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# Äspö Hard Rock Laboratory

## Demonstration of repository technology

### Flow and pressure measurements in the pilot holes

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June 1999

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## **Demonstration of repository technology Flow and pressure measurements in the pilot holes**

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This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the author(s) and do not necessarily coincide with those of the client.

## Abstract

An approximately 50 m long tunnel was excavated at the 420 m level in the Äspö Hard Rock Laboratory for the tests of the prototype deposition machine. Four full size deposition holes are needed in the tunnel and five pilot holes with 76 mm diameter have been drilled in possible locations.

Flow and pressure measurements have been carried out in these pilot holes. The pressures range from 0 to 27 bars and the flow rates from negative 0.005 to 0.325 ml/min. The 0 pressure hole also had the negative flow rate, and the 27 bars pressure hole had the 0,325 ml/min flow rate

## Sammanfattning

En cirka 50 m lång tunnel har tillretts på 420 m nivå i Äspölaboratoriet för tester med prototypen till deponeringsmaskin. Fyra fullstora deponeringshål behövs i tunneln och fem pilothål med 76 mm diameter har borrats på möjliga platser.

Flödes- och tryckmätningar har gjorts i dessa pilothål. Trycket varierar från 0 till 27 bar och flödet från minus 0,005 till plus 0,325 ml/min. I hålet med trycket 0 bar erhöles också det negativa flödet, och i hålet med 27 bar erhöles flödet 0,325 ml/min.

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# 1 INTRODUCTION

The objectives of the project Demonstration of Deposition Technology at the Äspö Hard Rock Laboratory are to develop and test methodology and equipment for deposition of encapsulated spent nuclear fuel .

An approx. 50 m long tunnel was excavated at the 420 m level in the Äspö Hard Rock Laboratory. Geological characterisation of the tunnel was performed and four positions for boring of full size deposition holes were selected. Prior to the boring of the canister holes four pilot holes were drilled. A fifth hole, never used as a pilot hole, was also drilled.

This report describes the flow and pressure measurements that were carried out in the five holes of the K-tunnel.

The boreholes were vertically drilled between March 11<sup>th</sup> and March 25<sup>th</sup> 1998. Mechanical packers were installed in the five boreholes between March 19<sup>th</sup> and March 31<sup>st</sup> . The borehole interval from about 0.5 m depth to the borehole bottom was shut in.

## 2 SCOPE

Flow- and pressure measurements were carried out twice in KK0045G01 and once in the four other holes. In Table 2-1 drilling data and borehole data for the five boreholes have been compiled.

**Table 2-1 Drilling data and borehole data for the pilot holes and KK0037G01, Demonstration of Deposition Technology, 1998.**

Borehole	Drilling completed	Borehole depth (m)	Diameter (m)	Date of packer installation
KK0025G01	98-03-16	8.00	0.076	98-03-19
KK0031G01	98-03-25	8.00	0.076	98-03-31
KK0037G01	98-03-12	8.00	0.076	98-03-19
KK0045G01	98-03-24	8.50	0.076	98-03-25
KK0051G01	98-03-11	8.00	0.076	98-03-19

Later (August 1998) borehole KG0045G01 was extended to 65.06 m for rock stress measurements.

### 3 PERFORMANCE AND EQUIPMENT USED

After the packer installation the boreholes were opened and closed a number of times, but during the period from March 31<sup>st</sup> at 10:30 to the time of the flow measurement each borehole was closed

The mechanically operated packer, used in the borehole, were manufactured by Livinstone AB. The sealing rubber length of the packers is 0.15 m. The length of the packer system is approx. 1.5 m. A valve arrangement, including a pressure gauge for manual reading, was connected to the inner packer pipe. On the top of the packer pipe a polyamide pipe (Tecalán) was vertically applied for flow measurements. The inner diameter of this pipe was 4 mm.

The pressure values were read on the pressure gauges. When necessary the packer pipes were filled up with water before the measurements. Water flow rates of the boreholes KK0031G01 and KK0037G01 were measured by registration of the rise of the water level when the water flew through the Tecalan pipe. The flow rates of the boreholes KK0025G01 and KK0051G01 were achieved using graduated cylinders and a stopwatch

In KG0045G01 no flow out from the borehole was observed. Instead the rate of descent of the water level of the inner packer pipe was measured.



## 4 RESULTS

The results of the pressure measurements and the flow measurements are presented in Table 4-1

**Table 4-1 Manually measured pressures and flow rates in four pilot boreholes and in KK0037G01. Demonstration of Deposition Technology, April 1998.**

Borehole	Date	Time	Section (m)	Pressure (bar)	Flow rate (ml/min)	Flow rate (m <sup>3</sup> /s)
KK0025G01	980401	14:00	0.50 – 8.00	12	0.045	$7.5 \cdot 10^{-7}$
KK0031G01	980401	14:08	0.50 – 8.00	6.5	0.0025	$4.2 \cdot 10^{-8}$
KK0037G01	980401	14:22	0.50 – 8.00	10	0.0013	$2.2 \cdot 10^{-8}$
KK0045G01	980401	14:30	0.50 – 8.50	0	Negative flow	
KK0045G01	980402	10:03	0.50 – 8.50	0	- 0.005	$- 8.7 \cdot 10^{-8}$
KK0051G01	980401	14:36	0.50 – 8.00	27	0.325	$5.4 \cdot 10^{-6}$