

== TopSeal 2006 ==

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# Disposal of Spent Fuel in Vertical Boreholes in Salt - An Industrial Demonstrator Program -

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## == Outline ==

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1. Introductory remarks
2. Waste canister types
3. BSK 3-Emplacement system
4. Full-scale demonstration program
5. Summary and outlook

## == Introductory Remarks ==

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- Optimization of disposal concept for spent fuel
  - o German atomic act requires a 1:1 demonstration of disposal technique prior to implementation
  - o Nuclear Industry developed optimized disposal canister for spent fuel
    - BSK 3 canister  
(suitable for spent fuel rods from 3 PWR- or 9 BWR-fuel elements)
  - o Set up of an appropriate R&D-program for borehole disposal of BSK 3 canisters

## == Introductory Remarks ==

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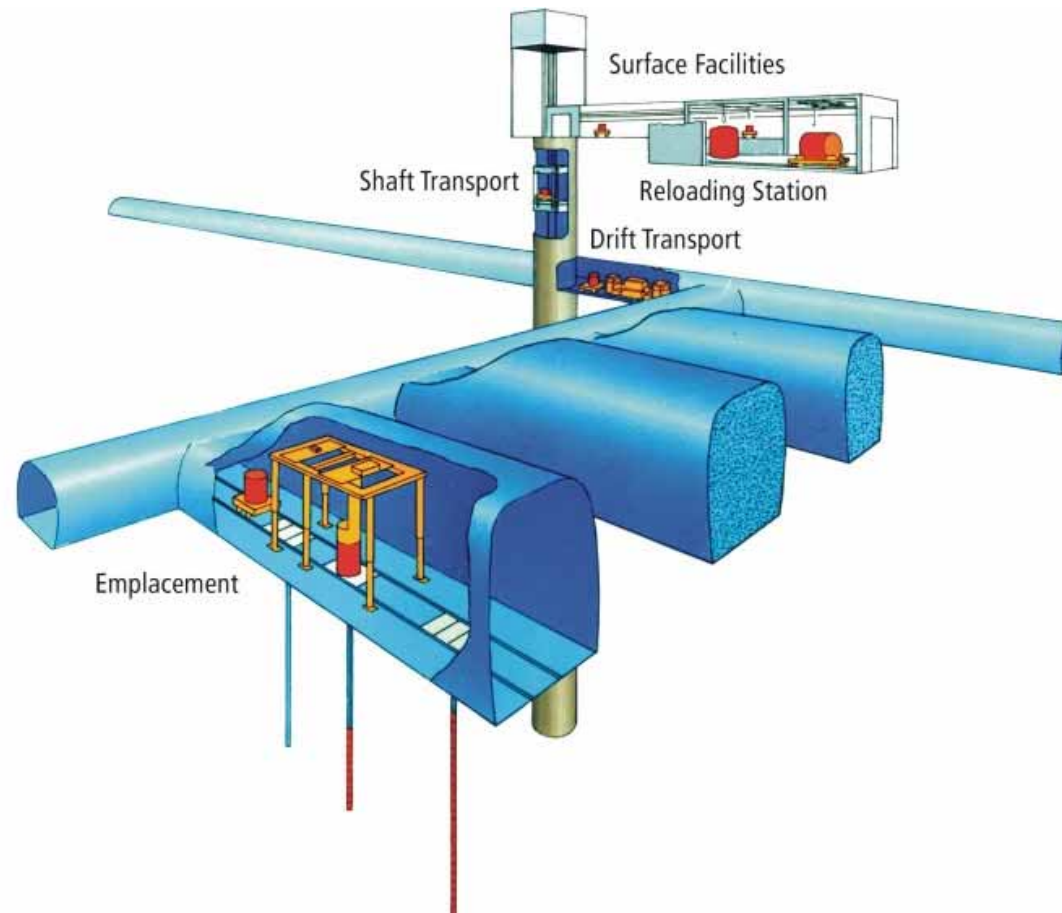
- EC 6<sup>th</sup> frame work program for nuclear research and training (2002 – 2006)
- Integrated project ESDRED
  - o ESDRED  
Engineering Studies and Demonstration of REpository Designs
  - o 5 years program (Feb. 2004 – Jan. 2009)
  - o Consortium of 13 waste management and research organization of 9 European countries

