Well Intervention

Production monitoring

Production Logging Services

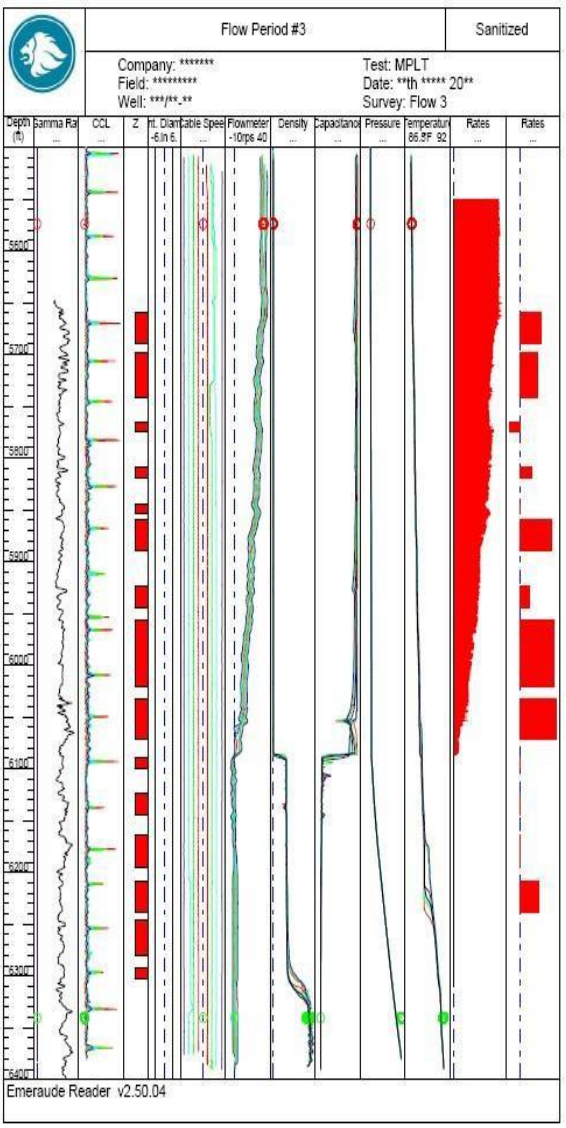
Expro is a global market leader in cost-effective memory production logging, providing first memory production log for the North Sea in 1985.

The on-site acquisition services are backed up by Data Analysis Centres, which provide expert analysis to meet customer requirements.

Expro's production logging strings can be deployed via slickline, coil tubing, electric-line or tractor systems in vertical, deviated or horizontal wells.

A wide range of sensors are available, to optimise data recovery depending on the customer needs. Including the latest in multi-sensor array tools for logging deviated multi-phase wells.

All tools are manufactured from corrosion resistant materials with full material traceability.



Applications

- Determine downhole flow rates
- Establish flow profile and zonal contribution
- Identify crossflow / thief zones
- Leak detection
- Fluid identification

Features and benefits

- Portable and fast mobilisation
- Combined logging
- On-site reporting
- High resolution
- Expand memory capacity
- Single pin connections with telemetry
- Quartz pressure gauges

Telemetry Unit (XTU)

The XTU downhole controller is a communications interface between the logging tool operating on the Ultrawire toolbus and Ultralink telemetry system.

It incorporates a DC-DC converter to convert high voltage on the Ultralink line to power the Ultrawire toolbus. As a logging controller, the XTU polls each tool in the tool string for its data packet, assembling all packets into data frames for transmission to the surface acquisition system. The polling programme is generated and executed by the XTU, making logging very simple.

