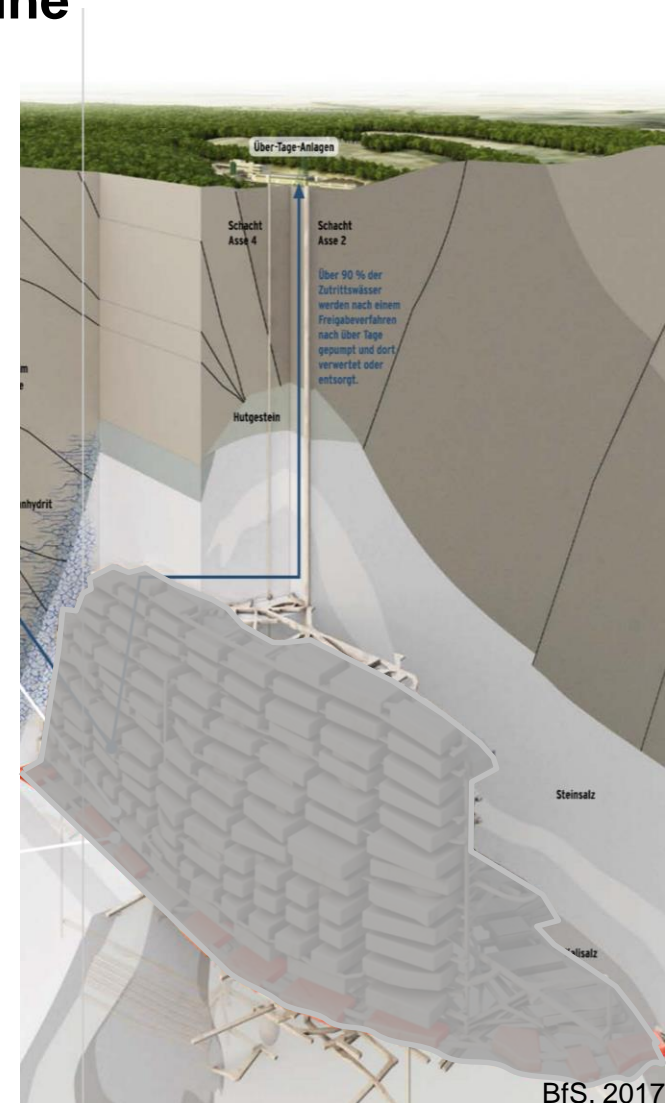
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Options:

- 1) Complete waste retrieval
- 2) Complete backfilling of chambers and drifts



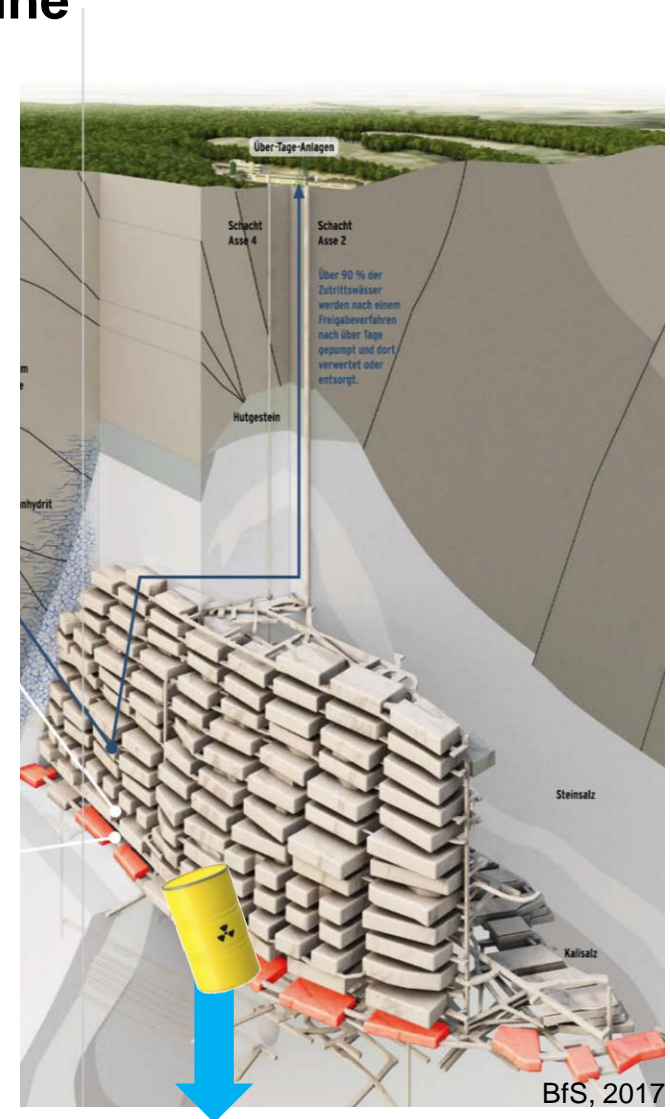
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Options for remediation of the ASSE II salt mine

