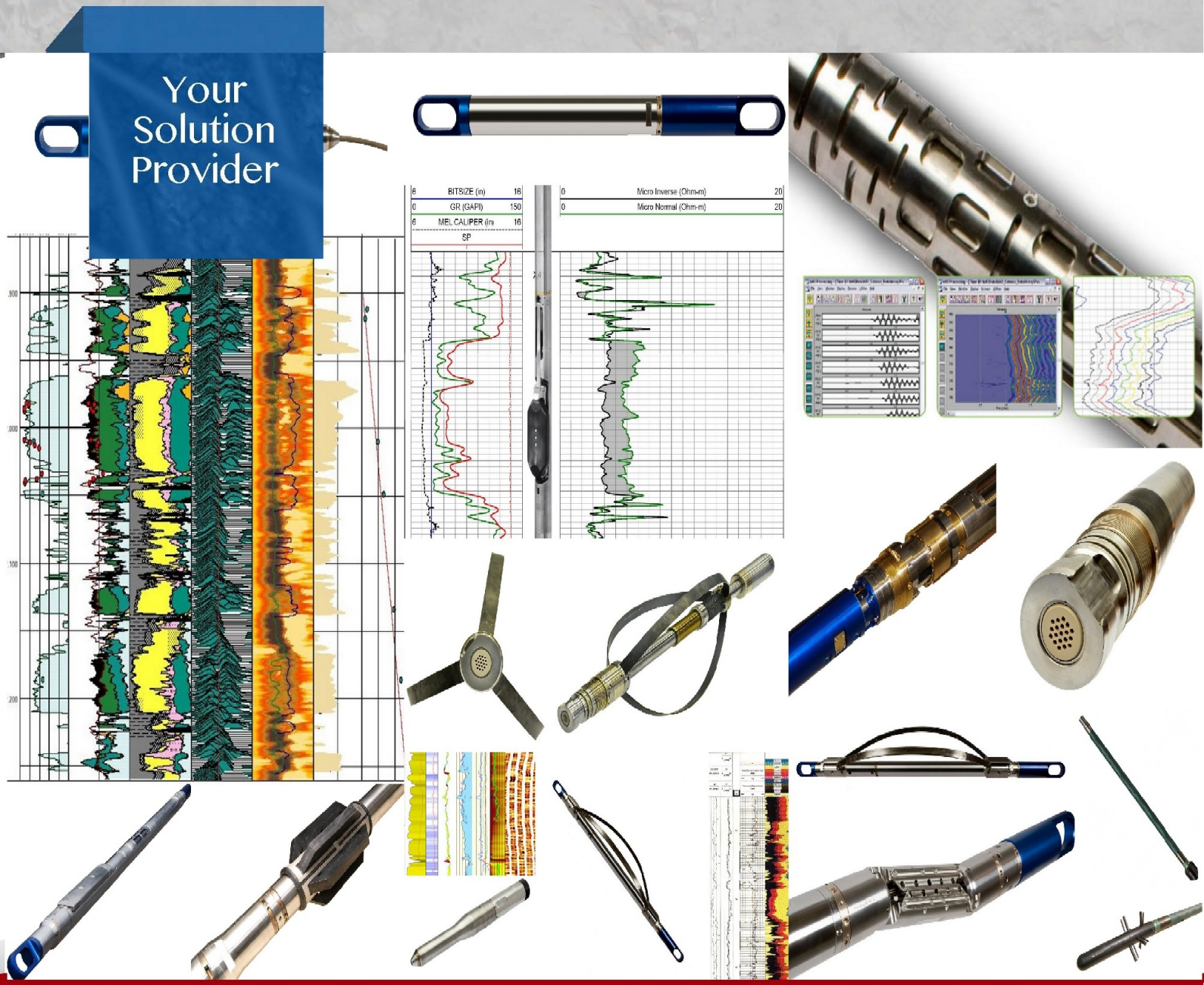


Open Hole Services & Technology

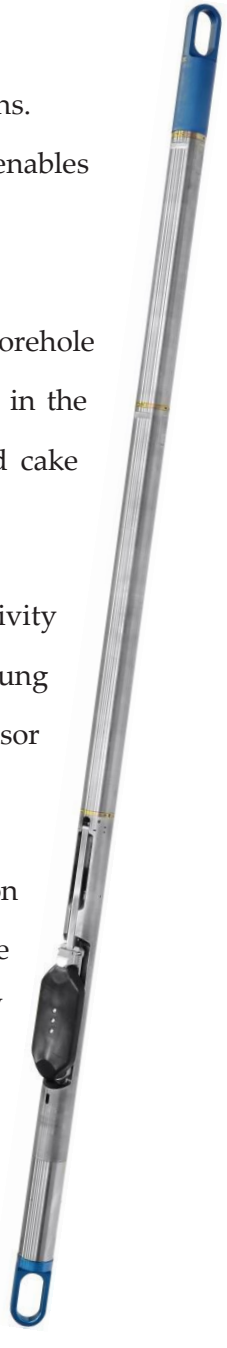
Eastern United
PETROLEUM SERVICES

الشركة الشرقية المتحدة للخدمات النفطية

Table of Contents

Section 1: Micro Electric Tool (MEL)

The Micro Electric Log (MEL) identifies permeable rock formations.



The MEL provides a high resolution qualitative indication of permeable rock formations. Identifying reservoir permeability, in combination with other logging measurements, enables the volume of movable hydrocarbons to be identified.

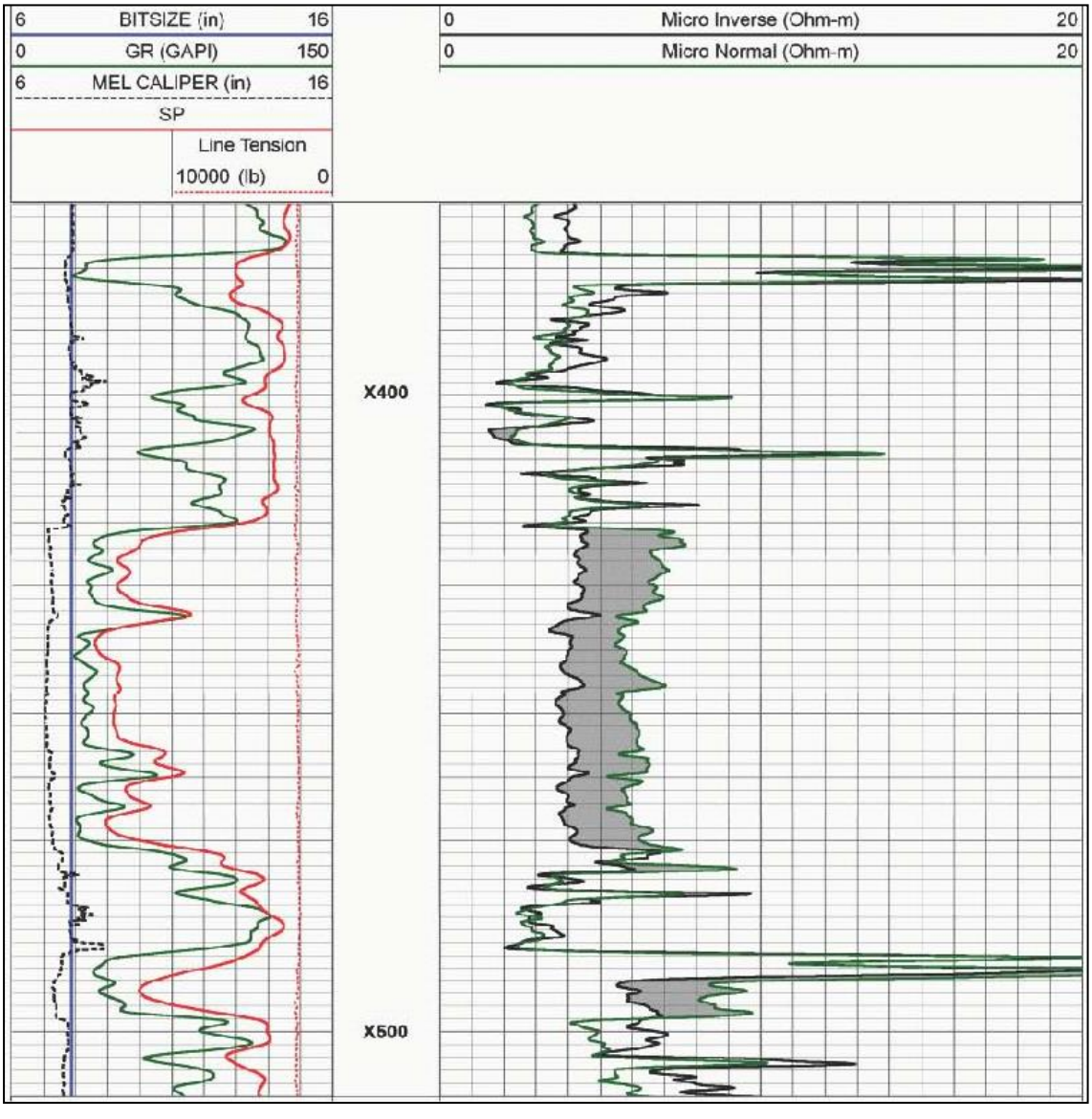
The column of drilling mud in an open hole creates hydrostatic pressure against the borehole wall. A permeable reservoir allows mud filtrate to enter the formation while solids in the mud form a mud cake along the borehole wall. Consequently, where there is mud cake build-up it can be deduced that the formation is permeable.

The MEL detects the presence of mud cake along the borehole wall by making resistivity measurements near to the borehole wall. The tool also has two independently sprung Calliper Arms, one on either side of the Arm Housing, and each calliper arm has a sensor to measure its position.

The MEL has three electrodes in an oil filled rubber pad. The rubber pad is mounted on the end of a Calliper Arm and maintains good wall contact as it conforms to borehole irregularities. The tool measures the resistivity of the mud cake (micro-inverse, MINV curve), and a shallow depth of the flushed zone resistivity (micro-normal, MNOR curve).

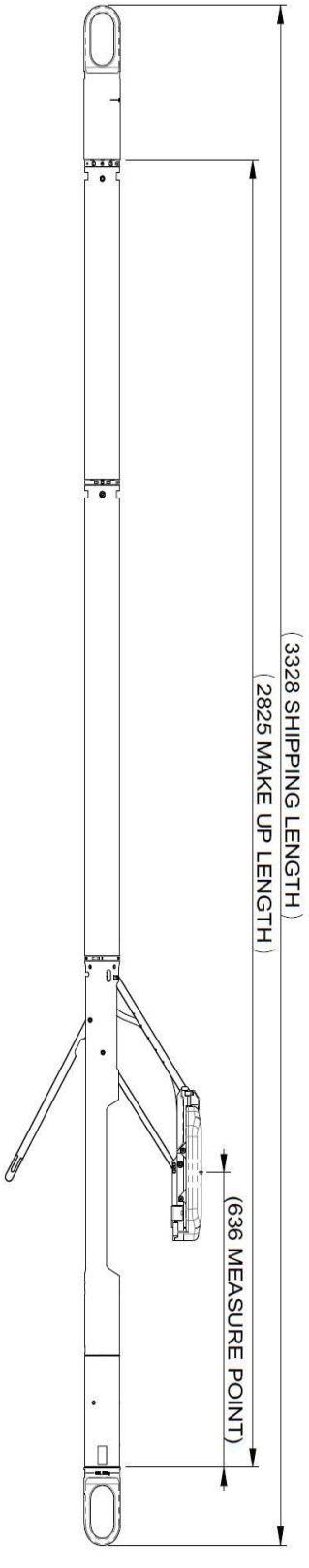
The mud cake has a lower resistivity than the flushed zone. The MINV measurement has a shallow depth of investigation and is influenced more by the low resistivity mud cake than the flushed zone. The MNOR measurement has a deeper depth of investigation, representative of the flushed zone. Consequently, when MNOR > MINV, this is considered positive separation and indicates permeability.

The MEL can also be used to estimate mud resistivity when run into the well with the calliper arms closed.



Features

- Identifies permeable reservoir zones
- Two fully independent calliper arms
- Mud resistivity estimate while running in hole
- Tool can be placed anywhere in the string
- MEL & MSFL share a common sonde body allowing the pads to be interchanged



Specifications	
Maximum OD	3 3/8 in. (85.7 mm)
Makeup length	9.825 ft (2.8 m)
Weight	219 lb (99 kg)
Maximum temperature	302°F (150°C)
Maximum pressure	20 kpsi (137.9 Mpa)
Minimum hole	6 in. (152 mm)
Maximum hole	16 in. (406 mm)
Tensile strength	50,000 lb (22,700 kg)
Sensor Offsets	
MINV/MNOR/MCAL	2.09 ft (0.636 m)
Borehole Conditions	
Borehole fluids	Fresh, salt
Recommended logging speed	30 ft/min (9.1 m/min)
Tool position	Centralized/Decentralized
Measurement	
Accuracy	MINV & MNOR: +/-5% Calliper: +/-3.8 mm Calliper: +/-0.15 in.
Vertical resolution	1.5 in (3.8 cm)
Radial Depth of Investigation (50%)	MINV: 1.5 in. (3.8 cm) MNOR: 4.0 in (10.2 cm)
Measurement range	0.2–200 ohm-m
Primary curves	MINV, MNOR
Secondary curves	MCAL
Hardware and Power Requirements	
Tool bus	Ultrawire
Power	18 VDC 150 mA - 400 mA

Section 2: Lithology Density (LDT)

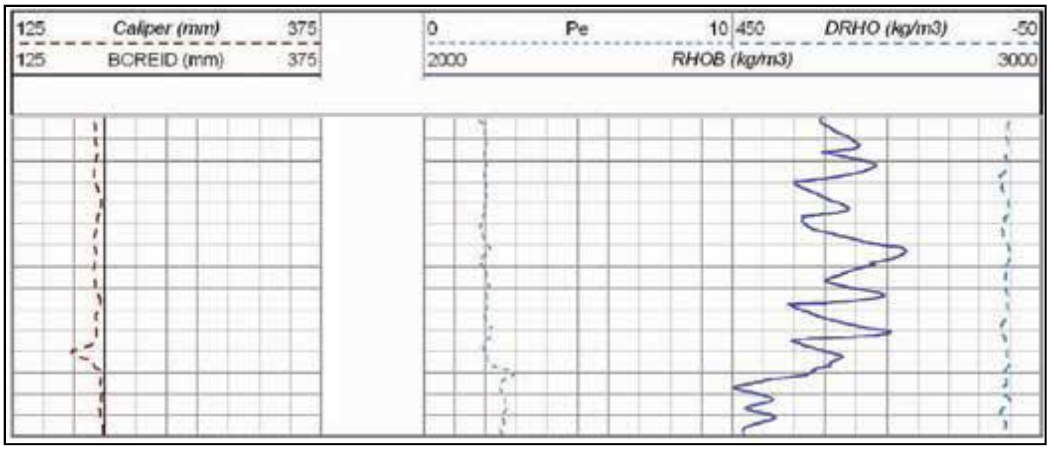
The Lithology Density Tool (LDT) is used to measure the bulk density of a formation, which is then related to formation porosity. The tool also determines the Pe of the formation, allowing for lithology identification, and contains a motorized caliper that is used to obtain borehole diameter information. When the LDT is logged in combination with the Compensated Neutron tool, gas identification is possible.

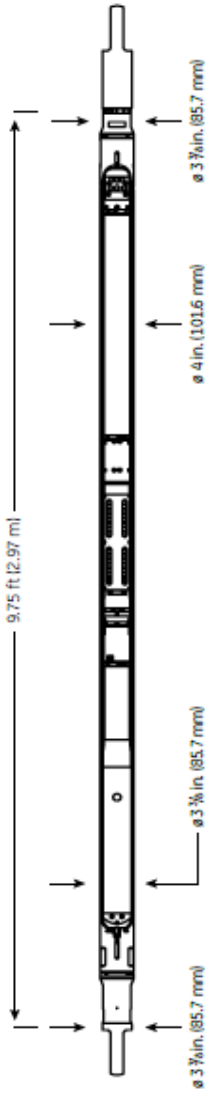
Description

The LDT tool has a pad section that contains a radioactive 2 Ci (74 Gbq) Cesium 137 gamma source and two scintillation detectors. The pad is pressed against the formation wall by the caliper while focused high-energy gamma rays are emitted from the source. Some of the gamma rays are absorbed by the formation. The LDT tool monitors the energy levels of the gamma rays that reflect back to the detectors and records this energy spectrum. By examining the position of the gamma ray energy in the spectrum, both the bulk density and the formation lithology can be determined. The two-detector arrangement of the LDT compensates for mud cake effects.