## == Introductory Remarks ==

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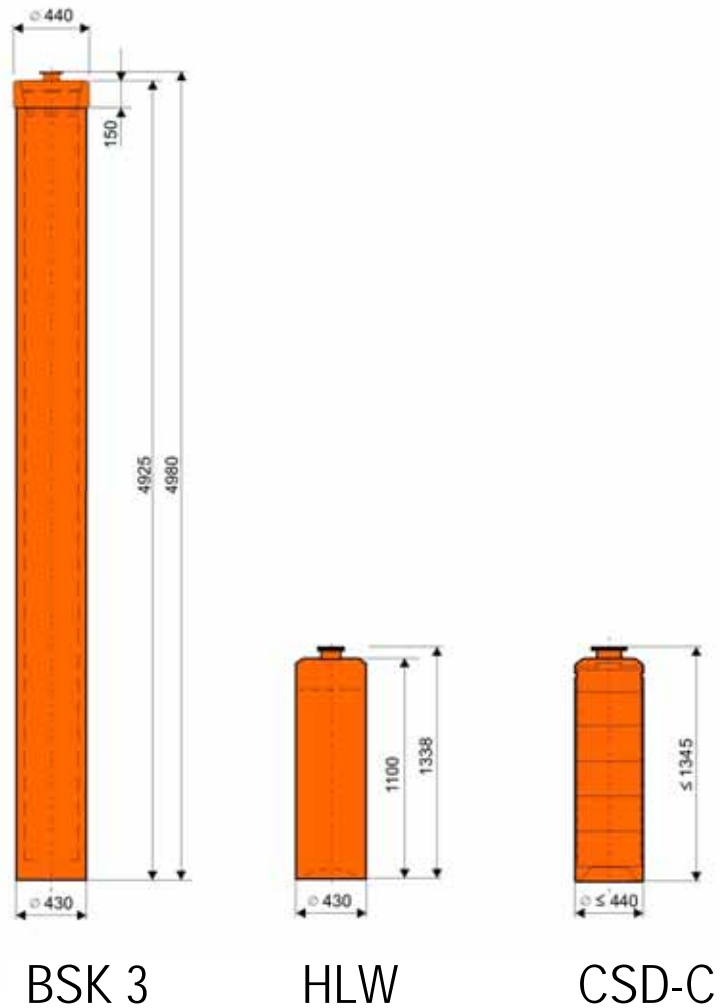
- Objectives of ESDRED project
  - o Demonstrate technical feasibility of emplacement and sealing technologies for HLW repositories at an industrial scale (waste canister transfer and emplacement, heavy load emplacement, buffer and sealing construction)
  - o The borehole emplacement technique for BSK 3 canisters is part of the ESDRED demonstration program

## Introductory Remarks



Emplacement sequence of the German vertical borehole disposal concept in rock salt

## Disposal Canister Types



## == Disposal Canister Characteristics ==

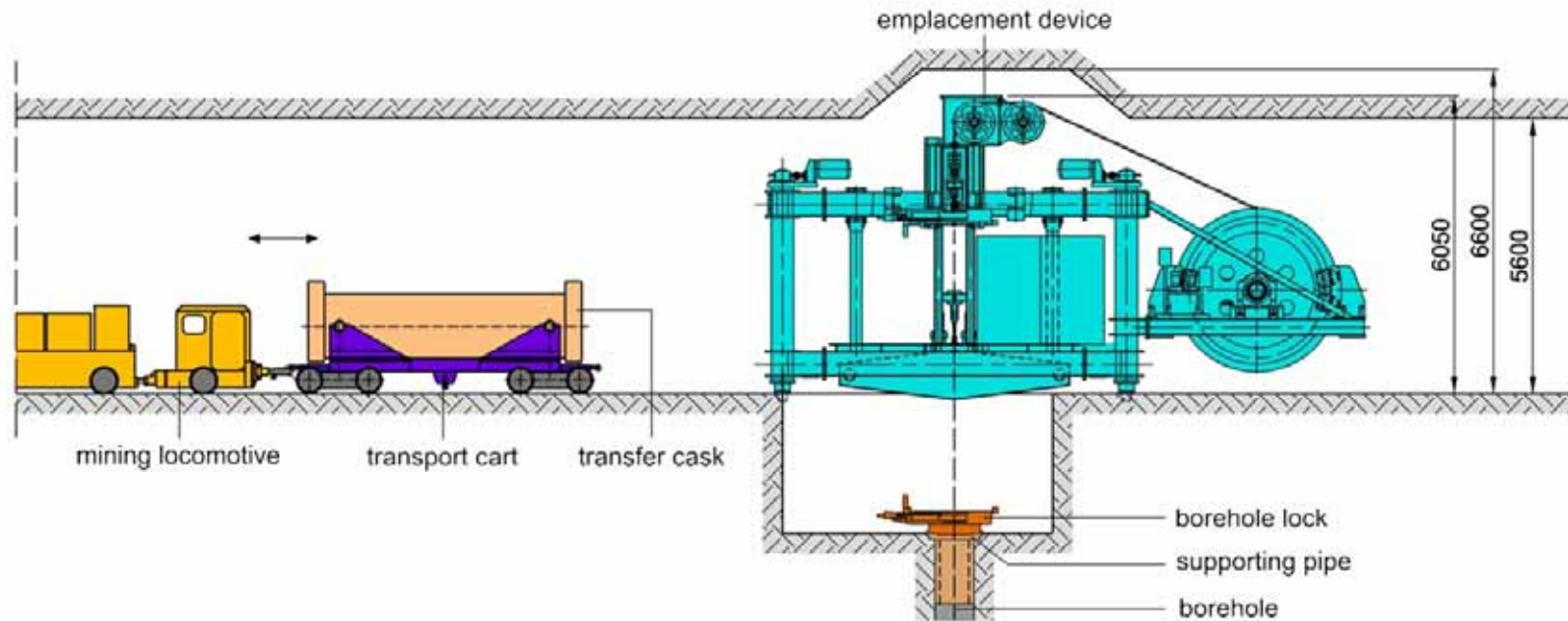
		HLW Canister	CSD-C Canister	BSK 3 Canister
Number of canisters		4,778	8,764	appr. 5,525
Number of boreholes needed		30	55	95
Length	mm	1,338	≤ 1,345	4,980
Diameter	mm	430	≤ 440	≤ 440
Total mass	kg	appr. 492	≤ 850	5,226
Mass HM	tHM	-	-	1.6
Heat generation	kW			
• at loading			0.02	21.220
• after 10 years		1.12 <sup>*)</sup>		3.030
• after 30 years		0.67 <sup>**)</sup>		1.930