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Options:

- 1) Complete waste retrieval
- 2) Complete backfilling of chambers and drifts
- 3) Internal replacement of all or parts of the waste to lower depths



History of the Asse II salt mine

Ranking of measures by the Federal Office for Radiation Protection (BfS), 2010

Criteria	Rank 1	Rank 2	Rank 3
Safety during operation	Backfilling	Internal Replacement	Retrieval
Environmental impact due to uncontrolled water access	Backfilling	Retrieval	Internal Replacement
Assessment of long term safety	Retrieval	Backfilling	Internal Replacement
Technical feasibility	Backfilling	Retrieval	Internal Replacement
Duration of measure	Backfilling	Retrieval	Internal Replacement

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„Lex Asse“ ,Act to Accelerate the Retrieval of Radioactive Waste and the Decommissioning of the Asse II Mine'

- The mine is to be closed immediately after retrieval of the waste.
- For the operation including the retrieval of radioactive waste **no licensing procedure acc. to §9b is required** until closure.
- Waste retrieval must be interrupted **if the implementation is not acceptable (justifiable) for the population and employees due to radiological and other safety related issues.**
- The licencing authority can, in an emergency case, stipulate **the design basis accident planning value** at a value above the **50 mSv planning value** for the effective dose provided in the StrlSchV.
- If waste retrieval and other measures for closure are not possible without deviation from legal requirements the best option for closure has to be selected.
- Before a respective decision is taken, the parliament and the public need to be informed, unless urgent action is required.

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Challenges for retrieving the waste

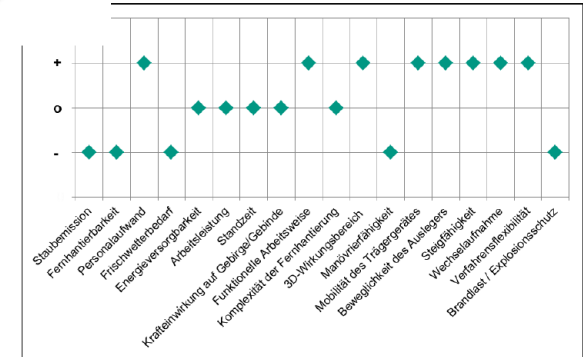
- Not really clear how the waste and emplacement chambers look like (exploration ongoing)
- Not clear how to retrieve the waste (stabilization of the mine required; part of radioactive waste might not be retrievable)