Features

- Full energy spectrum displayed at surface for both detectors
- Quick-release source handling to reduce radiation exposure for operators
- Easily removable pad to reduce the weight of loading and unloading tools
- Fully compatible with Sondex Ultrawire tools
- Easy to transport—can be broken down into sections less than 10 ft





Specifications	
Maximum OD	4 1/2 in. (114.3 mm)
Makeup length	9.75 ft (2.97 m)
Weight	310 lb (141 kg)
Maximum temperature	302°F (150°C)
Maximum pressure	20 kpsi (137.9 Mpa)
Minimum hole	6 in. (152 mm)
Maximum hole	22 in. (0.55 m)
Sensor Offsets	
Induction	RHOB 1.84 ft (0.56 m)
Spontaneous potential	Caliper (8 in. hole) 1.84 ft (0.56 m)
Borehole Conditions	
Borehole fluids (IAT)	Salt, fresh, oil, air
Maximum logging speed (IAT)	30 ft/min (10 m/min)
Tool position	Eccentralized
Measurement	
Accuracy (RHOB)	+/- 0.015 g/cc
Accuracy (Pe)	+/- 0.2 barns/electron for <1/8 in. of mud cake, no barite
Accuracy (Caliper)	+/- 0.1 in. (+/- 3 mm)
Vertical resolution (RHOB)	1.33 ft (0.41 m)
Vertical resolution (Pe)	1.33 ft (0.41 m)
Measurement range (Pe)	1.4–10 barns/electron
Measurement range (RHOB)	1.3–3.0 g/cc
Primary curves	RHOB, DRHO, Pe, caliper
Secondary curves	Limestone porosity, sandstone porosity, dolomite porosity
Hardware and Power Requirements	
Tool bus	Ultrawire
Power	142 mA (18V DC)

Section 3: Induction Array Tool (IAT)

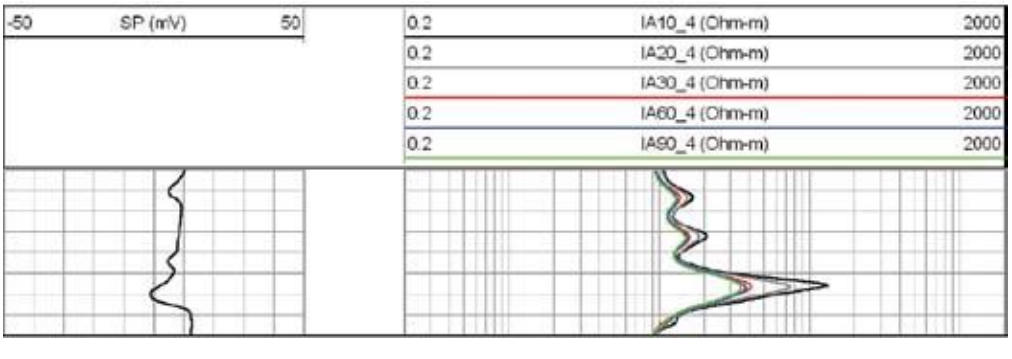
The Induction Array Tool (IAT) measures the openhole formation conductivity at five depths of investigation, and can offer legacy deep and medium curves. The Spontaneous Potential (SP) curve is also provided by the tool.

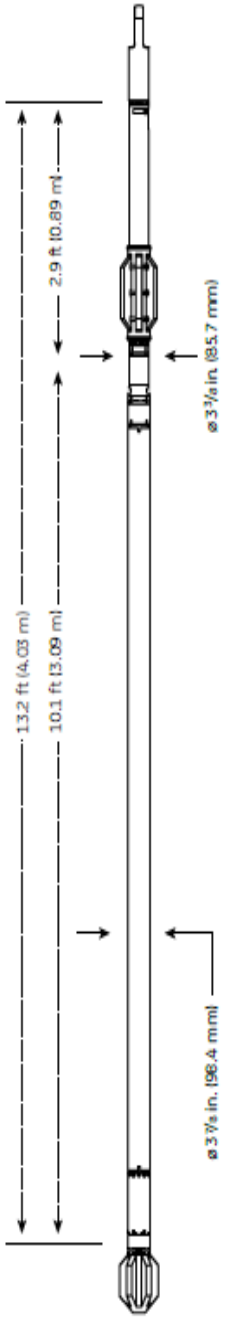
Description

The IAT tool establishes formation resistivity by using the real and quadrature signal responses from the formation. By using both signals from the array coil combinations, the tool compensates for skin effect. This provides a more accurate tool response, improves invasion profiling and allows precise water saturation calculations. The IAT tool provides information at radial distances of 10, 20, 30, 60, and 90 in., and at vertical resolutions of 2 and 4 feet. A separate electrode included in the tool is used to measure the SP.

Features

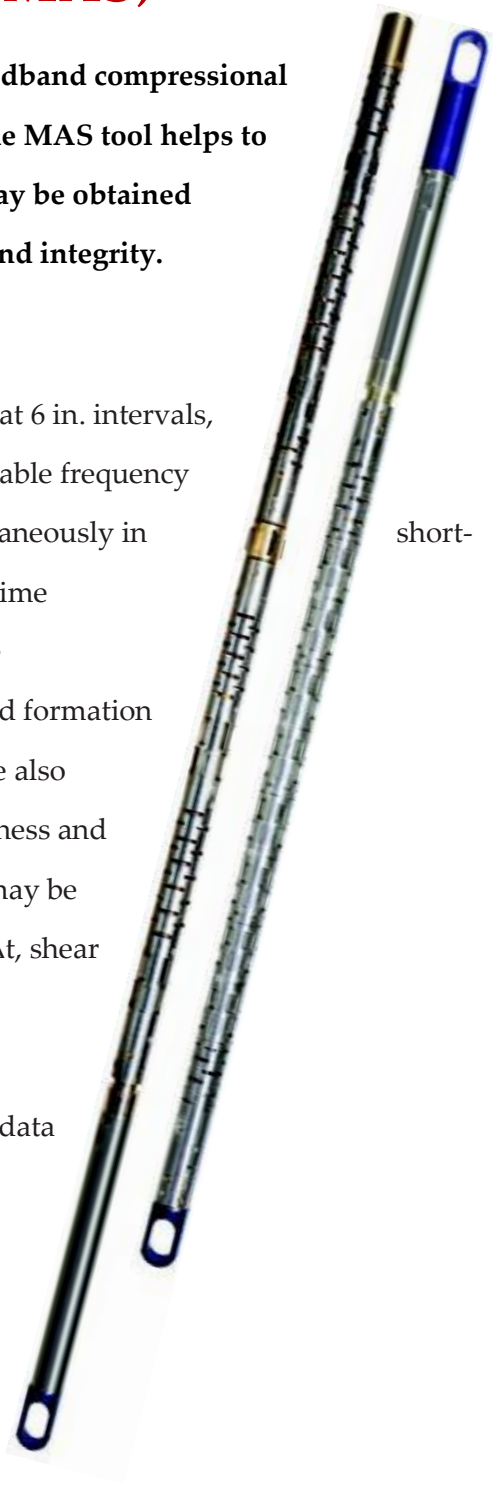
- Standard deep and medium resistivity output
- Array output with five depths of investigation
- 2 and 4 ft vertical resolution outputs
- SP curves are incorporated into the tool
- Fully compatible with Sondex Ultrawire tools
- Easy to transport—can be broken down into sections less than 10 ft





Specifications	
Maximum OD	3 7/8 in. (98.4 mm)
Makeup length	13.2 ft (4.03 m)
Weight	196 lb (89 kg)
Maximum temperature	302°F (150°C)
Minimum hole	6 in. (152 mm)
Maximum hole	16 in. (406 mm)
Sensor Offsets	
Induction	8.06 ft (2.46 m)
Spontaneous potential	2.95 in. (75 mm)
Borehole Conditions	
Borehole fluids (IAT)	Fresh, salt, oil, air
Borehole fluids (IAT)	Fresh, salt
Maximum logging speed	60 ft/min (18 m/min)
Tool position	1.5 in. standoff, and 0.5 in. standoff
Measurement	
Accuracy	+/- 2.5% or +/- 2 mmho
Vertical resolution	4 ft (1.22 m)
Vertical resolution enhanced	2 ft (0.61 m)
Radial depth of investigation (50%)	(50%) 10–90 in. (25.4–229 cm)
Measurement range	0.2–2000 ohm-m
Primary curves	10, 20, 30, 60, 90 in., and SP
Secondary curves	ILM, ILD
Hardware and Power Requirements	
Tool bus	Ultrawire
Power	195 mA (18V DC)

Section 4: Multi Array Sonic (MAS)



The Multi Array Sonic (MAS) tool provides quality broadband compressional measurements of both hard and soft rock formations. The MAS tool helps to assess/confirm formation porosity. Shear information may be obtained allowing assessment of formation mechanical strength and integrity.

Description

The MAS tool provides a set of eight acoustic waveforms, at 6 in. intervals, which are located between 10 and 13.5 ft away from a variable frequency acoustic source. Acoustic waveforms are generated simultaneously in short-spaced and/or long-spaced arrangements to provide real-time compressional measurements in both open and cased hole environments. This yields real-time, borehole-compensated formation Δt or porosity information. In addition, full waveforms are also recorded for post processing to determine formation slowness and rock properties. Acoustic data acquired by the MAS tool may be post processed using MASWare to obtain compressional Δt, shear Δt and formation rock properties (under certain borehole conditions). MASWare includes both semblance and instantaneous frequency slowness processing for difficult data sets and array waveform data sets.

Features

• User-selectable frequency transmitters fire alternately to provide compressional wave travel time; frequency can be selected from 6, 8, 10, 12, and 18 kHz.

• Any combination of the five modes can be run simultaneously to obtain required information in one pass.

• Proprietary (patent-pending) Sondex design provides strength, rigidity, and acoustic isolation.

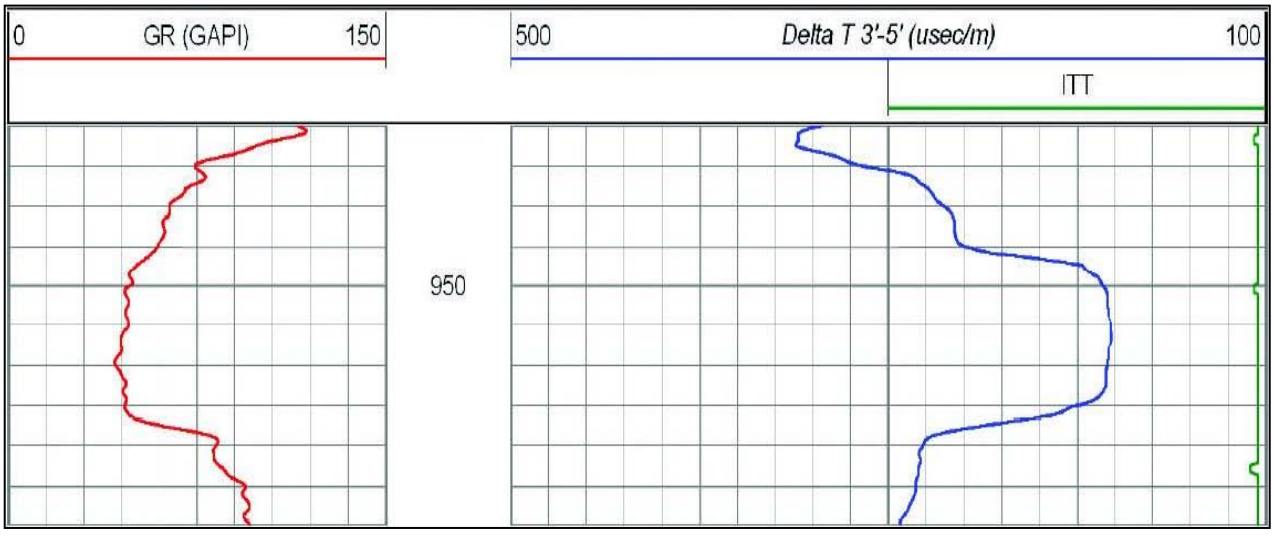
• Records four simultaneous real-time measurements, as well as recorded full waveforms.

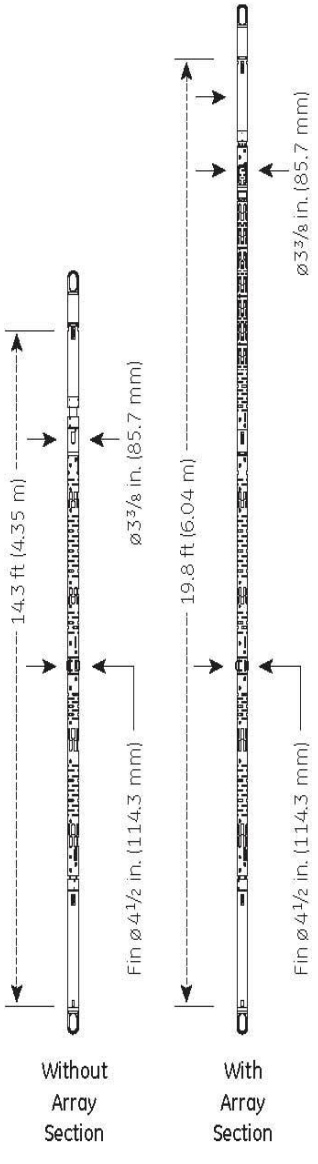
• Can be run with or without the array section.

• Can be run as a CBL

• Can be separated down to less than 10 ft lengths for transport.

• Can be run in both open and cased hole environments.





SPECIFICATIONS	
Maximum OD	3 3/8 in. (85.7 mm)
Makeup length (with array)	19.8 ft (6.04 m)
Makeup length (without array)	14.3 ft (4.35 m)
Weight (with array)	340 lb (154 kg)
Weight (without array)	240 lb (109 kg)
Maximum temperature	302°F (150°C)
Maximum pressure	20 kspi (137.9 Mpa)
Minimum hole	6 in. (152 mm)
Maximum hole	16 in. (406 mm)
SENSOR OFFSETS	
Near Receiver	67.0 in. (2.6 m)
Far Receiver	127.0 in. (3.2 m)
Array 1	163.0 in. (4.1 m)
Array 2	169.0 in. (4.3 m)
Array 3	175.0 in. (4.4m)
Array 4	181.0 in. (4.6 m)
Array 5	187.0 in. (4.7 m)
Array 6	193.0 in. (4.9 m)
Array 7	199.0 in. (5.1 m)
Array 8	205.0 in. (5.2 m)

BOREHOLE CONDITIONS	
Barehole fluids	Salt, fresh, oil
Maximum logging speed	75 ft/min (23 m/min)
Tool position	Centralized
Measurement	
Accuracy	2 µs
Vertical resolution	0.5 ft (0.15 m)
Depth of investigation	3–5 ft spacing 6.0 in. (0.15 m) 10–12 ft spacing 1 ft (0.30 m)
Measurement range	43–300 µs/ft (141–984 µs/m)
Primary curves	Formation slowness, porosity, integrated travel time
Hardware and Power Requirements	
Tool bus	Ultrawire*
Power	930 mA (18V DC)

Section 5: Gamma Ray Tool (GRT)

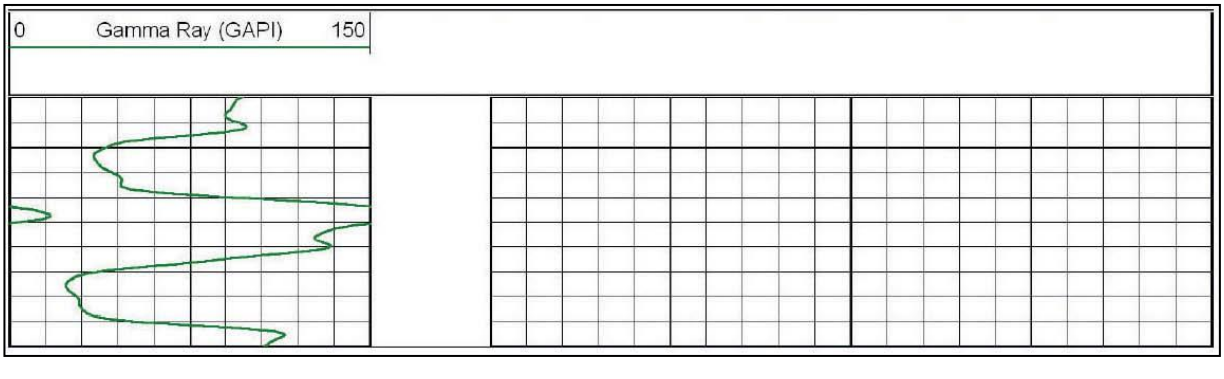
The Ray Tool (GRT) measures the natural radioactivity of the formation. These measurements provide lithological identification, definition of clay content, depth control, reservoir delineation, well-to-well correlation, and the correlation between different logging runs.