<sup>\*)</sup> after 9 years

<sup>\*\*)</sup> after 29 years



# == Borehole Emplacement System ==



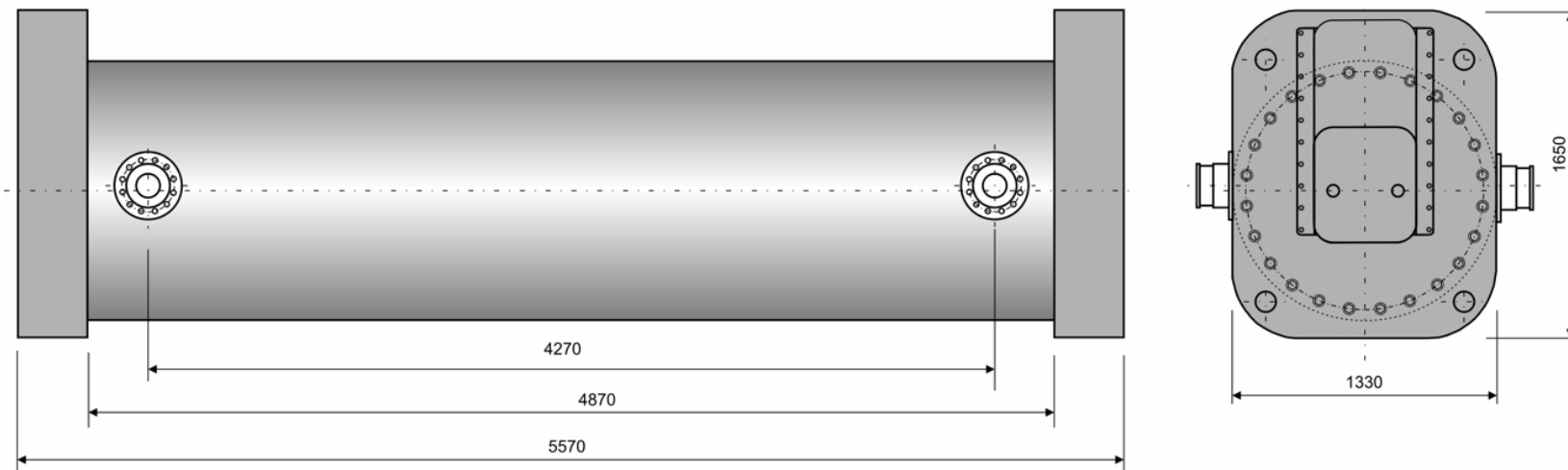
# == Borehole Emplacement Demonstration Program ==

- Main objectives
  - o Develop a complete borehole emplacement system for BSK 3 canisters
  - o Prove technical feasibility
  - o Demonstrate functionality of components and of entire system
  - o Prove operational safety by means of a series of demonstration tests
  - o Prove reliability of the transfer and emplacement components
  - o Eventually provide a licensable borehole emplacement system (fulfilment of mining law and atomic act requirements)

# == Borehole Emplacement Demonstration Program ==

- Demonstration program
  - o Demonstration of proper emplacement process (reliability and maintenance requirements)
  - o Simulation tests (prove design)
  - o Tests to solve potential operational malfunctions