Discussion on technical measures for waste retrieval

- Major steps for retrieval



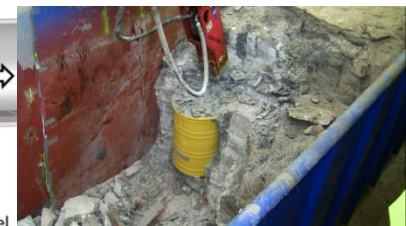
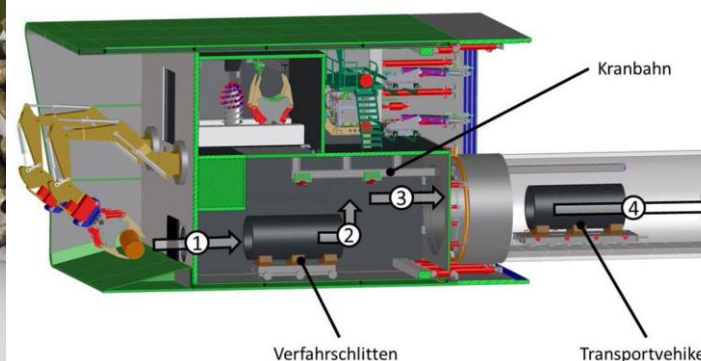
- Identification of available technologies
- Assessment of technologies based on various criteria
- Identification of a need for development



Example for a possible technology:

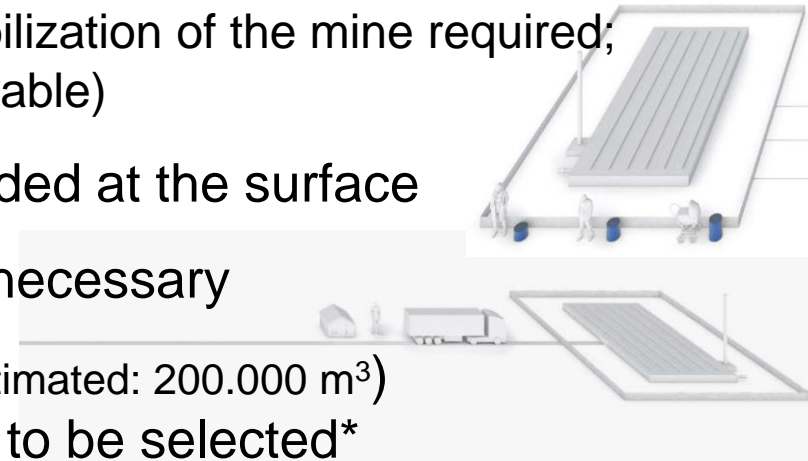


S. Gentes, N. Gabor, BfS Report, 2016
BfS 2017



Challenges for retrieving the waste

- Not really clear how the waste and emplacement chambers look like (exploration ongoing)
- Not clear how to retrieve the waste (stabilization of the mine required; part of radioactive waste might not be retrievable)
- Conditioning/interim storage facility needed at the surface
- Nuclear transports to disposal facilities necessary
- Final disposal of the retrieved waste (estimated: 200.000 m³) preferentially at the HLW repository site to be selected* (Asse II waste cannot be disposed in the licensed repository for L/ILW waste at the Konrad site)
- “Lex Asse” interferes with the principles of justification and optimisation of radiation protection measures** (in case of emergency)
- Mistrust of local population in all measures to be taken



Figures from BfS, 2017

* National waste management programme (NaPro), Federal Ministry for the Environment (BMUB), 2014

** Radiation Protection Commission (SSK) of the Federal Ministry for the Environment (BMUB), 2016

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Conclusions

- The „Asse case“ is not representative for retrievability discussion in HLW repository concepts
 - repository design not state-of-the-art
 - no retrievability measures initially planned

- „Lessons to be learnt“ from the Asse case:
 - There is a difference in **public perception** of waste retrieval and what it means **in practice**
 - **Therefore:** Clarification **and** communication of waste retrieval consequences needed
 - Long time scales (several decades to centuries) need to be considered for the measure
 - Retrievability measures (simplified access to the waste) are associated with uncertainties and risks increasing over time!
 - Risks regarding economy development
 - Risks regarding society evolution
 - Risks related to a decline of technical robustness of the barrier system

Conclusions

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Thank you for your attention!