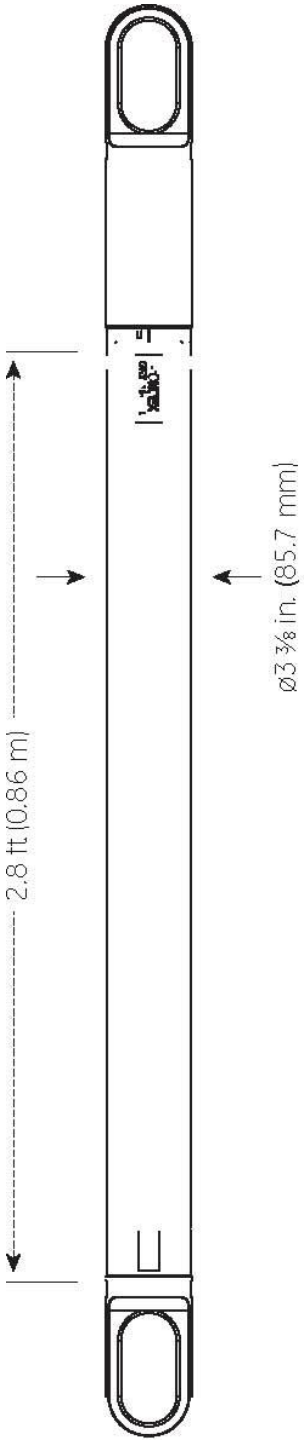
Description

Naturally-occuring gamma radiation within the formation are measured by the GRT tool. The GRT tool uses a scintillation crystal combined with a photomultiplier to detect the level of gamma radiation surrounding the well. This measurement is related back to an API standard.

Features

- Can be run in both open and cased hole environments
- Fully compatible with Sondex Ultrawire* tools
- API calibrated





Specifications	
Maximum OD	3 3⁄8 in. (85.7 mm)
Makeup length	2.8 ft (0.86 m)
Weight	69 lb (29 kg)
Maximum temperature	302°F (150°C)
Maximum pressure	20 kpsi (137.9 Mpa)
Minimum hole	6 in. (152 mm)
Maximum hole	22 in. (559 mm)
Tensile strength	50,000 lb (22,700 kg)
Compressive strength	175,000 lb (79,400 kg)
Sensor Offsets	
GR Crystal	2.2 ft (0.67 m)
Borehole Conditions	
Borehole fluids	Salt, fresh, oil, air
Maximum logging speed	66 ft/min (20 m/min)
Tool position	Centralized, eccentralized
Measurement	
Accuracy	+/- 5%
Vertical resolution	6 in. (0.15 m)
Sensitivity	3.0 Counts/API
Primary curves	Gamma ray API
Hardware and Power Requirements	
Tool bus	Ultrawire*
Power	45 mA (18V DC)

Section 6: Compensated Neutron (CNL) Tool

The Compensated Neutron (CNL) tool measures the hydrogen content of the formation surrounding the wellbore. The hydrogen content is related to porosity, and can be used for gas detection in combination with other tools in both open and cased hole applications.

Description

The CNL tool contains a neutron emitting source producing fast neutrons that bombard the formation. The emitted neutrons are thermalized by collisions with other nuclei. The hydrogen nuclei are considered the chief moderator of neutrons, thus porosity is measured based on the hydrogen content of the formation. Some of the thermalized neutrons are scattered back to the tool where they are counted by two neutron detectors filled with He-3 gas. The detectors are spaced at fixed distances from the source to compensate for hole rugosity and borehole effects. The porosity measurement consists of counting the number of neutrons reaching the detectors and relating them to the pore space in the rock.

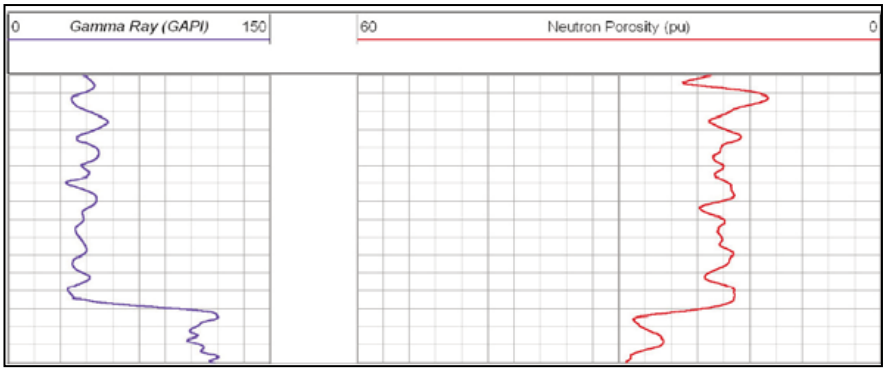
Typical uses for the CNL tool are:

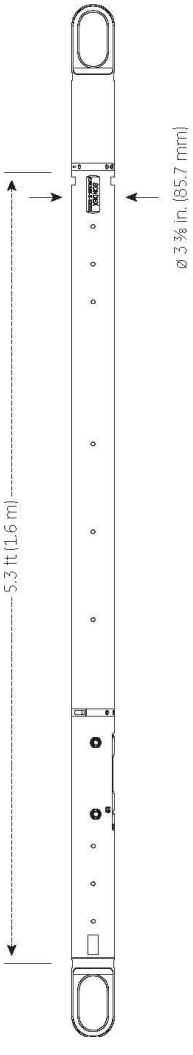
- Porosity measurement
- Lithological identification
- Clay analysis
- Gas detection

Features

- Can be run in both open and cased hole environments
- Fully compatible with Sondex Ultrawire* tools
- Modeled for both AmBe and Cf neutron sources

- Industry-leading neutron detectors with excellent signal-to-noise ratio, gamma discrimination, and shock and vibration ratings





Specifications	
Maximum OD	3 3⁄8 in. (85.7 mm) 5 in. (127 mm) with eccentralizer
Makeup length	5.3 ft (1.6 m)
Weight	125 lb (57 kg)
Maximum temperature	302°F (150°C)
Maximum pressure	20 kpsi (137.9 Mpa)
Minimum hole	6 in. (152 mm)
Maximum hole	16 in. (406 mm)
Tensile strength	50,000 lb (22,700 kg)
Compressive strength	7,500 lb (3,550 kg)
Sensor Offsets	
SS Detector	1.71 ft (0.52 m)
LS Detector	2.23 ft (0.68 m)
Borehole Conditions	
Borehole fluids	Salt, fresh, oil
Maximum logging speed	33 ft/min (10 m/min)
Tool position	Eccentralized
Measurement	
Accuracy	0–20 pu +/- 1 pu 20–30 pu +/- 2 pu 30–60 pu +/- 6 pu
Vertical resolution	2.0 ft (0.61 m)
Depth of investigation	Dependent on hydrogen index
Measurement range	0–60 pu limestone units
Primary curves	Limestone porosity, sandstone porosity, dolomite porosity
Hardware and Power Requirements	
Tool bus	Ultrawire*
Power	75 mA (18V DC)

Section 7: Ultrawire* Crossover (XTU) Tool

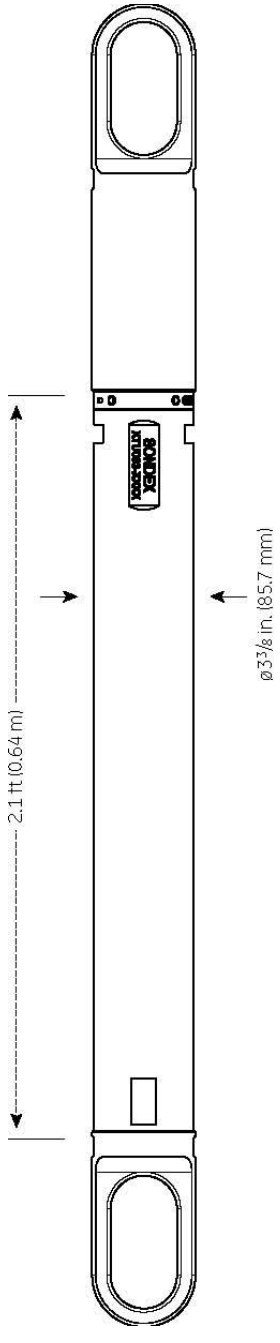
The Ultrawire Crossover (XTU) tool serves as a communications interface, a programmable logging controller, and a step-down DC voltage converter. It is designed to run at high data rates on multi-or mono-conductor wireline.

Description

Ultrawire is a high speed, high capacity, digital wireline communication tool bus. It permits greater amounts of information to be gathered from more advanced wireline tools, and allows for several tools to be combined, thereby eliminating the need for multiple runs. The XTU tool is an intelligent bridge between the Sondex Ultrawire tool bus and the Sondex Ultralink telemetry system. The XTU tool polls each tool on the Ultrawire tool bus for its data packet, and assembles the packets into frames to be sent to the surface via the Ultralink telemetry system. The XTU tool also converts high voltage DC power from the Ultralink line to the low voltage DC necessary to power the Ultrawire tool bus.

Features

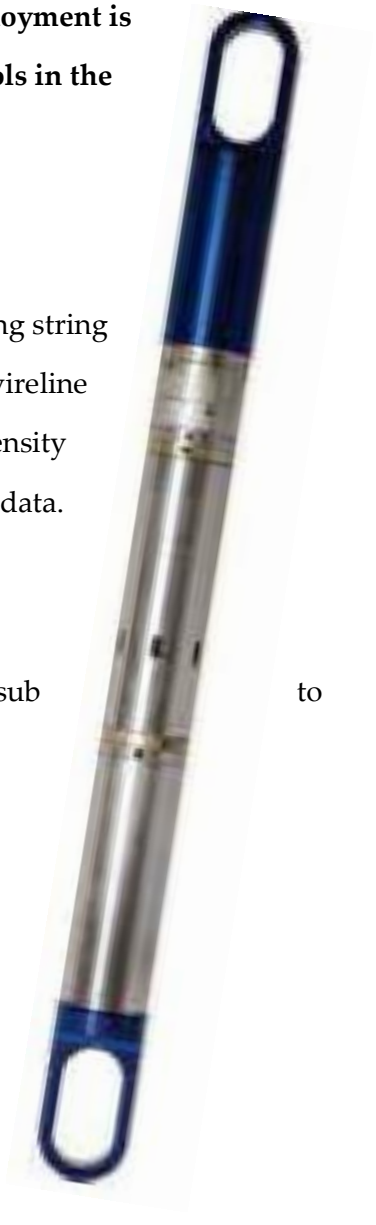
- Fully automatic configuration and start-up
- Selectable Ultralink system bit rate to suit varying conditions
- Support for downloadable user-defined logging programs
- Detailed error reporting at surface
- Multi- and mono-conductor compatible
- High power capability
- Can be run in both open and cased hole environments
- Fully compatible with Sondex Ultrawire* tools



Specifications	
Maximum OD	3 3/8 in. (85.7 mm)
Makeup length	2.1 ft (0.64 m)
Weight	44 lb (20 kg)
Maximum temperature	302°F (150°C)
Maximum pressure	20 kpsi (137.9 Mpa)
Hardware and Power Requirements	
Tool bus	Ultrawire*
Power	45 mA (18V DC)

Section 7: Mechanical Accessories

For precise logging data and equipment longevity, correct sensor deployment is crucial. These accessories are designed to centralize or eccentralize tools in the tool string with minimal wear and tear.



Open Hole Swivel (SJT)

The Open Hole Swivel (SJT) is intended to be run at the top of the logging string to prevent the wireline cable from becoming torqued due to increased wireline tension. The SJT may also be used in deviated wellbores allowing the density pad to remain face down and achieve good borehole contact for quality data.

Description

The SJT contains a 19–conductor slip ring assembly allowing the upper sub to rotate freely from the bottom sub.

Features

- Can be run in both open and cased hole environments
- Fully compatible with Sondex Ultrawire* tools

Open Hole Knuckle Joint (KJT)

The Knuckle Joint (KJT) can be placed between two tools in an open hole string enabling one tool to be centralized while the adjacent tool can be eccentered. The KJT reduces the rigid length of a tool string by allowing it to flex and negotiate doglegs.

Description

The KJT incorporates two ball joints that can move a maximum of 20 degrees each in any direction. It has an electrical feed-through connection allowing it to be placed anywhere in the tool string.

Features

- Can be run in both open and cased hole environments
- Fully compatible with Sondex Ultrawire* tools

Open Hole Offset Joint (OJT)

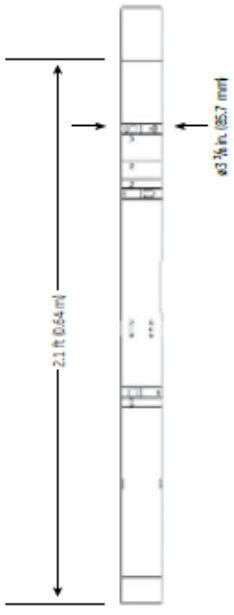
The Offset Joint (OJT) is intended to be used where it is necessary for a tool in the logging string to be decentralized. Either one or two offset joints are used, depending on the tool string order.

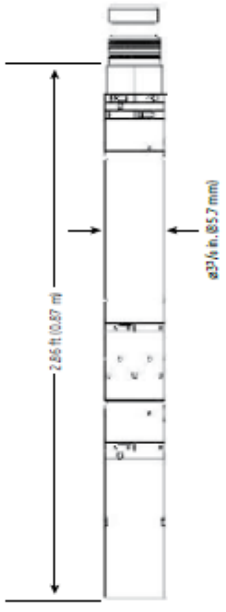
Description

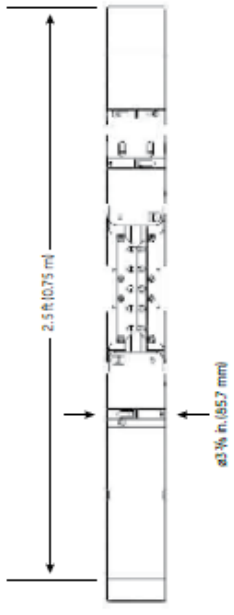
The OJT is adjustable from 6 to 16 inches by replacing the offset weak point. If a tool string becomes stuck, the offset weak point may be broken by pulling 3,500 pounds on the tool, straightening the OJT. It has an electrical feed-through connection allowing it to be placed anywhere in the tool string.

Features

- Can be run in both open and cased hole environments
- 3,500 lb tensile weak point
- Fully compatible with Sondex Ultrawire* tools







Open Hole Swivel (SJT) Specifications	
Maximum OD	3 3/8 in. (85.7 mm)
Maske Up Length	2.1 ft. (0.64 m)
Weight	50 lb (23 kg)
Maximum Temperature	347°F (175°C)
Maximum Pressure	20 kspi (137.9 Mpa)
Hardware Power Requirements	
Tool bus	Feed Through

Open Hole Knuckle Joint (KJT) Specifications	
Maximum OD	3 3/8 in. (85.7 mm)
Maske Up Length	2.86 ft (0.87 m)
Weight	79 lb (36 kg)
Maximum Temperature	347°F (175°C)
Maximum Pressure	20 kspi (137.9 Mpa)
Hardware Power Requirements	
Tool bus	Feed Through

Open Hole Offset Joint (OJT) Specifications	
Maximum OD	3 3/8 in. (85.7 mm)
Maske Up Length	2.5 ft (0.75m)
Weight	62 lb (28 kg)
Maximum Temperature	347°F (175°C)
Maximum Pressure	20 kspi (137.9 Mpa)
Offset Weak Point	3,500 b (1,588 kg)
Barehole Diameter Offsets Available	
15 in. (381mm)	14 1/4 in. (362 mm)
13 1/2 in. (343 mm)	12 in. (305 mm)
11 in. (279 mm)	9 in. (251 mm)
9 in. (229 mm)	7 in. (200 mm)
6 1/4 in (171 mm)	6 in. (152 mm)

Section 8: Dual Laterolog Tool (DLL)

The Dual Laterolog (DLL002) identifies hydrocarbon bearing zones in wells drilled with water based muds.