Applications

- Transmission of the tool string data to the surface system

Features and benefits

- Automatic “Plug and play” configuration
- Automatic downlink failure detection triggers reversion to default bit rate
- Automatic generation of a polling programe that allows all identified tools to share the available bandwidth on the wireline
- Facility to monitor the head voltage and internal temperature of the downhole controller

Technical specifications

	XTU011
Temperature rating	350ºF (177ºC)
Pressure rating	20,000psi (137.9MPa)
Tool diameter	1 11/16 “ (43mm)
Length	18.5” (471mm)
Weight	7.5 ilbs. (3.4Kg)
Supply voltage	+180 to + 400V DC
Supply current (depends on tool string)	20 mA (no load)
Max. number of tools supported	62
Ultrawire toolbus data rate	500 kbits/s
Ultrawire toolbus current (max)	1A at 350ºF (177ºC) 1.5A at ambient temperature
Ultralink uplink data rates	50,71,100 & 143 kbits/s
Ultralink downlink rate	300 bits/s
Upper connection	13/16 UNF female thread with 4 mm single socket (GO joint)
Lower connection	13/16 UNF male thread with 4mm single socket (SX joint)
Material	Corrosion resistant

Memory Battery Housing

The battery housing contains the lithium battery pack to power the memory tools during the logging survey.

Two sizes are available to accommodate different battery packs, with the five cell pack being used for standard production logging surveys. The 10 cell pack is used were a longer duration is required or a higher current consumption toolstring is utilised (i.e. additional sensors such as array tools or with caliper tools).

Battery housing has an industry standard sucker rod thread and fish neck at the top.

Technical specifications

	5 cell battery housing	10 cell battery housing
Temperature rating	350 °F (177 °C)	350 °F (177 °C)
Pressure rating	15000psi (103MPa)	15000psi (103MPa)
Tool OD	1 11/16” (43mm)	1 11/16” (43mm)
Length	16.6“ (421mm)	28” (711mm)
Weight	8 lbs (3.6Kg)	9.7 lbs (4.4Kg)

Ultrawire Memory Tool (UMT)

Designed to acquire and store data from a string of logging sensors to non-volatile memory chips. The UMT can log data from any combination of Ultrawire telemetry tools (i.e. calipers, radial bond tools and production logging tools).

The memory tool is programmed and uploaded through a USB interface using Windows software. When the toolstring is returned to surface, the UMT data is downloaded to a laptop. The UMT data is then merged with depth-time data before being processing to industry standard depth-based log files.

Features

- Logging without electric wireline
- Production and injection well profiling
- Well integrity surveys – casing and cement
- Operates with any combination of Ultrawire cased hole tools
- Up to 1 GB memory

Technical specifications

	UMT 003	UMT 007
Temperature rating	350 °F (177 °C)	350 °F (177 °C)
Pressure rating	15000psi (103MPa)	20000psi (138MPa)
Tool OD	1 11/16” (43mm)	1 11/16” (43mm)
Length	25.66” (652mm)	12.7” (317.6mm)
Weight	10.6 lbs (4.8Kg)	5.9 lbs (2.7Kg)
Memory size	128 Mbytes	1 GB (512 MB Dual)
Minimum sample rate	20 msec to days	20 msec to days

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Quartz Pressure / Casing Collar Locator (CCL) tool

The combined quartz pressure and CCL tool is designed to minimise tool length. A quartz sensor is used for the pressure measurement and the CCL detects casing collars and other variations in the casing and tubing.

The quartz pressure transducers contain three quartz crystal sensor elements. The first of these senses exposed pressure, the second responds to temperature, and the third has minimal sensitivity to either pressure or temperature. The crystals are arranged mechanically to provide good thermal coupling. The quartz sensing elements provide high stability and extremely fine resolution for sensing pressure. A bellows is used to protect the pressure crystal and corrosion-resistant, high-strength alloy housing provides mechanical support and protection to each of these elements.

The CCL uses a pair of rare earth magnets and a single coil to detect changes in magnetic material around the tool. These variations induce an electro magnetic field (EMF) within the coil, which is processed to produce the log.

