

Stora bergrum i Sverige LRC gaslager i Halmstad

Per Tengborg, FB Engineering AB

Vattenkraft

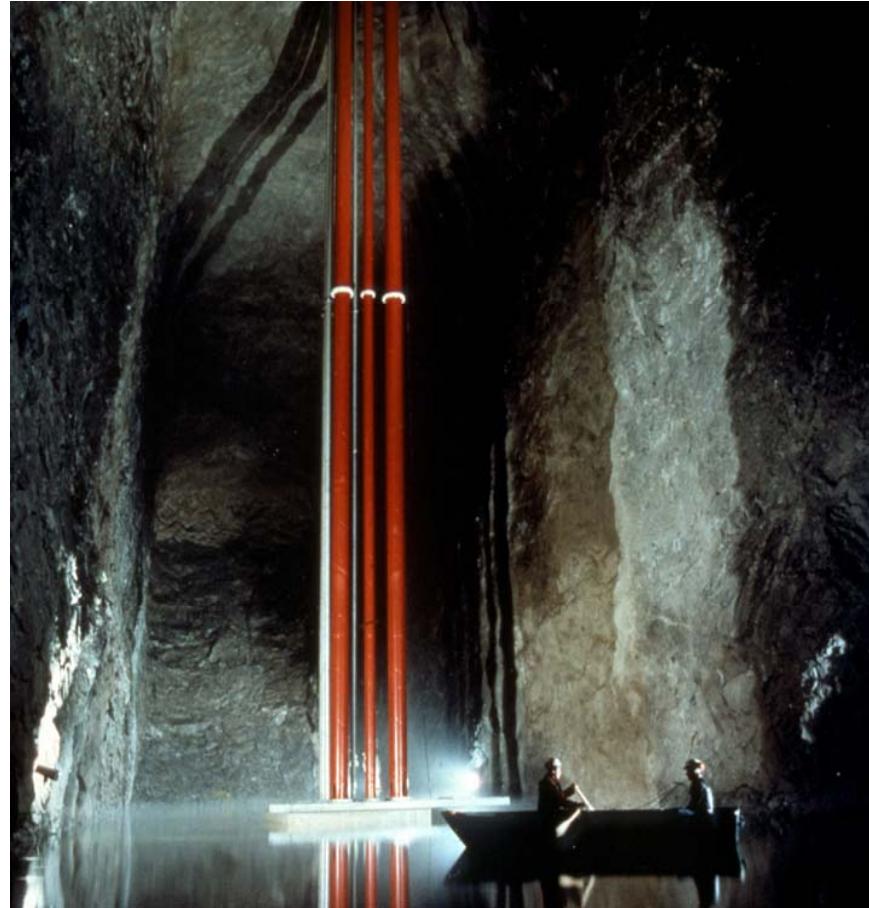
Ca 50% av elproduktionen i Sverige från vattenkraft.
1 000 vattenkraftstationer och 14 st > 200 MW.

60% av vattenkraften produceras i bergrum. Normalt bra
berg (precambrian) i Sverige (80%), men fjällkedjan sämre
(paleozoic/mesozoic).

Stora utloppstunnlar: Stornorrhors 390 m² och Harsprånget
325 m².

Lagring av olja och gas

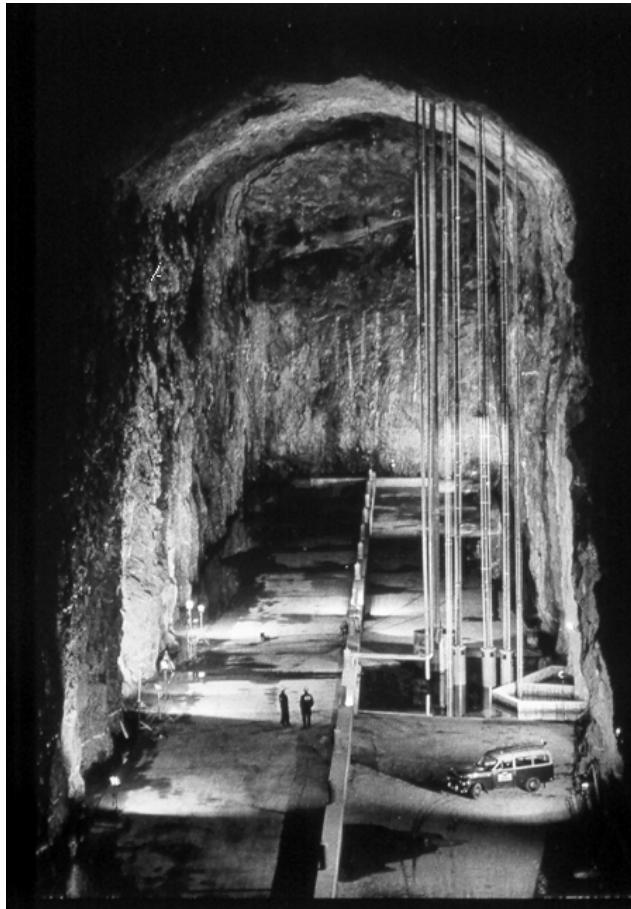
>200 installationer för crude oil och andra petroleumprodukter



