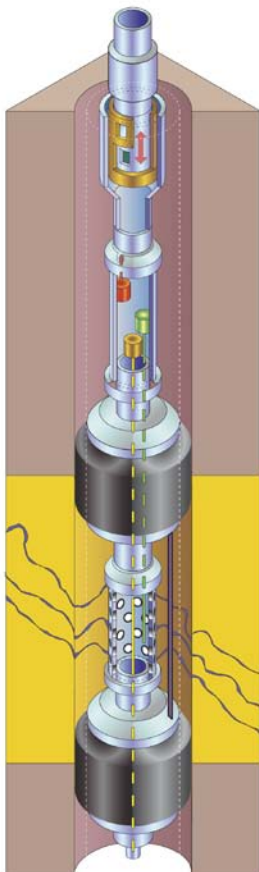


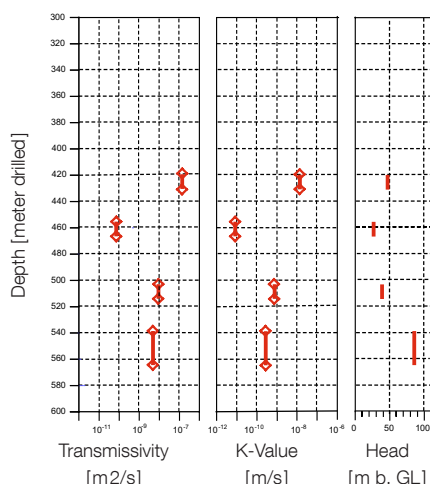
# HDDP - Heavy - Duty Double Packer System

## Hydrogeological in-situ investigation in deep boreholes up to 1800 m

- Evaluation of hydraulic parameters (K, T, formation pressure, temperature) at different depths
- Sampling at selected test intervals
- Real-time graphical representation of the measurements
- Interpretation of the test data at the site
- Continuous overview of the testing procedure for optimisation of the test duration



Bore: installation of the heavy-duty double packer system



Representation of double packer test results in a vertical profile



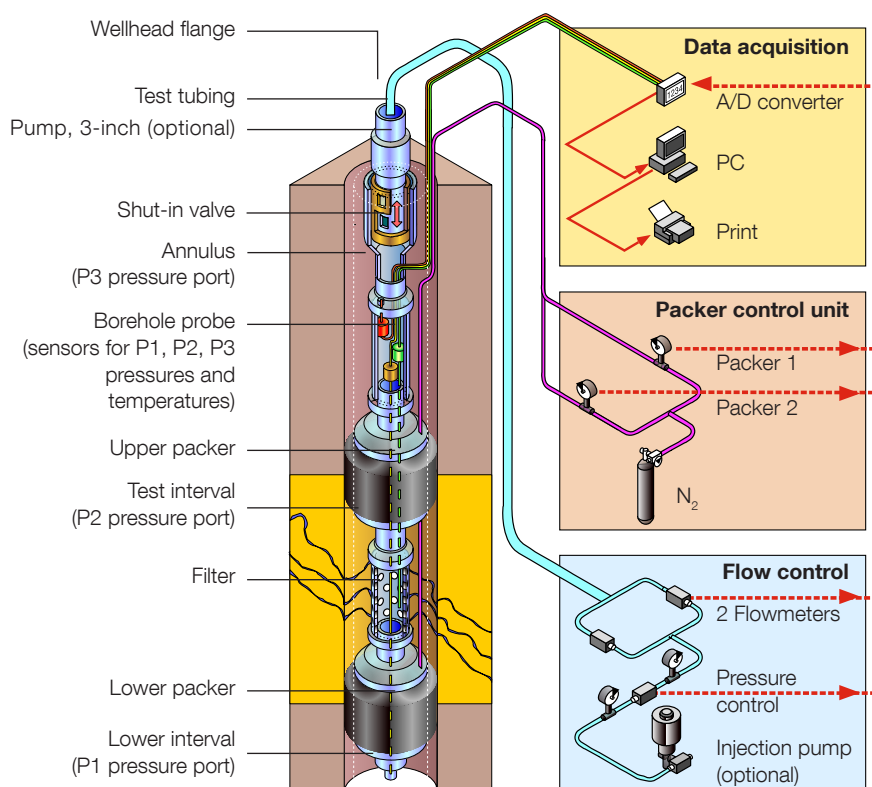
Heavy-duty double packer system (HDDP)

## Solexperts Heavy-Duty Double Packer System (HDDP)

Solexperts developed a heavy-duty double packer system for accurate and reliable hydraulic characterisation up to a depth of 1800 m. HDDP equipment have been used for more than 10 years in numerous international hydrogeological investigations at great depths.

