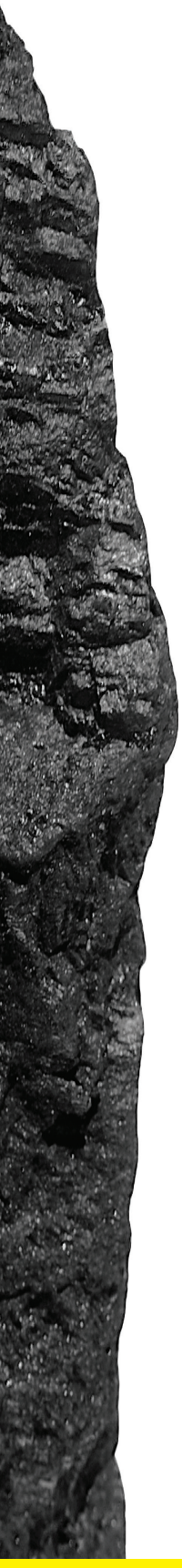
IN-SITU PERMEABILITY TESTING FROM SURFACE HOLES
DST



Sigra carry out testing to measure permeability and reservoir pressure in formations such as coal seams to determine their in-situ conditions. Tests are typically undertaken in HQ size (96 mm) exploration holes, however, they are also undertaken in larger holes. The most successful and unambiguous testing involves drawing fluid from the formation to be tested, rather than injecting.

The reason for this is that the drill stem test (DST) is undertaken using reservoir fluids of known viscosity and temperature. Injection testing can be performed, but this frequently leads to sharply increasing injection pressures associated with changing well bore losses during the test. These occur because clays in the drilling fluid tend to plug cleats near the well bore. DST involves emptying part of the fluid from the drill string, sealing the test zone, waiting for pressure stabilisation and then opening a valve between the test zone and the drill string to induce flow. After a period of inflow the valve is closed to induce pressure build up. This procedure may in some cases be repeated to confirm behaviour.

The extreme range of characteristics of coal seam reservoirs prevents the use of an identical test for each seam. It is essential to be able to monitor at surface the formation response to the test process and to adapt testing to meet in-hole behaviour. Sigra surface readouts permit viewing of the well test progress in both numerical and graphical forms. Plots of the total test, the derivative with respect to Agarwal time, and the Horner build up are available on surface. The ability to view these plots in real time ensures that **all tests Sigra controls and undertakes with its own equipment produce a valid result,** providing that the packers can be seated on a formation that permits a seal to be formed.

The DST system developed by Sigra Pty Ltd comprises a trailer containing data logging equipment, control equipment, and down hole tools. The down hole tools are in two forms.

The first tool is designed to be run through the HQ or HRQ drill string on a drill rig's wire line. It may be run as either a straddle or bottom test tool depending on whether a bottom packer and extension rods are used. The advantage of this tool is that it may be run quickly without pulling the drill string, and therefore tests can be conducted with unstable sections of borehole above the test zone. It can be used in holes up to 105 mm diameter.

Sigra DST trailer

The second tool is an end-of-string tool and is also used in straddle or bottom test configuration. It utilises an assembly that is designed to be screwed on to the bottom of the drill string. Packer inflation and communication lines are lowered inside the drill pipe on wire line to connect with the tool. The tool can be used for multiple tests without pulling the drill string, provided that the test zone straddle spacing requirement remains the same.

Both tools use either compressed air or nitrogen to push down the fluid in the drill string prior to a test. Each system contains a zero volume change valve which controls connection between the test zone and the inside of the drill string. The valve is operated by raising or lowering the string once the packers are set. Pressure transducers monitor pressure in both the test zone and above the valve in the drill string, along with the packer pressure.

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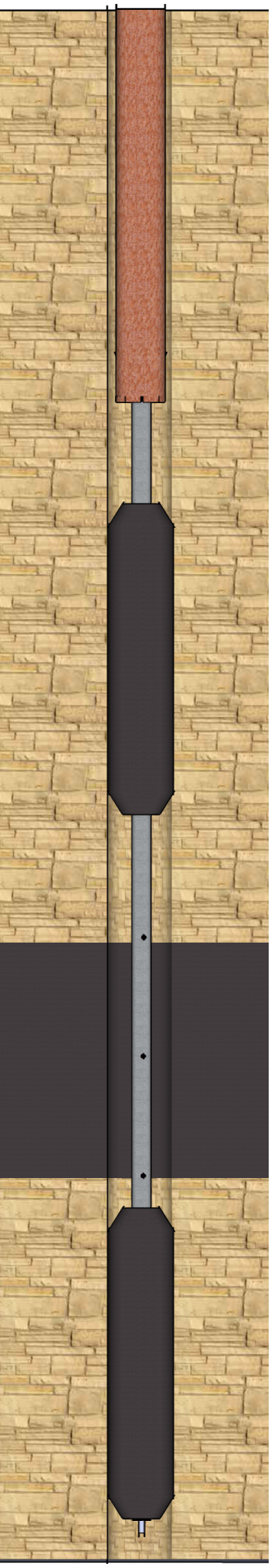


