International Perspectives on the Impacts of the Design of the Spent Fuel Management Programme on Spent Fuel Handling, Transportation and Disposal

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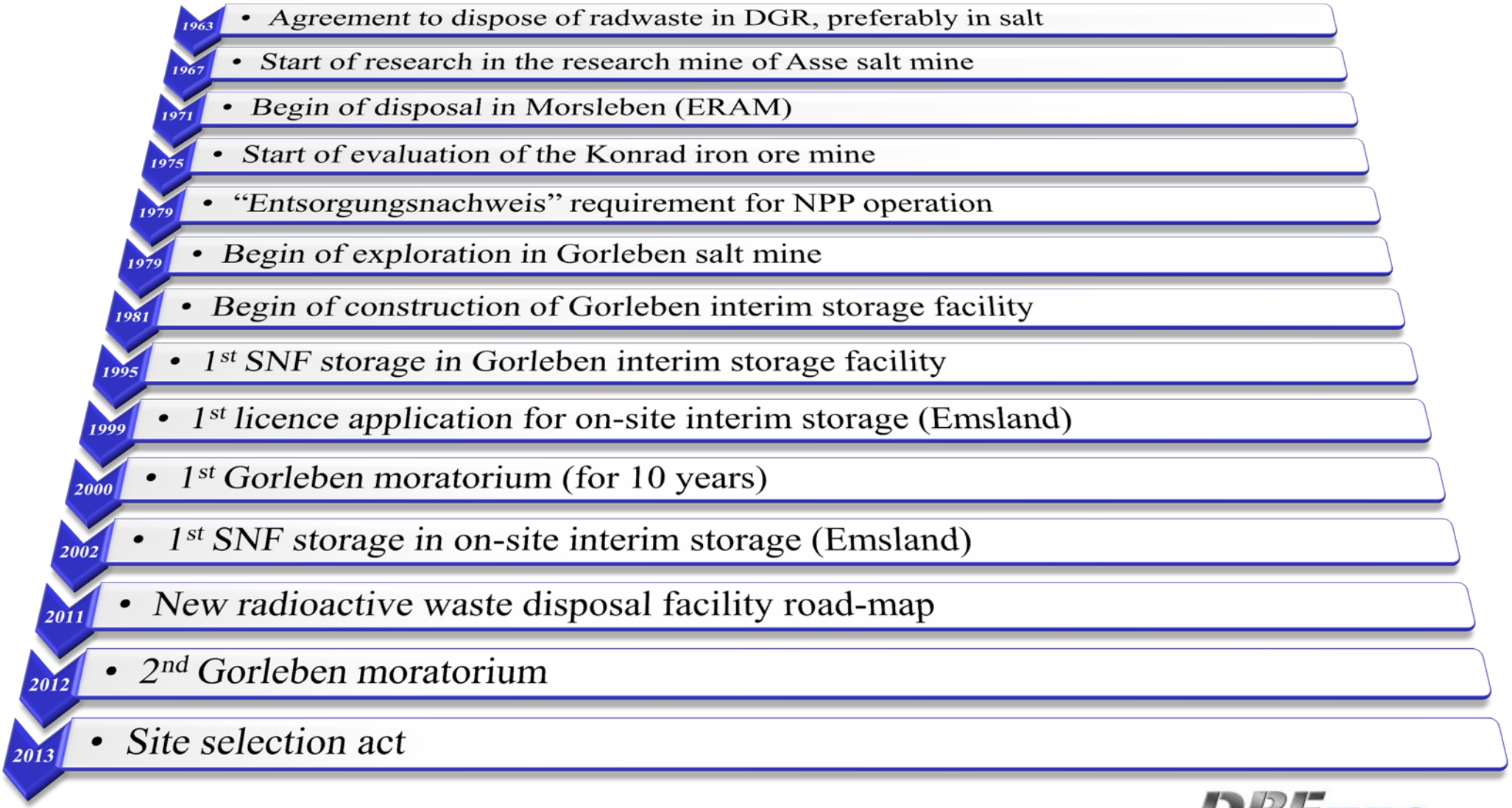
Milestones of Radioactive Waste Management in Germany



Some Assumptions and Definitions …

Borehole Emplacement

- NOT deep boreholes, rather ‘tight drilled vertical drifts‘

BSK3

- Disposal only casks for borehole emplacement

CASTOR®

- Transport and storage cask

Conditioning

- Here: Preparation for disposal – Originally planned at the repository site (nuclear waste management center) with the full scale pilot plant still near the Gorleben exploration mine, but principally without formal decision on the final location