Features

- Depth control in casing and tubing
- Location of severe casing or tubing damage
- Confirmation of perforation depths/intervals
- Data for productivity index and nodal analysis
- Draw-down and build-up pressure transient analysis
- Downhole pressure gradient measurement

Technical specifications

	QPC
Temperature rating	350ºF (177ºC)
Pressure rating	15,000psi (103MPa)
Tool OD	1 11/15 “ (43mm)
Length	19” (483mm)
Weight	8.8 ilbs. (4.0Kg)
Pressure accuracy	±3.2 psi (22 KPa)
Pressure resolution	<0.008 psi (0.055 KPa)
Pressure response	< 1 sec for 99.5%
Temperature accuracy	±0.27 °F (0.15 °C)
Temperature resolution	<0.009°F (0.005°C)

Gamma Ray

Consisting of a sodium iodide scintillating crystal and photomultiplier tube. The detector is unshielded enabling detection of incident gamma radiation from any direction.

Technical specifications

	PGR
Temperature rating	350ºC (177ºC)
Pressure rating	15,000psi (103MPa)
Tool OD	1 11/16” (43mm)
Length	23.1” (586mm)
Weight	9.4 lbs (4.3Kg)
Material	Corrosion resistant
Sensitivity threshold	20 keV approx.
Nominal calibration	1 count per API
Maximum count rate	2000 cps

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In-line Spinner

The in-line spinner flowmeter is a compact flowmeter that can be run in combination with other production logging tools. The tool may be used in areas where fullbore spinners can be closed due to restricted diameters. Consisting of a symmetrical spinner mounted on two precision roller bearings, with rotation detection being accomplished by a zero drag hall effect device and dual magnets attached to the spinner shaft completing the circuit.

Applications

- Production profiling
- Leak detection
- Additional spinner measurement in high deviation//horizontal wells
- Flow measurement inside sand screens/slotted liners
- Compatible with other Ultrawire* tools
- Surface readout or memory operation

Technical specifications

	ILS
Temperature rating	350 °F (177 °C)
Pressure rating	15000psi (103MPa)
Tool OD	1 11/16” (43mm)
Shroud OD	2 1/8” (54mm)
Length	17.3” (586mm)
Weight	6.8 lbs (3.1Kg)
Maximum fluid velocity	3000 ft/min (15m/sec)
Spinner threshold	12 ft/min (0.06m/sec)
Output	10 pulses/rev (directional)
Spinner size	1.772”
Spinner pitch	7” (0.029 RPS/ft/min)

Fluid Density Sensors

Different fluids have different densities so by measuring the density, the type of fluid or fluid mixture can be identified. Several techniques are used to determine fluid density.

FDI: The Fluid Density Inertial tool uses the inertial response characteristics of a vibrating tuning fork to determine the density of the wellbore fluid mixture.

FDR: The Fluid Density Radioactive tool uses low energy gamma rays from an internal Americium-241 source to determine the downhole fluid density during a production log. It provides a safe and reliable measurement that is unaffected by well deviation and flow rates.

FDD: The Differential Pressure Fluid Density tool uses a differential pressure transducer to derive the density of wellbore fluids by measuring the hydrostatic pressure gradient of the fluids in the wellbore.

Benefits

- Production profiling
- Fluid identification
- Fully compatible with all Ultrawire* Production Logging Tools
- Surface readout or memory operation
- Density measurements in a range of fluid flow rates
- Used for fluid identification and multiphase production profiling
- Tool provides fluid interface detection

Technical specifications

	FDI	FDR	FDD
Temperature rating	350 °F (177 °C)	350 °F (177 °C)	350 °F (177 °C)
Pressure rating	15000psi (103MPa)	15000psi (103MPa)	15000psi (103MPa)
Tool OD	1 11/16” (43mm)	1 11/16” (43mm)	1 11/16” (43mm)
Length	23” (585mm)	23” (585mm)	51.9” (1318mm)
Weight	7.8 lbs (3.55Kg)	12 lbs (5.4Kg)	22 lbs (10Kg)
Measurement accuracy	± 0.03 g/cc	± 0.03 g/cc	± 0.03 g/cc
Resolution	0.01 gm/cc	0.01 gm/cc	0.001 gm/cc
Measurement range	0 to 1.25g/cc	0 to 1.25g/cc	0 to 1.50g/cc

Capacitance Temperature Flow (CTF)

The CTF combines three sensors together – capacitance water holdup, temperature, and flowmeter with a single electronics section. This sensor combination provides all three measurements in a short tool section, ensuring they are effectively taken from the same depth in the well, unlike the sensors on a standard production logging string that are a much greater distance apart.