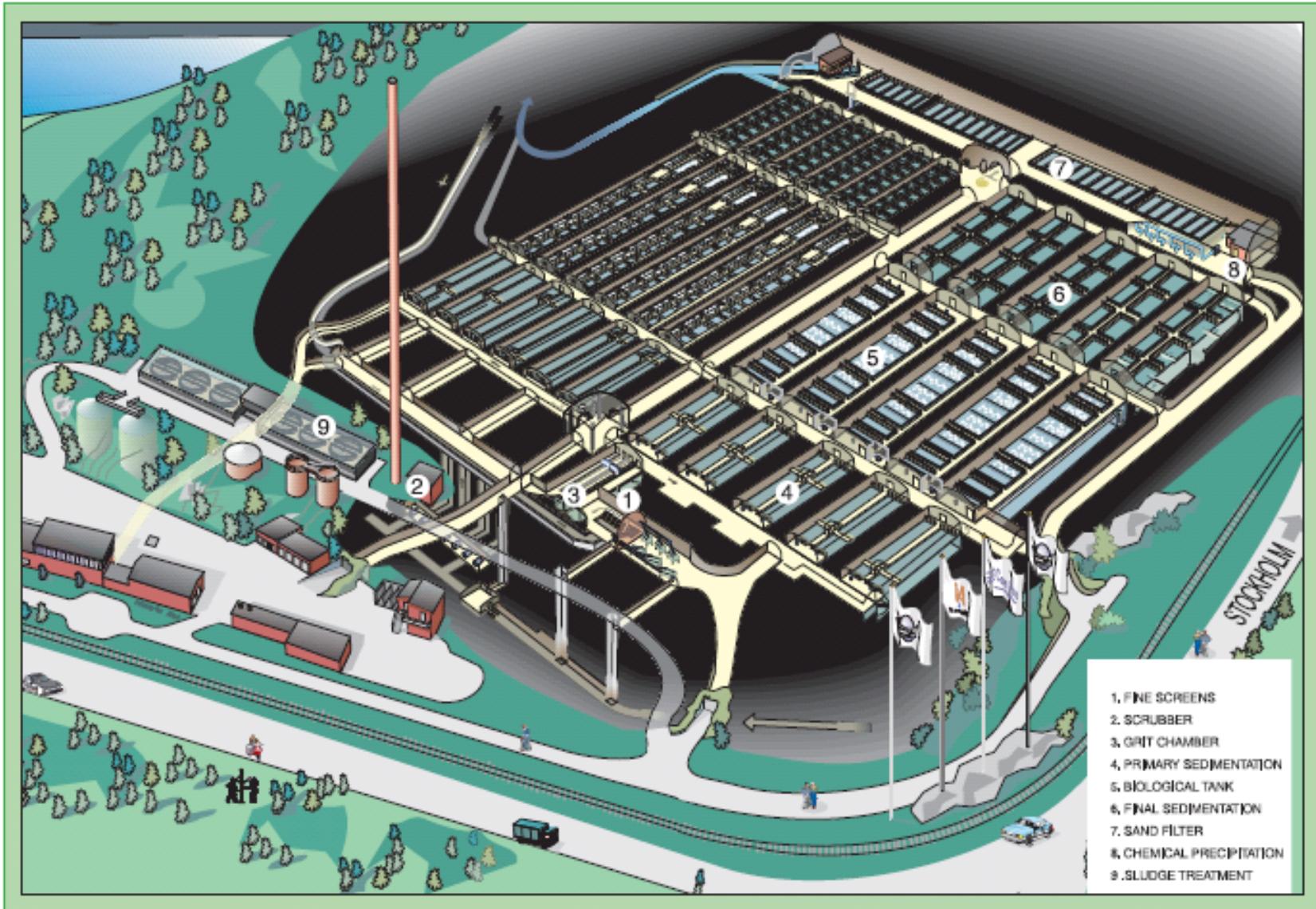
Typical dimensions

Lagring av olja och gas

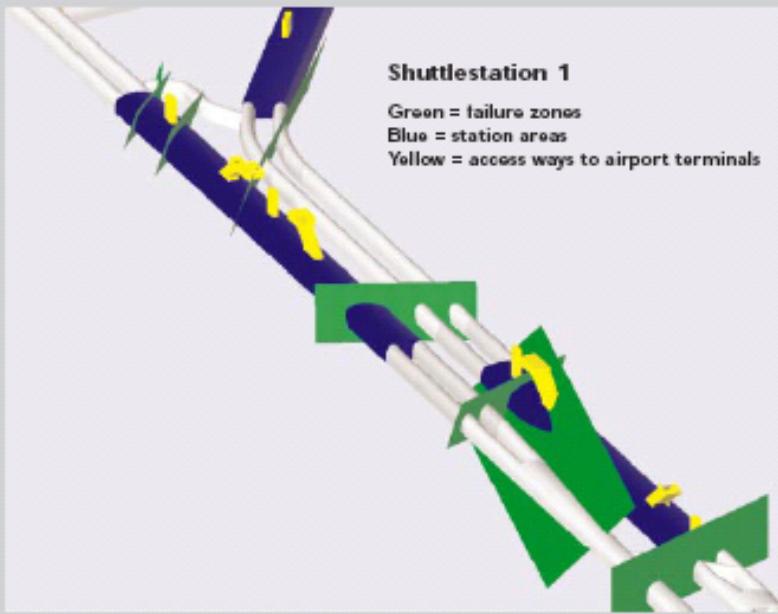
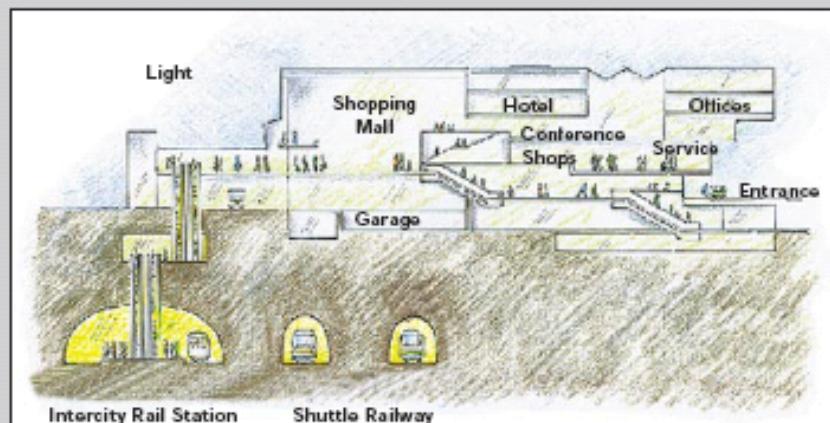
Nynäshamn lagring från 1941
1980 commissioned 1 000 000 m³