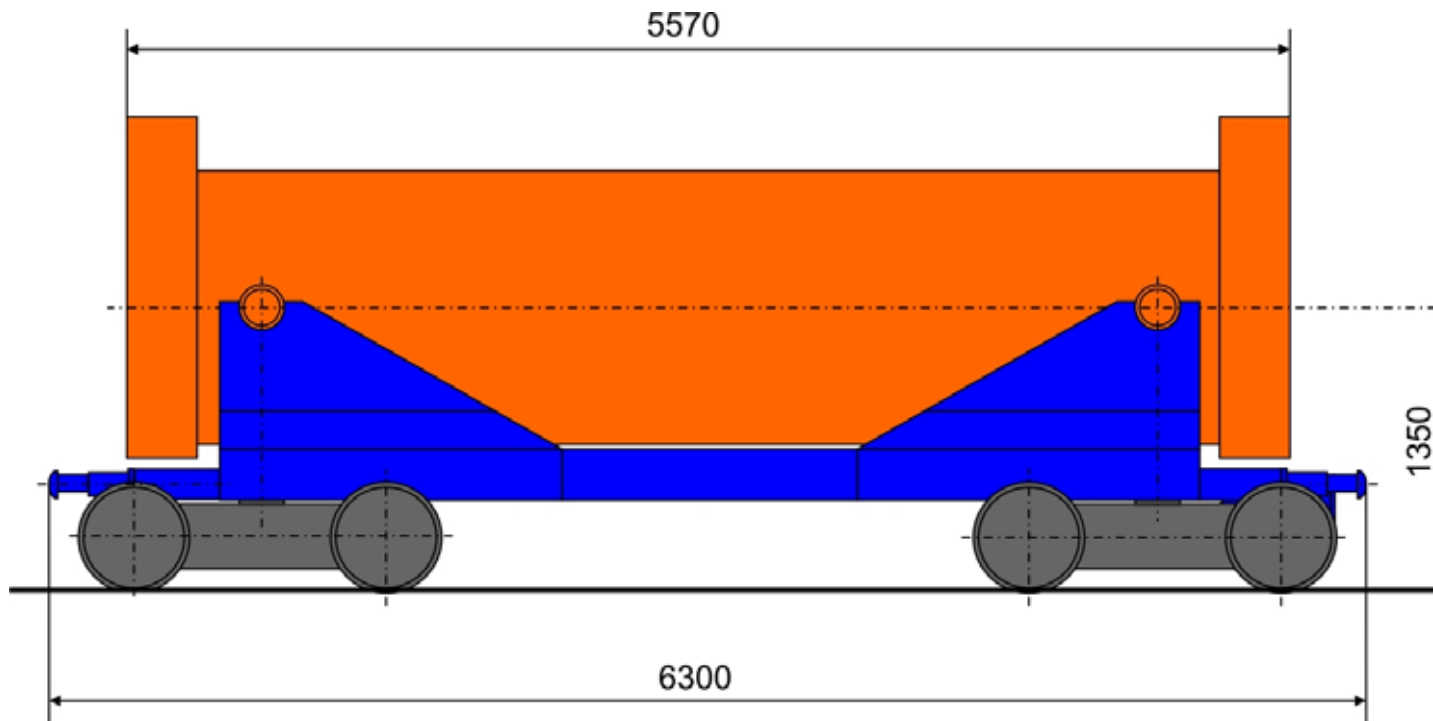
## Transfer Cask



Shielded cask for BSK 3 transport

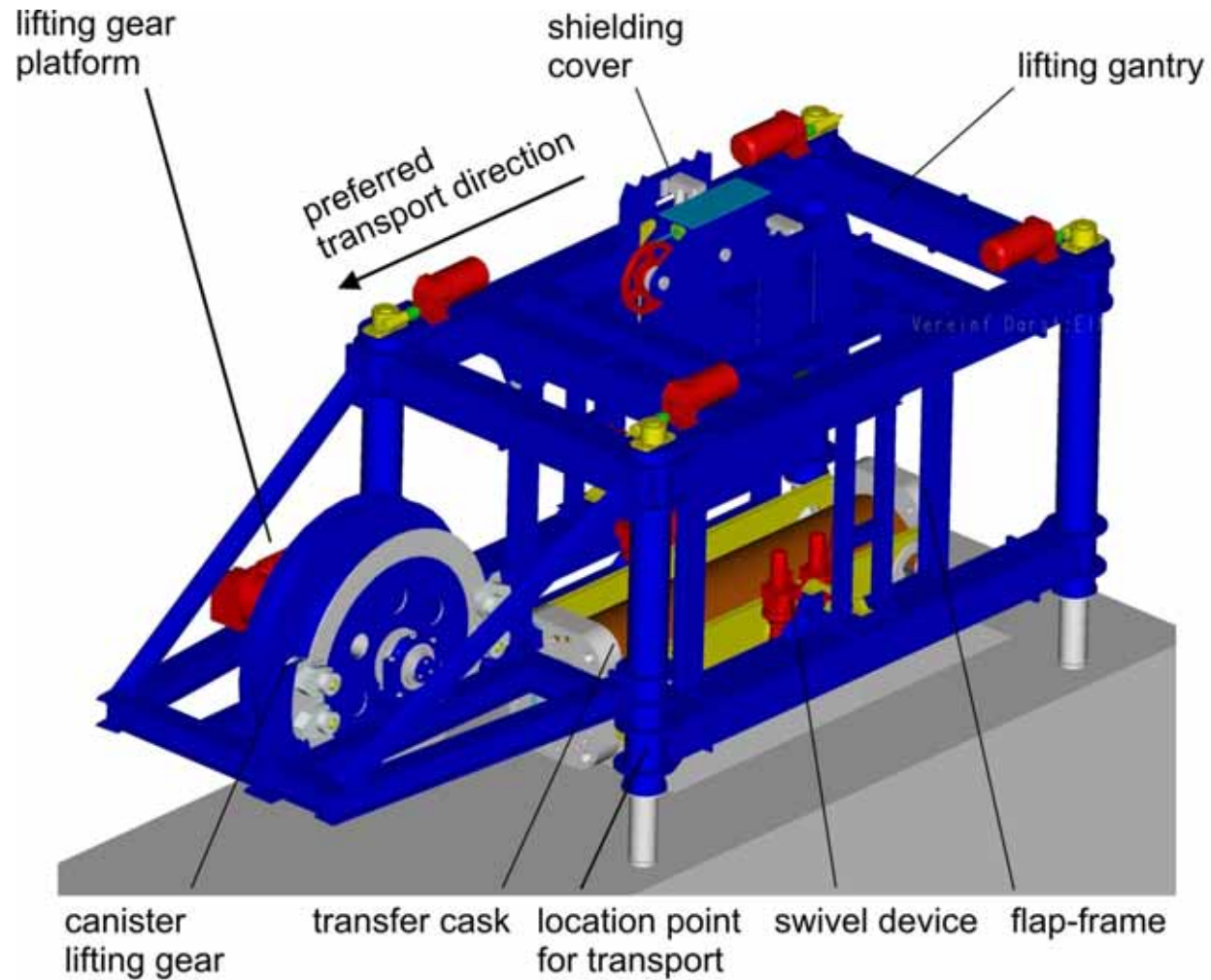
Total weight: 45 t