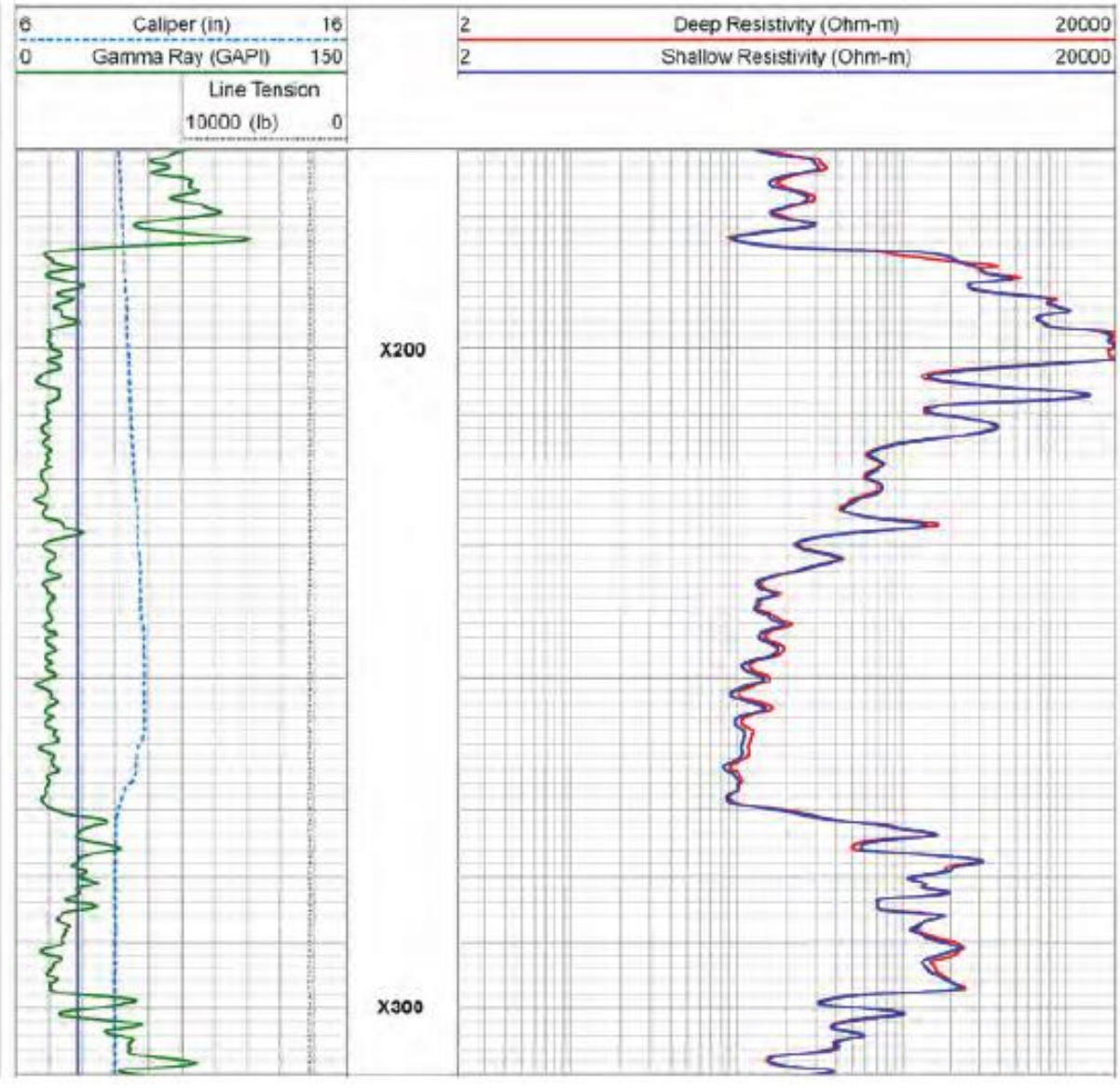
The Dual Laterolog (DLL) measures formation resistivity over a wide range in boreholes with salty or moderately fresh drilling muds. The DLL has an array of electrodes that focus electrical current into the formation. The current returns either to the tool body (for the shallow "LLS" resistivity measurement), or to a surface reference (for the deep "LLD" resistivity measurement). The result is a reliable resistivity measurement in circumstances where an induction tool response may be adversely affected by the mud salinity or high formation resistivity.

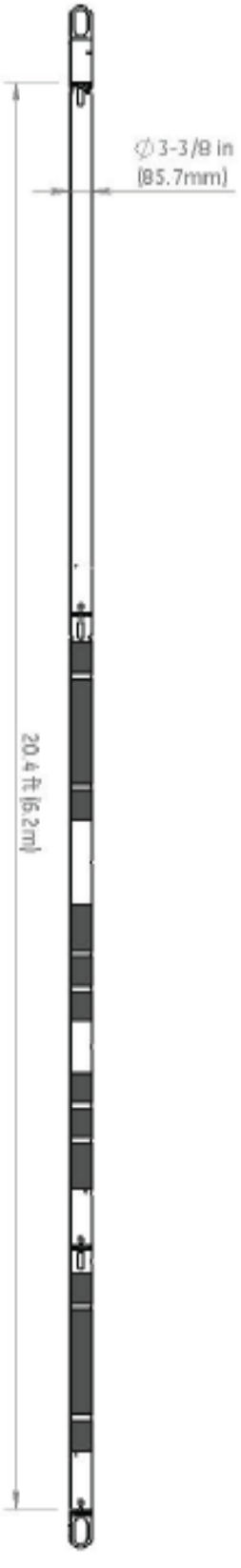
When the DLL is combined with a Micro Spherically Focused Log (MSFL), a resistivity profile with three depths of investigation is possible. The combination of the DLL and MSFL readings can be used to calculate Rt and Rxo.

The DLL is run with a rigid bridle. One section of the bridle has an electrode to measure the Spontaneous Potential (SP).

Features

- Rugged construction: 302°F and 20 kpsi
- LLS and LLD vertical resolution of 24 inches
- Fully compatible with Sondex Ultrawire tools
- Easy to transport: can be broken down into sections less than 10 feet


6
Caliper (in)
16
0
Gamma Ray (GAPI)
150
Line Tension
10000 (lb)
0
2
Deep Resistivity (Ohm-m)
20000
2
Shallow Resistivity (Ohm-m)
20000
X200
X300



Specifications	DLL002
Maximum OD	3 3/8 in. (85.7 mm)
Makeup length[1]	20.4 ft (6.2 m)
Weight[1]	310 lb (141 kg)
Maximum temperature	302°F (150°C)
Maximum pressure	20 kpsi (137.9 Mpa)
Minimum hole	6 in. (152 ml)
Maximum hole	16 in (406 mm)
Sensor Offsets	
LLS/LLD	6.70 ft (2.04 mm)
Borehole Conditions	
Borehole fluids	Moderately fresh, salt)
Recommended logging speed	30 ft/min (9m/min)
Tool position	Centralized/Eccentralized
Measurement	
Accuracy	0.2-2.000 ohm- 5.0 % or +/-0.6 ohm- 2.000-40.000 ohm-
Vertical resolution	2 ft (0.6 m)
Radial SOI (50%)	LLS Rxo < 0.1 x Rt 14 in. Rm < 0.2 ohm-m LLD Rxo < 0.1 x Rt 14 in. Rm < 0.2 ohm-m
Measurement range	0.2-40,000 ohm - m
Primary curves	LLS,LLD
Secondary curves	SP
Hardware and Power Requirements	
Tool bus	Ultrawire
Power	18 VDC

1. Tool must run with a lower electrode A2L or MSGL (excluded from makeup length). Rigid bridle required for tool operation (said separately).

Section 9: Micro Spherically Focused Log (MSFL-002)

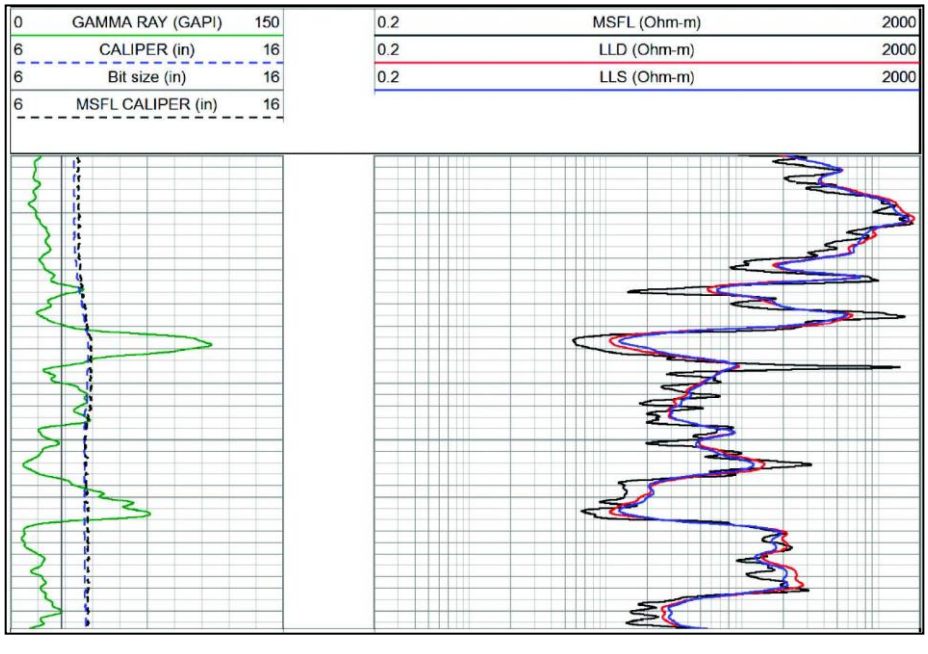
The micro spherically focused log (MSFL) is used to measure the flushed zone resistivity (R_{xo}) in boreholes. The tool has a high vertical resolution, and due to its pad design has limited influence by the borehole. When logged in combination with the DLL, the MSFL will provide the shallow measurement for invasion profiling.

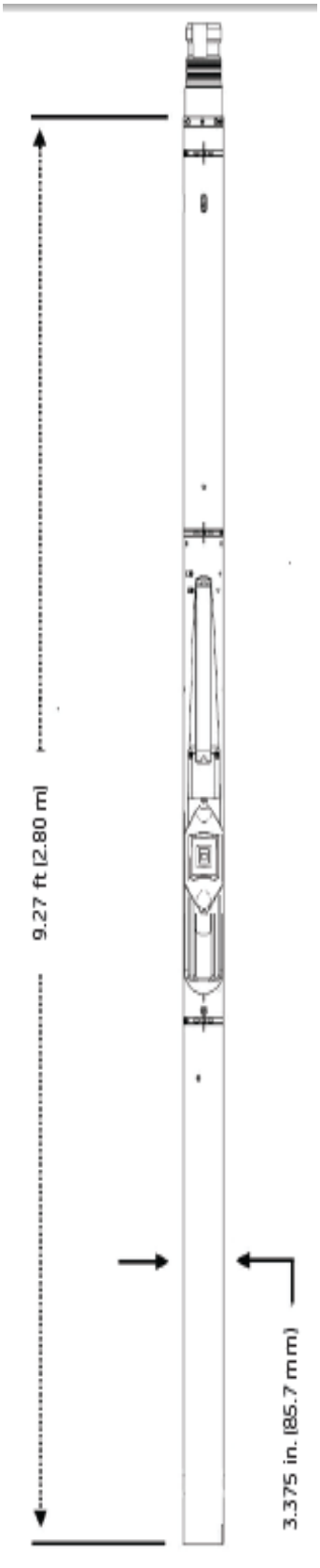
Description

The MSFL is a pad mounted device and incorporates a focusing system to direct its measurement current into the formation. The placement of the measuring electrodes is such that it allows the tool to measure into the flushed zone. The tool uses two fully independent caliper arms to force the pad against the mudcake and output a hole gauge measurement as well.

Features

- Fully compatible with Sondex Ultrawire* tools
- Fully independent tool that can be placed anywhere in the string
- MSFL/MEL use a common sonde body allowing the pads to be interchangeable
- Easy to transport: less than 10 feet in length





Specifications	
Maximum OD	3 3/8 in. (85.7 mm)
Makeup length'	9.28 ft (2.8 m)
Weight'	194 lb (88 kg)
Maximum temperature	302°F (150°C)
Maximum pressure	20 kpsi (137.9 Mpa)
Minimum hole	6 in. (152 ml)
Maximum hole	16 in (406 mm)
Sensor Offsets	
LLS/LLD	1.91 ft (0.58 m)
Borehole Conditions	
Borehole fluids	Fresh,salt
Recommended logging speed	30 ft/min (9m/min)
Tool position	Centralized/Eccentralized
Measurement	
Accuracy	MSFL: +/- 5% Caliper: +/- 3.8 mm Caliper: +/- 0.15 in.
Vertical resolution	4.0 in (10.2 cm)
Radial SOI (50%)	4.0 in (10.2 cm)
Measurement range	0.2-20,000 ohm - m
Primary curves	MSFL
Secondary curves	MSFCAL
Hardware and Power Requirements	
Tool bus	Ultrawire
Power	18 VDC 165 mA

Section 10: Head Tension Unit (HTU-011)

The HTU-011 provides information on the forces applied to the tool string while in the borehole. It is capable of measuring both tensile and compressive forces applied across it, which helps avoid accidental breakage of logging cable or the weakpoint in the cablehead, as well as prevent toolstring damage.

Description

During logging operations, excess longitudinal forces can result in significant damage. Excess tensile force can break the logging cable or cablehead weakpoint. Excess compressive force can damage the logging tool. This makes it imperative to have a means of detecting the longitudinal forces on the tool string to provide an early indication of over-pull, tool drag, stuck tools, tool compression, and irregular tool movement. The HTU 011 detects longitudinal force in the tool string by employing a pressure balanced strain gauge load cell. The HTU-011 can be placed at any position in an Ultrawire* tool string, but is best placed at the top where it can measure the force applied to the cablehead and weakpoint.

Features

- Early indication of over-pull, key seating, and tool sticking
- Pressure compensated
- Measures both tensile and compressive loads
- Can be run in both open and cased holes
- Suitable for all well deviations
- Fully compatible with Sondex Wireline Ultrawire Tools
- Linear response

Specifications	
Temperature rating	302ºF (150ºC)
Pressure rating	20,000 psi (137.9 MPa)
Tool diameter	3 3/8 in. (98.4 mm)
Tool length	2.7 ft (0.82 m)
Tool weight	55 lb (25 kg)
Measurement range	-20,000 lbf to +20,000 lbf (-9074 kg to +9074 kg)
Accuracy	+/- 200 lbf (+/- 90.7 kg)
Resolution	10 lbf (4.5 kg)

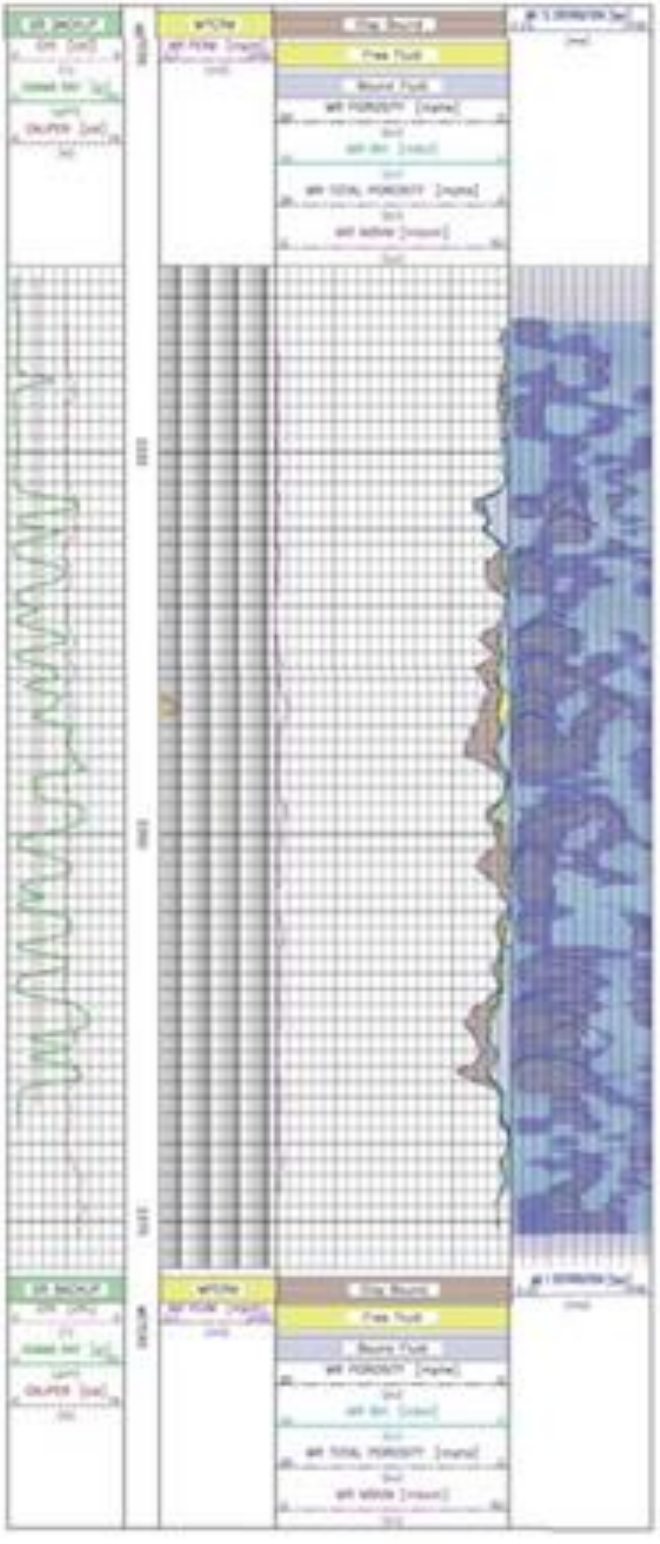
Section 11: Nuclear Magnetic Resonance Tool (NMR-M)

The NMR-M tool measures hydrogen for porosity and relaxation rates of protons. This tool is primarily a digital device. NMR experiments are a measurement of time required for protons to either align with an external magnetic field or for processing protons to de-phase, or relax (T2 measurement).