Käppala reningsverk

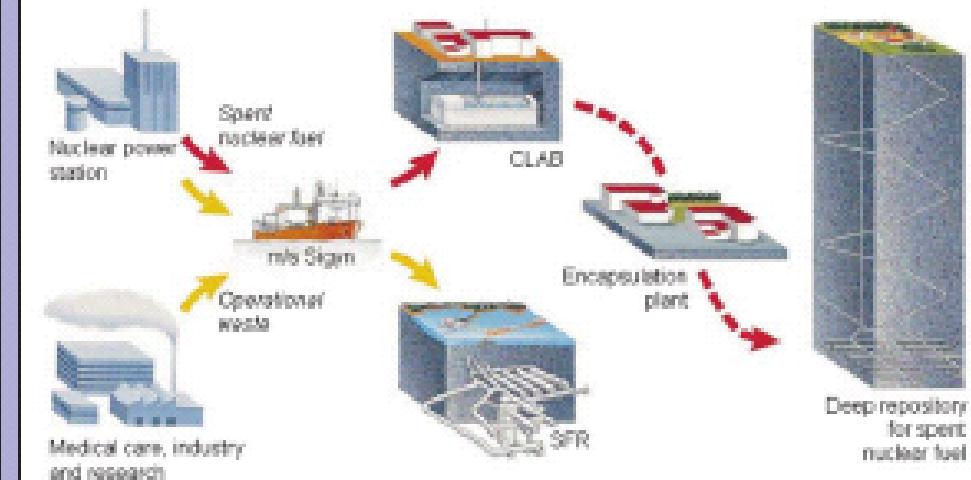
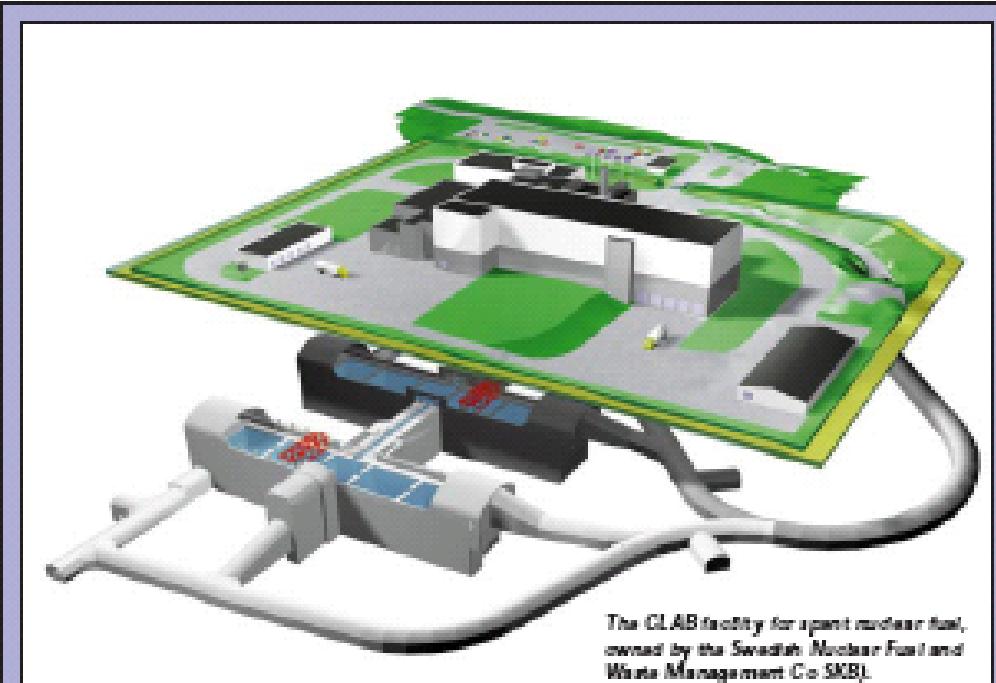


