Introduction

ImageLog provides graphical logging data including resistivity, acoustics, nuclear magnetic resonance, and etc. It evaluates complex formation and provides high-reliability formation evaluation result based on imaging logging data.

DOWNHOLE TOOLS

Array Laterolog Tool (ALT)
Array Induction Tool (AIT)
Nuclear Magnetic Resonance Tool (NMR-M)
Multi-dipole Array Acoustic Tool (MAA)
Hexapod Resistivity Imaging Tool-WBM (RIT-WBM)
Hexapod Resistivity Imaging Tool-OBM (RIT-OBM)
Slim Hexapod Resistivity Imaging Tool-WBM (SRI-WBM)
Slim Hexapod Resistivity Imaging Tool-OBM (SRI-OBM)
Spring Hexapod Diplog Tool (SHD)
Ultrasonic Scan Imaging Tool (USI)
Ultrasonic Scan Imaging Tool-V (USI-V)
Hexapod Segmented Bond Tool (HSB)
Multi-Finger Imaging Tool (MFI)
Radial Cement Bond Logging Tool (RadialCBL)
Elemental Capture Tool (ECT)
Thin Layer Resistivity Tool (TLR)
Flow Imaging Scanner (FIS)
Reservoir Monitor Tool (RMT)
**Introduction**

The ALT provides five independent, actively focused, depth- and resolution-matched measurements that can resolve the true formation resistivity in thinly bedded and deeply invaded formations. Unprecedented combinability results from the through-wired tool design. The absence of a current return at surface as well as no required use of a bridle greatly improves wellsite efficiency.

**Specifications**

- **Maximum Temperature**: 300°F (150°C)
- **Maximum Pressure**: 15,000 psi (103.4 MPa)
- **Minimum Hole Diameter**: ≥5 in. (4-3/4 in. under certain borehole conditions)
- **Maximum Hole Diameter**: ≤16 in. (≤12 in. preferred)
- **Tool Diameter**: 3.625 in. (92 mm)
- **Make-up Length**: 24 ft.-1.2 in. (7.34 m)
- **Shipping Length**: 25 ft. (7.62 m)
- **Weight**: 394 lbs. (179 kg)
- **Maximum Logging Speed**: 60 ft./min (18 m/min)
- **Resistivity Range (Rm=1)**: 0.2 to 100,000 ohm-m
- **Resistivity Range (Rm=0.02)**: 0.2 to 20,000 ohm-m
- **Accuracy**: ±0.1 ohm-m@0.2~1 ohm-m
  ±5%@1~1000 ohm-m
  ±20%@10,000~40,000 ohm-m
- **Vertical Resolution**: 12 in. (30.48 cm)
- **Depth of Investigation**:
  - RAL0: 9.84 in. (25 cm)
  - RAL1: 12.60 in. (32 cm)
  - RAL2: 15.35 in. (39 cm)
  - RAL3: 18.90 in. (48 cm)
  - RAL4: 25.20 in. (64 cm)
  - RAL5: 55.12 in. (140 cm)
- **Maximum Tensile Force**: 30,000 lbf
- **Maximum Compressive Force**:
  - with fin standoff: 3600 lbf
  - with rigid centralizers: 7800 lbf
Applications

- Open hole formation conductivity
- SP measurements
- Determination of Rt
- Invasion profiling
- Hydrocarbon identification

Introduction

The Array Induction Tool (AIT) uses multi-spacing and multi-frequency measurements to acquire a complete set of data from the formations surrounding the borehole. The multi-spacing measurements allow improved conductivity measurements in complex environments. The short-spacing measurements (as short as 6-inch spacing) allow improved correction for borehole, rugosity and invasion effects. The long-spacing measurements (up to 94-inch spacing) are useful in deep invasion situations. The multiple-frequency measurements allow for an improved skin-effect correction and data quality checking. AIT allows us to characterize invasion profiles, even in oil-based muds.

Specifications

Maximum Temperature 400°F (200°C) for 1 hour
350°F (175°C) for 4 hours

Instrument Lengths:
- Mandrel (make-up length) 19 ft. 9.9 in. (6.04 m.)
- Electronics (make-up length) 7 ft. 3.7 in. (2.23 m.)
- Total (make-up length) 27 ft. 1.6 in. (8.27 m.)

Instrument Weight:
- Mandrel 282 lbs. (127.9 kg)
- Electronics 151 lbs. (68.5 kg)
- Total 433 lbs. (196.4 kg)

Logging speed:
- Recommended 30 ft./min
- Maximum 60 ft./min at 4 samples per foot
100 ft/min at 2 samples per foot

Focused conductivities:
- Depths of investigation 10, 20, 30, 60, 90, 120in.
- Apparent vertical resolution true or matched to 1, 2 or 4ft.
- Measurement Range: 0.1 to 2000 ohm-m

Measurement Accuracy (homogenous formations):
- 60, 90, 120in. depth of investigation ±1 mS/m, ±2% of reading
- 30in. depth of investigation ±2 mS/m, ±2% of reading
- 20in. depth of investigation ±4 mS/m, ±2% of reading
- 10in. depth of investigation ±10 mS/m, ±2% of reading

Borehole Properties
- 6 in hole Rt/Rm < 7000
- 8 in hole Rt/Rm < 2000
- 12 in hole Rt/Rm < 1000
- Hole Size 4.5 in. to 20 in.
- Hole Deviation Vertical to Horizontal
- Minimum Radius of Curvature 24 ft. (7.30m)
- Tensile Strength 50,000 lbf. (22,500kg)
- Compressive Strength 6500 lbf. (2925kg) (in 14 in. hole)
7600 lbf. (3420kg) (in 12/4 in. hole)
12800(lbf (5760kg) lbf. (in 8 in. hole)

Wireline Requirements
- 7 conductor
- Calibration Environment: 10 feet off ground
30 feet from metallic materials
Applications

- Reveal different properties of the formation fluid and pore size distribution
- Effective and total porosity
- Movable water and bound water
- Permeability
- Pore size, microporosity and vugs
- Hydrocarbon Typing and Quantification
  - Low-R, low-contrast pay
  - Water, gas, oil saturations or flushed zone saturations
  - Oil viscosity
  - Characterizing unconventional reservoirs such as gas shale, tar and heavy oil

Features

- Multi-frequency, multi-investigation depth measurements
- Side-looking data acquisition expands operating envelope
- Direct measurement of lithology independent effective porosity, free fluid and capillary bound porosity, bound water
- Accurate measurements utilizing fully recovered wait time

Benefits

- Improved reservoir quality estimate (permeability, pore size distribution)
- Reduction of rig time through improved logging speed and tool combinability
- Accurate reserves determination with minimal uncertainty