SPECIFICATIONS	
Maximum Temperature	350°F (175°C) for 2 hours
Maximum Pressure	20,000 psi (140 MPa)
Logging Speed (typical): 150°F, Rxo>2 ohm.m., standard resolution.	8 in. ,
Formation Evaluation (TWs2.1 s)	15 ft/min (4.6 m/min) Rm>0.1 ohm.m
	4.9 ft/min (1.5 m/min) Rm=0.02 ohm.m
Fluid-Typing (TWs11 s)	10.8 ft/min (3.3 m/min Rm>0.1 ohm.m
	2.7 ft/min (0.8 m/min) Rm=0.02 ohm.m
Bound Water Logging	24 ft/min (7.3 m/min) Rm>0.1 ohm.m
	8.1 ft/min (2.5 m/min) Rm=0.02 ohm.m
	(Stationary Measurements Possible)
Measurement Range	0 – 100 pu
Minimum TE	0.3 ms
Measurement Accuracy	2%
Maximum Average Pulse Rate	≥ 1200 echoes/s
Max Aata Bandwidth @1200 Echoes Per Sec	36 Kbps
Depth Of Investigation Beyond Borehole Wall	2.2 – 4.0 in. (56 – 102 mm)
Shell Thickness	1.1 – 2.3 mm
Arc length	120°
Static Field Gradient	14 – 39 gauss/cm
Wireline Requirements	7 conductor
Operating Power AC DC	 190 V, 240 mA 600 V, 700 mA

Make-up Length	15.52 ft (4.73 m)
Make-up inc. QA cap/charger	24.41 ft (7.44 m)
Instrument Weight EC	
	178 lb (80.7 kg)
MB	310 lb (140.6 kg)
QA	156 lb (70.8 kg)
Diameter	3.625 in.(QA)
	5.06 in.(EC/MB)
Minimum Diameter	5.8 in. (147 mm)
Maximum Hole Diameter	14.0 in.
Operating Position	Decentralized
Hole Deviation	Vertical to horizontal
Minimum Tool String	RTS-1, PAS, NMR-EC, MMR-QA, MNR-MB (decentralizer for holes 7-7/8 in (200 mm) and greater)

Minimum Dogleg Radius (no tool bending)	
6" hole	337 ft (17°/100 ft)
8" hole	112 ft (51°/100 ft)
12.25" hole	47 ft (120°/100 ft)
Minimum Dogleg Radius (bending, with safety factor 2)	
14" hole	37 ft (153°/100 ft)
6" hole	173 ft (33°/100 ft)
8" hole	85 ft (67°/100 ft)
12.25" hole	42 ft (136°/100 ft)
14" hole	33 ft (169°/100 ft)
Tensile Strength (safety factor 2)	35,000 lb
Compressive Strength (with safety factor 2)	
Unsupported	4,300 lbs
6" hole	48,000 lbs
8" hole	16,000 lbs
12.25" hole	6,700 lbs
14" hole	5,300 lbs
Bending Strength Of Mandrel (safety factor 2)	4,000 ft-lbf



Section 12: Multi-dipole Array Acoustic Tool (MAA)

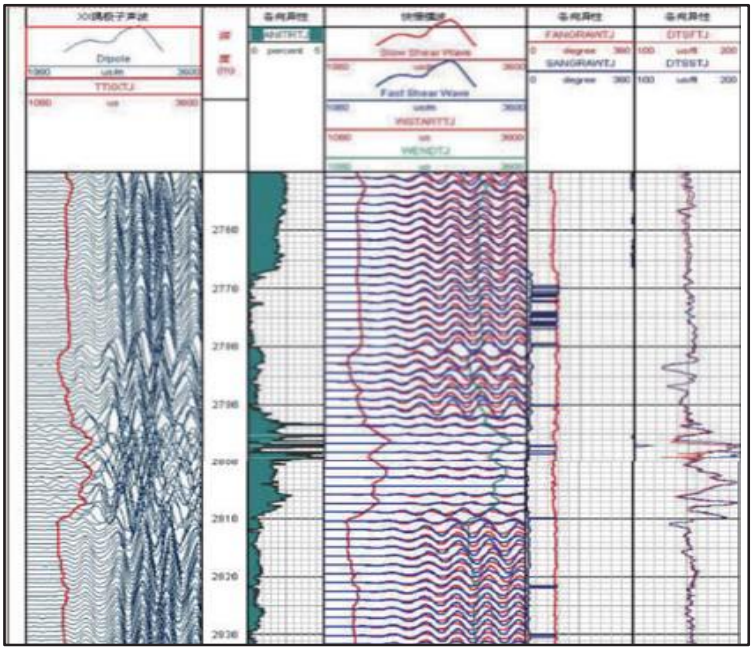
The Multi-dipole Array Acoustic Tool (MAA) is a full wave monopole, dipole, and cross dipole acoustic logging tool. MAA cross multipole array acoustilog service acquires full-wave acoustic data for compressional, shear, and Stoneley evaluations. The significant design improvements have resulted in a broader range of capabilities. And it incorporates the simultaneous acquisition of two-directional dipole measurements aligned 90 degrees apart in the wellbore. MAA could run in both open hole and cased hole. It supported to detect the effect of fracturing when performed MAA with ORT-C together.MAA contains five major components: MAA-EA, MAA-MC, MAA-PB, MAA-BA, MAA-FA.

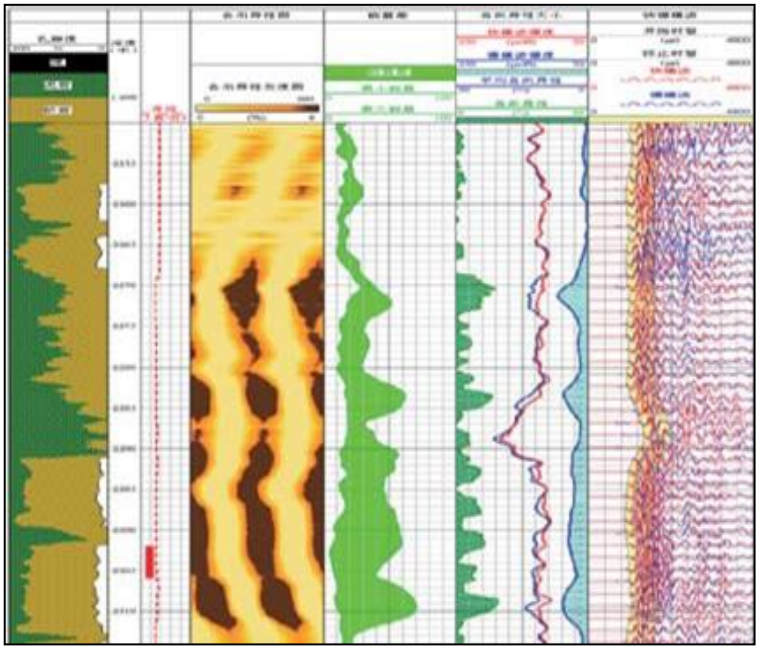
Specifications	
Maximum Temperature	350oF (175oC)
Maximum Pressure	20,000 psi (140 MPa) (1406 kg/cm2)
Borehole Diameter	4.5 in. (11.4 cm) to 17.5 in. (45.5 cm)
Deviation	Vertical to Horizontal
MAA-BA	
Instrument Diameter	3.88 in. (9.86 cm)
Makeup Length	7.9 ft. (2.41 m)
Weight	Estimated 240 lbs. (109 kg)
Tensile Strength	26,500 lbs. (12,000 kg)
Compressive Strength	26,500 lbs. (12,000 kg)
Minimum T-R Spacing Monopole Dipole	8.50 ft. (2.59 m) 10.25 ft. (3.11 m)
Monopole Transmitters Bandwidth Type Number Spacing	 Pair of piezoelectric cylinder 1.0 - 20.0 kHz 2 42.0 in. (106.7 cm)
Dipole Transmitters Type Bandwidth	 Pair of orthogonal piezoelectric 0.5 - 5.0 kHz

Number	2
MAA-PB	
Instrument Diameter	3.625 in. (9.2 cm)
Tensile Strength	45,000 lbs (20,411 kg)
Compressive Strength	45,000 lbs (20,411 kg)
Max Angle of Twist (Longitudinal Axis) < 1°	
Weight	143 lbs (65 kg)
Makeup Length	60 in. (152.4 cm)
MAA-FA	
Length Makeup	4.3 ft (1.31 m)
Weight	74 lbs. (33.6 kg)
Tensile Strength	78,000 lbs. (35,400 kg)
Compressive Strength	78,000 lbs. (35,400 kg)
Power Requirements	180 VaC, 55 mA
MAA-EA	
Instrument Diameter	3.375 in. (8.57 cm)
Length Make-up	7.8 ft. (2.38 m)
Weight	130 lbs. (59 kg)
Tensile Strength	60,000 lbs. (27,000 kg)
Compressive Strength	60,000 lbs. (27,000 kg)
Logging Speed Subset 6 Subset 10	 28 ft/min 15 ft/min

MAA-MC	
Instrument Diameter	3.88 in. (9.86 cm)
Makeup Length	10.9 in. (3.32 m)
Weight	240 lbs. (109 kg)
Maximum Tensile Load	35,000 lbs. (15,625 kg)
Maximum Compression Load	35,000 lbs. (15,625 kg)
Vertical Resolution Semblance Threshold detection	 3.5 ft. (1.07 m) 0.5 ft. (0.15 m)
Minimum T-R Spacing Monopole: Dipole:	 8.50 ft. (2.59 m) 10.25 ft. (2.82 m)

Transducer Type	
Type	Four orthogonal piezoelectric elements
Bandwidth	0.5 - 30 kHz
Number	8
Spacing	6.0 in. (15.2 cm)





Section 13: Hexapod Resistivity Imaging Tool-WBM (RIT-WBM)

This new electrical wireline borehole imaging tool is designed to obtain superior quality images even in high Rt:Rm environments. The expanded operating range of the RIT-WBM over conventional electrical imaging tools is achieved through its new, state-of-the-art, 32 bit digital signal acquisition architecture combined with a large increase in available power for the excitation current.

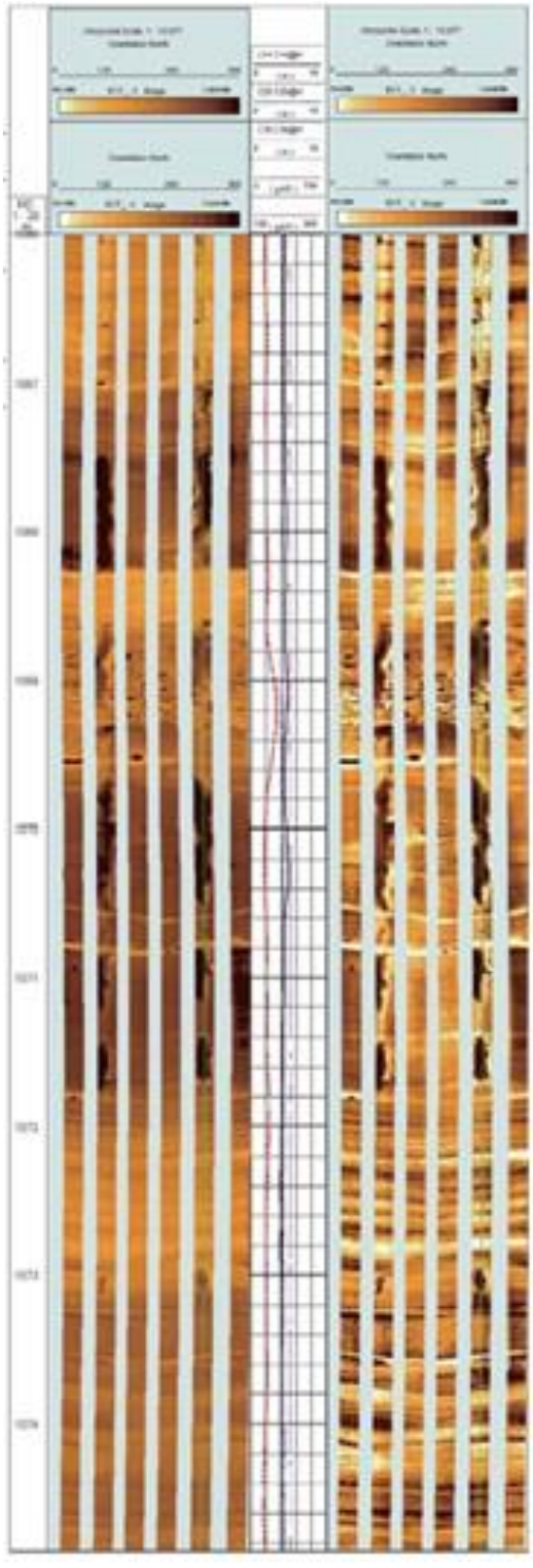
Specifications			
DIMENSIONS AND RATINGS		**BOREHOLE CONDITIONS**	
Max Temp.	350°F (175°C)	Borehole Fluids	Salt/Fresh
Max Press.	20,000 psi (140 MPa)	Recommended Logging	
Max OD	4.5 in. (11.7 cm)	Speed (High Data Rate)	30 ft/min (9.1 m/min) Image Mode
Min Hole	5.875 in. (14.92 cm)	Recommended Logging	
Max Hole	21 in. (53.34 cm)	Speed (Low Data Rate)	20 ft/min (6.1 m/min) Image Mode
Length	25.24 ft. (7.69 m)	Tool Positioning	Centralized
Weight	496 lb (97.5 kg)		

HARDWARE CHARACTERISTICS	
Source Type	Induced Current
Sensor Type	Micro-Resistivity Buttons
Sensor Spacings	2 rows containing 12 & 13 sensors, respectively
	0.300 in. between rows
	0.200 in. between sensors on each row
	0.100 in. between sensors when both rows are superimposed
Firing Rate	Continuous
Sampling Rate	120 samples/ft (394 samples/meter)
	@20 ft/min (Low Data Rate) & 30 ft/min (High Data Rate)
	310 Words/Frame(Low Data Rate)
	456 Words/Frame(High Data Rate)

Measurement					
	Resistivity	Azimuth	Rotation	Deviation	Caliper
Principle	Micro-Resistivity	Navigation			6 Indep.
Range	0.2-10,000 ohm-m 0<Rt/Rm<20,000	0-360°	0-360°	0-90°	6-21 in.
Vertical Resolution 90%	0.2 in.	N/A	N/A	N/A	N/A
Depth of Investigation 50%	Formation Dependent	N/A	N/A	N/A	N/A
Sensitivity	N/A	0.1°	0.1°	0.03 °	0.1 in.
Accuracy	N/A	±5°	±2°	±0.4°	±0.1°
Primary Curves	Image	AZI,HAZI	ROT	DEVI	CAL 1-6
Secondary Curves	Micro-Resistivity, Dip Angle, Dip AZI, Borehole Inclination				

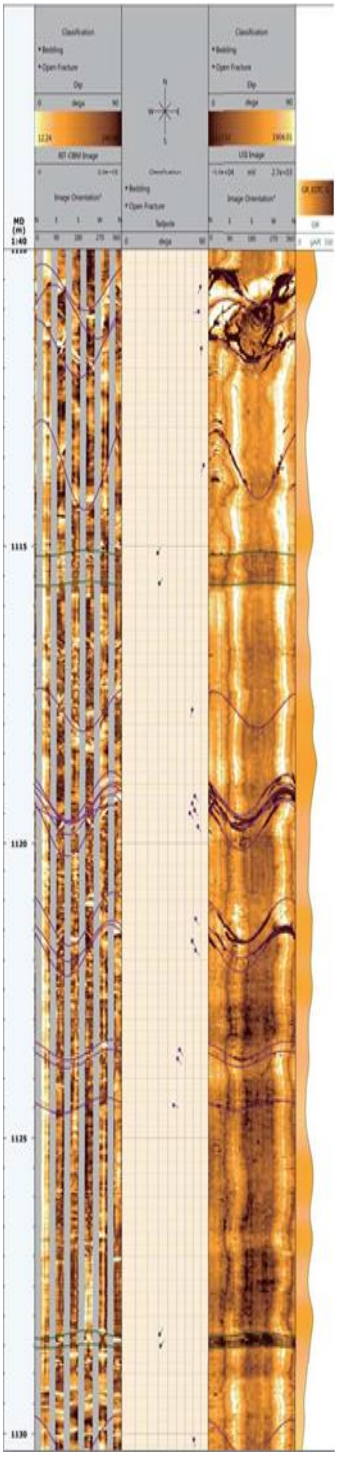
Calibration	
Primary	Resistor box, navigation cal stand & vertical hoist, 7-15 in. caliper rings
Wellsite	Resistor box, operation check of navigation sensors, 7 in Caliper ring

Physical Strengths*			
Hardware	Tension	Compression	Torque
Tool Joints	130,000 lbs	130,000 lbs	600lb-ft
Mandrel Body Under Calipers	150,000 lbs	150,000 lbs	1800lb-ft
4.25inch Isolator	130,000 lbs	130,000 lbs	1800lb-ft
*Strengths apply to new tools at 70°F(21°C) and 0 psi.			