Arlanda Express

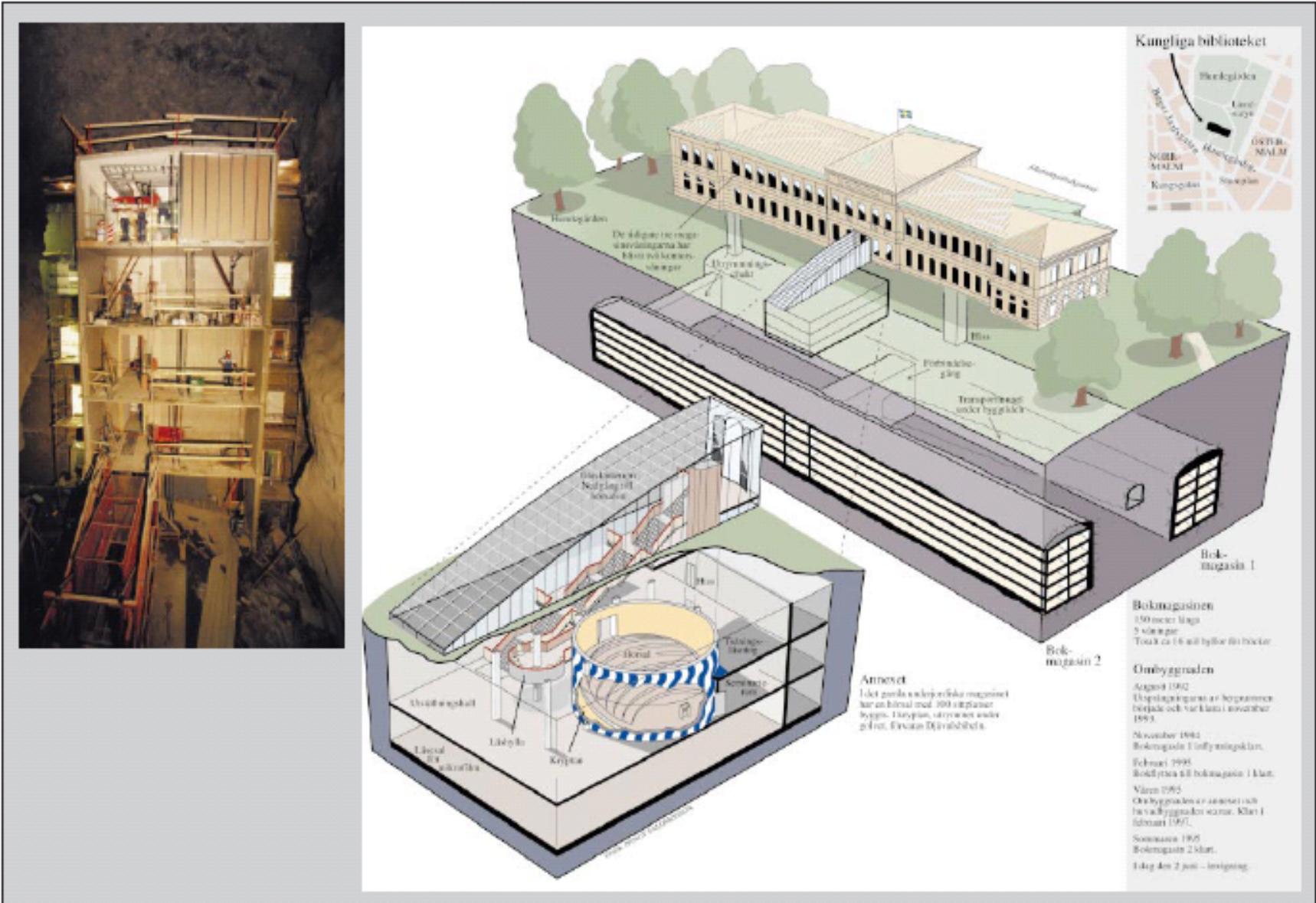


CLAB

Interim Storage for Spent Nuclear Fuel



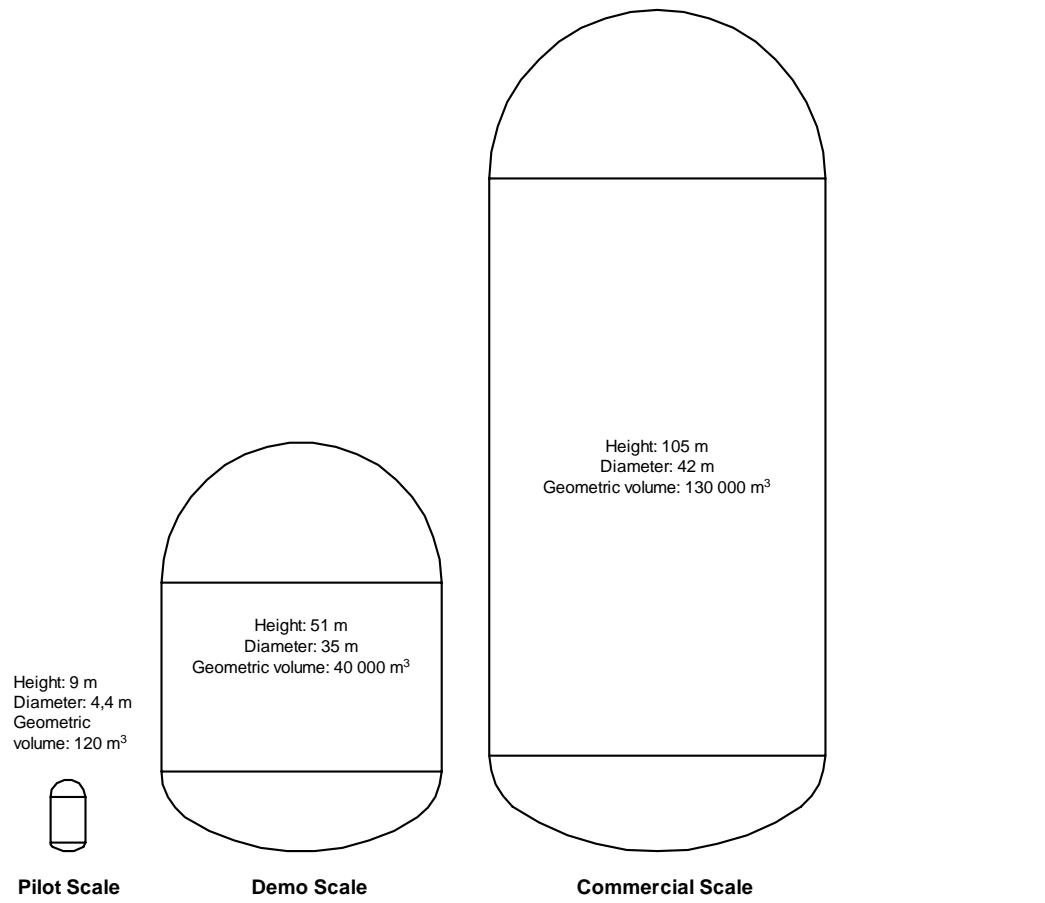
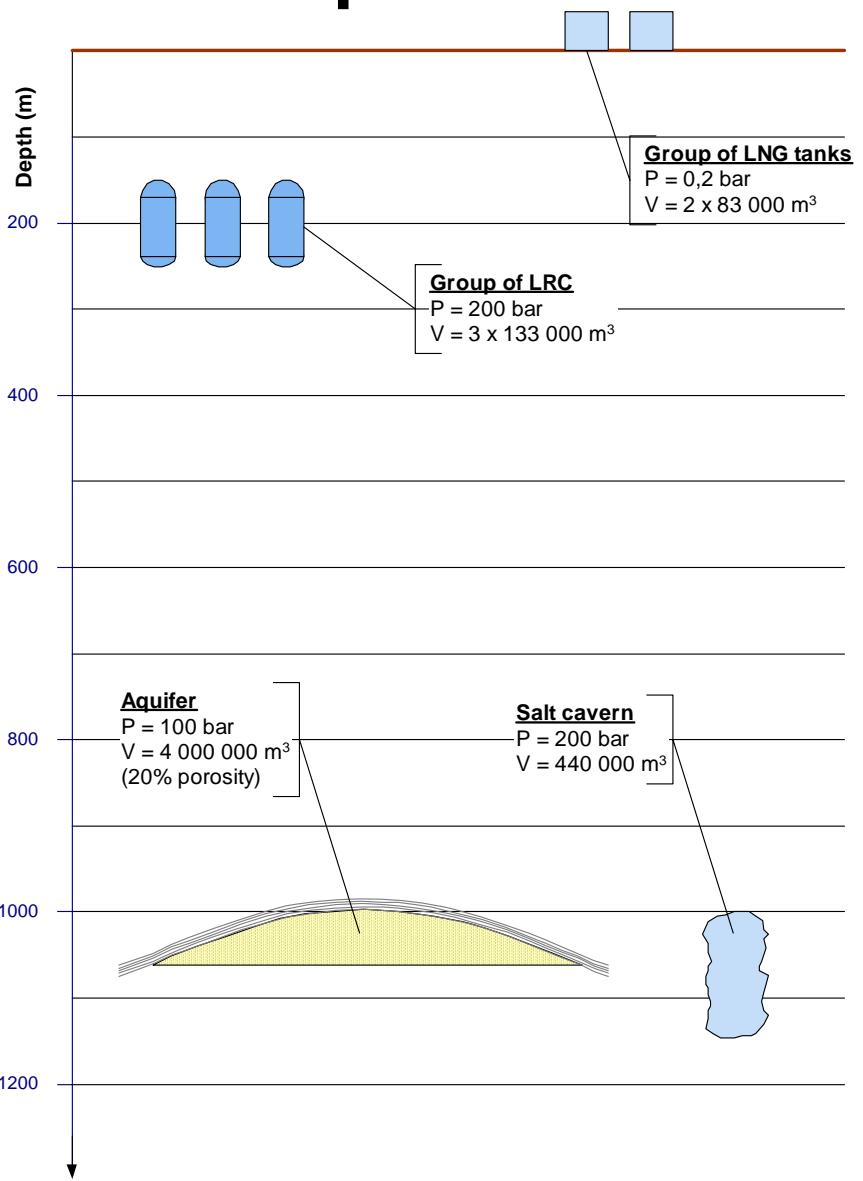
Kungliga Biblioteket