Introduction

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 (137.9 MPa)
- Make-up Length: 15 ft. - 6 in. (4.73 m)
- Make-up Including QA cap/charger: 24 ft.- 5 in. (7.44 m)
- Instrument Weight: 156 lbs. (70.8 kg)
- NMR-M-QA: 178 lbs. (80.7 kg)
- NMR-M-MB: 310 lbs. (140.6 kg)
- Diameter: 3.625 in. (92 mm)
- NMR-M-QA: 5.06 in. (127 mm)
- Minimum Hole Diameter: 5.8 in. (147 mm)
- Maximum Hole Diameter: 14.0 in. (355 mm)
- Logging Speed (typical): 36 kbps
- BHD=8 in., BHT=150°F, Rxo>2 ohm.m, standard resolution 4 points/ft. (0.0762 m)
- Formation Evaluation (TWs2.1 s): 15 ft./min (4.6 m/min) Rm=0.1 ohm.m
- Fluid-Typing (TWs11 s): 4.9 ft./min (1.5 m/min) Rm=0.02 ohm.m
- Bound Water Logging: 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)
- Number of Operate Frequencies: 7
- Vertical Resolution: optional 6, 4, 3, 2.5, 2 ft. default 6 ft. (1.8 m)
- Measure Point: 4933 ft. (12.52 cm) above matching point of bottom of NMR-M-MB
- Measurement Range: 0-100 pu
- Minimum TE: 0.3 ms
- Set in TE value: 0.3 ms for CBW others 0.4 ms
- 0.6 ms, 0.8 ms, 1.5 ms
- Measurement Accuracy: ±2 pu
- Maximum Average Pulse Rate: ±1200 echoes/s
- Max Data Bandwidth @1200 Echoes Per Sec: 2.2-4.0 in. (56-102 mm)
- Sensitive Volume: 24 in. (61 cm)
- Arc length: 120°
- Shell Thickness: 1.1-2.3 mm
- Volume (7 freqs): 1.3 L
- Static Field Gradient: 14-39 gauss/cm
- Wireline Requirements: 7 conductor
Specifications

Power Requirements:
- Minimum Instrument Voltage: 185 Vac
- AC Power Operating Voltage & Current: 190 Vac, 300 mA
- DC Power Operating Voltage & Current: 620 Vdc, 220 mA
- Vibration & Shock: Meets Spec. GV-WI/RE-0009-A/1

Electrical/Telemetry
- Acquisition Cycle: Selectable (2-20 s typical 8 s)
- Send data Cycle: Selectable (0.25-1 s typical 0.5 s)
- Send Data Rate: 93.75 kb/s
- Data Block Length: Variable but ≤180 ms, with 0.5 s send data rate

(Decentralized for holes 7-7/8 in. (200 mm) and greater)

Operating Position: Decentralized
Hole Deviation: Vertical to horizontal

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.)
- 14" hole: 37 ft. (153°/100 ft.)

Minimum Dogleg Radius (bending, with safety factor 2)
- 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): 46,000 lbs (205 kN)
Parting strength (safety factor 2): 68,000 lbs (303 kN)

Compressive Strength (with safety factor 2)
- 6" hole: 30,000 lbs (133 kN)
- 8" hole: 10,000 lbs kN (44 kN)
- 12.25" hole: 4,200 lbs kN (19 kN)
- 14" hole: 3,300 lbs kN (15 kN)

Bending Strength Of Mandrel (safety factor 2): 2,500 ft.-lbf (3,390 N.m)
Multi-dipole Array Acoustic Tool (MAA)

Introduction

The MAA provides the best quality monopole and dipole measurements in unconsolidated Formations (Delta-T Shear > 350 μsec/ft.). The same depth transmitter offers improved low frequency content to allow improved data in slow formations with large (+16") boreholes. The cross-dipole anisotropy measurement is enhanced with the ability to obtain eight 4-Component (4-C) measurements over the current MAA six 4-C. The mandrel is configured with eight (8) receivers, each having four (4) orthogonal crystals for true four-component cross dipole acquisition. MAA contains five major components: ACT-EA, MAA-MC, MAA-PB, MAA-BA, MAA-FA.

Specifications

- Maximum Temperature: 350°F (175°C)
- Maximum Pressure: 20,000 psi (137.9 MPa)
- Total Weight: 780 lbs. (354.1 kg)
- Minimum Borehole Diameter: 4.5 in. (11.4 mm)
- Maximum Borehole Diameter: 17.5 in. (455 mm)
- Borehole Deviation: Vertical to Horizontal
- Telemetry Mode: Standard GTS
- Data Transmission Time: (Inline & Cross dipole, fullwave mono, Mono DT-44 channel acquisition) 1.7 s
- (Mono DT, Fullwave Monopole, Mono DT) 0.86 s
- Sample Rate: 2 samples per foot recommended
- Maximum Logging speed (Standalone): 15 ft./min
- Recommended subset 1: 28 ft./min
- Recommended subset 2: 20 channels
- Depth Control: Relative instrument depth control to an accuracy of 12 in.
- Data Available for Plotter/CRT Display: Auxiliary curves, gains, Mono DT All Waveforms
- Data Recorded: Monopole-Fullwave (range 40-300 us/ft.) Dipole-Fullwave (range 80-1000 us/ft.) Quadrupole-Fullwave (range 80-TBD us/ft.) Stoneley-Fullwave (range 180-600 us/ft) Mono DT-From monopole Cross Dipole-Fullwave (same depth)

Features

- Acquires all waveforms simultaneously
- High power broadband dipole transmitters with superior low-frequency content
- Provides high-quality shear data that eliminates the need for dispersion correction

Applications

- Petrophysical evaluation
  - Porosity estimation (also in cased hole)
  - Lithology and clay identification
  - Gas identification
- Sonic imaging
- Rock mechanical properties
- Anisotropy analysis
- Thin bed analysis

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Specifications

Data Presented
Mono DT (Methods—First break, Avan real time)

Vertical resolution (Semblance)  3.5 ft.
Vertical Resolution (First Break)  1.0 ft.

Measurement Range:
- Compressional Slowness  40-280 usec/ft.
- Shear Slowness  80-1000 usec/ft.
- Stoneley Slowness  80-1000 usec/ft.
- A/D conversion Rate  5 usec to 250 usec

Number of A/D Channels  8
A/D Resolution  16 bits
Record Length  3125 samples max
Compaction/Compression  12 bit compaction & data compression
Measurement Accuracy:
+3% error on compressional slowness
+5% error on shear slowness
+5% error on Stoneley slowness

Total Power  GTS Instrument Bus
Source Functionality  AC power (180Vac) <300 mA
Accuracy  ±3% error on compressional shear velocity
Vertical Resolution  3.5 ft. for semblance. 0.5 ft. for inner Rx first break and monoΔT.

Tensile Strength
- Transmitter & Receiver  35,000 lbf
- Isolator  14,000 lbf

Compressive Strength
- Transmitter & Receiver  35,000 lbf
- Isolator  1,000 lbf

Absolute Bending Strength of Mandrel  2000 ft./lbs.
Hexapod Resistivity Imaging Tool (RIT-OBM)
Hexapod Resistivity Imaging Tool (RIT-WBM)

Applications
- Structural analysis
- Detailed stratigraphic and sedimentological analysis
- Dip and strike determination
- Fracture identification and characterization
- Thin bed analysis
- Fault mapping
- Seismic upslope and verification of a seismically derived structural model

Features
- Provides high-resolution images
- Combinable with acoustic and ultrasonic imaging services

RIT-OBM Introduction
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.