Section 14: Hexapod Resistivity Imaging Tool (RIT-OBM)

Hexapod Resistivity Imaging Tool (RIT-OBM) is a micro-conductivity–based service used for imaging boreholes in wells drilled with electrically non-conducting mud systems. It is designed to be an exact parallel of the RIT-OBM service, which can only be run in electrically-conductive mud systems.



Specifications	
RIT-EC	
Telemetry	Standard WTS
Sample Interval	
Imaging Mode	
High Resolution Resistivity 120 samples/ft	
Diplog Mode	
Resistivity	60 samples/ft
Instrument Logging Speed (max. instrument capability)	
High Resolution Imaging Mode 20 ft/min	
Extra High Resolution Imaging Mode 10 ft/min	
Diplog mode	50 ft/min
NOTE: The max. logging speeds achievable are governed by the Telemetry and ACQ. System capabilities.	
Measuring Range Caliper RAD1 through RAD6 as allowed by mandrel 6 in. to 21 in. Oil based mud (RIT-OBM) BTN1 through BTN8 Resistance 1200 Ohms to 1,200 MOhms (Formation Apparent Resistivity 0.1 to 100k Ohm-m w/theoretical K factor) Actual tool response depends on pad version	
Orientation Sensor Type	Orientation obtained from ORT
Wireline Requirements	7 conductor
Maximum Temperature	350°F (175°C)
Maximum Pressure	20,000 psi (140 MPa)

Instrument Weight	150 lbs (68.2 kg)
Instrument Length	9.1 ft. (2.77 m)
Instrument Diameter	3.63 in. (92.2 mm)
Electrical Isolation Between RIT-EC and RIT-MC Built-in top of RIT-MC Between RIT-MC and USI-EB IOS	
Tensile Load Capacity	78,000 lbf (35,380 kgf)
Compressive Load Capacity	100,000 lbf (45,359 kgf) in 6 in.
	63,000 lbf (28,576 kgf) in 8 in.
	29,000 lbf (13,154 kgf) in 14 in.

RIT-PA	
Maximum Temperature	350°F (175°C)
Maximum Pressure	20,000 psi (140 MPa)
Instrument Weight	150 lbs (68.2 kg)
Instrument Length	9.1 ft. (2.77 m)
Instrument Diameter	3.63 in. (92.2 mm)
Components Tensile Load Capacity (For tool string in a 13.625 in. wellbore)	40,000 lbf (18,182 kg)
Components Compressive Load Capacity (For tool string in a 13.625 in. wellbore)	4,000 lbf (1,818 kg)

Section 15: Hexapod Resistivity Imaging Tool - OBM (RIT-OBM)

Hexapod Resistivity Imaging Tool-OBM (RIT-OBM) is a micro-conductivity–based service used for imaging boreholes in wells drilled with electrically no-conducting mud systems. It is designed to be an exact parallel of the RIT-OBM service, which can only be run in electrically-conductive mud systems.

Specifications	
RIT-MC	
Telemetry	Standard WTS
Sample Interval	
Micro-Conductivity	120 samples/ft
Acoustic (if USI in combo)	60 samples/ft
Effective Instrument Logging speed (MAX)	
High-resolution imaging mode	10 ft/min
Borehole Coverage	
Conductivity Image	66.7% in 7.875 in. diameter borehole
Orientation Sensor Type	
Accelerometer, Magnetometer —obtained from ORT instrument	
Resistivity Pad Characteristics	
Number of pads	6
Number of sensors per pad	8
Circumferential spacing	0.3 in. (8.5 mm)
Note: Pads are staggered vertically to allow nesting to a 5.25 in. diameter when fully closed.	

Minimal Combination	ORT/DST/TTR/RTS-1/PAS
Operating Power (using PAS) (approximate with maximum load)	
Cable Head	
Tool Bus	180 Vac/1.2 A
Cable Head (with USI)	420 Vac/0.8 A
Tool Bus (with USI)	180 Vac/2.0 A
Maximum Temperature	350°F (175°C)
Maximum Pressure	20,000 psi (140 MPa)
Mechanical Features	
Arms	6 independent
Pad Force (approximate)	5–55 lbf (2.3–24.9 kgf); adjustable
Calipers	6 independent readings
Target Borehole Diameter	6.25 to 11.5 in. (15.88-29.21cm)
Hole Deviation	Vertical to horizontal
Caliper Range Diameter	5.25 in. to 21 in. (13.34-53.34 cm)
Centralization 6 Arms Ganged Powered Standoff 3.5 in. (8.9 cm) maximum extent (radially/adjustable)	
Lifting Force	Approximately 300–400 lbf (136.1 kgf)
Mechanical Features Pad Articulation	± 10 degrees (Circumferentially)
Motor Power	115 VDC <1.0 Amps intermittent duty cycle
Mechanical Alignment Instrument Logging Speed (max. instrument capability) 60 ft/min Lower logging speeds are required when the pad sensors are used combination.	Keyed Joints
Data Recorded	RAD1 through RAD6
Measuring Range	Caliper RAD1 through RAD6 as allowed by mandrel 6 in. to 21 in.
Accuracy	Caliper ±0.1 in. from 2.75 in. to 10.5 in. (Radius)
Tensile Load Capacity: (For tool string in a 13.625 in. wellbore) 41,000 lbf (18,597 kgf)	
Compressive Load Capacity: (For tool string in a 13-5/8 in. wellbore)	
41,000 lbf (18,597 kgf)	

Note: Individual pads may deform at 4000 lbf (1,800 kgf) tension. Cradle and pad may fail at 7000 lbf (3,150 kgf) tension.	
Wireline Requirements	7 conductor
Instrument Weight	300 lbs (136.4 kg)
Instrument Length	12.5 ft. (3.81 m)
Instrument Diameter	5.15 in. (130.8 mm) (6 in. PADs) 5.25 in. (133.3 mm) (6 in. PADs)
Over Pad Saver Ring	5.25 in. (133.3 mm) (8 in. PADs) 5.5 in. (139.7 mm) (8 in. PADs)

Section 16: Ultrasonic Scan Imaging Tool-V (USI-V)

The USI-V provides a wealth of information about well in both open and cased holes. In open hole, the USI-V provides complete borehole imaging for accurate, precise formation evaluation. In cased hole, ultrasonic pipe inspection and cement evaluation can be obtained simultaneously. Operating over a wide range of downhole environments, the USI-V offers a full 360° profile of the borehole that can be presented in a variety of two- and three - dimensional formats. Powerful, yet userfriendly imaging analysis software is available to process images, histograms,and curve-type data from this advanced logging device.

Primary applications include:

- Casing Inspection (both Thickness and Diameter)
- Ultrasonic Cement Evaluation/ Imaging
- Openhole Borehole Imaging
- Fracture Detection

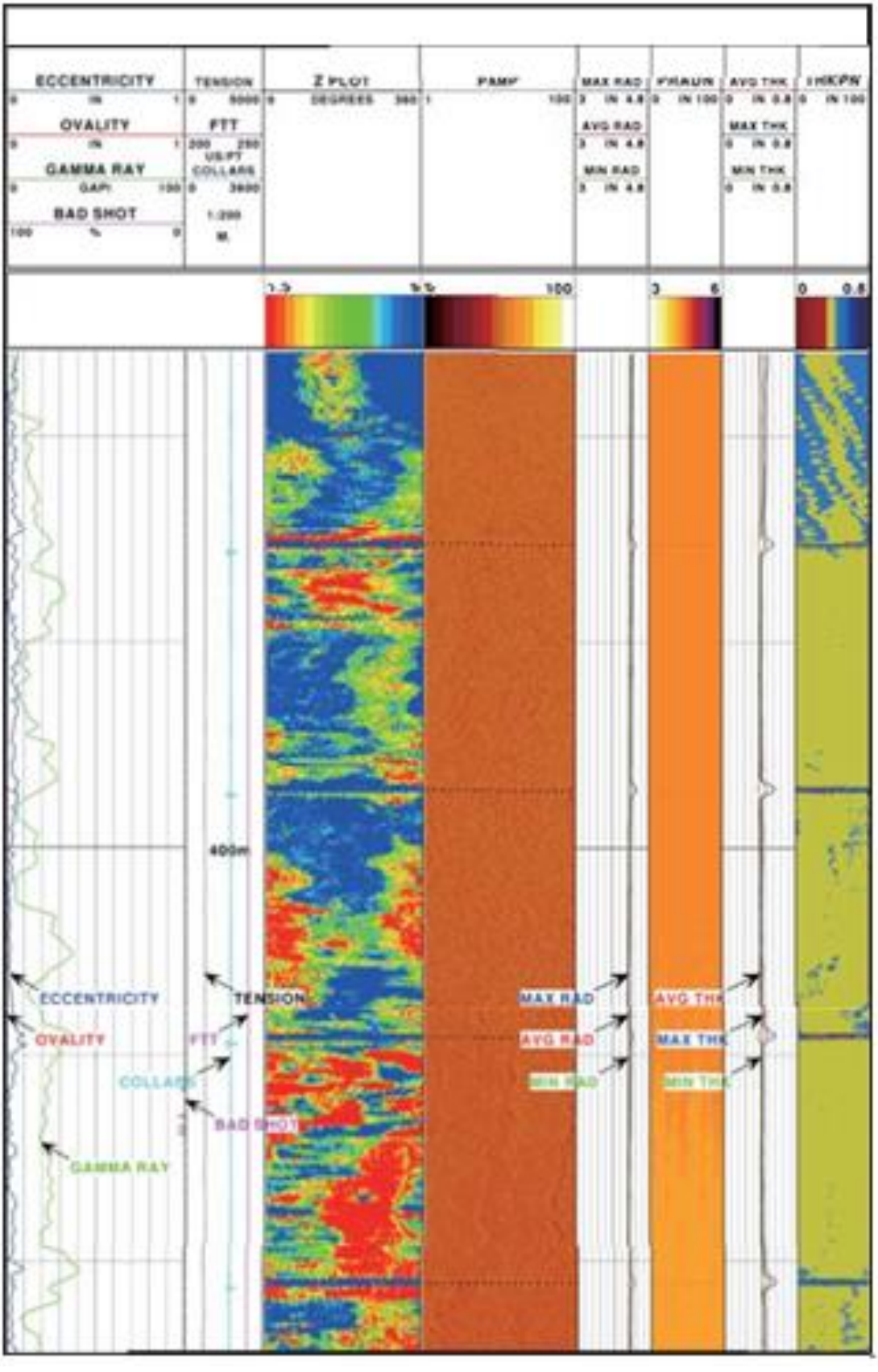
Mechanical	
Maximum Operating Temperature	350°F (175°C)
Maximum Operating Pressure	20,000 psi (140 MPa)
Length	17.9 ft. (5.45 m)
Weight	316 lb (143 kg)
Diameter	3.625 in. (9.2 cm)
Electronics Assembly	122.15 in. (3.1 m)
Directional Sub Assembly	36.5 in. (0.93 m)
Scanner Assembly	56.1 in. (1.43 m)
Electrical	
Power Requirements	120±18 Vac, 60 Hz, 250 mA
	150 Vdc, 1.5 A
Full Load Requirements	30 Wac, 225 Wdc

Measurement	
Open Hole Image Mode	
Sensor Type	Piezoelectric on rotating head
Firing Rate (shots/scan)	200
Vertical Scan Rate	40 scans/ft at 21 ft/min
Principle	Ultrasonic Pulse Echo
Azimuthal Sampling	1.8°
Vertical Sampling(Software)	0.2 in.
Logging Speed	21 ft/min
Primary Curves	Reflected Amplitude and Travel Time
Secondary Curves	Radius, Azimuth, Relative Bearing, Deviation and Fluid Transit Time
Maximum Diameter Hole	12.50 in. (31.75 cm)
Minimum Diameter Hole	4.5 in. (11.4 cm)

Cased-Hole Mode	
Sensor Type	Piezoelectric on rotating head
Firing Rate (shots/scan)	100
Vertical Scan Rate	40 scans/ft at 30/min
Principle	Ultrasonic
Logging Speed	60, 30 or 10 ft/min

Primary Curves	Reflected Amplitude, Radius Acoustic Impedance, and Casing Wall Thickness
Secondary Curves	Relative Bearing, Deviation, Fluid Transit Time, Compressive Strength,and Mud Impedance
Minimum Diameter Hole	5.5 in. (12.7 cm)
Maximum Diameter Hole	13.375 in. (33.97 cm)

USI-Slim (USI-S)	
Outside Diameter	2.75 in. (70 mm)
Maximum Pressure	20000 psi (140 MPa)
Maximum Temperature	350oF (175oC)
Hole Size	89-300 mm (3.5 - 12 in.)
Generator Type	Focus Piezoelectric Quartz
Generator Frequency	1.5 MHz
Generator Rotation Rate	5-20 r/s
Motor Power	1.5 kW
Downhole Gain	Automatic


ECCENTRICITY
OVALITY
GAMMA RAY
BAD SHOT
TENSION
FTT
COLLARS
Z PLOT
DEGREES
PAMP
MAX RAD
AVG RAD
MIN RAD
PRAUN
AVG THK
MAX THK
MIN THK
400m
ECCENTRICITY
OVALITY
TENSION
FTT
COLLARS
BAD SHOT
GAMMA RAY
MAX RAD
AVG RAD
MIN RAD
AVG THK
MAX THK
MIN THK

Section 17: Elemental Capture Tool (ECT)

The Elemental Capture Tool (ECT) incorporates an electronic pulsed-neutron source in order to generate gamma rays from capture and inelastic nuclear interactions with energies indicative of the parent elements. The ECT service incorporates both the ECT and the Gamma Ray instruments in order to provide lithological and quantitative mineralogical information about the subsurface formations that surround the borehole. This is achieved by first identifying the individual elements in the formation using the principles of gamma ray spectroscopy for both natural and neutron- induced gamma ray spectra.