LRC gaslager Halmstad

Per Tengborg, FB Engineering AB

Depth volume and pressure



LRC[®]
Storage

Storage demand in Sweden

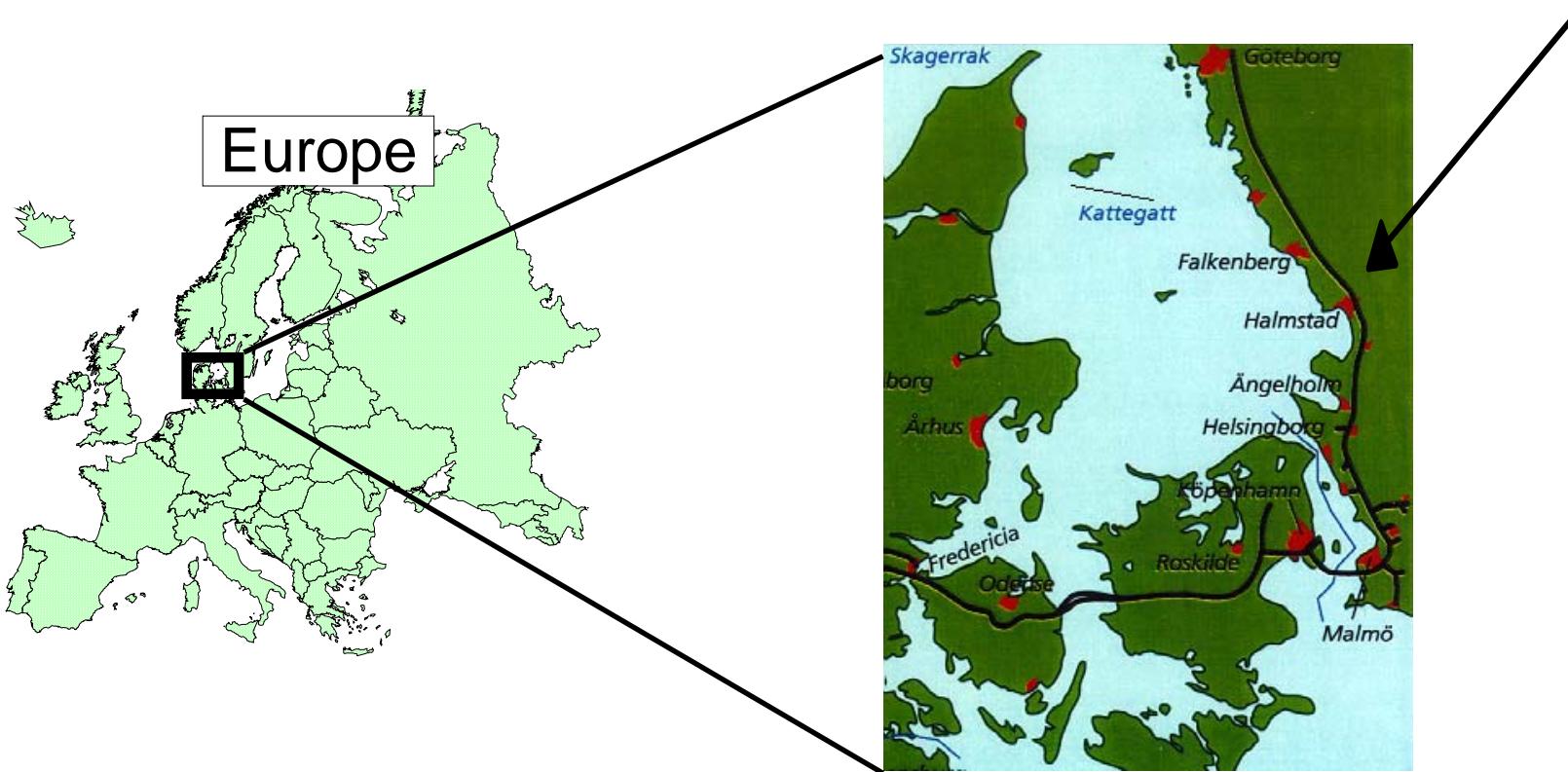
- Sweden connected to natural gas supply via Danish gas grid in 1985.
- No geological conditions underground for aquifere-, salt cavern storage or depleted oil and gas wells in Sweden => Drive to develop the alternative gas storage technology LRC

Three types of storage foreseen at that time:

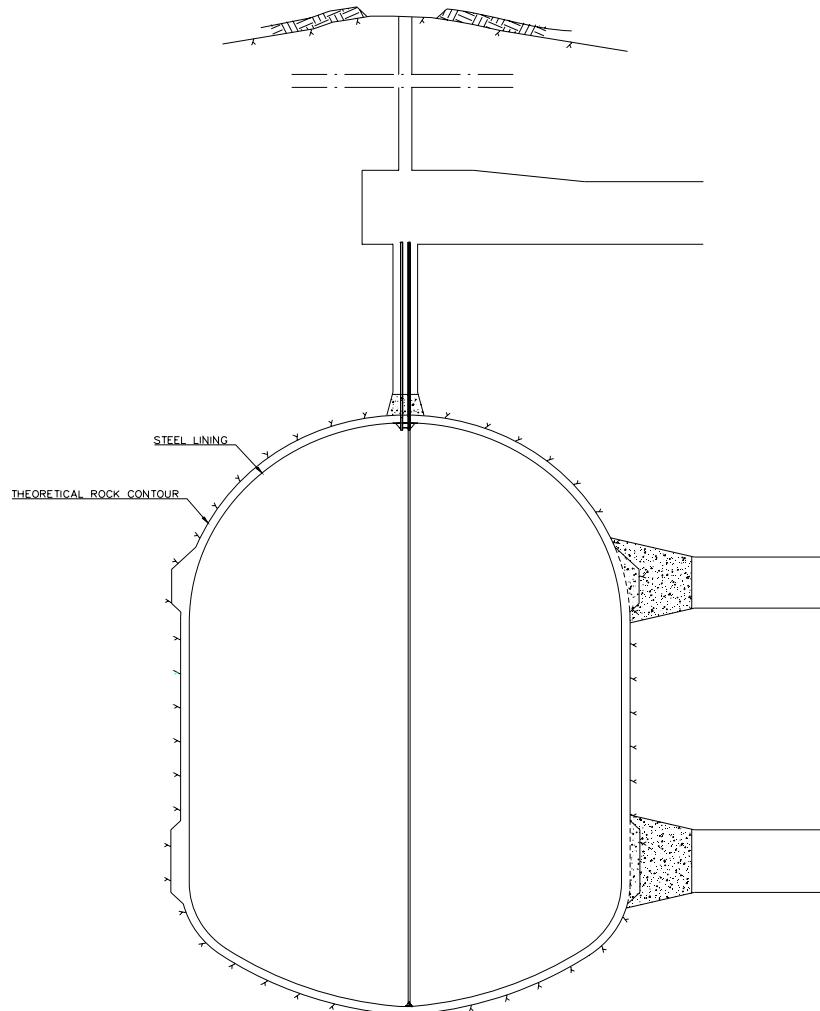
- Strategic storage in case of war situation. This need has been reduced considerably.
- Safety of delivery. Buffer storage in case of interrupted supply.
- Load balancing. Economically beneficial to balance