### Test equipment

The test equipment consists of the borehole instrumentation (packer and test tubing, probe, shut-in valve and measuring cable), the flow and pressure control units and the data acquisition system.



### Borehole Equipment

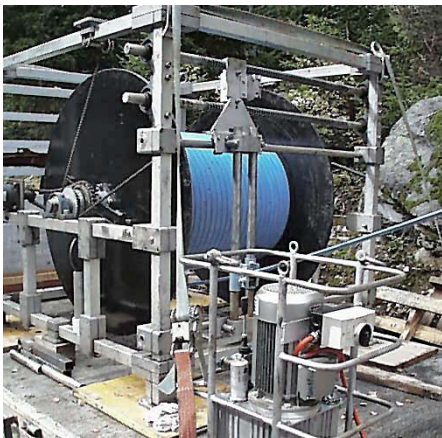
The packer system is composed of two expandable packers controlled by two separate pressure lines and is installed with Solexperts test tubing. The test interval is isolated by pneumatic or hydraulic expansion of the packer sleeves against the borehole wall. The length of the test interval can be varied. The tubing between the packers consists of a filter that allows hydraulic communication between the test zone and the test interval. The probe above the packer system is continuously measuring pressure and temperature in the test interval as well as the pressures in the annulus and lower interval for the control of any by-pass effects.

The shut-in valve is situated above the probe in the test interval and can isolate or connect the interval with the test tubing. The shut-in valve allows the application of modern hydraulic test procedures (slug- and pulse-tests, constant head tests, etc). Additionally, the stabilisation of the pressure (especially in low permeable zones) is accelerated due to the decrease in wellbore storage.





Connection between «triple-flat-pack» cable and packer system



Winch with measuring cable and hydraulic power unit on transport vehicle

Swabbing of the test tubing can be used to withdraw water for slug/pulse withdrawal tests. Water sampling in the test interval can be performed by using a bailer.

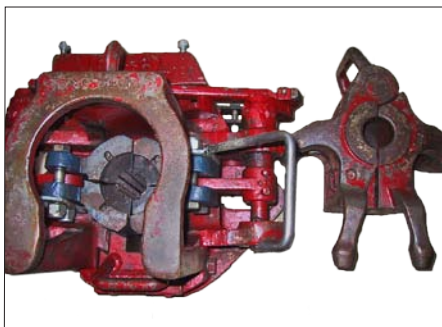
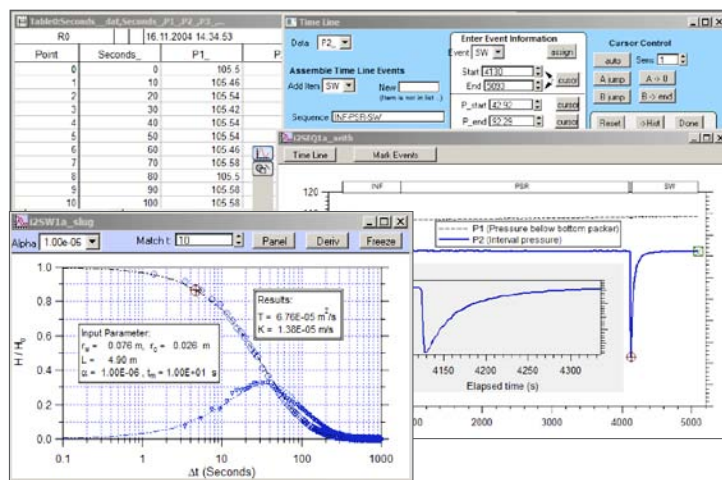
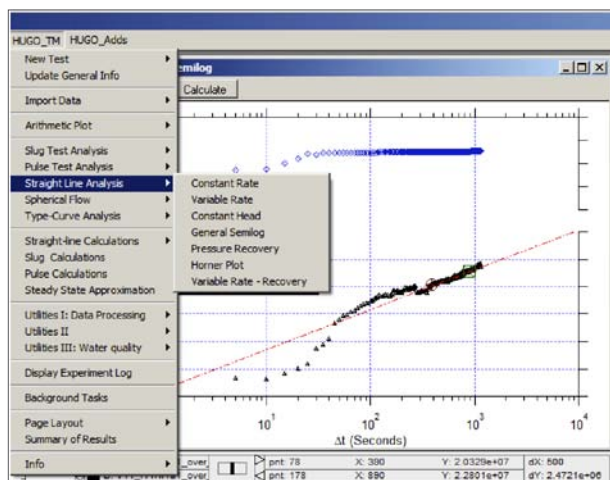
A «triple-flat-pack» cable consisting of two packer control lines and an electrical cable is used to connect the surface equipment with the downhole system. The «triple-flat-pack» cable is fixed to the test tubing by centring brackets. The cable winch system is controlled by a hydraulic power unit and is transported by an all-terrain vehicle allowing fast installation. Solexperts provides jaw and elevator tools that are optimally adapted to the test tubing for the installation of the HDDP. These tools can considerably reduce the installation time.