RIT-WBM Introduction
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 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

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Temperature</td>
<td>350°F (175°C)</td>
</tr>
<tr>
<td>Maximum Pressure</td>
<td>20,000 psi (137.9 MPa)</td>
</tr>
<tr>
<td>Make-up Length:</td>
<td></td>
</tr>
<tr>
<td>RIT-PB</td>
<td>9 ft.-1 in. (2.77 m)</td>
</tr>
<tr>
<td>RIT-EC</td>
<td>9 ft.-1 in. (2.77 m)</td>
</tr>
<tr>
<td>RIT-MC</td>
<td>12 ft.-5 in. (3.81 m)</td>
</tr>
<tr>
<td>Shipping Length</td>
<td></td>
</tr>
<tr>
<td>RIT-PB</td>
<td>10 ft.-6.9 in. (3.22 m)</td>
</tr>
<tr>
<td>RIT-EC</td>
<td>10 ft.-6.9 in. (3.22 m)</td>
</tr>
<tr>
<td>RIT-MC</td>
<td>14 ft.-0 in. (4.27 m)</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
</tr>
<tr>
<td>RIT-PB</td>
<td>150 lbs. (68.2 kg)</td>
</tr>
<tr>
<td>RIT-EC</td>
<td>150 lbs. (68.2 kg)</td>
</tr>
<tr>
<td>RIT-MC</td>
<td>300 lbs. (136 kg)</td>
</tr>
<tr>
<td>Tool Diameter</td>
<td></td>
</tr>
<tr>
<td>RIT-PB</td>
<td>3.63 in. (92.2 mm)</td>
</tr>
<tr>
<td>RIT-EC</td>
<td>3.63 in. (92.2 mm)</td>
</tr>
<tr>
<td>RIT-MC</td>
<td>5.25 in. (133.4 mm)</td>
</tr>
<tr>
<td>Minimum Hole Diameter</td>
<td>6.0 in. (152.4 mm)</td>
</tr>
<tr>
<td>Maximum Hole Diameter</td>
<td>16.0 in. (406.4 mm)</td>
</tr>
<tr>
<td>Arms</td>
<td>6 independent</td>
</tr>
<tr>
<td>Pad Force (approx)</td>
<td>25-100 lbf (113-454 kg) (Adjustable)</td>
</tr>
<tr>
<td>Calipers</td>
<td>6 independent readings</td>
</tr>
<tr>
<td>Hole Deviation</td>
<td>Vertical to Horizontal</td>
</tr>
<tr>
<td>Borehole Coverage</td>
<td></td>
</tr>
<tr>
<td>Conductivity Image</td>
<td>66.7% in 7-7/8 in.diameter borehole</td>
</tr>
<tr>
<td>Caliper Range Diameter</td>
<td>5.0 in. to 21 in. (127-533 mm)</td>
</tr>
<tr>
<td>Pad Articulation</td>
<td>± 10 degrees (Radially)</td>
</tr>
<tr>
<td>Power Train</td>
<td>RIT-MC, DC Motor W/Power Screw</td>
</tr>
<tr>
<td>Torque Output</td>
<td>4500 oz-in</td>
</tr>
<tr>
<td>Motor Power</td>
<td>RIT-MC, 115 Vdc&lt;1.0 Amps intermittent duty cycle</td>
</tr>
<tr>
<td>Combinations</td>
<td>Ultrasonic Scan Imaging Tool (USI)</td>
</tr>
</tbody>
</table>

Hole Deviation  Vertical to Horizontal
Borehole Coverage
Conductivity Image
Caliper Range Diameter
Pad Articulation
Power Train
Torque Output
Motor Power
Combinations

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Hexapod Resistivity Imaging Tool (RIT-OBM)
Hexapod Resistivity Imaging Tool (RIT-WBM)

Specifications

Telemetry
- Standard GTS

Modes
- Command: mode 2
- Data: mode 2, mode 5 and mode 7

Bandwidth
- 190 words per depth sample
- mode 2 – 40 kbits/sec
- mode 5 – 104 kbits/sec
- mode 7 – 121 kbits/sec

Sample Interval
- Imaging Mode (High resolution): 120 samples/ft.
- Instrument Logging Speed (maximum instrument capability):
  - High Resolution imaging mode: 20 ft/min (6 m/min)
  - Extra high resolution imaging mode: 10 ft/min (3 m/min)

NOTE: The maximum logging speeds achievable are governed by the Telemetry and ACQ.

System capabilities.

Data Recorded
- (Minimum)
  - Radius measure from tool axis to each pad
  - Gains (Bucker, Pad, Guard)
  - BTN1-BTN24 Button currents for each of six pads in WBM mode
  - BTN1-BTN8 Button currents for each of six pads in OBM mode
  - Auxiliary Curves

Data Available for
- Plotter/CRT Display
  - Auxiliary curves calipers, gains, etc.
  - All buttons as VDL or Wiggle plots

Data Available for Numerical Display
- All recorded data

Measuring Range
- Caliper RAD1 through RAD6
- as allowed by mandrel 5.5 in. to 21 in.
- Water based mud (WBM) BTN1 through BTN25
- Oil based mud (OBM) BTN1 through BTN8
- Resistance 1200 Ohms to 1,200 MOhms
- Formation Resistivity 0.1 to 10 KOhm-m
- Mud Resistivity 0.01 to 10 Ohm-m
- Actual tool response depends on pad version

Orientation Sensor Type
- Orientation obtained from ORT WTS

Wireline Requirements
- 7 Conductor

Resistivity Pad Characteristics
- Number of Pads: 6
- Number of Sensors Per Pad: 8 (OBM)/25 (WBM)

Circumferential Spacing
- Oil based mud (OBM): 8.5 mm (0.3 in.)
- Water based mud (WBM): 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

Note: Pads are staggered vertically to allow nesting to a 5.25 in. diameter when fully closed.

Components Tensile Load Capacity (For tool string in a 13-5/8 in. wellbore):
- RIT-PB: 78,000 lbf (35,380 kg)
- RIT-EC: 78,000 lbf (35,380 kg)
- RIT-MC: 36,000 lbf (16,329 kg)

Components Compressive Load Capacity (For tool string in a 13-5/8 in. wellbore):
- RIT-PB: 56,000 lbf (25,401 kg)
- RIT-EC: 29,000 lbf (13,154 kg)
- RIT-MC: 36,000 lbf (16,329 kg)

Vibration & Shock
- Meets Spec. GV-WI/RE-0009-A/1

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Slim Hexapod Resistivity Imaging Tool-WBM (SRI-WBM)

Applications
- Dip and strike determination
- Identifying and describing faults and fractures
- Sedimentary and stratigraphic interpretation
- Structural mapping
- High-resolution imaging in slimhole wells
- Deviated and horizontal wells
- Irregular and rugose boreholes

Introduction
Conveniently new designed to obtain superior quality images in WBM or OBM by changing PADs. Separated Pads designed reduce the tool diameter, that allows tool logging in small size borehole. No motor spring designed allows imaging logging is available in RIH or POOH.