Location of LRC Gas storage

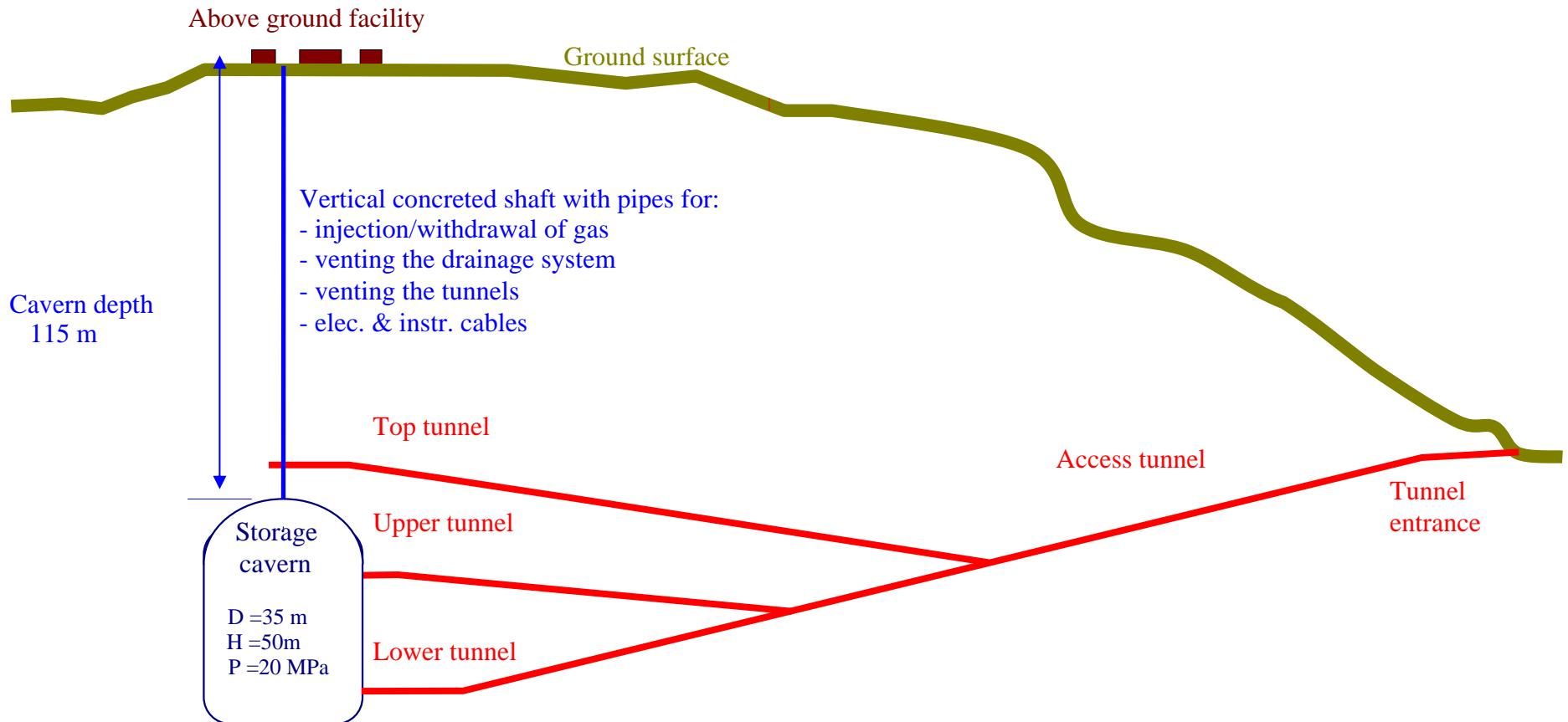


LRC DEMO PLANT "SKALLEN"