## Transfer Cart

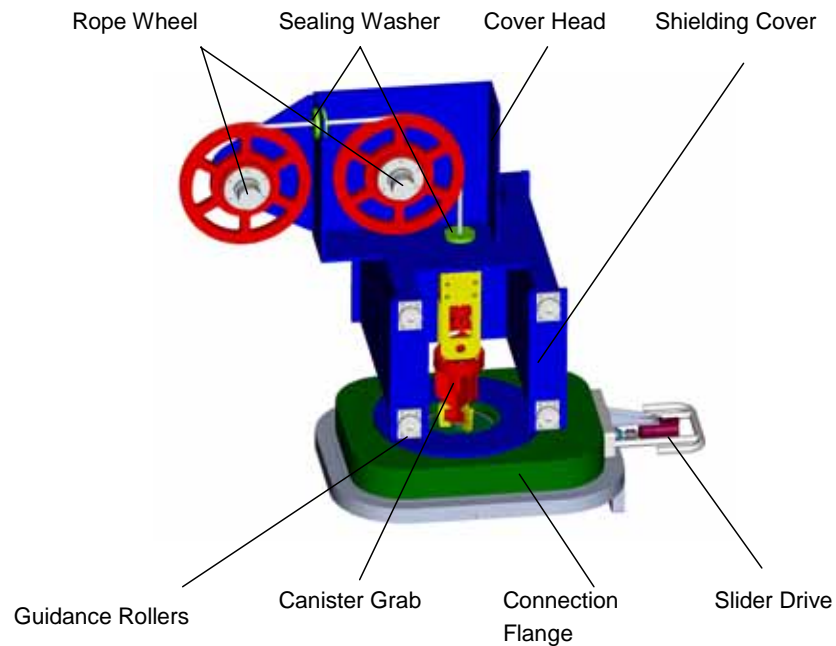


Rail-bound wagon for transfer cask transport

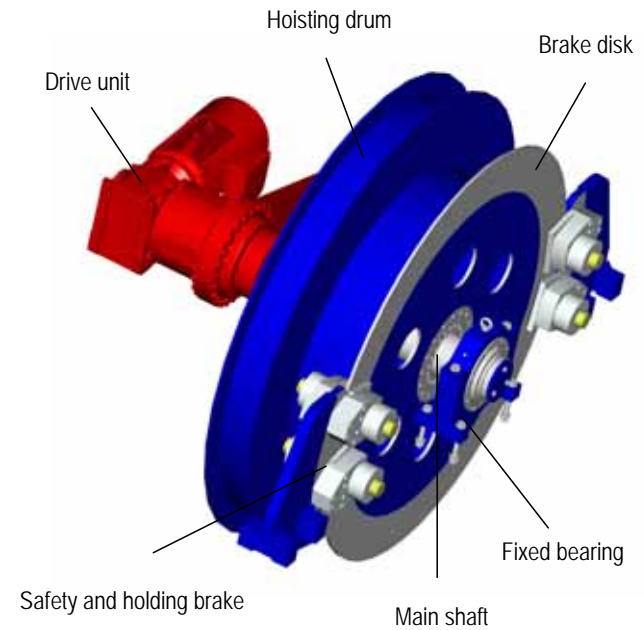
# Emplacement Device



# Details of Emplacement