Spent Fuel Management and Storage in Germany

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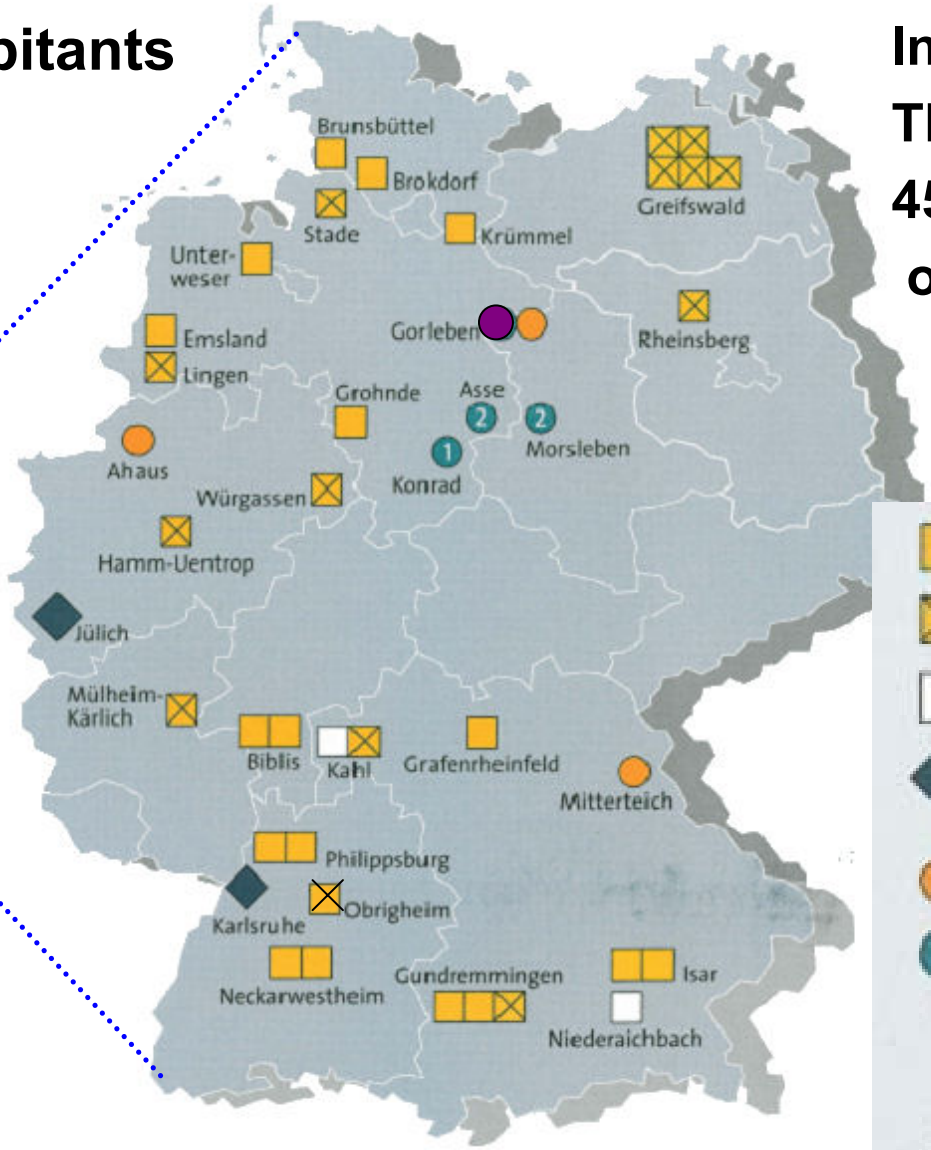
Tokyo, November 15-17, 2010