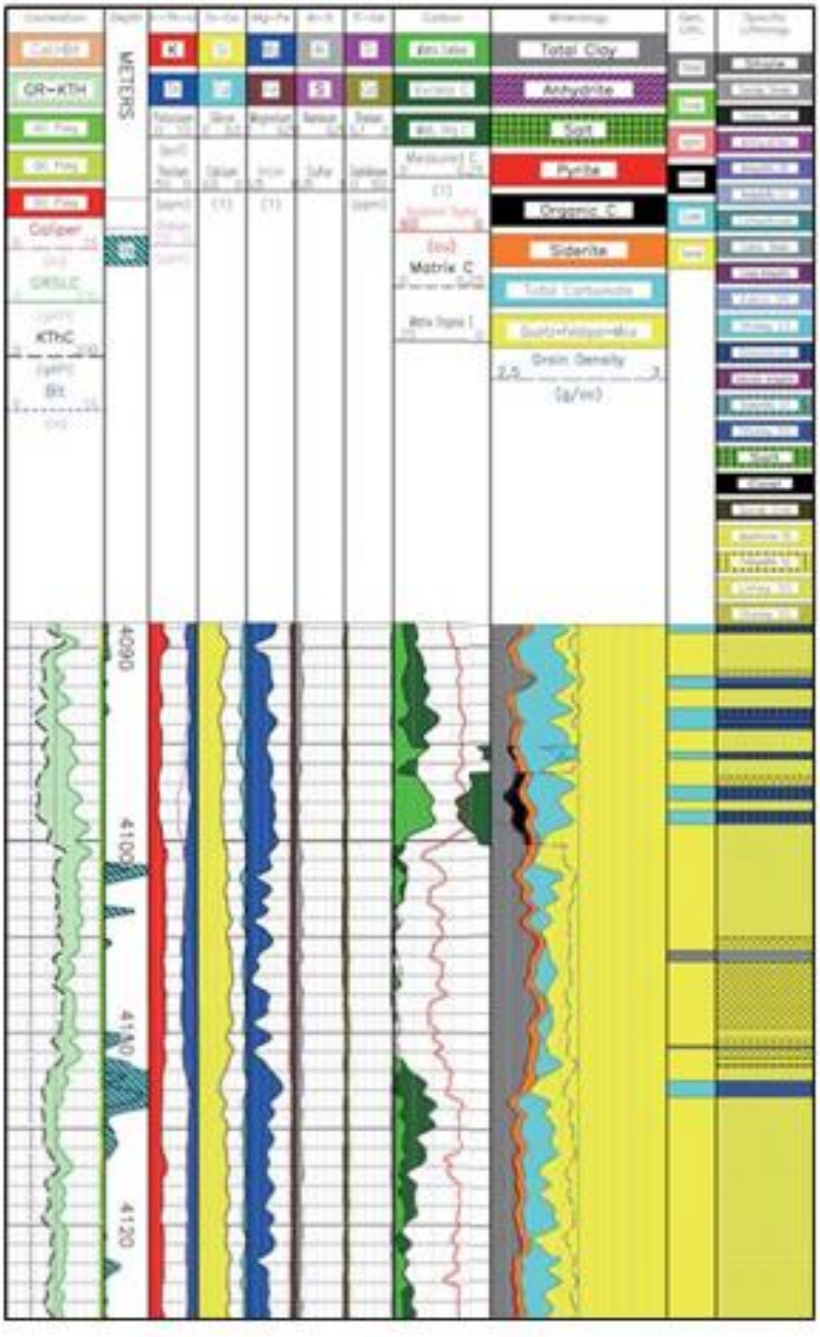
Specifications	
ECT-EA	
Maximum Temperature	350oF (175oC)
Maximum Pressure	20,000 psi (140 MPa) (1406 kg/cm 2)
Instrument Diameter	4.88 in. (9.22 cm)
Makeup Length	11.12 ft. (3.39 m)
Weight	Estimated: 220 lbs. (99.8 kg)
Tensile Strength	78,000 lbs. (35,380 kg)
Compressive Strength	380,000 lbs. (172,365 kg)-6 in. Hole 196,000 lbs. (88,904 kg)-8 in. Hole 97,000 lbs. (43,998 kg)-12.5 in. Hole 80,000 lbs. (36,287 kg)-14 in. Hole
Bucking Load (Unsupported)	25,000 lbs. (11,340 kg)
Borehole Fluids	Salt/Fresh/Oil/Air
Tool Positioning	Decentralized
Recommended Logging Speed	20 ft/min (6.1 m/min)
Max Logging Speed	30 ft/min (9.1 m/min)
Min Logging Speed	10 ft/min (3.0 m/min)
Max RIH	100 ft/min (30.5 m/min)
Max POOH	300 ft/min (91.4 m/min)
Max ID	24 in. (610 mm) Min ID
Min ID	6 in. (152.4 mm)
Principle	Neutron-induced gamma ray spectroscopy
Vertical Resolution (90%)	1.5-2.0 ft (0.46-0.61 m)
Depth Of Investigation	8.5 in. for inelastic ;21 in. for capture
Accuracy	elemental weight fractions are calibrated to core data
Repeatability	+/- 0.2-1.4 % wt

	(depending upon specific element)
Power Requirements	180 VaC,65 mA (QA/EA combined)
Wireline Requirements	7-conductor standard operation
Combinability	Recommended GR /CNT /ZDT

ECT-QA	
Maximum Temperature	350oF (175oC)
Maximum Pressure	20,000 psi (140 MPa)
Max OD	3.63 in. (92.2 cm)
Makeup Length	4.46 ft (1.36 m)
Weight	75 lbs.(34.0 kg)
Tensile Strength	16,000 lbs. (7,258 kg)
Compressive Strength	12,500 lbs. (5,670 kg)-6 in. Hole 7,000 lbs. (3,175 kg)-8 in. Hole 4,000 lbs. (1,250 kg)-12.5 in. Hole
Bucking Load (Unsupported)	1,000 lbs. (454 kg)
Borehole Fluids	Salt/Fresh/Oil/Air
Tool Positioning	Decentralized
Recommended Logging Speed	15 ft/min (4.6 m/min)
Max Logging Speed	30 ft/min (9.1 m/min)
Min Logging Speed	15 ft/min (4.6 m/min)
Max RIH	100 ft/min (30.5 m/min)
Max POOH	300 ft/min (91.4 m/min)
Max ID	24.in (610 mm)
Min ID	6.in (152.4 mm)
Principle	Neutron-induced gamma
	ray spectroscopy
Accuracy	+/- 1jJsec/ft(with stack of four)
Power Requirements	180 VaC,65 mA (QA/EA combined)
Repeatability	+/- 2% (with stack of four)
+/- 2% (with stack of four)	+/- 2% (with stack of four)

EC AA	
Maximum Temperature	350oF (175oC)
Max OD	3.50 in. (88.9 mm)
Neutron Energy(avg)	14 MeV
Neutron Output	3.0 x 10 7 neutrons/sec
Makeup Length	59 in (1.5 m)
Weight	19 lbs. (8.6kg)
Supply Voltage	150 VdC (ECT-QA power supply)
Operating Current	70 mA idle,160mA when generating neutrons

GR Tool	
Maximum Temperature	400oF (200oC) for 1h
	300oF (150oC) for 8h
Maximum Pressure	20,000 psi (140 MPa) (1406 kg/cm2)
Max OD	3.38 in. (85.7 mm)
Make-up Length	67.37 in. (171.12 mm)
Weight	110 lbs. (50 kg)
Reconmmended Logging Speed 30-40 ft/min (9.1 m/min)	
Maximum Logging Speed	150 ft/min
Power Requirements	180 VaC @ 15 mA
	150 VdC @ 40 mA
Detector Type	1.88″ X 12″ Scintillation
Wireline Requirements	DC Supply: Single Conductor AC Supply: Multi Conductor


GR-KTH
Caliper
KThC
Bit
METERS
Total Clay
Anhydrite
Salt
Pyrite
Organic C
Siderite
Matrix C
Grain Density
(g/cc)
4090
4100
4110
4120

Section 18: Pipe Conveyed Logging Tool (PCL)

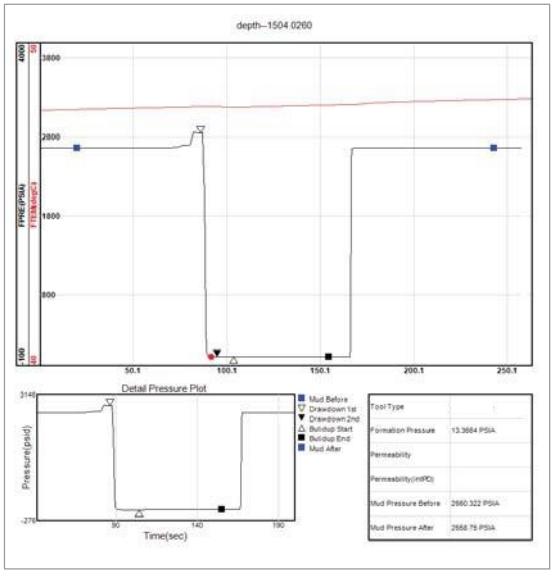
PCL tool is the indispensable special tools for horizontal well logging. It is necessary for transfer logging instruments through the horizontal well. This product is security, reliably, easy to use and data collection complete.

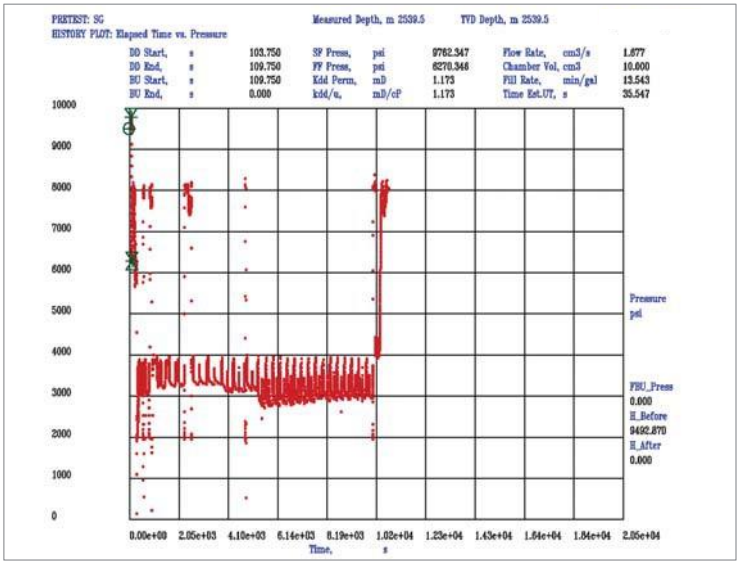
PCL-H		
Maximum Temperature		350oF(175oC)
Maximum Pressure		20,000 psi (140 MPa)
Pin No.		7
Diameter		38 mm
Male Connector		
Casing (Large)	Length	16 m
	Diameter	165 mm
Casing (Small)	Length	16 m
	Diameter	127 mm
Main Body	Length	10.8 m
	Diameter	90 mm
Female Connector		
Sniker Bar	Length	15 m
	Diameter	51 mm
	Diameter (with Weight Block)	60 mm
Pump Gun	Length	11.8 m
	Diameter	51 mm
Body (Female Connector)	Length	15.3 cm
	Diameter	40 mm
Contact Resistance		<0.1 Ω
I.R.		>200 MΩ
Drillpipe Size		2-7/8 in./3-1/2 in./ 5 in. Pipe
Port		>57 mm
Maximum Deviation		90°
Weakness Strength∧Box/Pin Tension∨		1000 lb to 1200 lb
Mud Logging Environment		Pure Water/Oil/Air

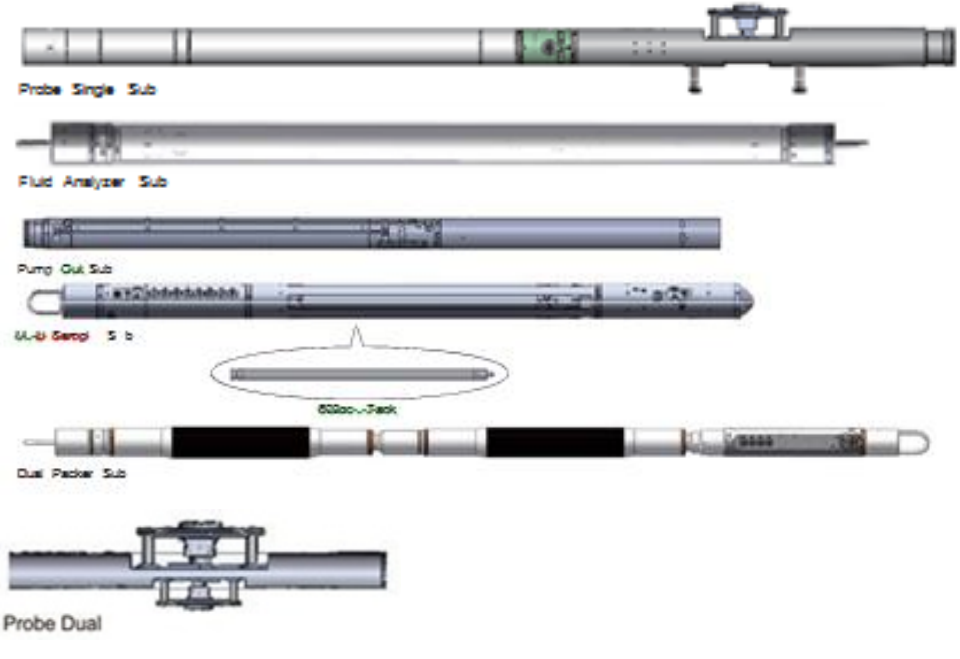
PCL-B		
Maximum Temperature		350oF(175oC)
Maximum Pressure		20,000 psi (140 MPa)
Pin No.		7
Plug Diameter		14.1 mm
Male Connector Casing (Large)	Length Diameter	24.8 mm 12.7 cm
Casing (Small)	Length Diameter	21.65 mm 8.9 cm
Cross Over	Length Diameter	75 cm 16.5 cm
Body(Male Connector)	Length Diameter	55 cm 3.5 cm
Female Connector Sniker Bar (with Standard Torpedo)	Length Diameter Diameter (with Guide Cone)	28.25 cm 42 cm 52 mm/58 mm/65 mm/70 mm
Body (Female Connector)	Length Diameter	52 cm 34 mm
	I.D. (Conductive Ring)	14.1 mm
Contact Resistance		<0.1 Ω
I.R.		>200 MΩ
Drillpipe Size		2-7/8 in. External Upset Tubing
Port		>48 mm
Maximum Deviation		60°
Weakness Strength∧Box/Pin Tension∨		1200 lb to 1500 lb
Mud Logging Environment		Pure Water/Oil/Air

Section 19: Reservoir Characterization Tester (RCT)

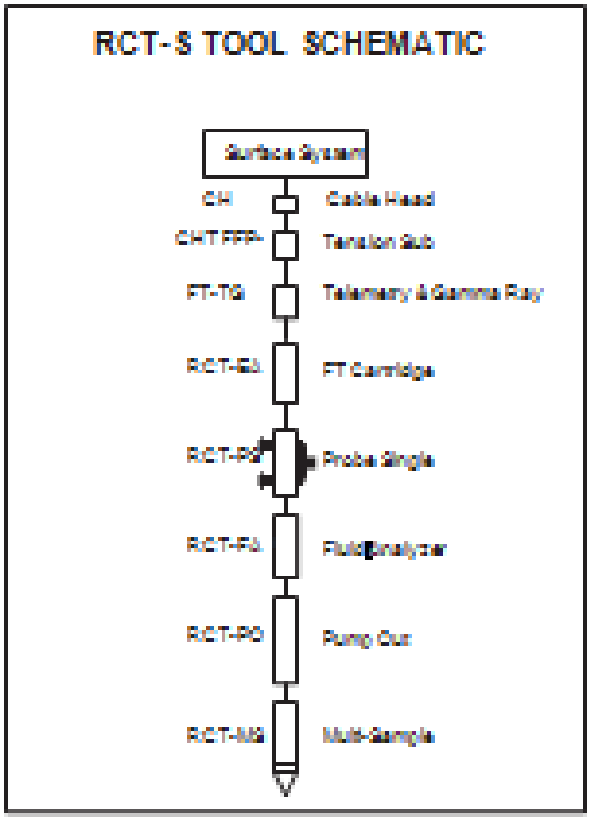
Reservoir Characterization Tester (RCT) is a petroleum device to obtain formation fluid in open hole and cased hole.It is designed specifically to improve our capabilities in the following fluid sampling, pressure measurement, permeability estimation. RCT = Single Probe (Dual-Packer/Dual-Probe)+ Fluid Identification Sensor + Pump Thru + Multi-Sample







Tool Specifications	
Maximum Temperature	350oF (175oC)
Maximum Pressure	20000 psi (140 MPa)
Length	55.84 ft (17.52 m)
Weight	1664.5 lbm (755.4kg)
Tool Diameter	4.75 in.(120.6 mm)
Probe	Broehole range
4.75 in. (120 mm)	5.75 in.-9.02 in.hole
6.75 in. (171 mm)	7.83 in.-16.97 in.hole (extended)
8.25 in. (222 mm)	9.42 in.-22.97 in.hole (extended)
Measurement point	16.02 in. (409 mm)
Tension	50000 lbf (222411 N)
Compression	166000 lbf (738404.8 N)
Motor Power	50 Vdc 600 W
Pre-test Room Volume	20 cc(adjustable)
Strain Pressure Gauge	
Scale	10000/20000 psi
Accuracy	±0.18% of Full Scale
Resolution	0.2 psi of Full Scale
Quartz Pressure Gauge	
Scale	20000 psi
Accuracy	0.02% of Full Scale
Resolution	<0.008% psi sec
RCT Pump Out Sub (RCT-PO)	
Maximum Temperature	350oF (175oC)
Minimum Temperature	20oF (- 6.7oC)
Maximum Pressure	20,000 psi (140 MPa)
Tool Diameter	4.75 in. (120 mm)
Length	9.315 ft. (2.84 m)
Weight	321.65 lbs. (145.9 kg)
Tank	
Volume	500 cc
Pump Differential Pressure	4680 psi(32.3 MPa)
Nominal System Pressure	3,000 psi @ 350oF (20.7 MPa @ 175oC)
RCT Multi-Sample Sub (RCT-MS)	
Tank Volume	4×600 cc
Outside Diameter	4.75 in. (120.6 mm)
Length	8 ft. (2.45 m)
Weight	277.8 lbs (126 kg)
Motor Power	50 Vdc