Specifications
- Max Temp: 350°F (175°C)
- Max Press: 15,000 psi (103 MPa)
- OD: 3.85 in. (98 mm)
- Min Hole: 4.5 in. (114 mm)
- Max Hole: 16 in. (406 mm)
- Make-up Length: 30.5 ft. (9.32 m)
- Weight: 565 lbs. (256.8 kg)
- Arms: 6 independent
- Wireline Requirements: 7 conductor
- Power Supply: 180 Vac
- Instrument Logging Speed: 20 ft./min (6 m/min) High Resolution imaging mode
- Mechanical Features: 10 ft./min (3 m/min) Extra high resolution imaging mode
- Tool Positioning: Centralized
- Hole Deviation: Vertical to Horizontal
- SRI-WBM

Sample Interval: 120 samples/ft. High resolution imaging Mode
120 samples/ft. Extra high resolution imaging Mode
60 samples/ft. Diplog Mode

Data Recorded (Min): RAD1 ~ RAD6
Radius measure from tool axis to each pad
Gains (Bucker, Pad, Guard)
BTN1-BTN24 Button currents for each of six pads
Guard Voltage

Measuring Range: Caliper RAD1 through RAD6 as allowed by mandrel 4.5 in. to 16 in.
BTN1 through BTN24 Resistance 1200 Ohms to 20 MOhms
(Formation Apparent Resistivity 0.1 to 2000 Ohm-m w/theoretical K factor)
Actual tool response to be evaluated during Field Test

Orientation Sensor Type: Orientation obtained from ORT

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**Introduction**

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- **Mechanical Features Arms**: 6 independent
- **Wireline Requirements**: 7 conductor
- **Power Supply**: 180 Vac
- **Instrument Logging Speed**: 20 ft./min (6 m/min) High Resolution imaging mode
  - 10 ft./min (3 m/min) Extra high resolution imaging mode
- **Tool Positioning**: Centralized
- **Hole Deviation**: Vertical to Horizontal
- **Sample Interval**
  - Imaging Mode
  - High Resolution Resistivity
  - 120 samples/ft
  - Diplog Mode
  - Resistivity 60 samples/ft
- **Data Recorded**: RAD1 through RAD6
- **Accuracy**: Caliper ±0.1 in. from 2.75 in. to 10.5 in.
  - (Radius)
- **Measuring Range**: Caliper RAD1 through RAD6 as allowed by mandrel 4.5 in. to 16 in.
  - Oil based mud (RIT-OBM) BTN1 through BTN8
  - Resistance 1,200 Ohms to 1,200 Mohms
  - (Formation Apparent Resistivity 0.1 to 10k Ohm·m with theoretical K factor)
- **Orientation Sensor Type Orientation obtained from ORT**

**Features**

- Measures acoustic amplitude reflectance and two-way travel-time
- Full 360° coverage of the borehole with images containing up to 256 data samples
- Reliably operates in any mud type
- Combines with Hexapod Resistivity Imaging Tool

**Applications**

- Structural and bedding analysis
- Completing detailed fracture studies
- Dip and strike determination
- Determining high-resolution borehole shape
- Stress analysis and borehole stability studies

**Slim Hexapod Resistivity Imaging Tool-OBM (SRI-OBM)**
Introduction

Spring Hexapod Diplog Tool is for determining formation structures and formation boundaries in open holes. By processing the resistivity signals obtained from the tool pads, along with the signals of calipers, azimuth, drift azimuth and deviations, the log analyst can get accurate earth formation structure and sedimentary information. This tool can provide six constant-voltage focusing-electrode conductivity logs, one pad-pressure force log, one gain-control log, three caliper logs (six pressure-arm radius logs). From these logs, the earth formation boundaries deviation and azimuth can be derived. No motor spring designed makes logging available in RIH or POOH.

Specifications

Maximum Temperature: 350°F (175°C)
Maximum Pressure: 20,000 psi (137.9 MPa)
Length: 11,625 ft. (3.54 m)
Diameter: 3.85 in. (98 mm)
Weight: 292 lbs. (132.5 kg)
Sample Interval: 64 samples/ft.
320 samples/m
Normal Logging Speed: @ 64 samp/ft.: 25 feet/min
@ 320 samp/m Metric: 16 feet/min
Maximum logging speed: @ 64 samp/ft.: 30 feet/min
@ 320 samp/m Metric: 19 feet/min
Data Recorded: RAD1 Through RAD6, Radius measured from tool center to each button.
Orientation Sensor Type: Orientation obtained from ORT
Caliper Accuracy: ±2% or 0.1 inch
Operating Power: 180 Vac (average) 60 Hz
Arms: 6 independent
Pad Force: 25-100 lbf (11.3-45.4 kgf) (Adjustable)
Calipers: 6 independent readings
Target Borehole Diameter: 4.5 to 14 in. (ecentered)
4.5 to 21 in. (centered)
Hole Deviation: Vertical to Horizontal
Caliper Range: 4.5 in. to 21 in. (11.4 - 53.3 cm)
Pad Articulation: ±30 degrees (Radially)
Mandrel Tension Capacity: 52,000 lbs. (23,587 kg)
Mandrel Compression Capacity: 32,000 lbs. (14,515 kg)
**Introduction**

This tool is an acoustic device designed to produce detailed images of the wellbore wall (or casing). The USI pulse-echo transducer emits a high frequency acoustic pulse and measures the amplitude and the time of flight of the reflected wave. The amplitude of the reflected wave is affected by variations in the borehole surface. The travel time is indicative of the distance from the transducer to the wellbore wall. The acoustic transducer is mounted on a rotating section, allowing the USI to scan the full 360 degrees of the wellbore producing two images or maps.