Nuclear power plants (NPP) in Germany

82 Mio inhabitants

357,104 km²



In total: 17 active NPP

Thereof: 11 PWR and 6 BWR

450 tons annual discharge of spent fuel

NPP in operation/on-site SFSF

NPP cut-off or closed-down

NPP completely dismantled

Reseach/waste treatment plant

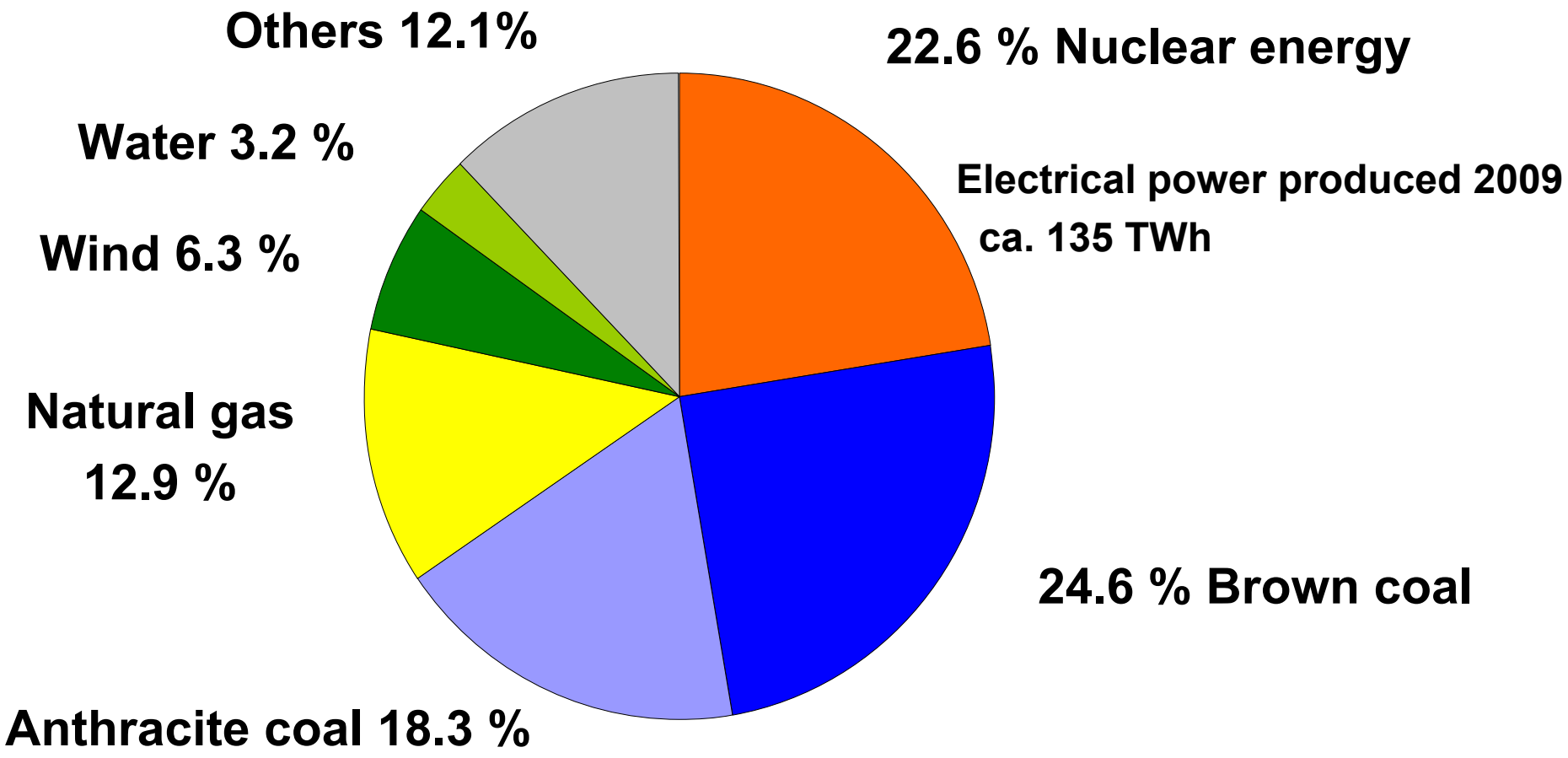
Centralized dry SFSF

L/ILW: Final repository

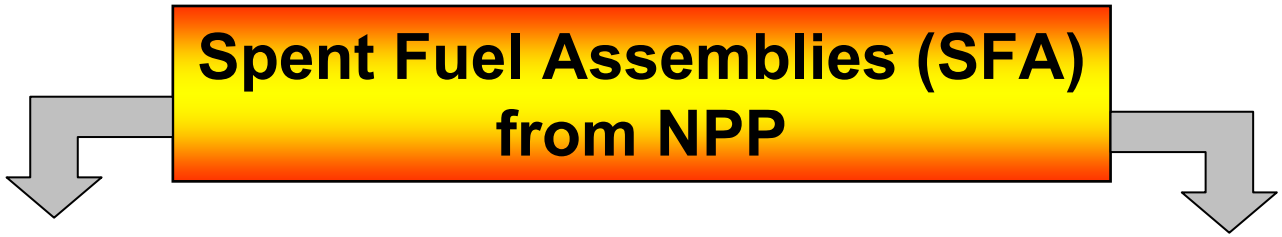
1 Operating plan licence 2007 Emplacement stopped

2 HLW; exploration phase

Energy mix in Germany – status 2009



Disposal route in Germany



Reprocessing

- Sole disposal route up to the 1980/90s
- Since June 2005 any delivery of SFA to a reprocessing plant is prohibited.
- Completion of the reprocessed waste return is expected in 2024.

Direct Disposal

Sole potential disposal route since June 2005

- **Development began in 1970s as so-called reference concept**
- **Completion of the pilot conditioning plant (*Pilotkonditionierungsanlage*, PKA) in 2000**

Today‘s policy: Once through nuclear fuel cycle

Disposal of spent fuel assemblies (SFA) in Germany

Spent fuel assemblies

About 6,400 t HM **About 10,000 t HM**

MOX

Reprocessing

Waste from Reprocessing

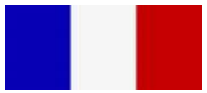
Intermediate Storage
Central and decentralized on-site-dry-storage facilities

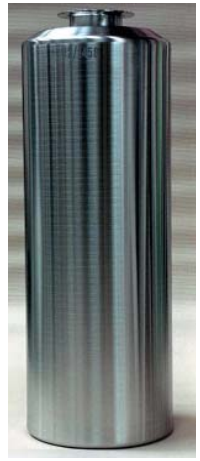
Conditioning
Pilot conditioning plant

Final repository

Return of waste from reprocessing plants

The reprocessed spent fuel (about 6,000 t HM) yields the following waste types and amounts:

Reprocessing plant Spent fuel reprocessed	Casks	Waste type	Number of casks	Return period
AREVA-NC 5,309 t 	TS 28V, CASTOR® HAW20/28CG, TN85, CASTOR® HAW28M	CSD-V ≙ HLW	108	until 2011
	TGC 36	CSD-C	≈ 150	from 2015
	CASTOR® HAW28M	CSD-B ≙ ILW	≈ 20	from 2014
NDA 768 t 	CASTOR® HAW28M	HLW	21	from 2014