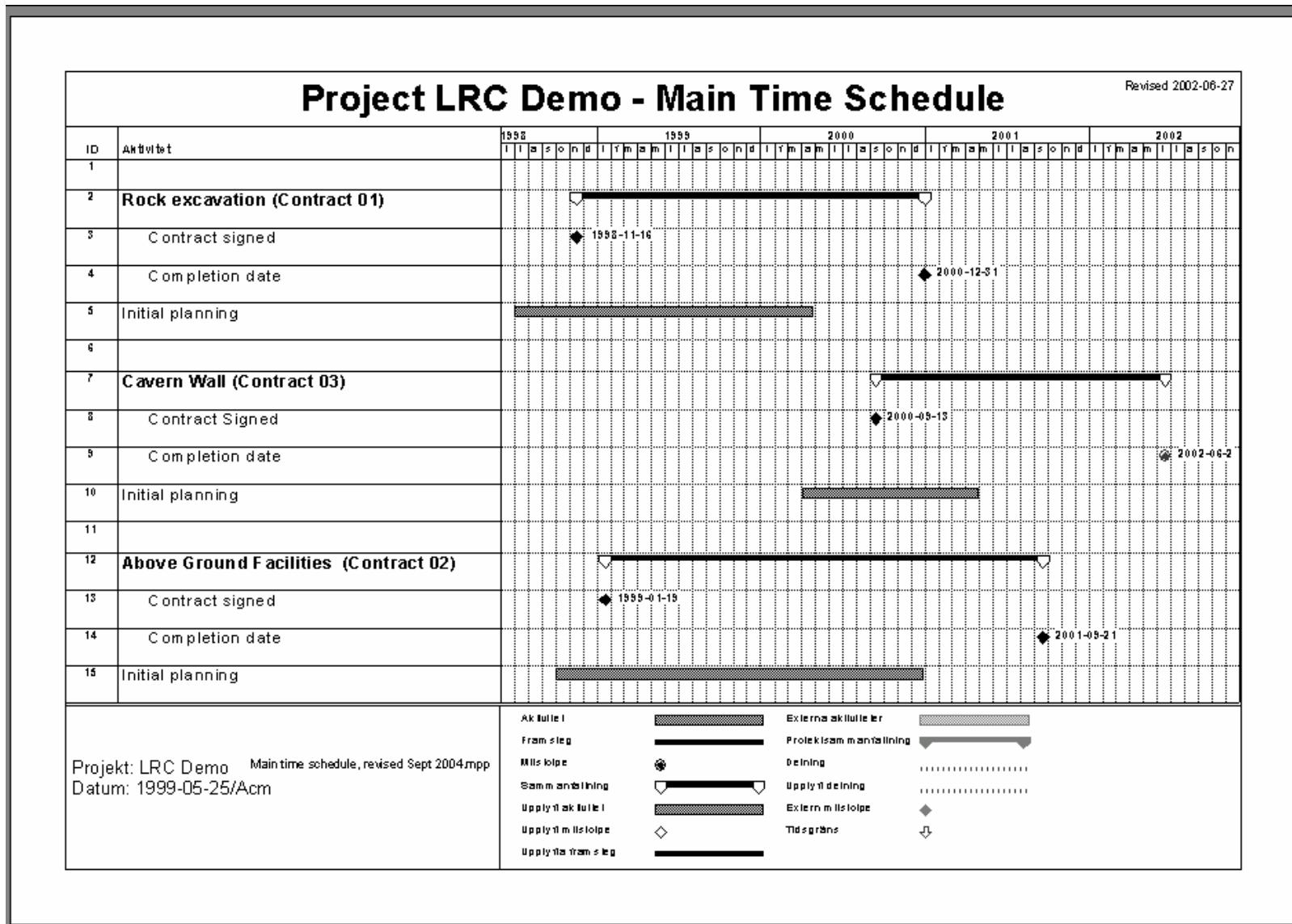


- Geometrical volume 40 000 m³
- Storage capacity 10 MNm³
- Maximum pressure 20 MPa
- Diameter 35 m
- Height 52 m
- Rock cover 115 m
- Injection time 20 days
- Withdrawal time 10 days

Schematic Principle of Skallen LRC Storage



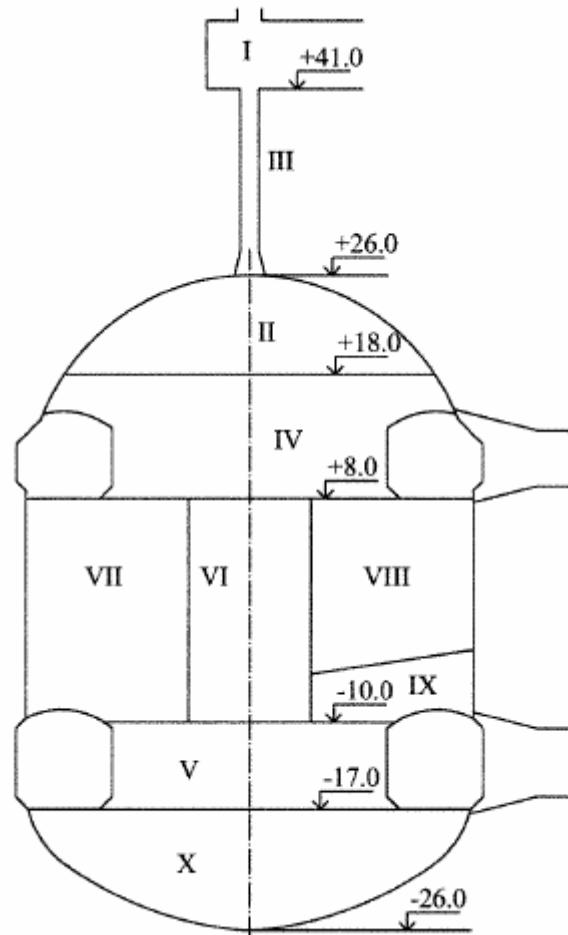
Main Time Schedule



Tunnel entrance

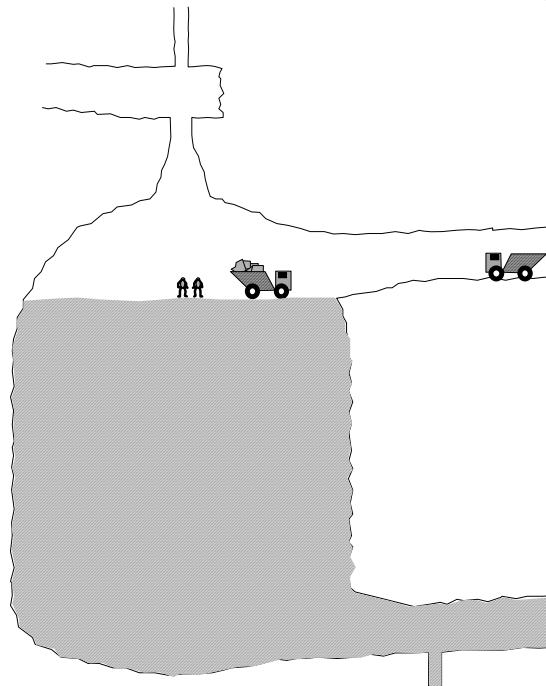


Blasting sequences

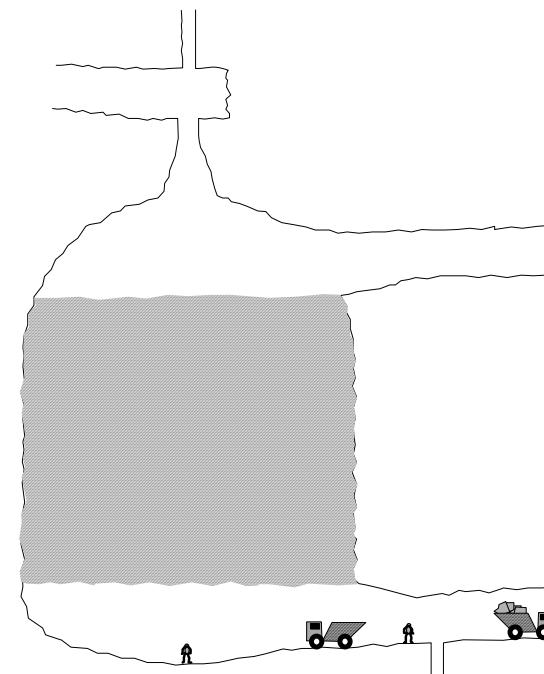


Rock Cavern Excavation 1

Principle



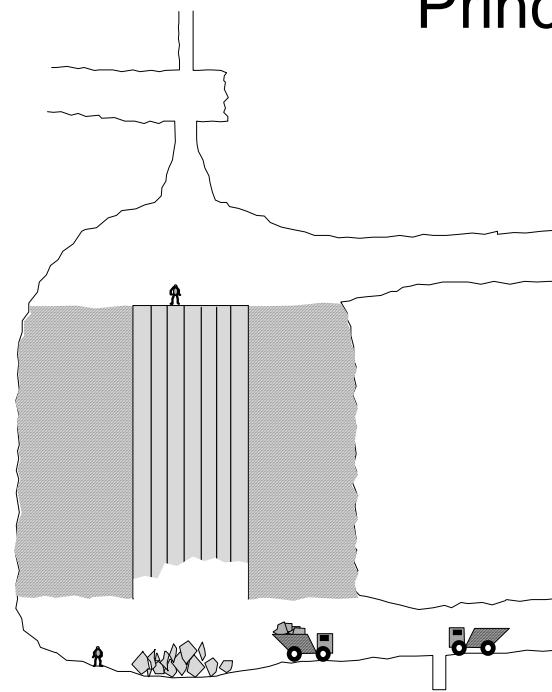
**Excavation of top tunnel,
cavern dome and shaft**