**Specifications**

- **Maximum Temperature**: 400°F (200°C)
- **Maximum Pressure**: 20000 psi (137.88 MPa) (1406.0 kg/cm²)
- **Tool Diameter**: 3.375 in. (8.57 cm)
- **Mandrel**: 3.625 in. (9.21 cm)
- **Make-up Length**: 7 ft.-5.8 in. (2.26 m)
- **Mandrel**: 8 ft.-0.6 in. (2.45 m)
- **Shipping Length**: 8 ft.-11.8 in. (2.74 m)
- **Mandrel**: 9 ft.-1.3 in. (2.78 m)
- **Tool Weight**: 120 lb (54.4 kg)
- **Mandrel**: 150 lb (68.0 kg)
- **Shipping Weight**: 140 lb (63.5 kg)
- **Mandrel**: 170 lb (77.1 kg)
- **Maximum Tensile Force**: 40,000 lbf
- **Mandrel**: 17,500 lbf
- **Maximum Compressive Force**: 4,000 lbf
- **Mandrel**: 4,000 lbf
- **Power Requirement**: 180 Vac, 60 Hz, 0.6 Ampere, nominal
- **Data Transmission Digital**: 7 conductor
- **Samples per Scan**: 250/125
- **Scan Speed**: 11 scans per second, nominal
- **Imaging Transducers**: 2
- **Size/type**: 1.5 in. (38.1 mm), and 2.0 in. (50.8 mm) focused, ceramic
- **Frequency of Operation**: 250 kHz
- **Orientation Facility**: Internal Magnetometer, or reference to ORT
- **Orientation**: Internal self-contained
- **Fluid Velocity Reference**: 250 kHz ceramic transducer
- **Logging Speed**: 10 ft./min. (3.05 m/min), 60 scans per foot (s.p.f.)
- **Vertical Resolution**: 20 ft./min. (6.10 m/min) @ 30 s.p.f.
- **Radial Resolution Typically**: 10 samples per inch in an 8 inch borehole
- **Borehole Diameter Range**: 5.5 in. (139.7 mm)
- **through**: 16 in. (304.8 mm)
- **Maximum Borehole Deviation**: 90°
### Applications
- Ultrasonic Cement Evaluation/ Imaging
- Casing Corrosion Inspection (both Thickness and Diameter).
- Openhole Borehole Imaging
- Fracture Detection
- Combining with ACT-C tool or DSB for reduced rigtime.
- Real-time fluid cell measures both borehole fluid transit time and fluid impedance for measured data correction.

### Introduction
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 user-friendly imaging analysis software is available to process images, histograms, and curve-type data from this advanced logging device. The uplink rate is up to 200 kbps, and power supply is 600 Vdc on the ground.

### Specifications

#### Mechanical
- **Maximum Operating Temperature**: 350°F (175°C)
- **Maximum Operating Pressure**: 20,000 psi (137.9 MPa)
- **Length**: 19.1 ft. (5.81 m)
- **Weight**: 316 lbs. (143 kg)
- **Diameter**: 3.5 in. (89 mm)
- **RTS-H Assembly**: 50.4 in. (1.28 m)
- **Electronics Assembly**: 122.15 in. (3.1 m)
- **Scanner Assembly**: 56.1 in. (1.43 m)

#### Electrical
- **Power Requirements**: 180 VAC 120 MA
- **Motor Power**: 150 Vdc, 1.5 A
- **Full Load Requirements**: 30 Wac, 225 Wdc

#### Measurement
- **Open hole Image Mode**
  - **Sensor Type**: Piezoelectric ultrasonic transducer on rotating head
  - **Firing Rate (shots/scan)**: 200
  - **Vertical Scan Rate**: 40 images/ft.
  - **Principle**: Ultrasonic Pulse Echo
  - **Vertical Sampling Rate (Software)**: 0.3 in.
  - **Logging Speed**: 21 ft./min (40 scan/ft., 14rev/sec)
  - **Primary Curves**: Reflected Amplitude and Travel Time
  - **Secondary Curves**: Radius, Azimuth, Relative Bearing, Deviation, and Fluid Transit Time
  - **Maximum Diameter Hole**: 13 in. (330 mm)
  - **Minimum Diameter Hole**: 4.5 in. (114 mm)
  - **Cased-Hole Mode**
  - **Sensor Type**: Piezoelectric on rotating head
  - **Firing Rate (shots/scan)**: 100
  - **Vertical Scan Rate**: 4 scans/ft. at 3.0 in/sampling
  - **Principle**: Ultrasonic Pulse Echo and time of flight
  - **Vertical Sampling (Software)**: 6.0, 3.0, or 1.0 in.
  - **Logging Speed**: 60, 30 or 10 ft./min (Depending on sampling rate)
  - **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**: 4.276 in. (108 mm)
  - **Maximum Diameter Hole**: 13 in. (330 mm)
  - **Wireline Requirements**: 7 Conductor
### Introduction

The HSB is a unique cement bond logging tool. It can find and define channels in the cement annulus which could result in a poor hydraulic seal. Conversely, the HSB can reliably find zones of uniform bonding over only a few feet of casing. Under conditions where a short bonded interval produces an adequate hydraulic seal, unnecessary squeeze jobs can be avoided.

### Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Temperature</td>
<td>350°F (175°C)</td>
</tr>
<tr>
<td>Maximum Pressure</td>
<td>20,000 psi (137.9 MPa)</td>
</tr>
<tr>
<td>Minimum Casing ID.</td>
<td>4.0 in. ID (101.6 mm)</td>
</tr>
<tr>
<td>Maximum Casing ID.</td>
<td>15.5 in. ID (393.7 mm)</td>
</tr>
<tr>
<td>Tool Diameter</td>
<td>3.38 in. (85.7 mm)</td>
</tr>
<tr>
<td>Make-up Length</td>
<td>Pad section: 17 ft. 3.87 in. (5.28 m)</td>
</tr>
<tr>
<td></td>
<td>VDL section: 7 ft. 8.13 in. (2.34 m)</td>
</tr>
<tr>
<td>Shipping Length</td>
<td>Pad section: 19 ft. (5.79 m)</td>
</tr>
<tr>
<td></td>
<td>VDL section: 9 ft. 3.81 in. (2.84 m)</td>
</tr>
<tr>
<td>Weight</td>
<td>Pad section: 240 lbs. (108 kg)</td>
</tr>
<tr>
<td></td>
<td>VDL section: 108 lbs. (49 kg)</td>
</tr>
<tr>
<td>Maximum Logging Speed</td>
<td>Limited only by GR resolution required</td>
</tr>
<tr>
<td>Auxiliary Data Mode</td>
<td>35 ft./min (10.7 m/min)</td>
</tr>
<tr>
<td>Normal Mode</td>
<td>0.22 dB/ft. Compensated attenuation</td>
</tr>
<tr>
<td>Absolute Accuracy</td>
<td>±1.0 dB/ft. or 10% of log value</td>
</tr>
<tr>
<td>Repeatability</td>
<td>±1.0 dB/ft. or 10% of log value</td>
</tr>
<tr>
<td>Vertical Resolution</td>
<td>0.25 ft. (76.2 mm) Basic measurement</td>
</tr>
<tr>
<td>Normal Presentation</td>
<td>presents data averaged over 3 ft. (91 mm)</td>
</tr>
<tr>
<td>Radial Resolution</td>
<td>60 degrees</td>
</tr>
<tr>
<td>Depth of Investigation</td>
<td>2 in. (50.8 mm)</td>
</tr>
<tr>
<td>Power Requirements</td>
<td>Logging: 150 Vdc at 120 mA</td>
</tr>
<tr>
<td></td>
<td>Motor Opening: 150 Vdc minimum at 0.25 Ampere for 60 seconds</td>
</tr>
<tr>
<td></td>
<td>Motor Closing: 150 Vdc minimum at 0.25 Ampere for 60 seconds</td>
</tr>
<tr>
<td>Wireline Requirements</td>
<td>Single conductor</td>
</tr>
<tr>
<td>Conductor Utilization</td>
<td>N/A (Single Conductor)</td>
</tr>
<tr>
<td>Detector Type</td>
<td>VDL: 20 kHz Piezo-electric cylinder</td>
</tr>
<tr>
<td></td>
<td>Pads: 100 kHz Piezo-electric Stack</td>
</tr>
<tr>
<td></td>
<td>Pad Force: 50 lbs. (22.7 kg)</td>
</tr>
</tbody>
</table>
Introduction

The Multi-Finger Imaging Tool (MFI) is used to detect very small changes to the internal surface condition of tubing or casing with a high degree of accuracy. A range of tool sizes with 24, 40, or 60 fingers are available to suit different casing diameters and each tool has two types fingers to increase the measurement range. The tool includes an inclinometer to indicate well bore deviation and the tool bearing relative to the high side of pipe.