CSD-V **CSD-B**

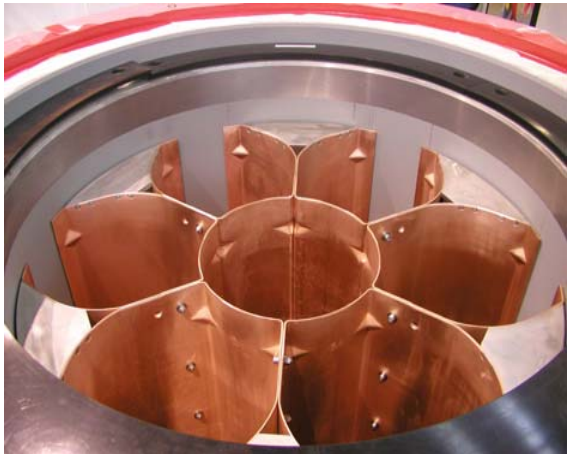
LLW vitrified ILW vitrified

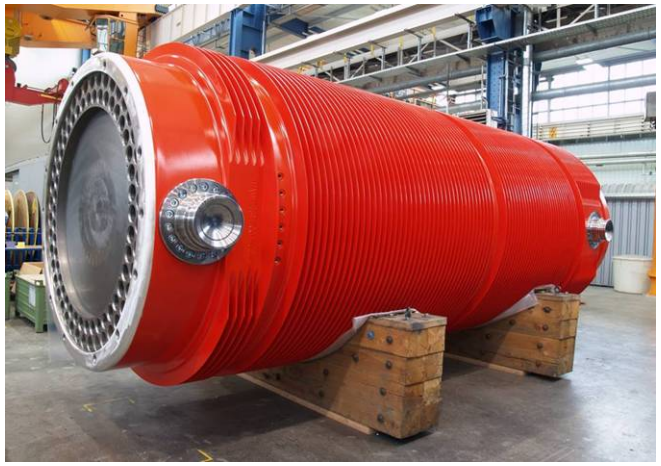
CSD-C

Compacted hulls, endpieces

New development: CASTOR® HAW28M

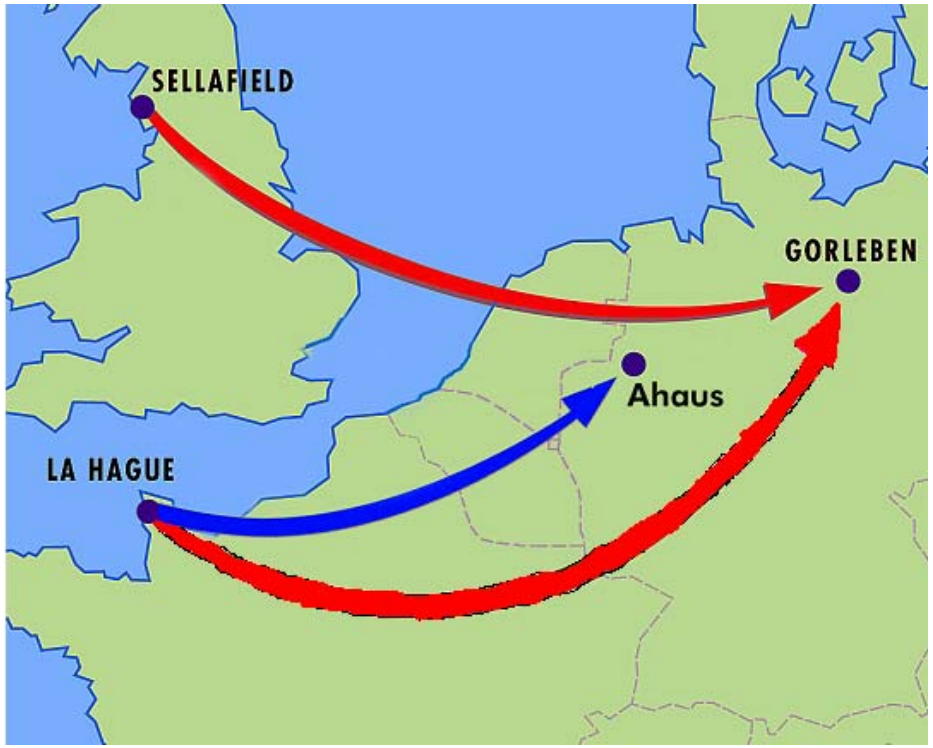
2010 - 2011 Loading of 22 casks





Dimensions:	**H = 6120 mm, Ø = 2430 mm**
Cask Weight loaded:	**114.3 t max.**
Loading:	**28 canisters with vitrified HLW**
Inventory:	**55 GWd/MGHM - equivalent**
Max. Heat Load:	**56 kW**
Total Activity:	**1270 PBq**

Storage hall for the HLW-casks returned to Gorleben

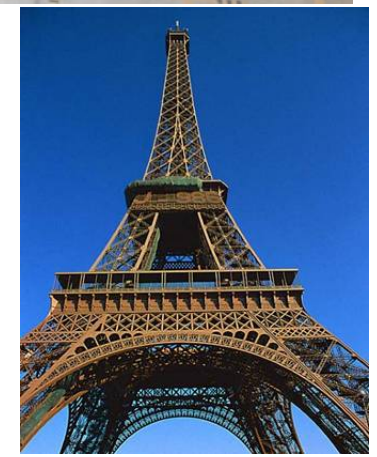


Vitrified HLW-Waste currently from France, from 2014 from United Kingdom: centralized storage at Gorleben