CSD-C

- Compacted waste packages from reprocessing in France

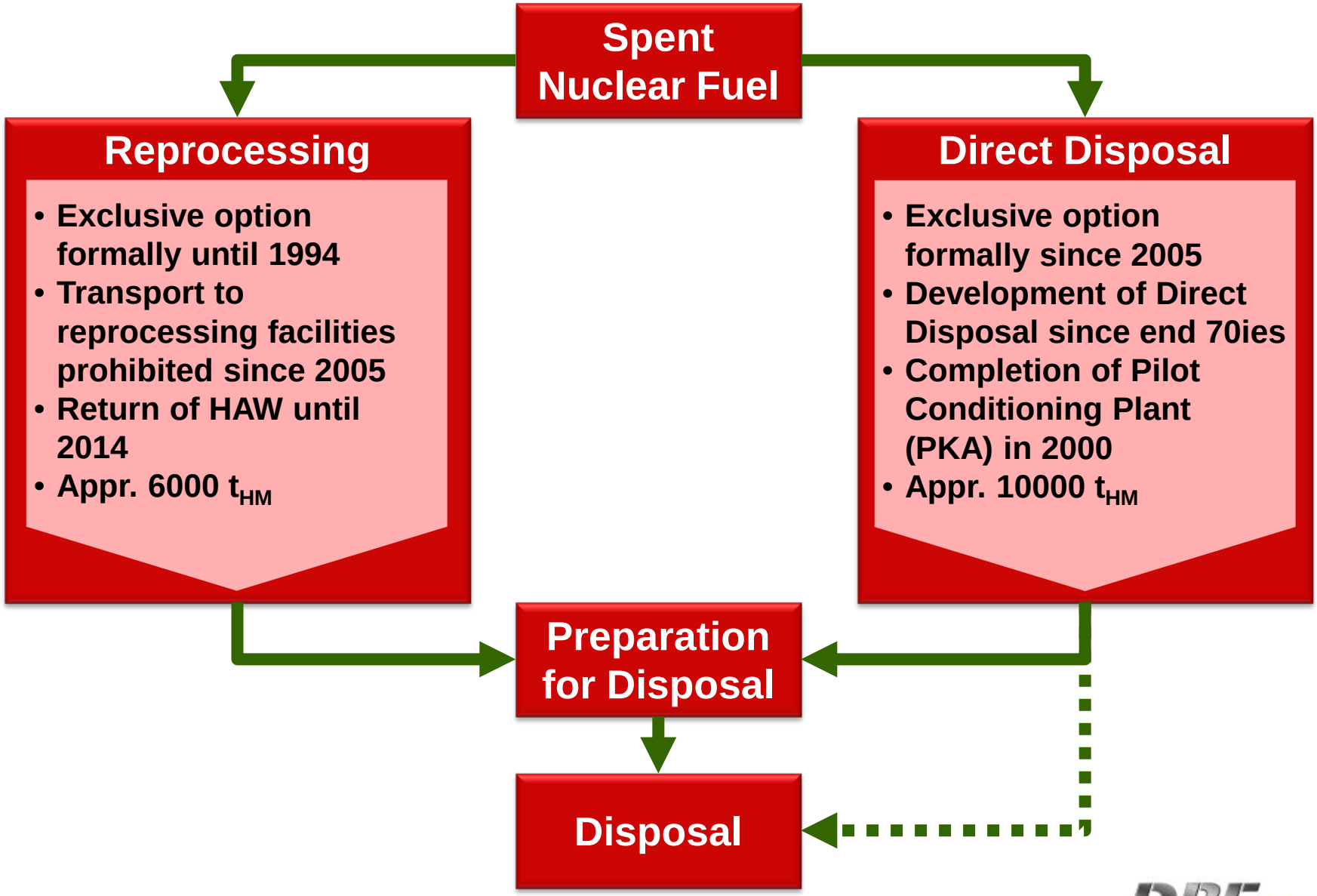
DIREGT

- Concept for the direct disposal of CASTOR® casks

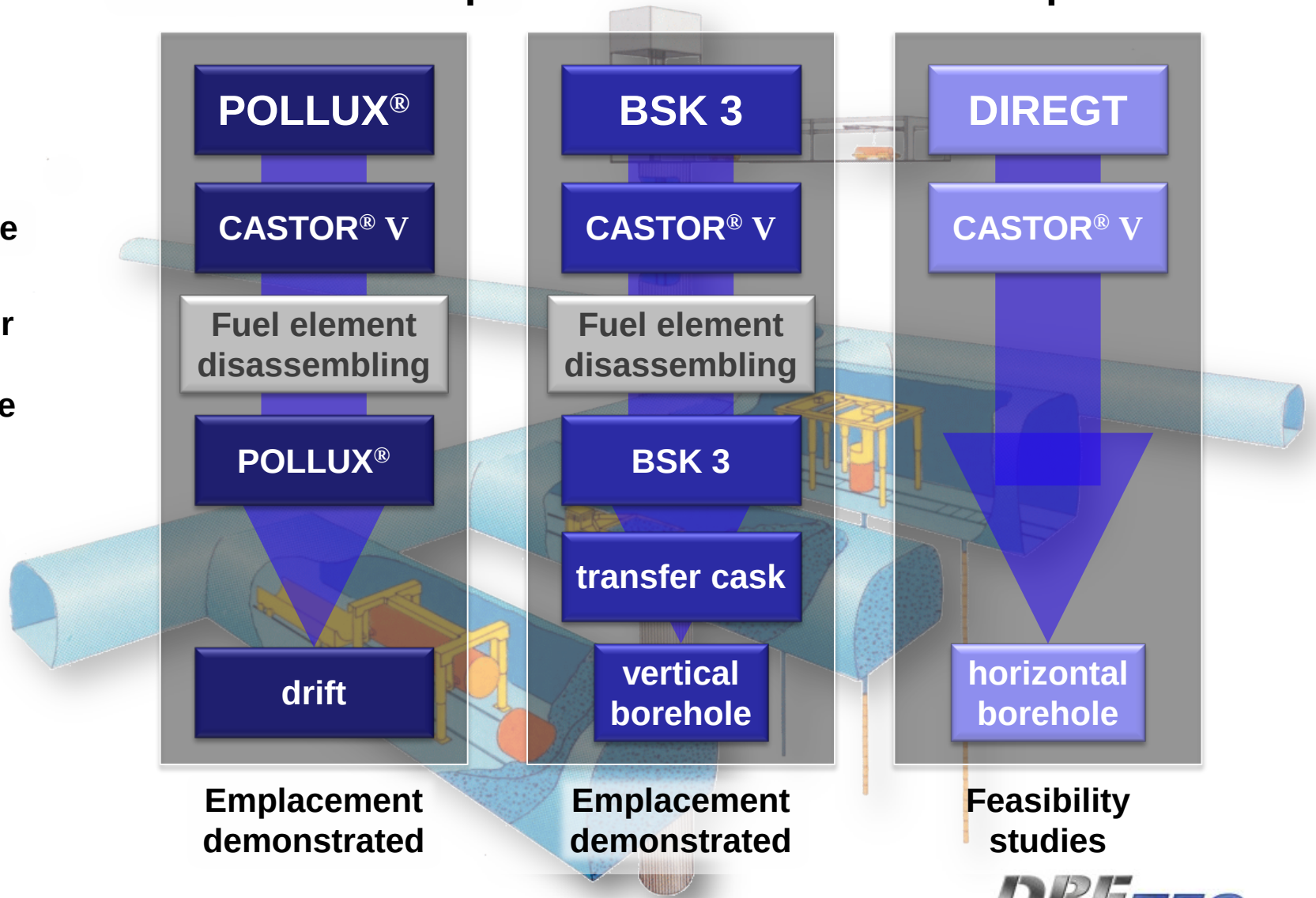
POLLUX®

- Transport and disposal cask

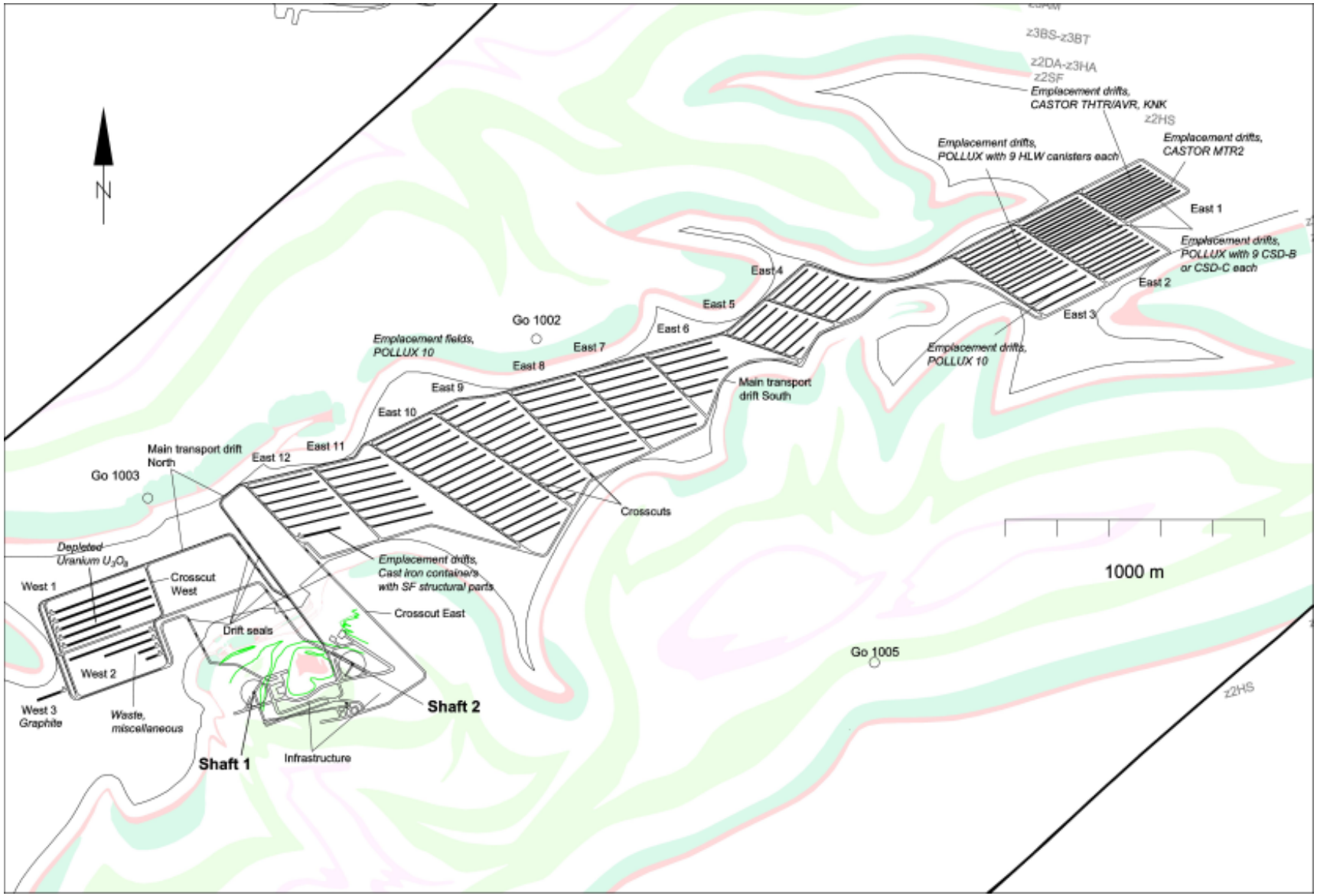
Spent Nuclear Fuel Management in Germany