## Data acquisition

All measurements (pressure, flow rate, temperature and geochemical parameters) are recorded with a data acquisition system located in a mobile measurement trailer. Additional channels are available for measuring pressures in adjacent boreholes or for the recording the water quality.

Sophisticated interpretation analysis software allows hydraulic tests to be evaluated on-line leading to an optimization of the test lengths.

Test results, graphical representations, test logbook and raw data can be provided shortly after the test is completed.



Jaws and elevator tools

## Flow/Pressure Control Unit and Accessories

Pump injection and withdrawal tests require an accurate control of the pumping rate as well as the hydraulic pressures. The flow/pressure control unit consists of control valves and flow meters for different flow ranges. A wide range of pumps are available. Depending on the test requirements the control unit can be equipped with modules such as:

- Valves for constant flow or pressure
- Geochemical unit for the recording of chemo-physical parameters
- Tracer tank
- Injection pump



Directional drilling at LTF Avrieux



Directional drilling at LTF Etache

## Technical data of the Heavy-Duty Double Packer System

### Models

Outer diameter: 3 1/16 inch (77.8 mm); 4 1/4 inch (108 mm)

### Data acquisition system

Custom Solexperts data acquisition and analysis software  
Assorted measurement equipment for monitoring and control

### Probe transducers

Measuring range: 0 – 207 bar; 0 – 125°C  
Resolution:  $1 \cdot 10^{-5}$  FS  
Accuracy: 0.02 %

### Test tubing

1.9 inch, steel  
Inner diameter: 40.5 mm  
Outer diameter: 48.3 mm  
Outer diameter of the coupling: 56.1 mm

### Packer 3 1/16 inch

Length: 0.75 m; diameter: 77.8 mm  
Pressure medium: water or N<sub>2</sub> gas  
Minimal length of the interval: 2.87 m

### Packer 4 1/4 inch

Length: 1.20 m; diameter: 108 mm  
Pressure medium: water or N<sub>2</sub> gas  
Minimal length of the interval 3.05 m

### Maximum packer working pressures (bar)

Borehole diameter (mm)	100	125	150	175	200	210
Packer diameter 77.8 mm	315	207	82	-	-	-
Packer diameter 108 mm	-	350	276	193	110	69

### Ideal packer application area

Packer diameter: 77.8 mm Borehole diameter: 100 – 140 mm  
Packer diameter: 108 mm Borehole diameter: 140 – 200 mm

### Maximum depth 1800 m

Subject to technical alterations

### References

Hydrogeological in-situ deep boreholes testing projects:  
LTF/ Alpetunnel, BBT Brenner Base Tunnel, Deep Boreholes Oftringen, Schlattigen, Remlingen 15.

### Additional hydraulic test systems and services

- Wire-line testing
- Pump-down packer system
- Products for the reconditioning of water supply boreholes
- Custom packer and test systems
- Hydrogeological instrumentation
- Conception and realisation of hydraulic tests in underground rock laboratories
- On-line tracer test in saturated and unsaturated zones
- Analyses of hydrogeological test data

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