Compacted hulls and endpieces: planned for centralized storage at Ahaus

75 CASTOR® HAW-casks ≙ 7500 t
≙ 1 Eiffel Tower

Since 2009 additional 11 TN85-casks



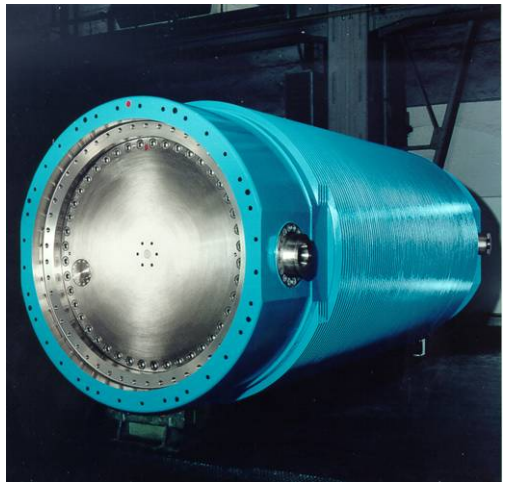
Accumulation of spent fuel

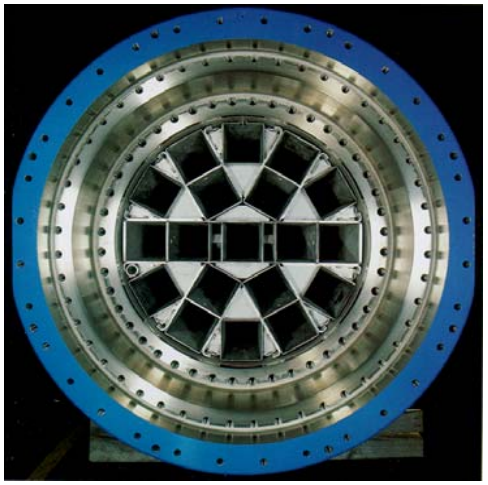
Total amount	**SFA**	**t HM**
- **Accumulated by 31 Dec 2009 in reactor pools and dry storage**	**17,300**	**5,700**

- **Intermediate storage in about 1,000 transport-/ storage casks** without considering the extension of reactor life time

- **Final repository**
  - **Reference concept POLLUX** **about 2,000 casks**
  - **Fuel rod container BSK3** **about 6,800 containers**

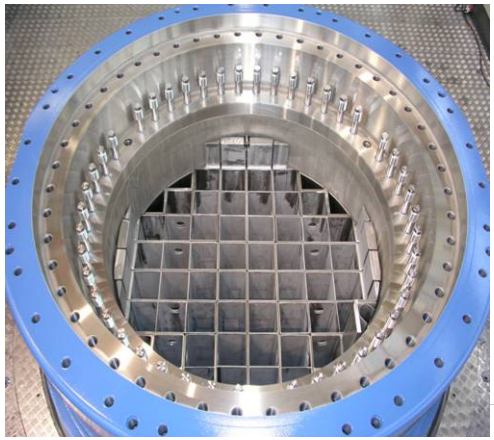
CASTOR® Casks used for Spent Fuel Storage





CASTOR® V/19

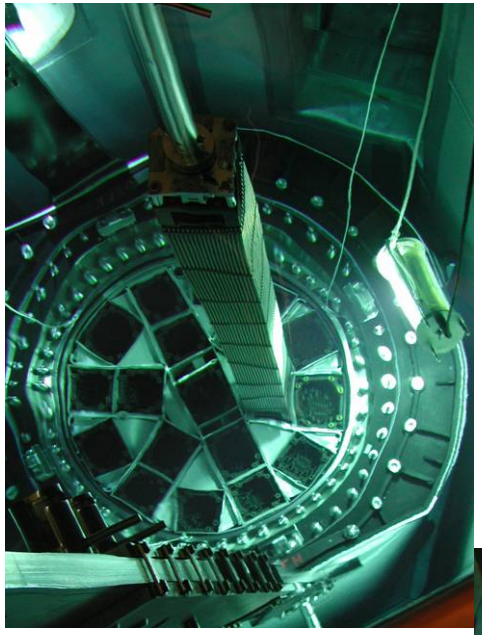
Dimensions:	H = 5860 mm, Ø = 2440 mm
Cask Weight Loaded:	125.6 t max.
Capacity:	19 PWR F.A.
Max. Initial Enrichment:	4.45 wt % U-235
Max. Average Burn-up:	65 GWd/MTHM
Max. Heat Load:	39 kW
Total Activity:	5.5·E+17 Bq

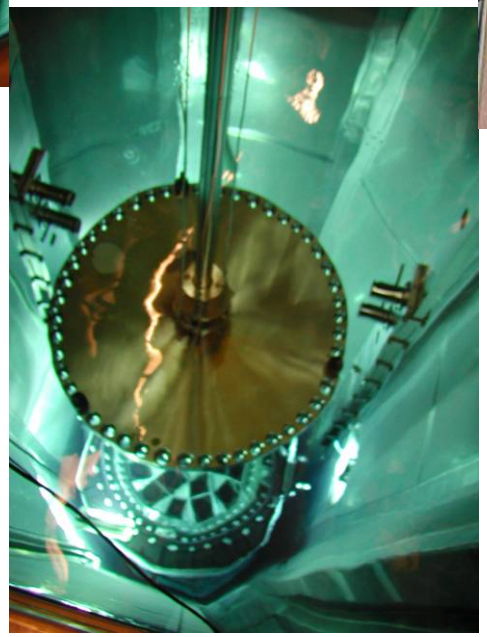


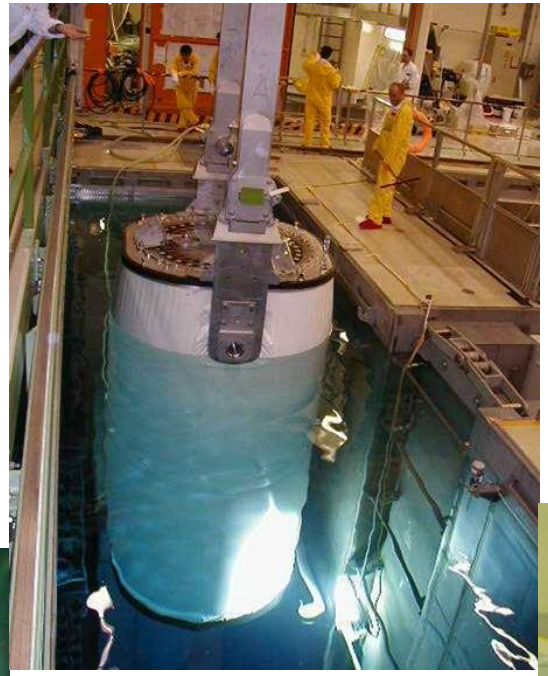
CASTOR® V/52

Dimensions:	H = 5450 mm, Ø = 2440 mm
Cask Weight Loaded:	123.4 t max.
Capacity:	52 BWR F.A.
Max. Initial Enrichment:	4.6 wt % U-235
Max. Average Burn-up:	65 GWd/MTHM
Max. Heat Load:	40 kW
Total Activity:	1.2 ·E+18 Bq