Main Concepts for Spent Nuclear Fuel Disposal

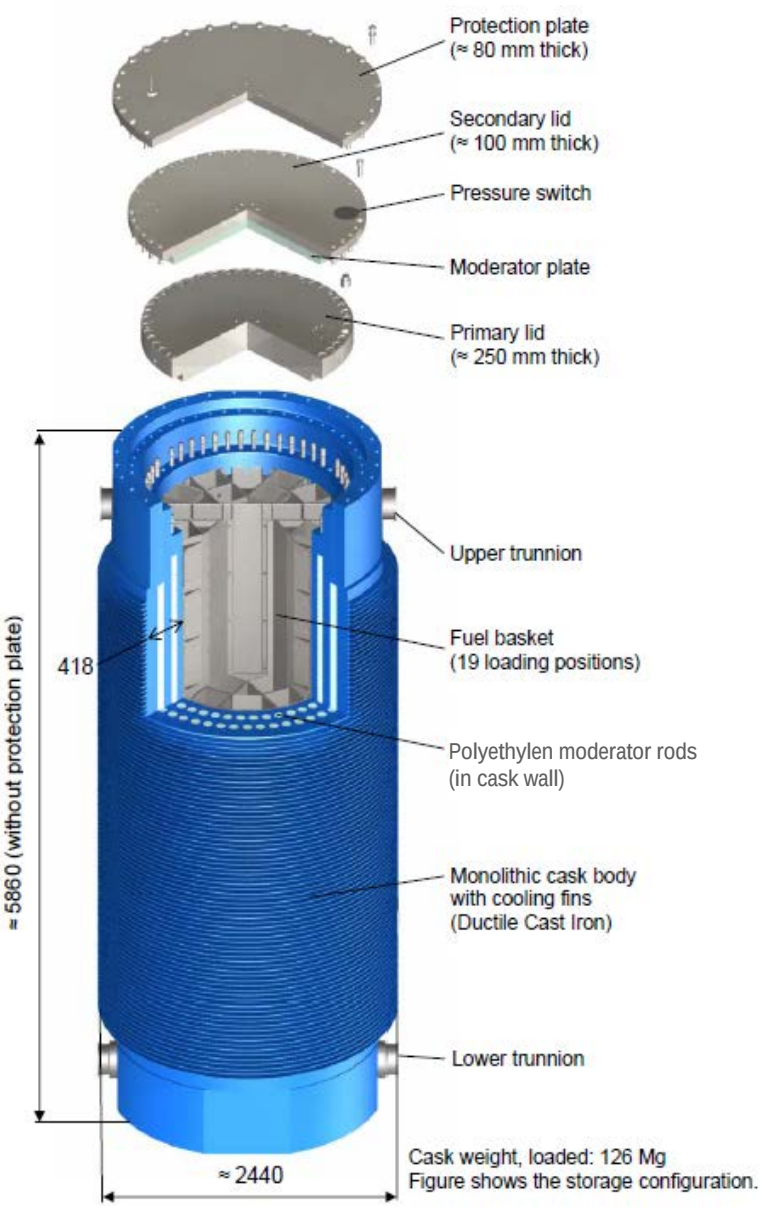


Reference Concept – Repository Design



Reference Concept – On Site Storage

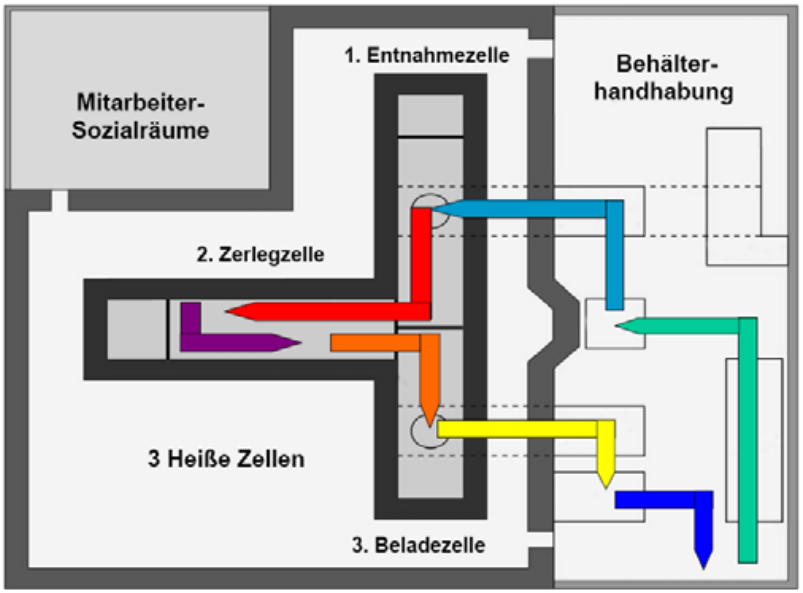
CASTOR® V/19



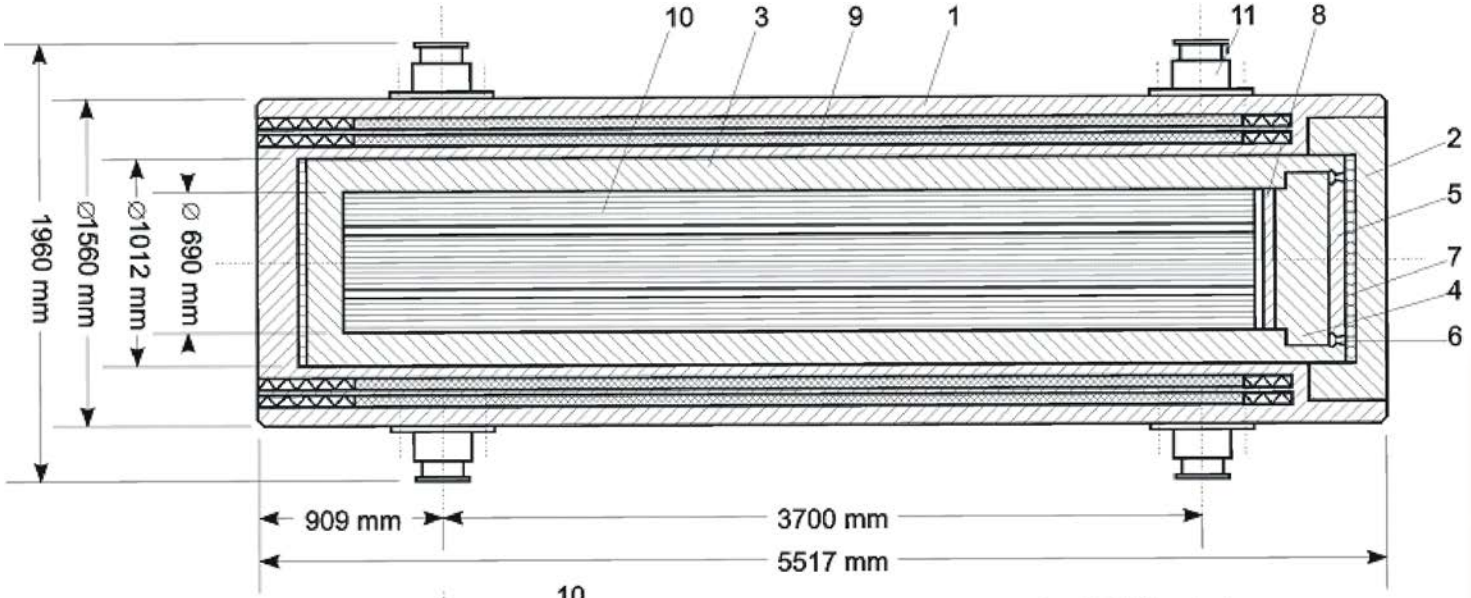
125 t CASTOR ® cask for max. 19 PWR spent fuel elements