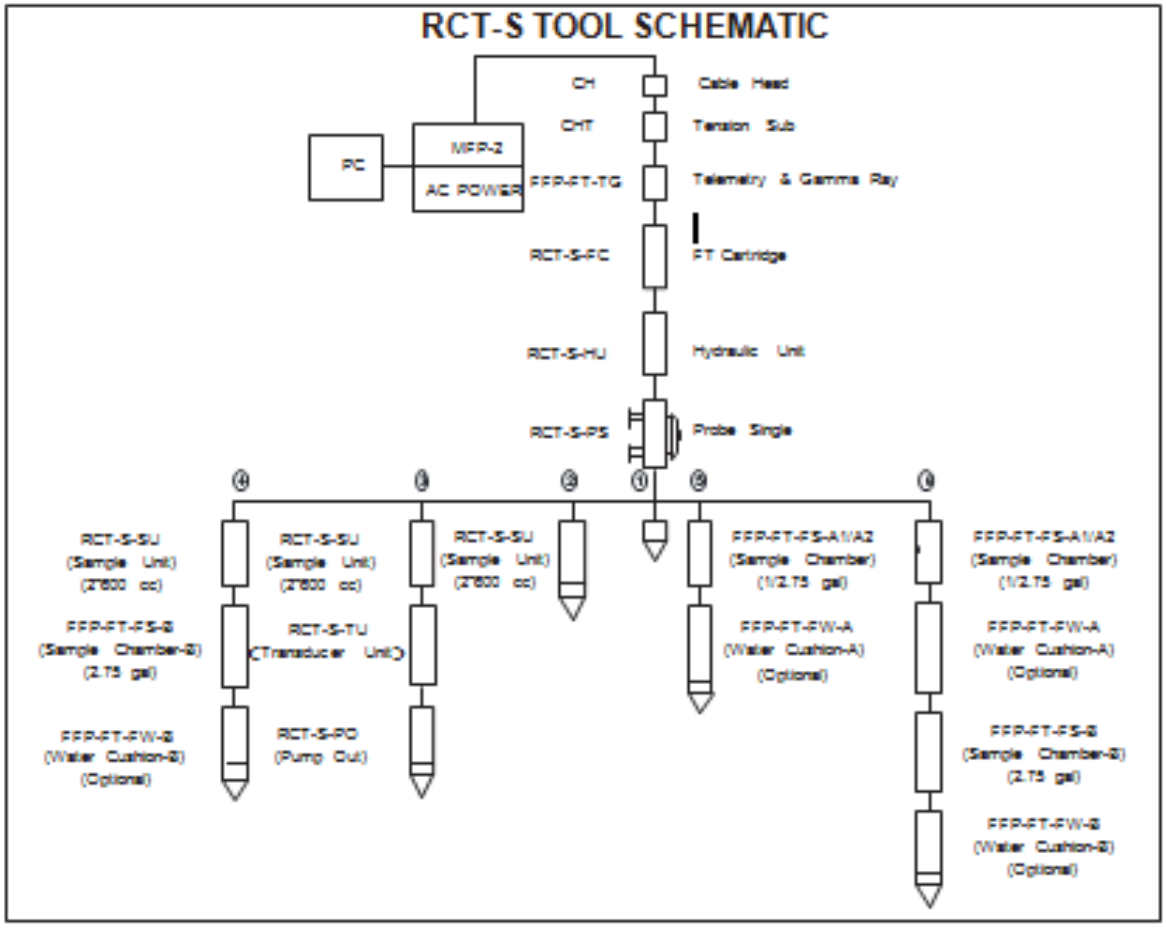
RCT Fluid Analyzer Sub (RCT-FA)	
Maximum Temperature	350oF (175oC)
Maximum Pressure	15,000 psi (104 MPa)
Tool Diameter	4.375 in. (111.3 mm)
Length	3.28 ft.(2.48 m)
Weight	240 lbs. (108.52 kg)
Capacitance WaterHoldup Sensor	
Range	0 -100% (best value 0 - 40%)
Accuracy	±1% (water holdup 40%)
Resolution	0.10%
Tuning Fork Density Sensor	
Range	Range of density measurement
	0 g/cc to 1.25 g/cc
	In the viscosity range of 1.0 cS to 50 cS
Accuracy	±0.03 g/cc
Resolution	0.01 g/cc
PVT tank	

Max Working Temperature	300oF (150oC)
Max Working Pressure	10000 psi (70 MPa)
Tank Diameter	1.77 in (45 mm)
Length	3.94 ft. (1.2 m)
Weight	19 lbs. (8.6 kg)
Tank Volume	600 cc
Special Applicationst	TPED-approved PVT tank
	Anti-H2S service
	PVT samples

Section 20: Reservoir Characterization Tester-Slim (RCT-S)

The RCT-S is a formation tester for slimhole. It can also be run in wells that conventional tools cannot operate because of abr upt changes in angle, swelling formations, hole restrictions, and other drilling problems.

The RCT-S can be repeatedly set and retracted during a single trip in the well. Meanwhile, the RCT-S can be used to test repeatly formation pressure and mud pressure, can record the pressure curve.The Quartz Pressure Gauge is used to provide quick, accurate pressure measureme nts. Sample chambers are available in the follow sizes:2×600 cc/1 gal/1 gal and 2.75 gal/2×600 cc and 2.75 gal. An optional water cushion is used to reduce the shock resulting from pressure drawdown when a sample chamber is opened for sample. In addition, the sample unit connected to the Pump Out (PO) can obtain PVT samples.



Tool Specifications	
Maximum Temperature	350oF (175oC)
Maximum Pressure	20000 psi (140 MPa)
Length	59.32 ft. (18.08 m)
Weight	1411.11 lbm (517.6 kg)
Tension	35000 lbf (155690 N)
Compression	3900 lbf (17350 N)
Motor Power	400 Vac 1/6 HP
Pre-test RoomVolume	5 cc+5 cc/10 cc
Strain Pressure Gauge	
Scale	10000/20000 psi
Accuracy	±0.18% of Full Scale
Resolution	0.2 psi of Full Scale
Quartz Pressure Gauge	

Scale	20000 psi
Accuracy	0.02% of Full Scale
Resolution	<0.008% psi sec

Standard Probe & Piston	
Minimum Hole Size	4.125 in. (104.8 mm)
Maximum Hole Size	6.3 in. (160 mm)
Tool Outside Diameter(Closed)	3.5 in. (90 mm)
Tool Outside Diameter(Opened)	6.5 in. (165.1 mm)
Stretch Piston	
Minimum Hole Size	4.8 in. (121.9 mm)
Maximum Hole Size	7.8 in. (198.1 mm)
Tool Outside Diameter(Closed)	3.5 in. (90 mm)
Tool Outside Diameter(Opened)	8 in. (203.2 mm)
Extended Piston	
Minimum Hole Size	6.5 in. (165.1 mm)
Maximum Hole Size	9.8 in. (248.9 mm)
Tool Outside Diameter(Closed)	4.5 in. (114.3 mm)
Tool Outside Diameter(Opened)	10 in. (254 mm)

Pump Out (PO)	
Maximum Temperature	350oF (175oC)
Minimum Temperature	20oF (- 6.7oC)
Maximum Pressure	20,000 psi (140 MPa)
Tool Diameter	3.375 in. (86 mm)
Length	12.8 ft. (3.9 m)
Weight	224.65 lbs. (101.9 kg)
Motor Power	400 Vac 1200 mA
Tank Volume	56.7cc
Pump Differential Pressure	4680 psi(32.3 MPa)
Nominal System Pressure	3,000 psi @ 350oF (20.7 MPa @ 175oC)
Sample Unit (SU)	
Tank Capacity	2×600 cc
Outside Diameter	3.5 in. (90 mm)
Length	167.48 in. (4 m)
Weight	252.4 lbs (114.5 kg)
PVT tank	

Max Working Temperature	300oF (150oC)
Max Working Pressure	10000 psi (70 MPa)
Tank Diameter	1.77 in (45 mm)
Length	3.94 ft. (1.2 m)
Weight	19 lbs. (8.6 kg)
Tank Capacity	600 cc
Special Applicationst	TPED-approved PVT tank Anti - H2S service PVT samples

Transducer Unit (TU)	
Maximum Temperature	350oF (175oC)
Maximum Pressure	15,000 psi (104 MPa)
Tool Diameter	3.375 in. (86 mm)
Length	9.8 ft.(3 m)
Weight	189.24 lbs. (85.84 kg)
Resistivity Sensor	
Range	0.01-20 ohm-m
Accuracy	±5% (full range)
Resolution	0.001 ohm-m
Capacitance WaterHoldup Sensor	
Range	0 -100% (best value 0 - 40%)
Accuracy	±1% (water holdup 40%)
Resolution	0.10%
Tuning Fork Density Sensor	
Range	Range of density measurement 0 g/cc to 1.25 g/cc In the viscosity range of 1.0 cS to 50 cS
Accuracy	±0.03 g/cc
Resolution	0.01 g/cc

Section 21: Reservoir Characterization Tester-Casing (RCT-C)

Reservior Characterization Tester-Casing confirm depth by natural gamma or CCL. Pack the target formation by packer, and then pump out formation fluid. Besides conventional formation test, it can be also used to obtain reservoir fluid in controllable vo lume, and identify properties of the fluid sample by water holdup sensor, resistivity sensor, pressure and temperature sensor at the same time.

Applications:

- Test in exploratory wells of medium to low porosity
- Determine water flooded level in development wells Examine infusion effect
- Determine remaining oil distribution
- Build development database for single well and single layer
- Replace part of C/O logging, pulse neutron logging services

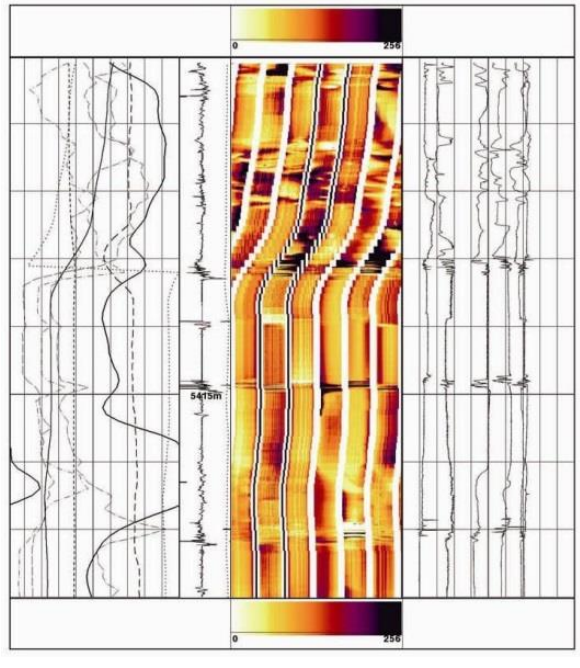
Specifications	
Maximum Pressure	2000 psi (140 MPa)
Maximum Temperature	350oF (175oC)
Diameter	3.875 in. (98 mm)
Length	44.3 ft.(13.5 m)
Weight	590 kg
Packing Length	5-11 m
Maximum Sample Volume	600 cc
Power Supply	400 Vac/1.2A
Strain Pressure Gauge	
Scale	10000/20000 psi

Accuracy	±0.18% of Full Scale
Resolution	0.2 psi of Full Scale
Quartz Pressure Gauge	
Scale	20000 psi
Accuracy	0.02% of Full Scale
Resolution	<0.008% psi sec

RCT-C-TU	
Maximum Temperature	350oF (175oC)
Maximum Pressure	15,000 psi (104 MPa)
Tool Diameter	3.375 in. (86 mm)
Length	9.8 ft.(3 m)
Weight	189.24 lbs. (85.84 kg)
Resistivity Sensor	
Range	0.01-20 ohm-m
Accuracy	±5% (full range)
Resolution	0.001 ohm-m
Capacitance WaterHoldup Sensor	
Range	0 -100% (best value 0 - 40%)
Accuracy	±1% (water holdup 40%)
Resolution	0.10%
Tuning Fork Density Sensor	
Range	Range of density measurement
	0 g/cc to 1.25 g/cc
	In the viscosity range of 1.0 cS to 50 cS
Accuracy	±0.03 g/cc
Resolution	0.01 g/cc

Section 22: Hexapod Resistivity Imaging Tool-X (RIT-X)

This new electrical wireline borehole imaging tool is designed to obtain superior quality images even in high Rt:Rm environments. The expanded operating range of the RIT-X over conventional electrical imaging tools is achieved through its new, state-of-the-art, 32 bit digital signal acquisition architecture combined with a large increase in available power for the excitation current.



Specifications	
DIMENSIONS AND RATINGS	
Max Temp:	350°F (175°C)
Max Press:	20,000 psi (140 MPa)
Max OD:	5 in. (12. 7 em)
Min Hole:	5.875 in. (14.92 em)
Max Hole:	21 in. (53.34 em)
Length:	25.24 ft (7.69 m)
Weight:	496 lb (97.5 kg)

BOREHOLE CONDITIONS	
Borehole Fluids:	Salt/Fresh
Recommended Logging Speed (High Data Rate):	30ft/min (9.1m/min) Image Mode
Recommended Logging Speed (Low Data Rate):	20ft/min (6.1 m/min) Image Mode
Tool Positioning:	Centralized

HARDWARE CHARACTERISTICS	
Source Type:	Induced Current
Sensor Type:	Micro-Resistivity Buttons
Sensor Spacings:	2 rows containing 12& 13 sensors, respectively 0.300 in. between rows 0.200 in. between sensors on each row 0.100 in. between sensors when both rows are superimposed
Firing Rate:	Continuous
Sampling Rate:	120 samples/ft (394 samples/meter) @20ft/min (Low Data Rate) & 30ft/min (High Data Rate) 310 Words/Frame(Low Data Rate) 456Words/Frame(High Data Rate)

MEASUREMENT

	Resistivity	Azimuth	Rotation	Deviation	Caliper
Principle	Micro-Resistivity	Navigation			61ndep.
Range	0.2-10,000 ohm·m	0-360'	0-360'	0-90'	6·21 in
	0<Rt/Rm<20,000				
Vertical Resolution 90%	0.2 in.	N/A	N/A	N/A	N/A
Depth of Investigation 50%	Formation Dependent	N/A	N/A	N/A	N/A
Sensitivity	N/A	0.1°	0.1°	0.03°	0.1 in.
Accuracy	N/A	±5°	±2°	±4°	±0.1°
Primary Curves	Image	AZI,HAZI	ROT	DEVI	CAL1-6
Secondary Curves	Micro-Resistivity, Dip Angle, Dip All, Borehole Inclination				

CALIBRATION
Primary: Resistor box, navigation cal stand & vertical hoist, 7-15 in. caliper rings
Wellsite: Resistor box, operation check of navigation sensors, 7 in Caliper ring

PHYSICAL STRENGTHS*			
Hardware	Tension	Compression	Torque
Tool Joints	130,000 lbs	130,000 lbs	6001b-ft
Mandrel Body Under Calipers	150,000 lbs	150,000 lbs	18001b-ft
4 1/4 inch Isolator	130,000 lbs	130,000 lbs	1800/b-ft
•Strengths apply to new tools at 70'F(21 'C) and 0 psi.			

Section 23: HHP-Formation Tester (FFP-FT)

Code	Description	Weight
CH	1-10-Pin Head	
AS	10 TO 31 Adapter	24 lbs 10.9kg
TCC	Telemetry Cartridge	75 lbs 34kg
GR	31-Pin Gamma Ray	87.5 lbs 39.7kg
FC	FT Cartridge	155.0 lbs 70.4kg
FM	FT Mechanical Unit	265 lbs 120.3kg
HP	Pressure Gauge	91.74 lbs 41.7kg
FS-A1	1 GAL Sample Unit	155 lbs 70.3kg
FS-a2	2.75 GAL Sample Unit	212 lbs 96kg
FW-A (optional)	FS-A Water Cushion	133 lbs 60.4kg
FS-B	2-3/4 GAL Sample Unit	205 lbs 93kg
FW-B (optional)	FS-8 Water Cushion	202 lbs 91.7 kg
OPTIONAL	Adapter For No Sample Operation	33 lbs 15 kg

TOOL SPECIFICATIONS

Pressure Rating	20.000 psi (140 MPa)
Temperature rating	350 ^{0}F (175 ^{0}C
Maximum Cable Length	30,000 ft. (9144 m)
Arruracy (MAX, Errors) With Temperature Corrections From Chart	0.98 % (10 K GAUGE) 0.97% (20K Gauge) 0.29% (NOTH GAUGES)
Outside Diameter	5.6 in (14.22 cm) /5in (12.7 cm

Contacts:

P.O. Box 9449, Ahmadi 610003, Kuwait
Tel: (965) 2398 9993
Fax: (965) 2398 9994
Email: info@easternutd.com
www.easternutd.com