Device

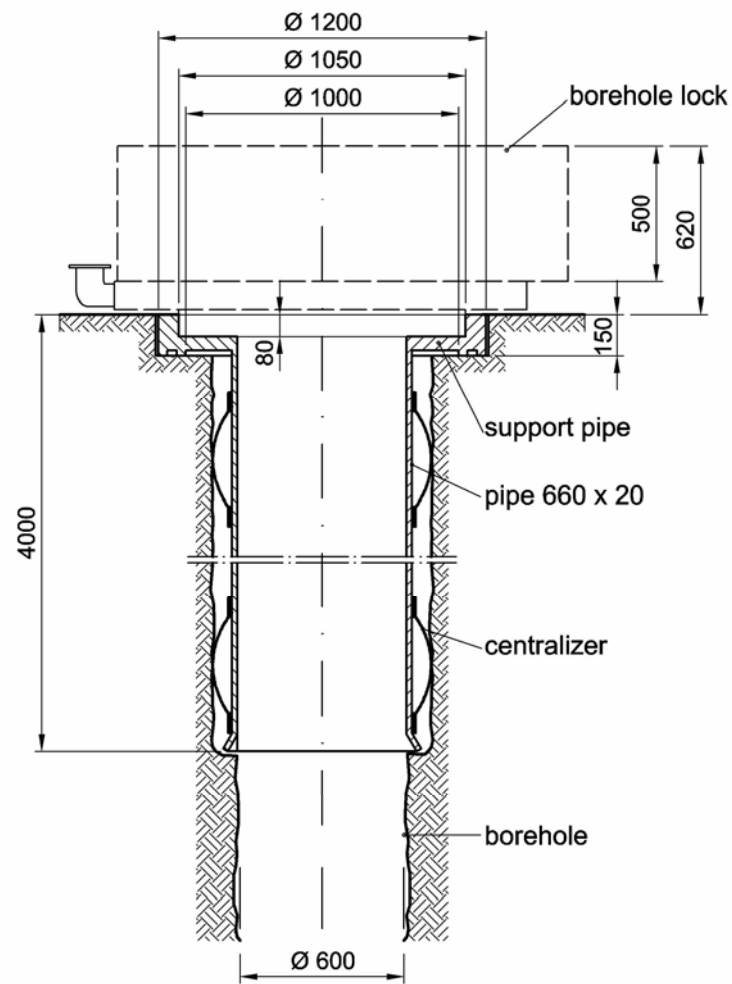


Shielding cover



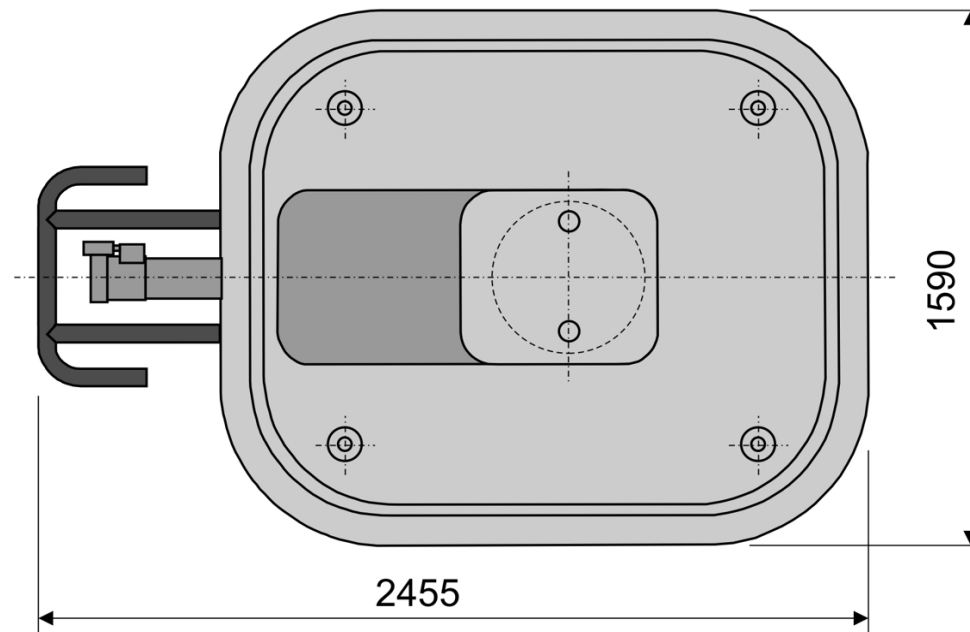
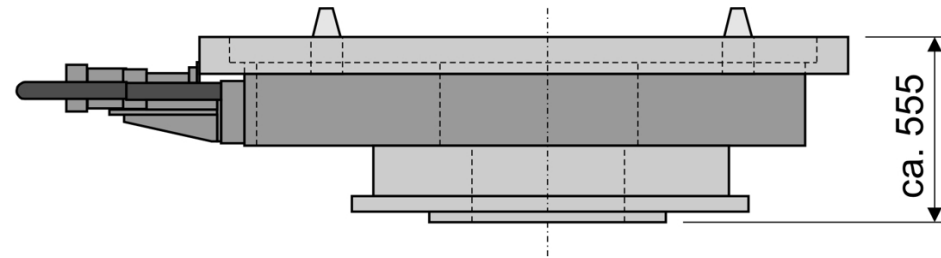
Canister lifting gear