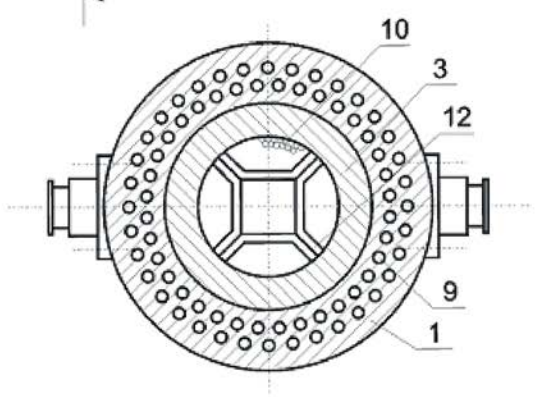
(Source: GNS)

Reference Concept – Preparation for Disposal



Reference Concept – Preparation for Disposal



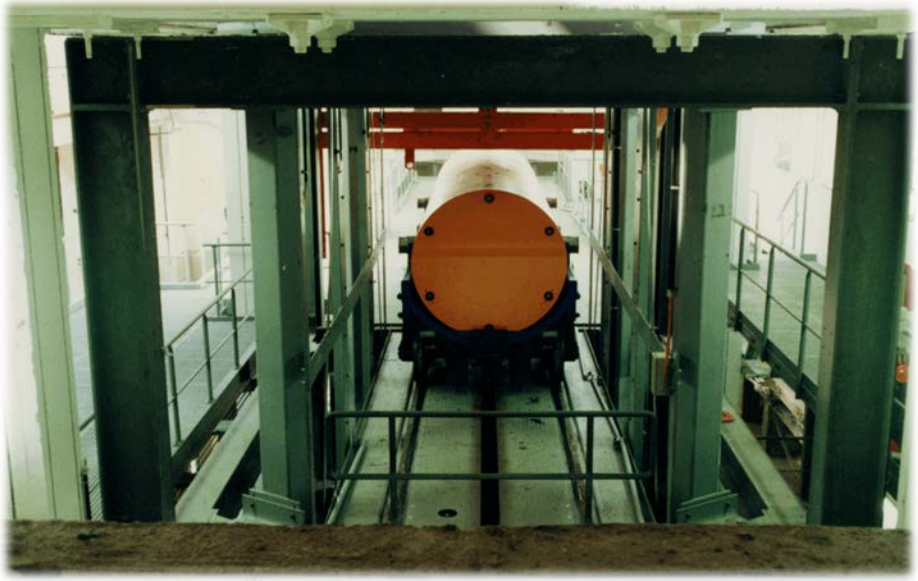


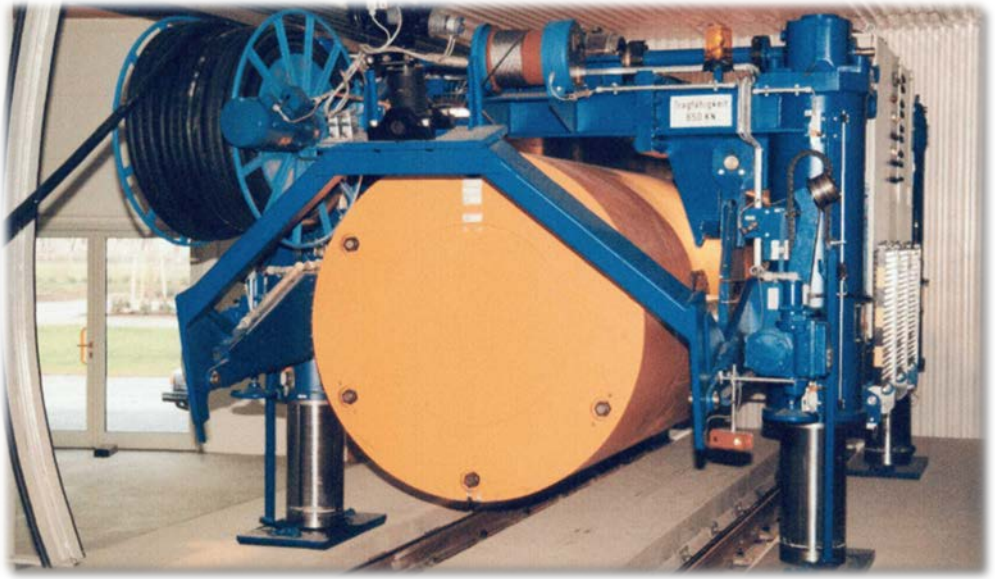
1 Shielding Cask
2 Shielding Lid
3 Inner Cask
4 Primary Lid
5 Welded Secondary Lid
6 Welding Seam
7 Damping Element
8 Moderator Plate (Graphit)
9 Moderator Rods
10 Fuel Rods
11 Trunnion
12 Basket Structure

65 t POLLUX ® cask for max. 10 PWR spent fuel elements

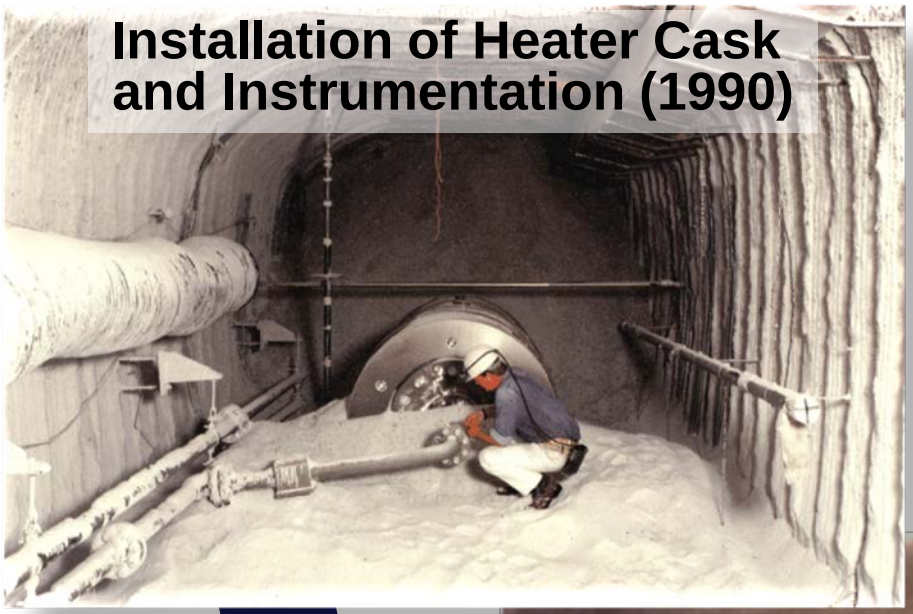
(Source: GNS)