Applications

- Casing Deformation
- Casing Wear
- Perforation Mapping
- Accurate location of holes or anomalies
## Specifications

<table>
<thead>
<tr>
<th></th>
<th>MFI-24*</th>
<th>MFI-40</th>
<th>MFI-60</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Temperature</strong></td>
<td>350°F (175°C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum Pressure</strong></td>
<td>15,000 psi (103 MPa)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Make-up Length</strong></td>
<td>4 ft.-2.59 in. (1.285 m)</td>
<td>7 ft.-6.12 in. (2.29 m)</td>
<td>6 ft.-0.36 in. (1.84 m)</td>
</tr>
<tr>
<td><strong>Shipping Length</strong></td>
<td>5 ft.-4.57 in. (1.64 m)</td>
<td>7 ft.-11.64 in. (2.43 m)</td>
<td>6 ft.-5.88 in (1.98 m)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>20.7 lbs. (9.38 kg)</td>
<td>79.4 lbs. (36 kg)</td>
<td>111.3 lbs. (50.5 kg)</td>
</tr>
<tr>
<td><strong>Tool Diameter</strong></td>
<td>1.77 in. (45 mm)</td>
<td>2.875 in. (73 mm)</td>
<td>4 in. (102 mm)</td>
</tr>
<tr>
<td><strong>Minimum Hole Diameter</strong></td>
<td>1.97 in. (50 mm) (4.5 in. finger)</td>
<td>3.15 in. (80 mm) (7 in. finger)</td>
<td>4 in. (102 mm) (10 in. finger)</td>
</tr>
<tr>
<td><strong>Maximum Hole Diameter</strong></td>
<td>4.5 in. (114.3 mm) (4.5 in. finger)</td>
<td>7 in. (177.8 mm) (7 in. finger)</td>
<td>10 in. (254 mm) (10 in. finger)</td>
</tr>
<tr>
<td><strong>Recommended Logging Speed</strong></td>
<td>22 ft/min (6.7 m/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum Logging Speed</strong></td>
<td>43 ft/min (13.3 m/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Radial Accuracy</strong></td>
<td>±0.035 in. (0.89 mm) (4.5 in. fingers)</td>
<td>±0.035 in. (0.89 mm) (7 in. fingers)</td>
<td>±0.027 in. (0.70 mm) (10 in. fingers)</td>
</tr>
<tr>
<td><strong>Measurement Resolution</strong></td>
<td>0.0039 in. (0.1 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rotation</strong></td>
<td>±3°</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Inclinometer</strong></td>
<td>±3°</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power Requirements</strong></td>
<td>18 Vdc (Nominal)</td>
<td>13-23 Vdc (Range)</td>
<td></td>
</tr>
<tr>
<td><strong>Current Consumption</strong></td>
<td>30 mA@18 Vdc (Logging)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>450 mA@18 Vdc (Motor operating)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Optional</strong></td>
<td>7 in. fingers Min: 1.97 in. (50 mm) Max: 7 in. (177.8 mm) Tool Diameter 1.77 in. (45 mm)</td>
<td>10 in. fingers Min: 4.7 in. (119 mm) Max: 10 in. (254 mm) Tool Diameter 2.875 in. (73 mm)</td>
<td>14 in. fingers Min: 4 in. (102 mm) Max: 14 in. (356 mm) Tool Diameter 4 in. (102 mm)</td>
</tr>
</tbody>
</table>

* Combinable with Radial Bond Logging with Memory Mode (RBM) for reduced operation time.
Introduction

The Radial Cement Bond Tools provide the operator with an accurate and economic means of inspecting the quality of the cement bond to casing and formation. The tools evaluate the cement bond quality and integrity to both pipe and formation by providing the measurements of the cement bond amplitude (CBL) through the near receiver (3 feet), and variable density log (VDL) through the far receiver (5 feet). Depending on tool size, the tool has the tool has 6/8/12 segmented receivers segmented receivers. These radial receivers are used to provide a high resolution cement bond imaging view.

Specifications

<table>
<thead>
<tr>
<th></th>
<th>Radial Bond Logging with Memory Mode (RBM) (6 segments)</th>
<th>Octopod Segmented Bond Tool (OSB) (8 segments)</th>
<th>Dodeca Segmented Bond Tool (DSB) (12 segments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure (Maximum)</td>
<td>20,000 psi (140 MPa)</td>
<td>20,000 psi (140 MPa)</td>
<td>20,000 psi (140 MPa)</td>
</tr>
<tr>
<td>Temperature (Maximum)</td>
<td>350°F (175°C)</td>
<td>350°F (175°C)</td>
<td>350°F/375°C (40°F/204°C) (Optional)*</td>
</tr>
<tr>
<td>Diameter</td>
<td>1.78 in. (45 mm), 2.13 in. (54 mm)</td>
<td>2.68 in. (73 mm)</td>
<td>3.50 in. (88.9 mm)</td>
</tr>
<tr>
<td>Length</td>
<td>9.93 ft. (3.03 m)</td>
<td>11.48 ft. (3.5 m)</td>
<td>13.12 ft. (4.00 m)</td>
</tr>
<tr>
<td>Weight</td>
<td>40 lb (18.1 kg)</td>
<td>110 lb (50 kg)</td>
<td>231.48 lb (105 kg)</td>
</tr>
<tr>
<td>Transducer Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver (s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bandwidth</td>
<td>Wideband (18-32 kHz)</td>
<td>Wideband (18-24 kHz)</td>
<td>Wideband (18-24 kHz)</td>
</tr>
<tr>
<td>Receiver (3 ft.)</td>
<td>6 segments synthesized</td>
<td>Monopole</td>
<td>Monopole</td>
</tr>
<tr>
<td>Receiver (5 ft.)</td>
<td>Monopole</td>
<td>Monopole</td>
<td>Monopole</td>
</tr>
<tr>
<td>Receiver (2 ft.)</td>
<td>8 segments</td>
<td>12 segments</td>
<td></td>
</tr>
<tr>
<td>Transmitter (s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Piezoelectric (Monopole)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bandwidth</td>
<td>Wideband (18-22 kHz)</td>
<td>Wideband (18-24 kHz)</td>
<td>Wideband (18-24 kHz)</td>
</tr>
<tr>
<td>Number</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Recommended Casing Range</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Casing OD</td>
<td>2.875 in. (73.0 mm)</td>
<td>4.00 in. (101.6 mm)</td>
<td>5.00 in. (127 mm)</td>
</tr>
<tr>
<td>Maximum Casing OD</td>
<td>7.5 in. (190.5 mm), 10 in. (254 mm)</td>
<td>10.75 in. (273 mm), 13.375 in. (340 mm)</td>
<td></td>
</tr>
<tr>
<td>Data Acquisition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Logging Speed</td>
<td>100 ft./min (30 m/min)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tool Positioning</td>
<td>Centralized</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Ray</td>
<td>Optional Integrated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCL</td>
<td>Optional Integrated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>Optional Integrated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Requirements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Voltage</td>
<td>180 to 220 Vdc</td>
<td>150 Vdc/180 Vac</td>
<td>150 Vdc/180 Vac***</td>
</tr>
<tr>
<td>Input Current Required</td>
<td>50 mA</td>
<td>90 mA</td>
<td>80 to 90 mA</td>
</tr>
</tbody>
</table>