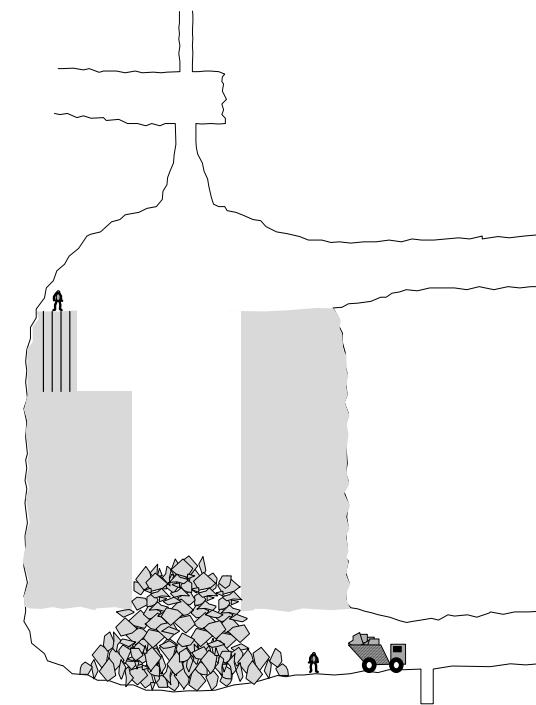
**Excavation of bottom
tunnel and cavern bottom**

Rock Cavern Excavation 2

Principle



**Excavation of central shaft
in caven centre w long hole
drilling/blasting**



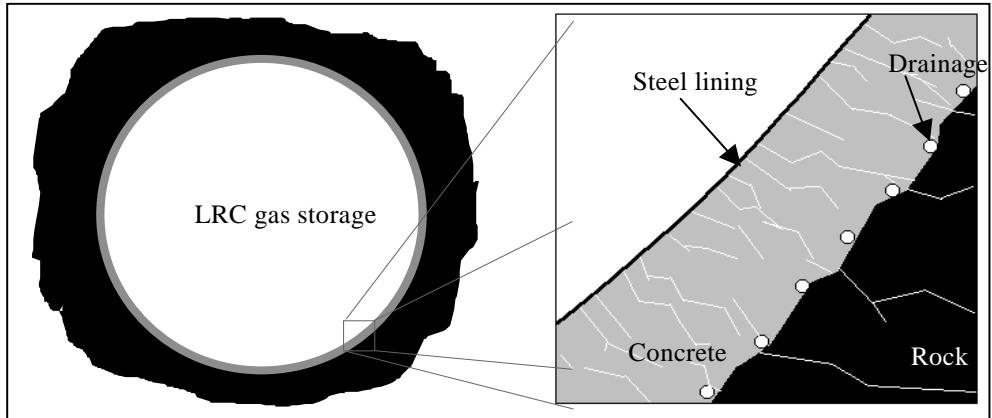
**Bench blasting blasting of
remaining part**



Rock excavation, dome

Cavern wall

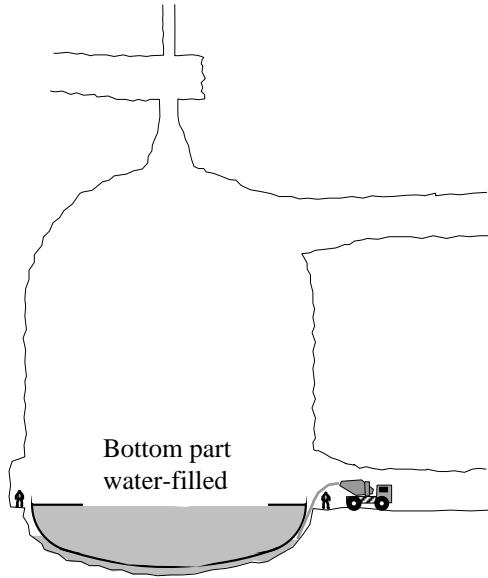
- Rock mass : pressure absorption
- Concrete layer :
 - Pressure transfer
 - Deformation distribution
 - Smooth basis for the liner
- Steel liner : gas tightness



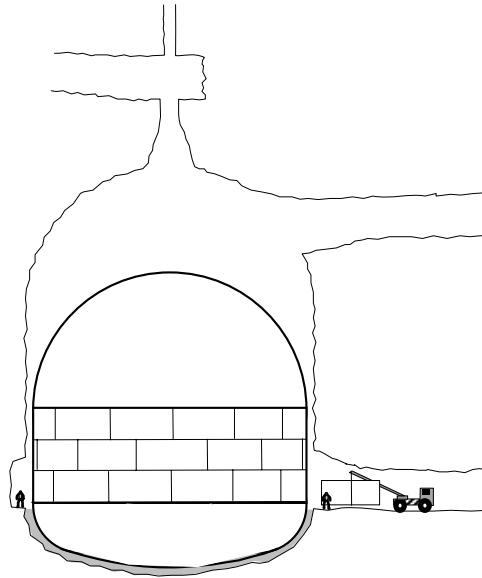


Ready bent steel plates unloaded at site

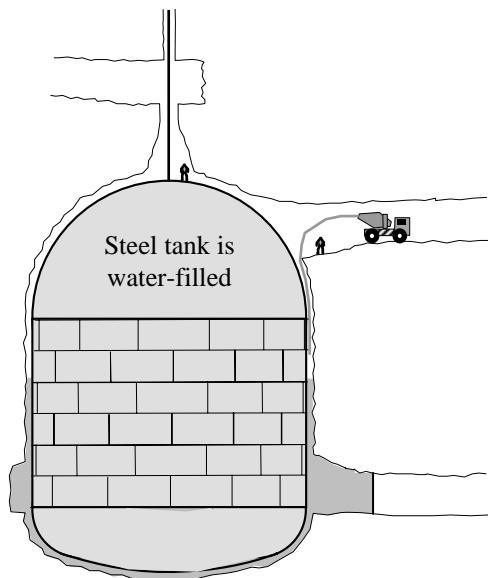
1



2



3



Water filling

Water filling being used as
counter weight



Hydraulic lifting jacks



Reinforcement mesh



Slump-flow test of Self Compacting Concrete



Slump and T-50 test



Underground concrete delivery



Distribution of concrete

Concreting

Detail showing the excellent flow properties of the SCC. The concrete fully encloses the reinforcement mesh without any need for vibrating





Top of shaft

Valve chamber



The valve chamber on top of the shaft houses the equipment at the well-head



Pipe ditch AGF - BGF

Tack för uppmärksamheten!