Packer inflation is from either a water pump at surface or, in shallower holes, by compressed air. The communication and inflation lines may be taped to the drill rig's wire line for raising and lowering or may be run on Sigra's own wireline winch.

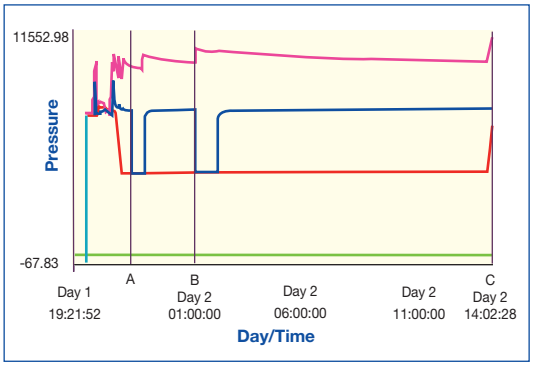
A snubber to shut in around the cables is located at the top of the drill string. This permits control of a blow out during running of the tool. Above this is a sealing head which seals around the cables during operation.

The trailer contains a regulator to control the pressure of air from a compressor which is used to push the water level down in the drill string. It also contains both high and low flow gas meters to measure the flow rate of gas from the drill string, and a water regulation system to permit water injection into the string at a controlled pressure or rate (should it be required).

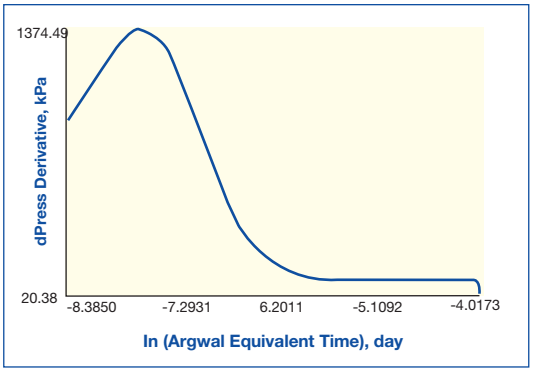
When the through-the-bit tool is used, the drill string is set at the correct level and the tool is lowered through the seal, snubber and string to protrude through the bottom of the core barrel. If the end-of-drill string tool is used, the tool is first attached to the bottom of the string and the string is then lowered to position.

Regulated air pressure is used to displace water from the drill string. A low enough pressure is used so that air will not blow out of the bottom of the string into the hole. The packers are then set and the drill string lowered to close the valve so that the compressed air may be bled off. The valve is then opened to induce flow from the test section into the string. The water inflow can be monitored by a change in head on the in-string pressure transducer whilst the flow of displaced air and any gas produced is measured on the gas flow meters. Any gas flow is detected as the difference between water inflow to the string and gas flow out of the string. A formation fluid sampler may be used with the tool.

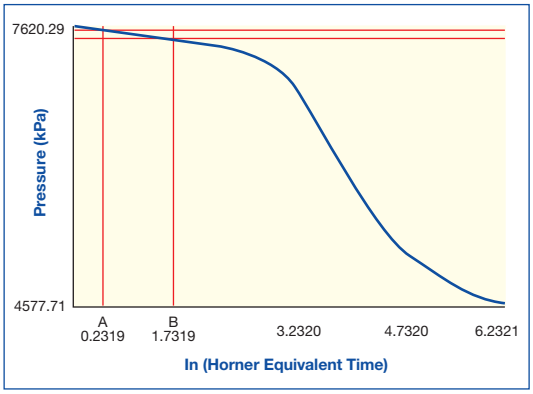
Following the test procedure, the drill string is filled and the pressure both inside and outside the tool are equalized. The packers are then deflated and the top seal around the cable and inflation line is opened. The through-the-bit tool is then withdrawn through the string or in the case of the end-of-string tool, the electronics module may be pulled. In each case blowout control is afforded during this operation by the snubber.



Example Total Plot of Sigra Drill Stem Test (DST)



Example of Plot of Derivative with Respect to Agarwal Time



Example of Horner Build-Up Plot