* The length of the toolstring is increased cause temperature flask is added.

** The Max speed is 30 ft/min (9 m/min) if connect with USI-V.

*** If connect with USI-V, the power supply is 180 Vac by 7-conductor cable.
Introduction

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

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Temperature Ratings</td>
<td>350°F (177°C) &gt; 6 hours</td>
</tr>
<tr>
<td>Maximum Pressure</td>
<td>20,000 psi (137.9 Mpa)</td>
</tr>
<tr>
<td>Length</td>
<td>15.6 ft. (4.75 m) with QA</td>
</tr>
<tr>
<td>Weight</td>
<td>267 lbs. (121 kg) with QA</td>
</tr>
<tr>
<td>Diameter</td>
<td>4.87 in. (124 mm)</td>
</tr>
<tr>
<td>Minimum Hole Diameter</td>
<td>6 in. (152 mm)</td>
</tr>
<tr>
<td>Maximum Hole Diameter</td>
<td>22.0 in. (558.8 mm)</td>
</tr>
<tr>
<td>Recommended Logging Speed</td>
<td>10 ft./min (3 m/min)</td>
</tr>
<tr>
<td>Maximum Logging Speed</td>
<td>15 ft./min (4.6 m/min)</td>
</tr>
<tr>
<td>Operating Voltage &amp; Current</td>
<td>180 VAC @ 220 mA (Source OFF)</td>
</tr>
<tr>
<td></td>
<td>180 VAC @ 300 mA (Source ON)</td>
</tr>
<tr>
<td>Gamma Ray Energy Range</td>
<td>0.5 to 10 MeV</td>
</tr>
<tr>
<td>Accuracy Element Uncertainty</td>
<td>Al 0.90%</td>
</tr>
<tr>
<td></td>
<td>C 1.3%</td>
</tr>
<tr>
<td></td>
<td>Ca 1.0%</td>
</tr>
<tr>
<td></td>
<td>Fe 0.22%</td>
</tr>
<tr>
<td></td>
<td>Gd 1.3 ppm</td>
</tr>
<tr>
<td></td>
<td>Mg 1.2%</td>
</tr>
<tr>
<td></td>
<td>Si 1.4%</td>
</tr>
<tr>
<td></td>
<td>Ti 0.05%</td>
</tr>
<tr>
<td>Vertical Bed Resolution</td>
<td>18 in. to 24 in. (457 mm to 610 mm)</td>
</tr>
<tr>
<td>Measure Point</td>
<td>5.6 ft. (1.71 m) from bottom sub</td>
</tr>
<tr>
<td>Wireline Requirements</td>
<td>7-conductor cable</td>
</tr>
<tr>
<td>Maximum Compressive Force</td>
<td>6-in. hole: 125,000 lbs. (56,699 kg)</td>
</tr>
<tr>
<td></td>
<td>8.5-in. hole: 76,500 lbs. (34,700 kg)</td>
</tr>
<tr>
<td></td>
<td>12.25-in. hole: 42,000 lbs. (19,051 kg)</td>
</tr>
<tr>
<td>Maximum Tensile Force</td>
<td>38,000 lbs. (17,292 kg)</td>
</tr>
<tr>
<td>Conductor Utilization</td>
<td>1 &amp; 4 for AC power</td>
</tr>
<tr>
<td>Combinability</td>
<td>2,3,5 &amp; 6 for data on Mode 5</td>
</tr>
<tr>
<td>Depth of Investigation</td>
<td>8.5 in. (216 mm) for Inelastic</td>
</tr>
<tr>
<td></td>
<td>21 in. (533 mm) for Capture for Solid Rock Matrix</td>
</tr>
<tr>
<td>Detector</td>
<td>3-in x 6-in BGO scintillation</td>
</tr>
<tr>
<td>Source Type</td>
<td>Pulsed Neutron (14 MeV)</td>
</tr>
<tr>
<td>Number of Energy Channels</td>
<td>256</td>
</tr>
<tr>
<td>Repeatability</td>
<td>± (0.2 to 1.4%) of weight, depending upon the specific element.</td>
</tr>
</tbody>
</table>

www.RenheSun.com  
www.geovista.cn
Features

- Resolve formation resistivity for beds down to about two inches (5 cm) in thickness
- Provides a borehole Caliper and rugosity Caliper and simultaneously perform measurements for Microlaterolog (MLL) or Minilog (ML)

Introduction

The Thin Layer Resistivity Tool (TLR) provides, under reasonable logging conditions, a very good estimation of the formation resistivity for beds of even less than two inches (5 cm.) in thickness. This is possible because while other high resolution, micro-resistivity type instruments generally exhibit a depth of investigation on the order of few inches, the TLR instrument has a depth of investigation in the range of 13 in. (33 cm.) to 21 in. (53 cm.), taken as the radial distance from the borehole wall into the formation which produces 50% of the tool response.

Specifications

- **Maximum Temperature**: 350°F (176°C)
- **Maximum Pressure**: 20,000 psi (137.9 MPa)
- **Minimum Hole Diameter**: 6 in. (152.4 mm)
- **Maximum Hole Diameter**: 22 in. (558.8 mm)
- **Tool Diameter**: 4.0 in. (101.6 mm) mandrel section
- **Make-up Length**: 3.625 in. (92.075 mm) electronics section
- **Shipping Length**: 14.5 ft. (4.42 m)
- **Weight**: 235 lb. (106.6 kg)
- **Maximum Logging Speed**: 40 ft./min (12.19 m/min)

**Measurement Range**

- **TLR**: 0.12 ohm-m to 1000 ohm-m
- **MLL**: 0.12 ohm-m to 1000 ohm-m
- **ML**: 0.12 ohm-m to 200 ohm-m
- **CAL**: 6 in. (152.4 mm) to 22 in. (558.8 mm)
- **BRIT**: Zero to 2.5 in (63.5 mm)

**Absolute Accuracy**

- **TLR & MLL**: Larger of ± 5% or ± 1 mmho
- **ML**: Larger of ± 5% or ± 0.01 ohm-m
- **CAL & BRIT**: Larger of ± 5% or ± 0.5 in.