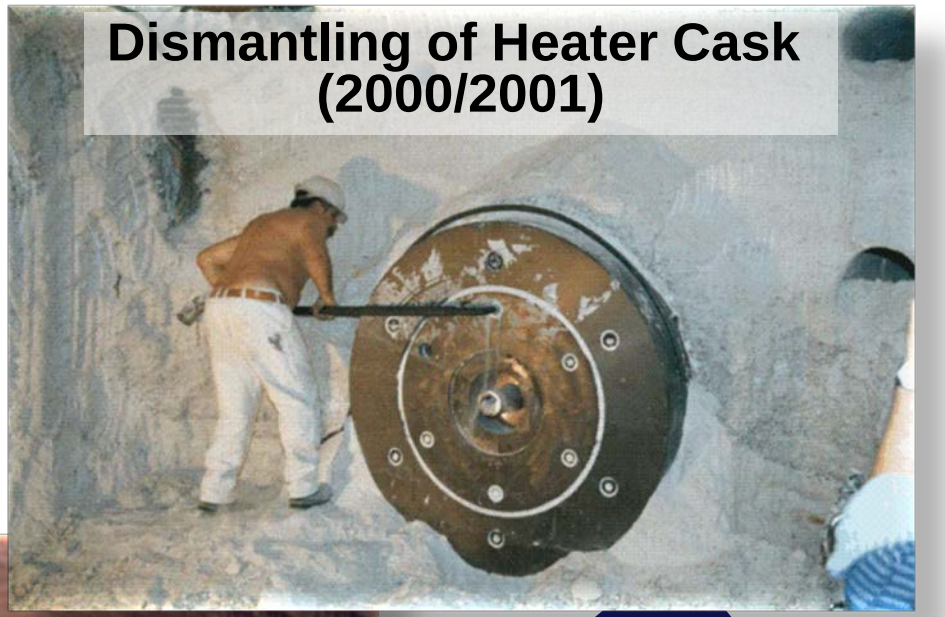
Reference Concept – Transfer to Final Disposal





Reference Concept – Final Disposal

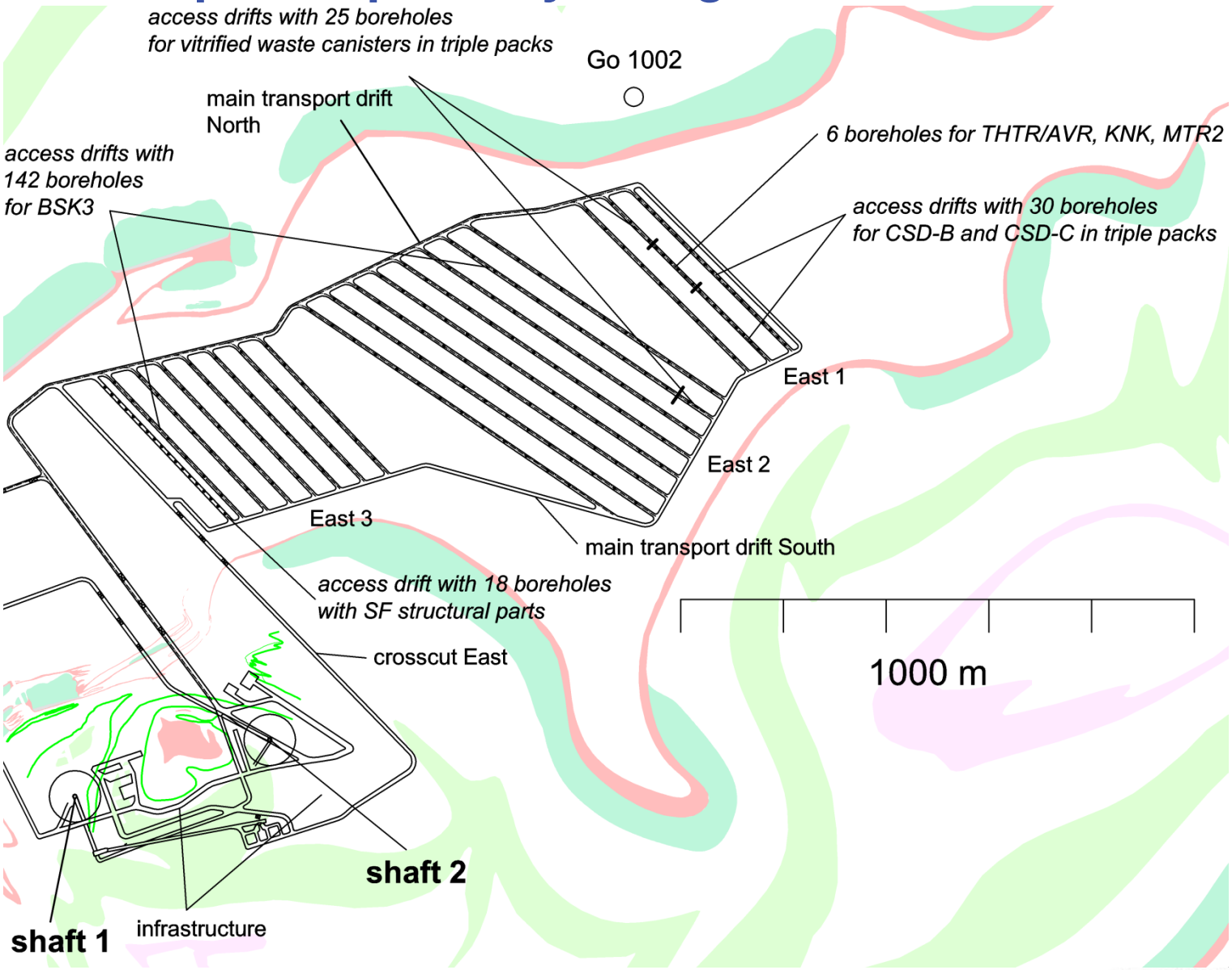




BSK Concept – Motivation

- Emplacement technologies for both categories of waste (vitrified waste and spent fuel)
- Emplacement technology which can be used for the handling and emplacement of different types of casks
- Improvement of heat transfer from waste canister to the host rock (rock salt) by means of close contact
- Compared to the POLLUX emplacement concept a faster process (creeping of host rock) to achieve the entire enclosure of the waste cask by host rock
- Reduction of required footprint of the repository by using the host rock in three dimensions
- Economical benefit by saving cask and operating costs
- Reduction of potential gas generation (corrosion) due to reduction of metallic material mass