Loading of a CASTOR®V-casks

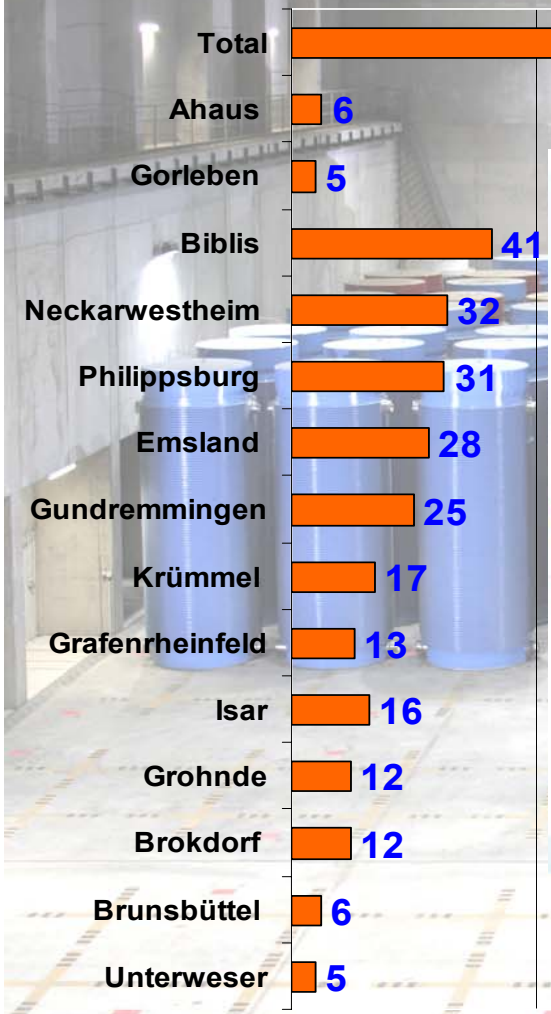


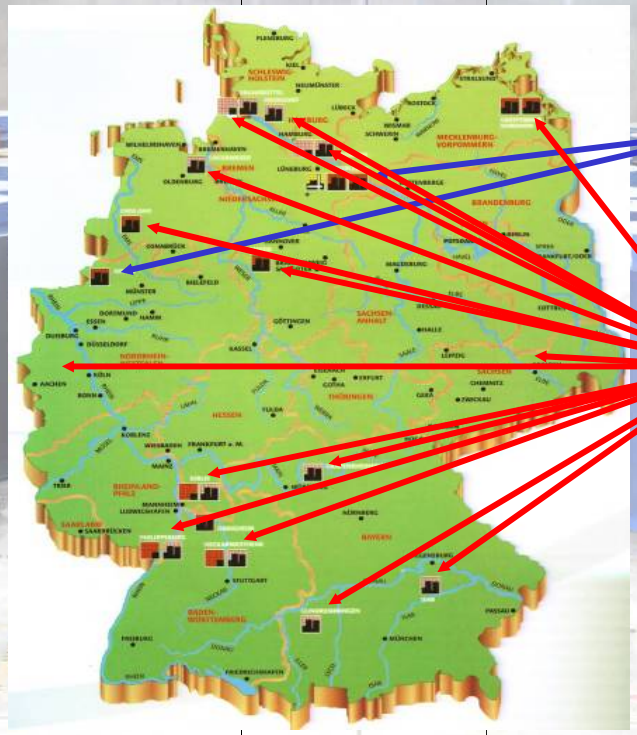




Intermediate storage of CASTOR®-casks filled with SFA

Status: 31th December 2009





2 centralized dry storage facilities Ahaus & Gorleben

12 + 3 decentralized storage facilities on-site near NPP

12 on-site intermediate dry storage facilites with 1435 storing positions

Pilot Conditioning Plant (PKA) at Gorleben

TSC

TSC without secondary lid

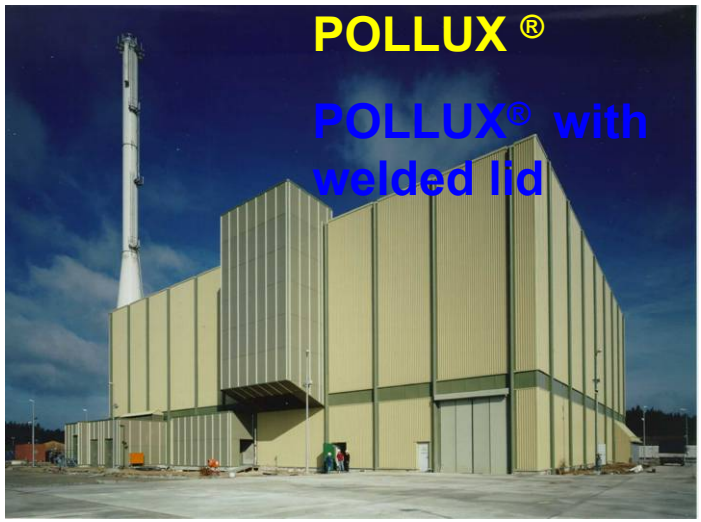
Fuel elements

Fuel rods

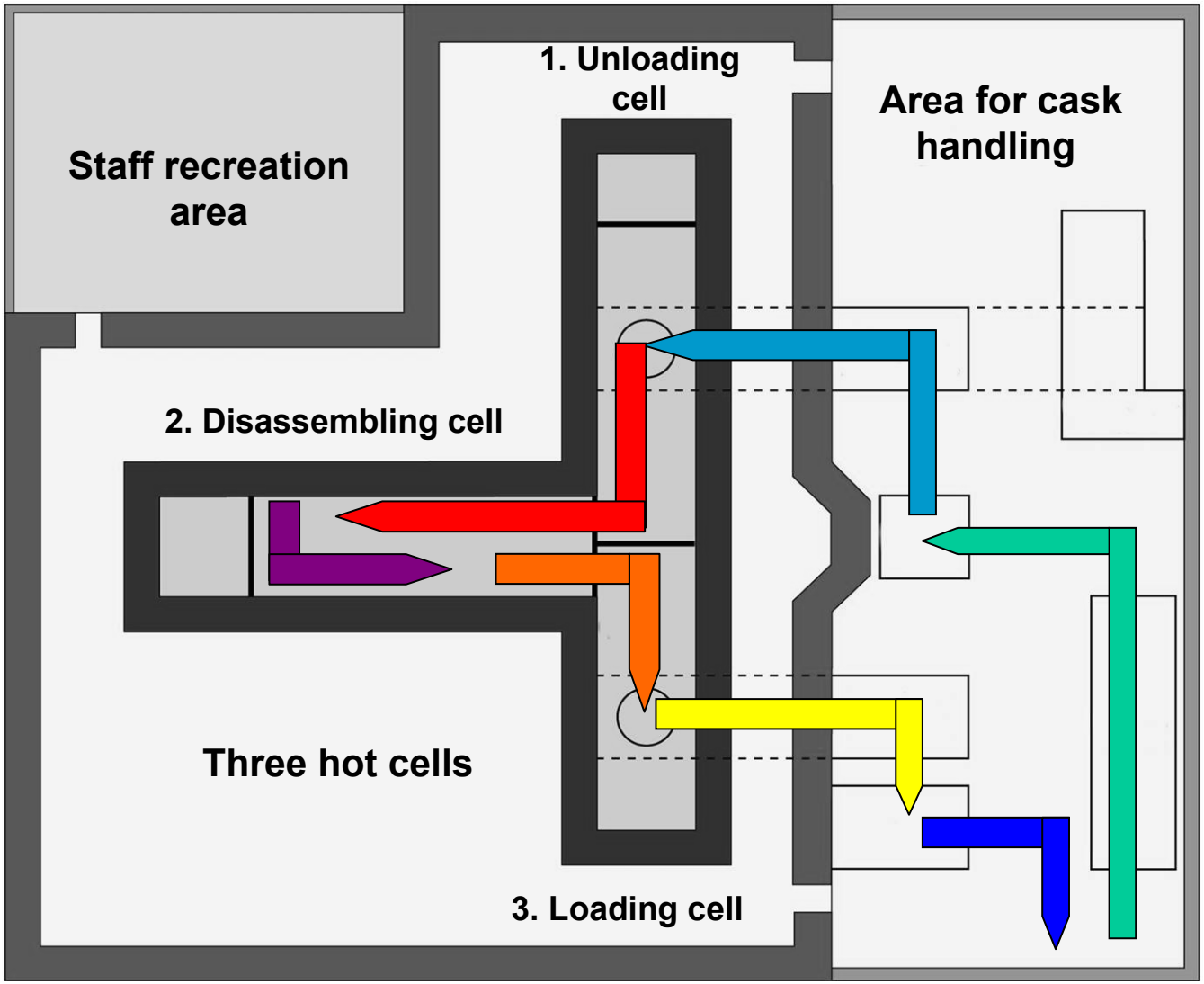