**Repeatability**

- **TLR & MLL**: Larger of ± 2% or ± 1 mmho
- **ML**: Larger of ± 2% or ± 0.01 ohm-m
- **CAL & BRIT**: Larger of ± 2% or ± 0.5 in.

**Mud Resistivity Range**: 0.1 ohm-m to 3 ohm-m

**Vertical Resolution**: < 2 in. (50.8 mm)

**Depth of Investigation**

- **TLR**: 13 in (33 cm) to 21 in (53.34 cm) radial distance from the borehole wall for various Rt/Rxo contrasts, calculated. Example, 19 in (48.26 cm) for Rt/Rxo=10.
- **MLL & ML**: Typical micro-resistivity type devices’ depth of investigation of < 1 in.

**Power Requirements**

- **Operating**: 60 mA @ 180 Vac at cablehead
- **Motoring**: 300 mA (minimum @ 120 Vdc at the top of tool)

**Wireline Requirements**: 7 conductor cable
Introduction

The FIS has a small outside diameter of 1.77 in. (45 mm), and it can be run in holes ranging from 2-7/8 in. to 9 in. (73.0 to 228.6 mm) using coiled tubing, wireline, or downhole tractor. The system operates in temperatures to 300°F (150°C) and at pressures to 15,000 psi (103 MPa). And it is a radioactive source free system.

Specifications

- Temperature: 300°F (150°C)
- Pressure: 15,000 psi (103 MPa)
- Outside diameter: 1.77 in. (45 mm)
- Hole size: 2.875 in. to 9 in. (73.0 mm to 228.6 mm)

Sensor Type & Number:
- Flow Meter: 5
- Fluid Density: 3
- Inclination: 1 per tool

- Three-phase holdup accuracy: ±10%
- Velocity accuracy: ±10%

Features

- All sensor measurements simultaneous
- Direct, localized measurements of phase velocities and calculation of a multiphase velocity profile
- Full three-phase holdup answer
- Scanning sensors across the vertical axis for more accurate detection of phase interfaces
- Measurement of mixed and segregated flow regimes
- Independent measurement of gas velocity in multiphase horizontal wells
- Detection of heavy phase recirculation downhole
- Software optimization and real-time display of data from all sensors
- Caliper and relative-bearing measurements for continuous sensor location

Real-time flow rate and phase distribution data are continuously optimized and displayed on the FIS monitor.
**Applications**

- Oil, gas, water interface monitoring, to determine the movement pattern of oil-water interface, improve oil recovery.

- Calculate the remaining oil saturation, analyze the use of production wells reservoir, to determine remaining oil distribution. In the latter part of oil field development, oil evaluation can be more effective.

- Single well residual oil saturation defined by RMT can be combined with the injection profile, it can be used to provide reservoir, adjusting the oil field development program.

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**Introduction**

The RMT is a slimhole, multi-detector, pulsed-neutron reservoir monitoring instrument. The following modes of operation are available:

- Pulsed Neutron Capture (PNC)
- C/O mode
- Activation (Hydrolog, AFL) mode

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**Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Temperature</td>
<td>300°F (150°C)</td>
</tr>
<tr>
<td>Maximum Pressure</td>
<td>15,000 psi (103 MPa)</td>
</tr>
<tr>
<td>Make-Up Length</td>
<td></td>
</tr>
<tr>
<td>RMT-EA (Electronics Ass.)</td>
<td>4 ft. - 5.74 in. (1.37 m)</td>
</tr>
<tr>
<td>RMT-FA (High Voltage Control Ass.)</td>
<td>4 ft. - 8.32 in. (1.43 m)</td>
</tr>
<tr>
<td>RMT-FA (Neutron Generator &amp; Detector)</td>
<td>9 ft. - 4.82 in. (2.97 m)</td>
</tr>
<tr>
<td>RMT-TT (Telemetry)</td>
<td>4 ft. - 9.09 in. (1.45 m)</td>
</tr>
<tr>
<td>RMT-PS (Power Supply)</td>
<td>3 ft. - 8.88 in. (1.14 m)</td>
</tr>
<tr>
<td>RMT-GR (Gamma Ray)</td>
<td>3 ft. - 1.40 in. (0.95 m)</td>
</tr>
<tr>
<td>Shipping Length</td>
<td></td>
</tr>
<tr>
<td>RMT-EA (Electronics Ass.)</td>
<td>5 ft. - 3.56 in. (1.61 m)</td>
</tr>
<tr>
<td>RMT-FA (High Voltage Control Ass.)</td>
<td>5 ft. - 1.87 in. (1.57 m)</td>
</tr>
<tr>
<td>RMT-FA (Neutron Generator &amp; Detector)</td>
<td>9 ft. - 6.32 in. (2.95 m)</td>
</tr>
<tr>
<td>RMT-TT (Telemetry)</td>
<td>5 ft. - 6.54 in. (1.69 m)</td>
</tr>
<tr>
<td>RMT-PS (Power Supply)</td>
<td>4 ft. - 3.39 in. (1.28 m)</td>
</tr>
<tr>
<td>RMT-GR (Gamma Ray)</td>
<td>4 ft. - 3.18 in (1.3 m)</td>
</tr>
<tr>
<td>Weight</td>
<td>133 lbs. (60.5 kg)</td>
</tr>
<tr>
<td>Combination Telemetry Tool/ Power Supply/Gamma Ray/RMT</td>
<td></td>
</tr>
<tr>
<td>Tool Diameter</td>
<td>1.70 in. (43 mm)</td>
</tr>
<tr>
<td>Minimum Hole Diameter</td>
<td>1.90 in. (48 mm)</td>
</tr>
<tr>
<td>Hole Deviation</td>
<td>0° to 100°</td>
</tr>
<tr>
<td>Bend Radius</td>
<td>30° in 100 ft.</td>
</tr>
<tr>
<td>Max. Tensile Force</td>
<td>22,000 lbs. (9979 kg)</td>
</tr>
<tr>
<td>Max. Compressive Force</td>
<td>570 lbs. (258.6 kg)</td>
</tr>
<tr>
<td>Operating Voltage &amp; Current</td>
<td>150 Vdc @ 350 mA</td>
</tr>
<tr>
<td>Neutron Pulse Generator</td>
<td>100 kV Energy: 14 MeV</td>
</tr>
</tbody>
</table>

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**Notes:**

- Hole Deviation: 0° to 100°
- Bend Radius: 30° in 100 ft.
- Max. Tensile Force: 22,000 lbs. (9979 kg)
- Max. Compressive Force: 570 lbs. (258.6 kg)
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