BSK Concept – Repository Design

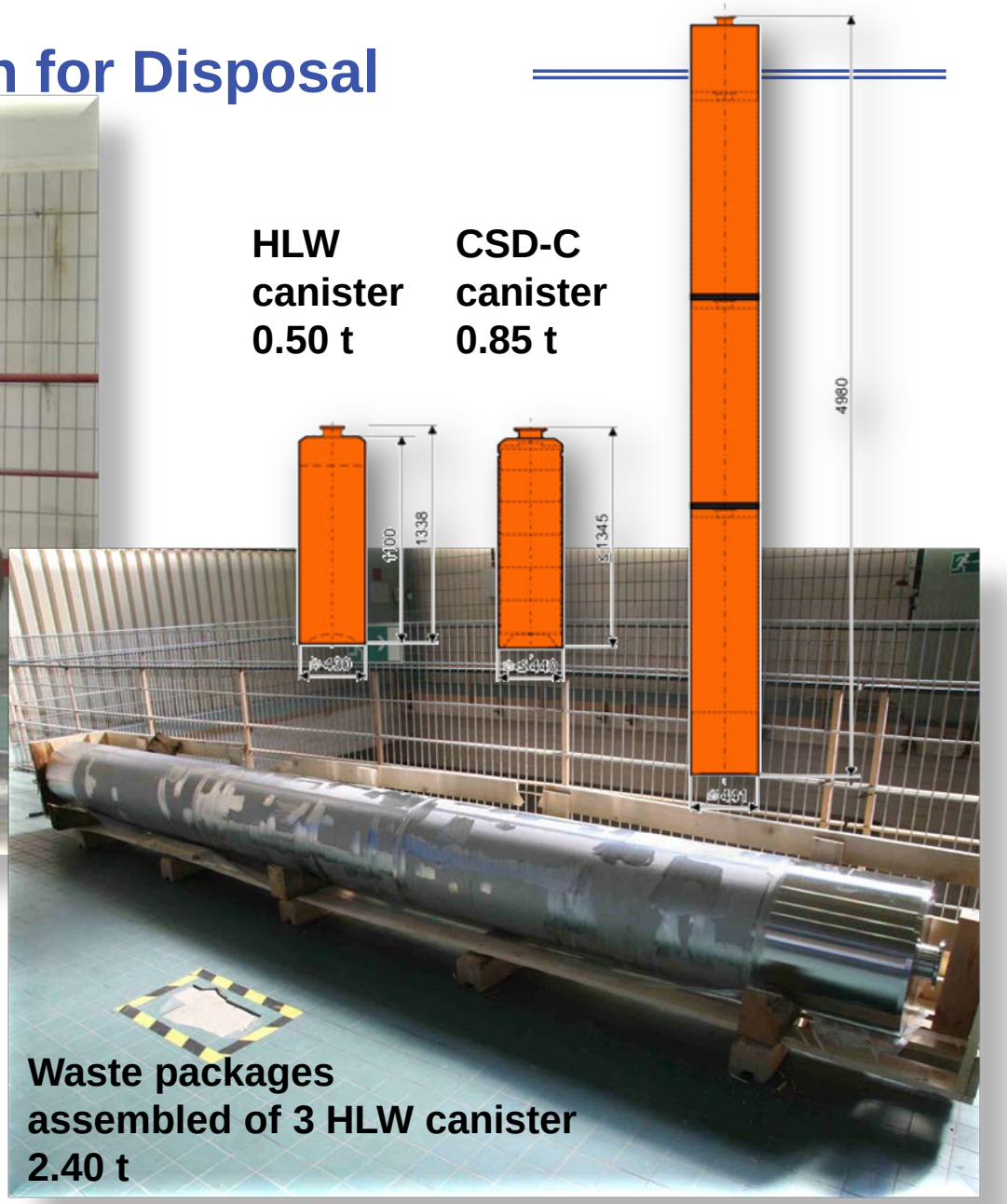


BSK Concept – Preparation for Disposal

BSK 3
canister
5.20 t

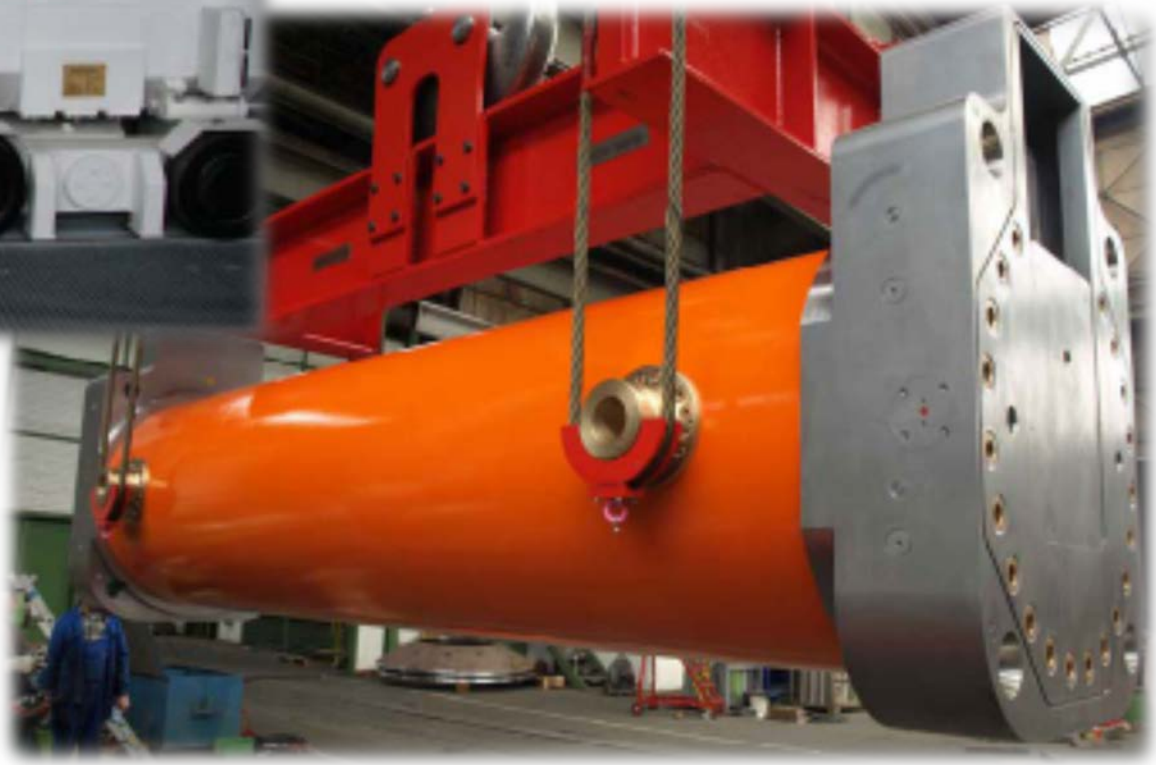
HLW
canister
0.50 t

CSD-C
canister
0.85 t



Waste packages
assembled of 3 HLW canister
2.40 t

BSK Concept – Transfer to Final Disposal

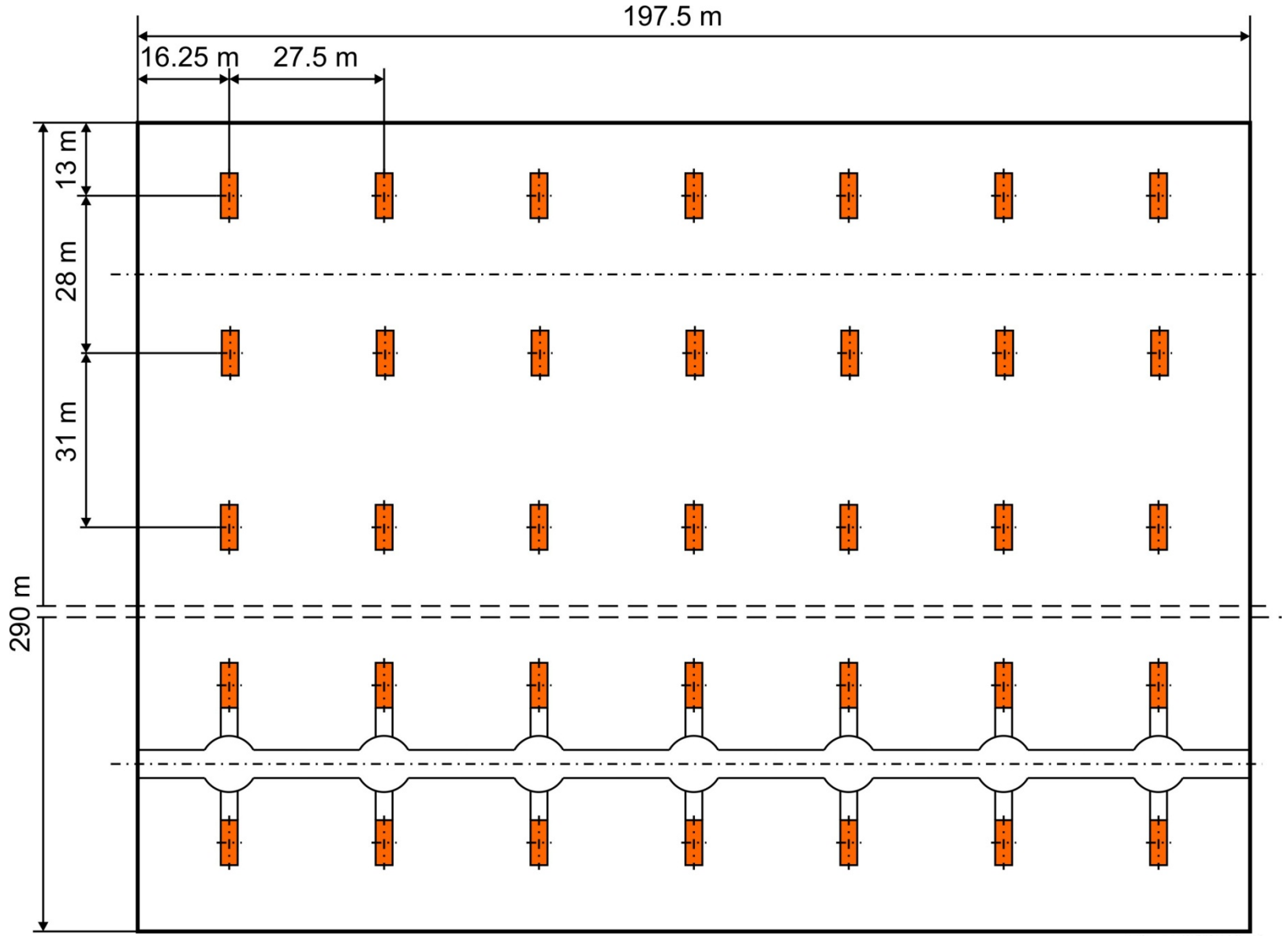


BSK Concept – Final Disposal

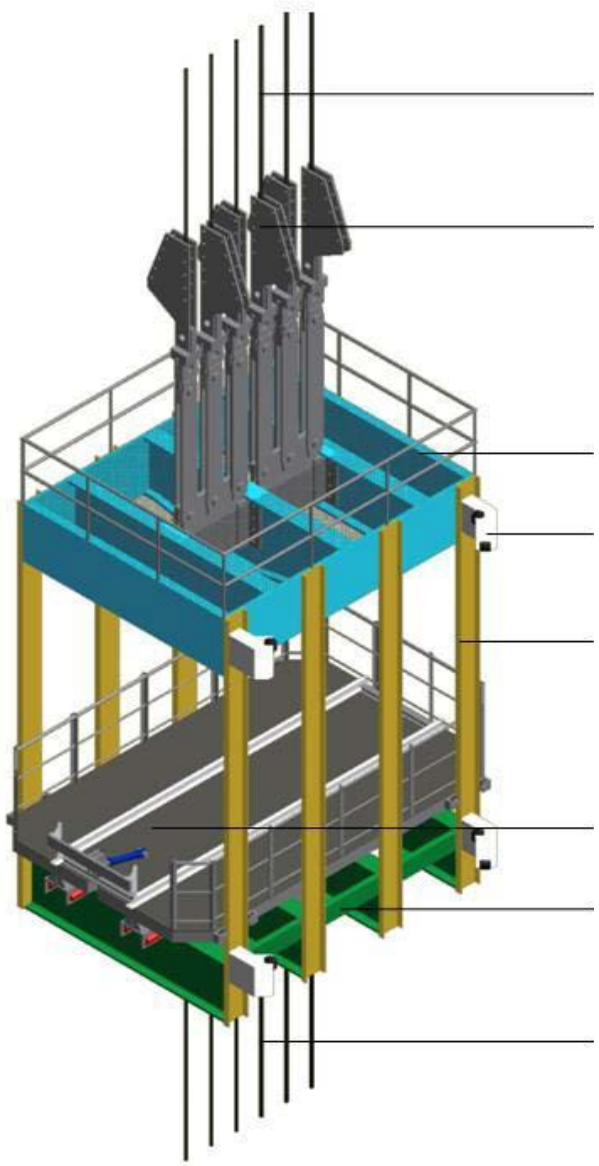
DIREGT – Motivation

- Consistent emplacement technology for direct disposal of nuclear waste from reprocessing and spent nuclear fuel
- Emplacement technology for disposal in transport and storage casks (CASTOR)
- Avoidance of Preparation for Disposal / encapsulation of spent nuclear fuel
- Prevention of time consuming and complex processes requiring severe radiation protection
- Minimising the transports of casks to the repository
- Minimising general handling activities with casks
- Concurrent disposal of redundant transport and storage casks