Cans with fuel rods

POLLUX ®

POLLUX® with welded lid



PKA-building

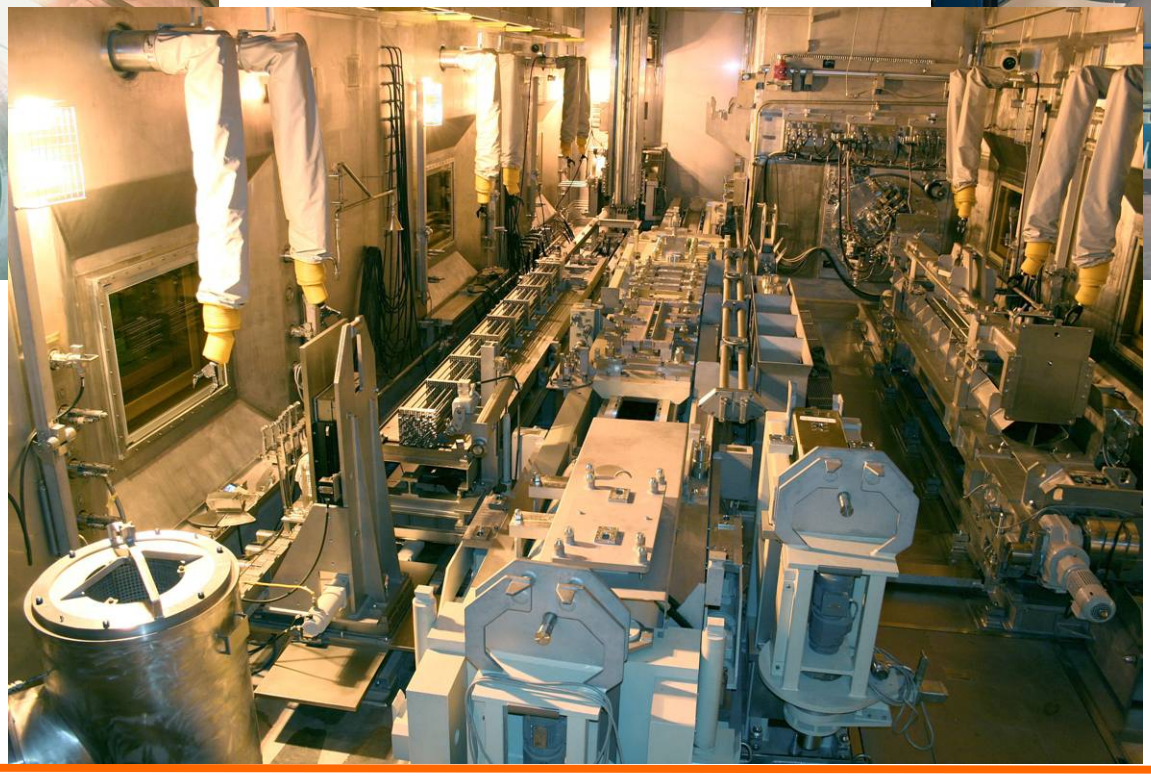


Handling sequence at the PKA

Hot cells of Pilot Conditioning Plant

Unloading

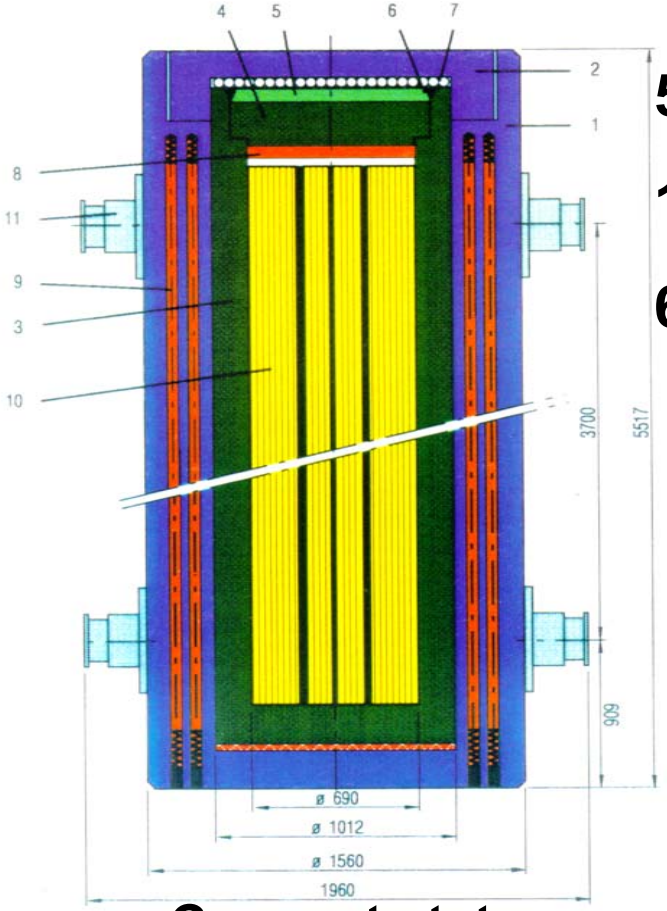
Disassembling



Loading

POLLUX®-Reference concept

POLLUX® - cask



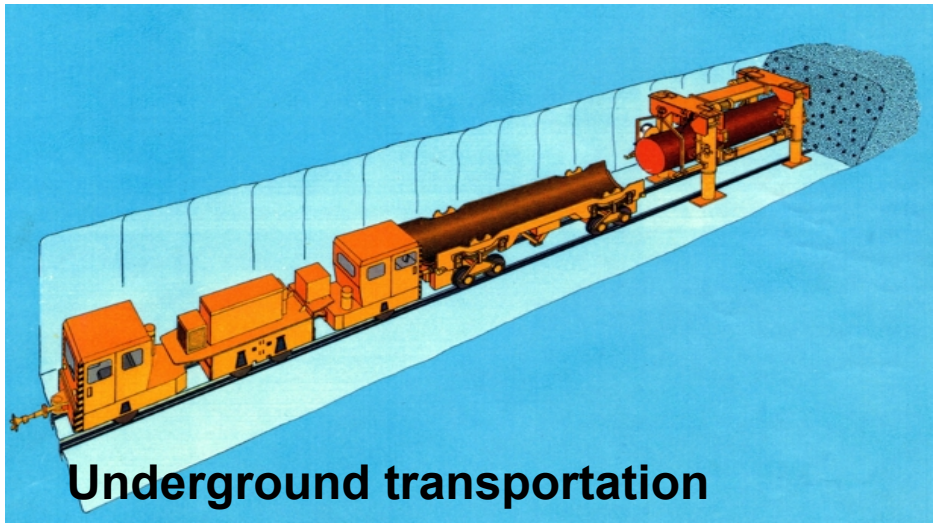
5 t HM

10 PWR-FA

60 t

Concept status: end of 1990s

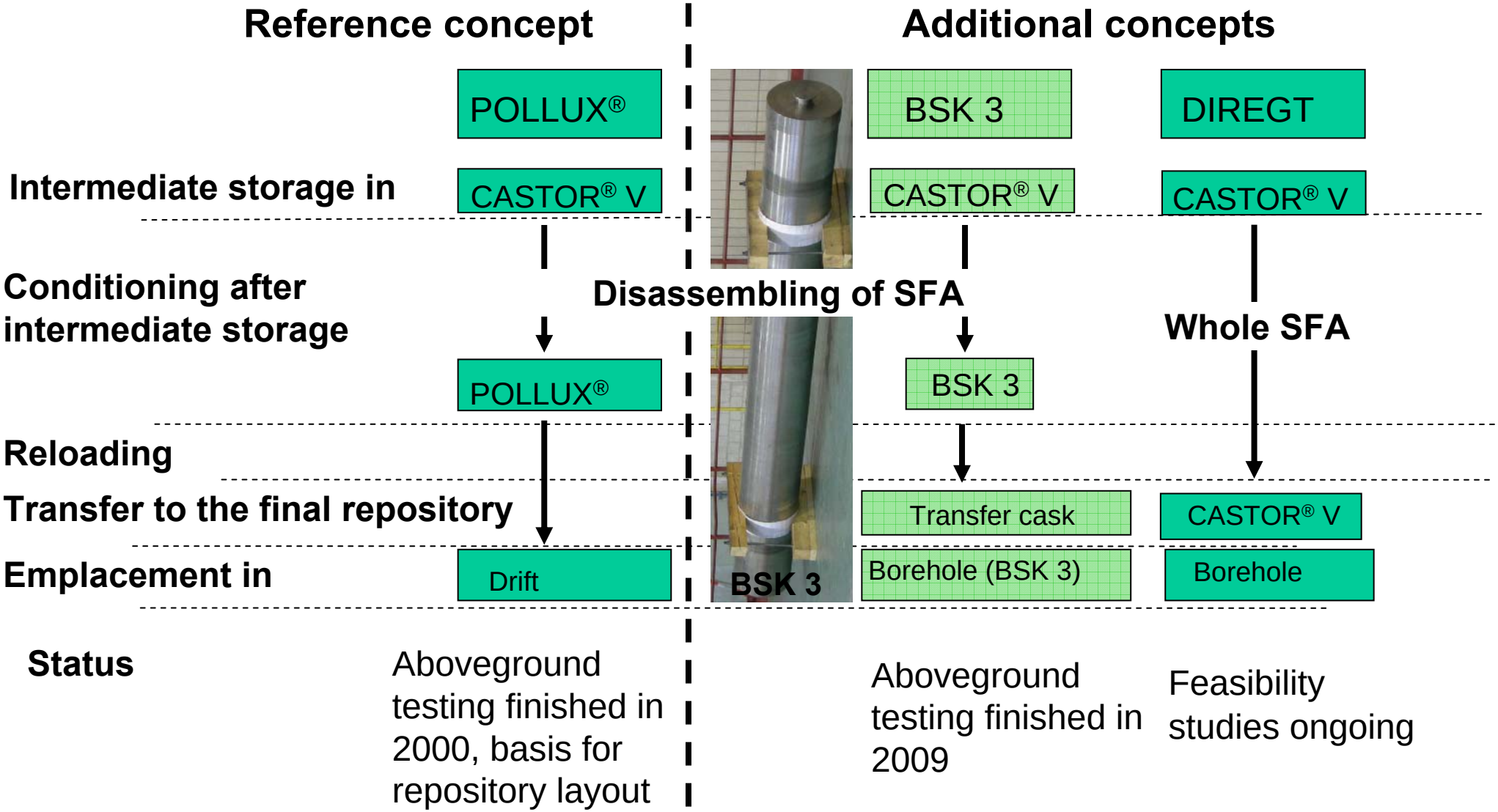
Disposal system



Underground transportation

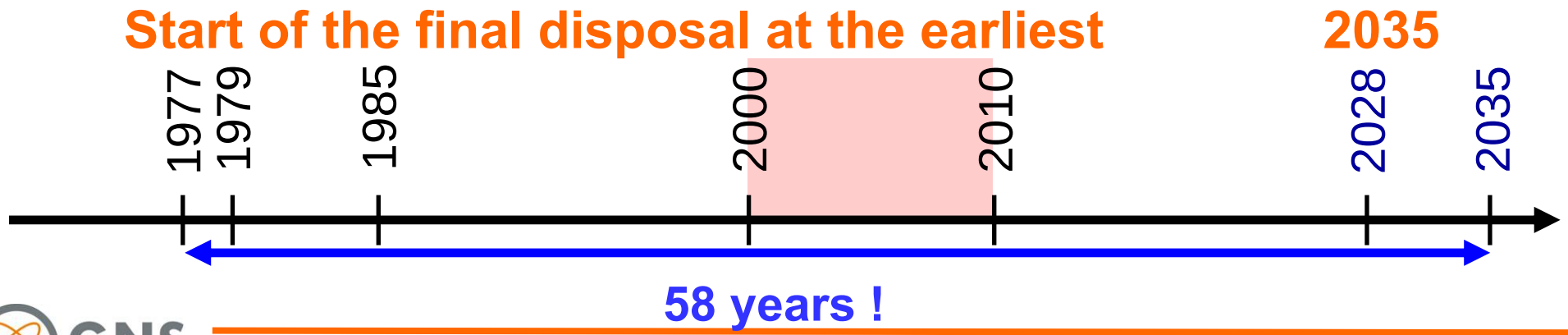
Aboveground disposal tests

Additional Disposal Concepts for SFA



Way ahead

- Resumption of exploration work of the salt dome in Gorleben — 2010 - 2015
- Development of a site related suitability statement — 2015 - 2016
- Decision on site — 2019
- Planning of the final repository layout and plan submission — from 2020
- Finishing of the plan approval procedure — 2028
- Construction until operational start — 2035



Conclusion

- The reprocessing of spent fuel is technologically mature and well experienced but was prohibited by the German AtG.
- There are proved procedures for transport, intermediate storage and the conditioning of spent fuel.
- The disposal of spent fuel is technologically already solved to a large extent.
- The exploration results obtained so far strongly suggest that the salt dome of Gorleben is suitable to host a repository for heat-generating waste and spent fuel.
- The political decision on resuming the exploration of the salt dome in Gorleben and commissioning the first tentative safety analysis are important steps to move ahead on the way to a deep geological repository for heat-generating HLW. A concept for an appropriate participation of the public would be desirable.