# Support Pipe

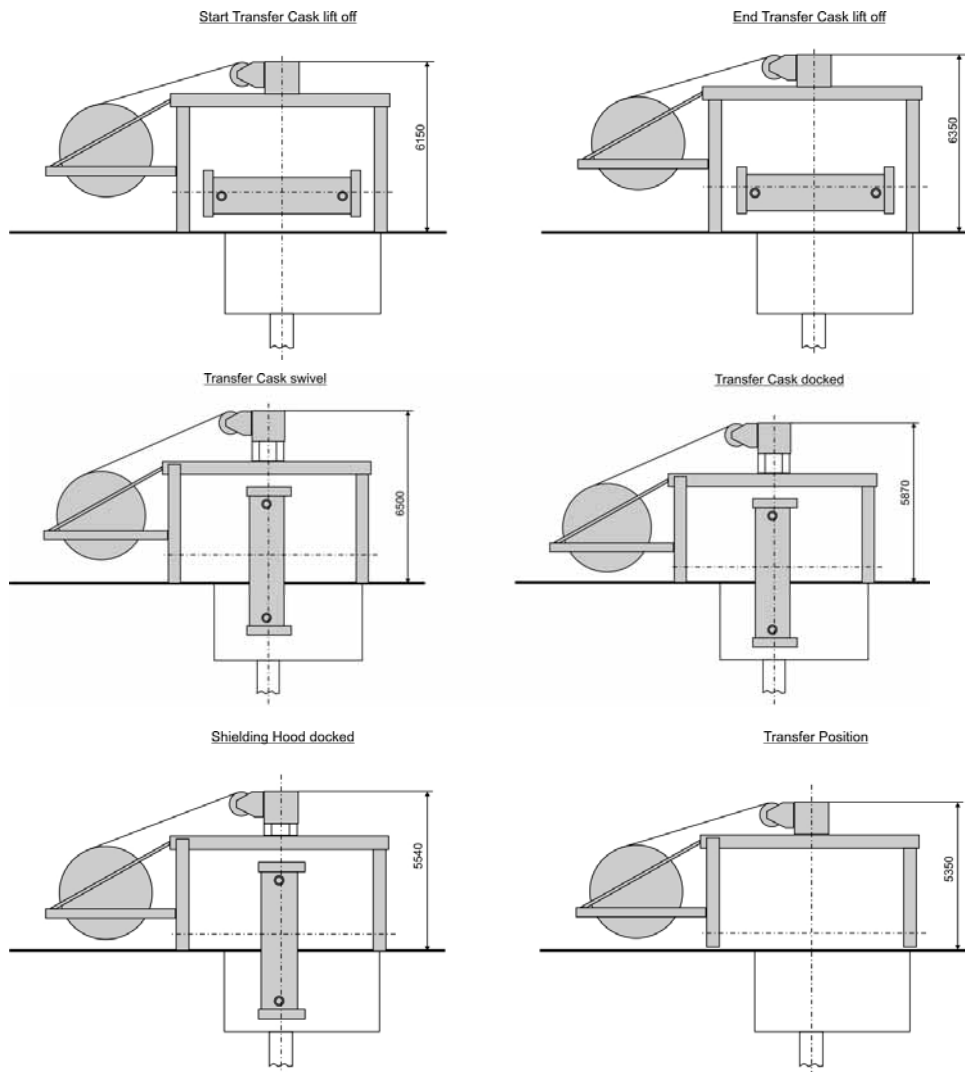




## == Borehole Lock



# Optimization of Emplacement Drift Hight

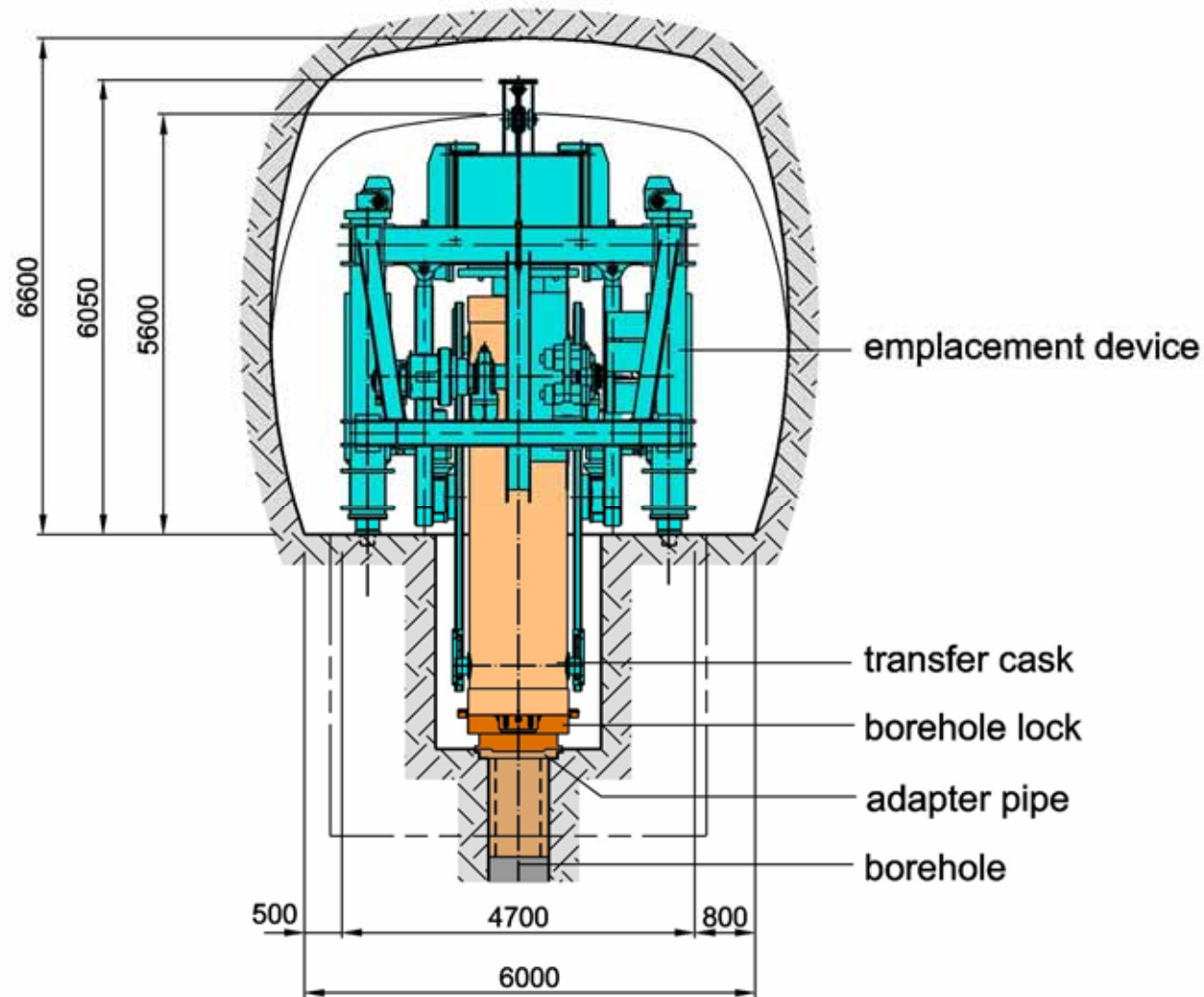


Emplacement device heights during operation I

Emplacement device heights during operation II

Emplacement device heights during operation III

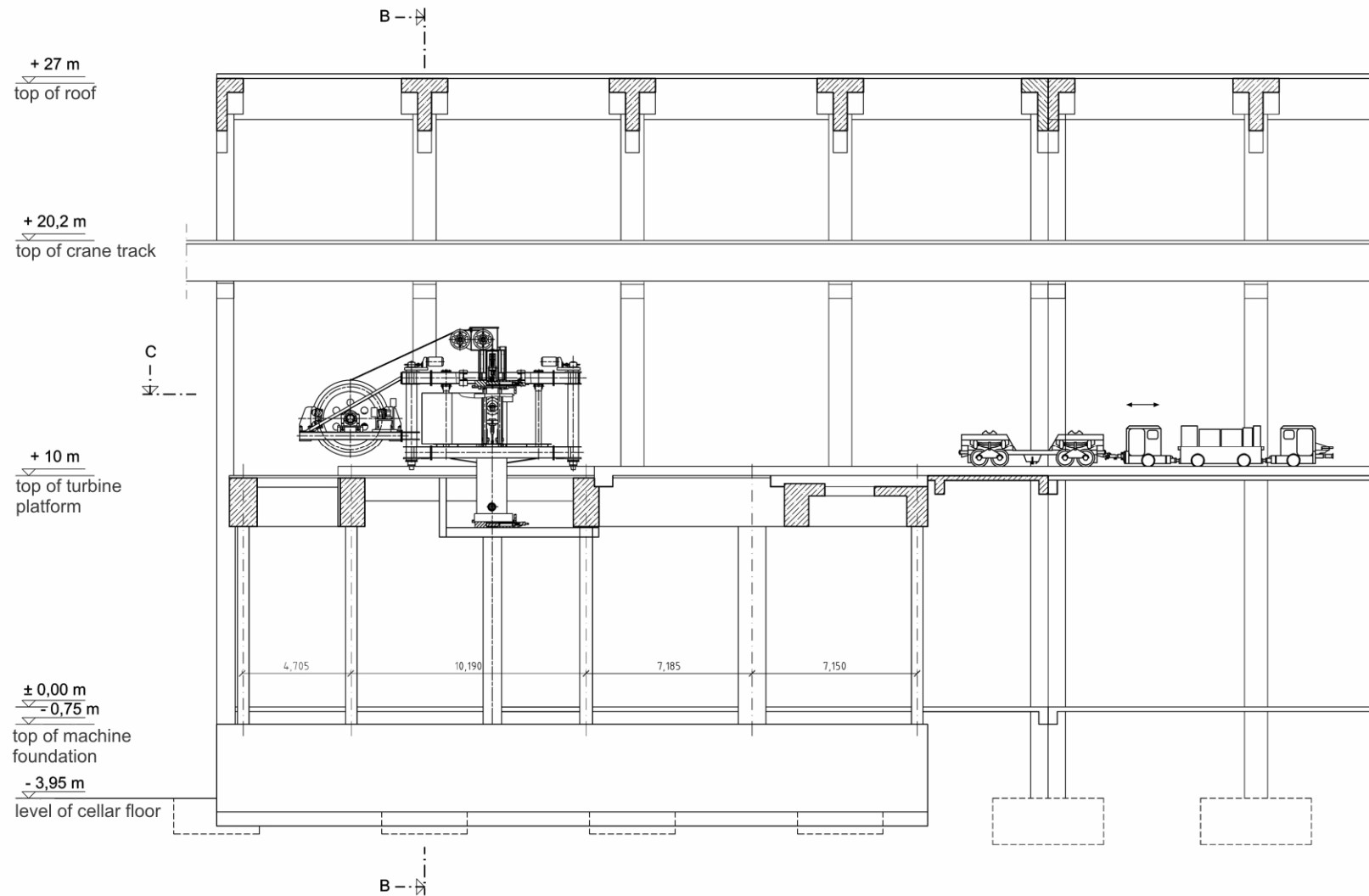
## Drift Cross Section



## = Assessment of Emplacement Time =

Total time required for emplacement of 5524 BSK 3 canisters				
	Emplacement capacity			
	1 BSK 3 / shift		2 BSK 3 / shift	
Borehole depth	1 emplacement drift	2 emplacement drifts parallel	2 emplacement drifts parallel	4 emplacement drifts parallel
300 m	48 BSK 3 canisters per borehole			
	9.6 weeks/bh	9.6 weeks/bh	4.8 weeks/bh	---
	<b>24 a</b>	<b>23 a</b>	<b>12 a</b>	---
100 m	15 BSK3-canisters per borehole			
	---	3 weeks/bh	---	1.5 weeks/bh
	---	<b>23 a</b>	---	<b>12 a</b>

# BSK 3 Test Stand



[www.dbe-technology.de](http://www.dbe-technology.de)

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## Summary and Outlook

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- Financial support of German nuclear industry in addition to EC and national (BMWi /PTKA) funding
  - o Development and demonstration of licensable borehole emplacement system for BSK 3-canisters
- Borehole-emplacement system for BSK 3-canisters
  - o Optimization of disposal concept for spent fuel
  - o Accomplishment of emplacement technique for a repository in salt

## Summary and Outlook

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- Actual state of project
  - o Start of design activities early 2004
  - o Basic design almost finished for all components
  - o Detailed design of components launched this summer
- Outlook
  - o Manufacturing of components until end 2007  
(concurrent process)
  - o Demonstration and reliability test until end 2008
  - o International workshop at the test site (Landesbergen)  
spring 2008