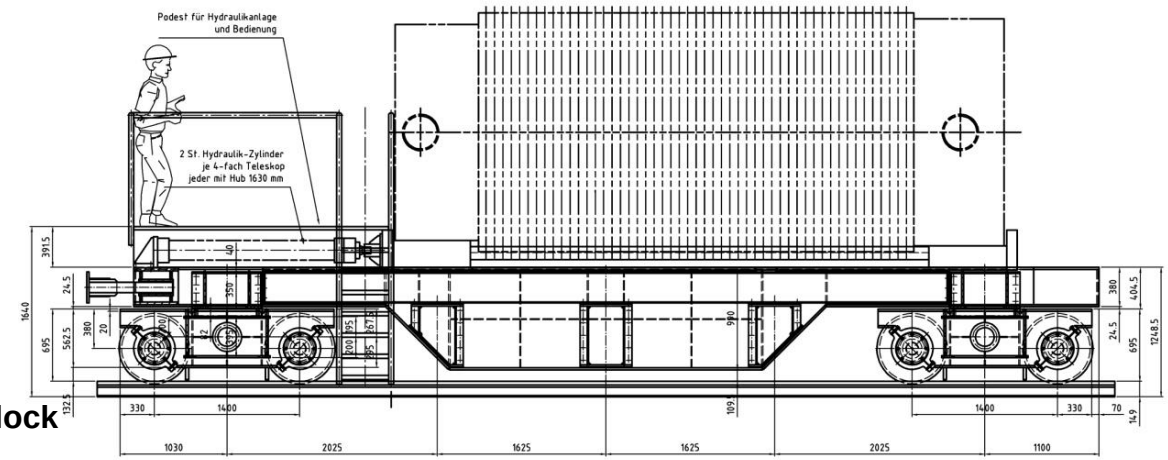
DIREGT – Repository Design

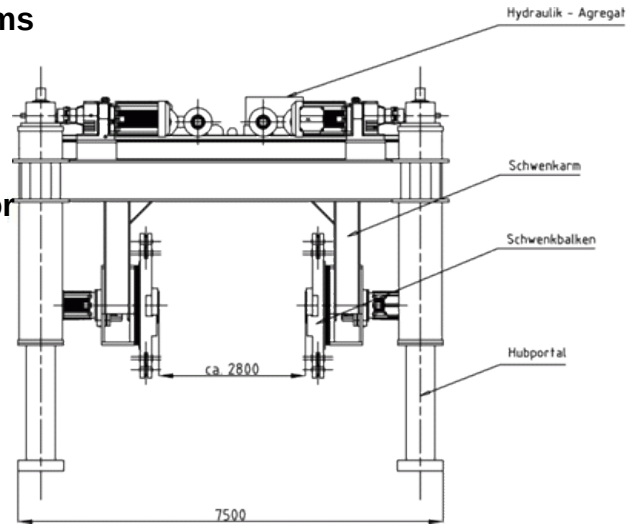


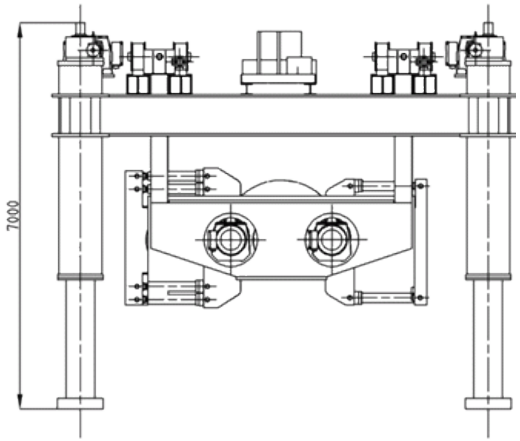
DIREGT – Transfer to Final Disposal



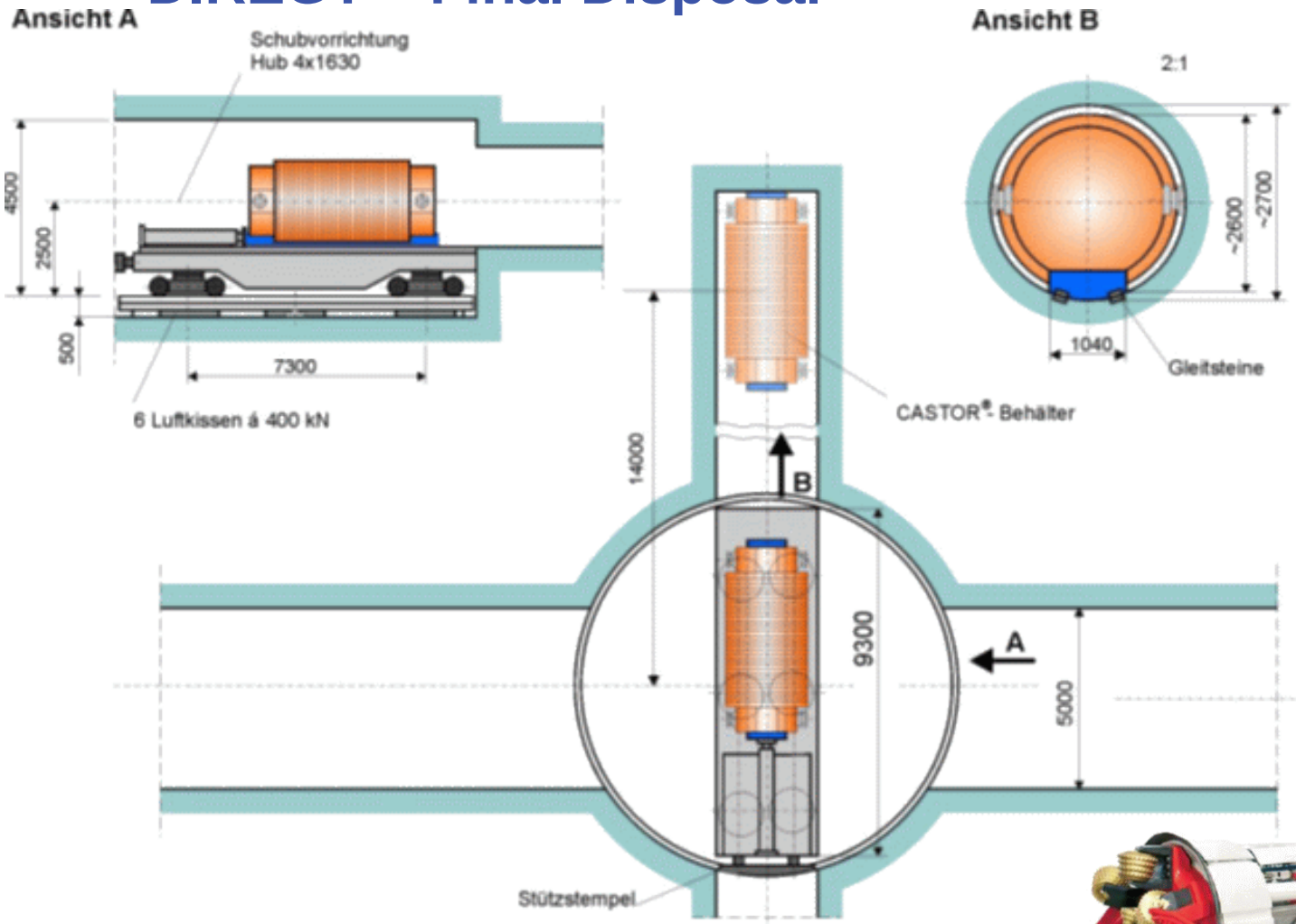
- Cage ropes
- Cage bail
- Head frame
- Cage guide block
- Vertical beams
- Floating floor
- Cage bottom frame
- Tail ropes







DIREGT – Final Disposal



(Source: Sandvik)

Major Limitations of BSK and DIREGT concept

Reference Concept

BSK Concept

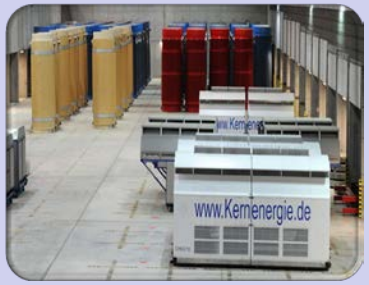
- Feasible for deep layers only
- Demonstration of retrievability
- Proof of backfilling
- Low radiation shielding requires complex emplacement technology
- High radiation impact on host rock

DIREGT

- Handling of very heavy loads
- Voids in casks
- Criticality
- Up to now only concept, no demonstration yet

Challenges

Challenges generally encounter when commencing with detailed planning of operation or even when starting operation, e. g.:

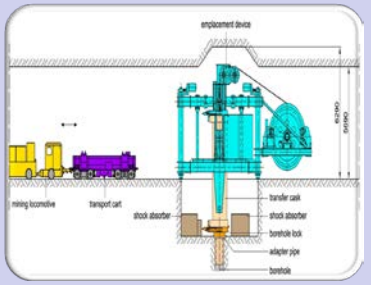


Challenging handling equipment design due to different cask designs

Specific requirements on hoisting system due to transport of very heavy loads

Uncommon radiation protection issues due to back-scattering of neutrons by the host rock

Complex and time consuming activities due to limited space under-ground



To ensure cost effectiveness excavations have to be as little as possible