Capacitance water holdup: hydrocarbons and water have different dielectric constants. The output frequency of the probe responds to the average dielectric constant of the fluid as it passes between the cage of the tool and the inner probe.
From this, the downhole water-hydrocarbon ratio can be derived.

Temperature: A fast response platinum-resistance temperature probe detects changes in fluid temperature.

Features and benefits

- Three sensor measurements combined in a single tool
- Quantitative downhole fluid holdup measurement
- Surface readout or memory operation
- Leak and cross-flow detection

Technical specifications

	CTF
Temperature rating	350 °F (177 °C)
Pressure rating	15000psi (103MPa)
Tool OD	1 11/16” (43mm)
Length	18.5” (470mm)
Weight	5.4 lbs (2.45Kg)
Water holdup accuracy	1%
Water holdup resolution	± 1% (Yw < 40%)
Temperature range	10 - 177°C
Temperature accuracy	± 1 °F (0.56 °C
Temperature resolution	< 0.0055 °F (0.003 °C)
Temperature response	0.5 seconds
Flow meter output	10 pulses/rev (directional)

The main spinner section is run at the bottom of a PL tool string to monitor downhole fluid flow rates. Each model should be chosen to optimise the measurement and enable passage through completion restrictions.

All spinners turn as fluid passes by, this rotation is converted to signal pulses by zero drag Hall effect sensors. The pulses are then used to calculate flow rates and fluid direction (up or down flow).

CFSM: The Continuous Spinner impeller assembly is mounted on precision roller bearings.

CFJM: The Jewelled Continuous Spinner has low friction jewelled bearings to reduce the mechanical threshold of the spinner and improve sensitivity to fluid flow.

CFBM: The Fullbore Flowmeter spinner blades and cage assembly collapse down to tool diameter, enabling it to pass through tubing restrictions without damage.

CTF compatible spinner specifications

	CFSM	CFJM	CFBM
Spinner type	Fixed cage	Jewelled bearing fixed cage	6 arm fullbore
Temperature rating	350 °F (177 °C)	350 °F (177 °C)	350 °F (177 °C)
Pressure rating	15000psi (103MPa)	15000psi (103MPa)	15000psi (103MPa)
Tool OD	1 11/16” (43mm)	1 11/16” (43mm)	1 11/16” (43mm)
Maximum OD	1 11/16” or 2 1/8”	1 11/16” or 2 1/8”	4 1/2” to 9 5/8”
Length	8” (203mm)	9” (229mm)	35” (349mm)
Weight	1.7 lbs (0.77Kg)	2.2 lbs (1 Kg)	10 lbs (4.5Kg)
Maximum fluid velocity	>2500 ft/min	>4000 ft/min	>1300 ft/min
Spinner threshold	5 ft/min	1.5 ft/min	1.7 ft/min
Spinner size	1.402” (1 11/16” OD) 1.772” (2 1/8” OD)	1.402” (1 11/16” OD) 1.772” (2 1/8” OD)	2.6” (4 1/2” Casing) 3.15” (5” Casing) 3.3” (5 1/2” Casing) 4.24” (7” Casing) 5.5” (9 5/8” Casing)
Spinner pitch	4”	5.6” (1 11/16” OD) 7” (2 1/8” OD)	4”

X-Y Caliper

The X-Y caliper tool has a pair of caliper arm mechanisms set at 90 degrees to each other to measure the internal casing diameter in the X and Y axes. The caliper assembly is fully collapsible for running into and pulling out of hole. Consists of two sleeves, each attached to one of two centralising spring loaded arms, which are offset by 90 degrees. The arms operate independently of each other and exert a constant radial fore onto the tubing or casing wall.

The ID of the tubing or casing is related to the position of the sleeve on the shaft and this is accurately measured by an induction coil array protected from well fluid within the shaft.

Benefits

- Determination of X-Y diameters at 90°
- Measurement of casing deformation and major corrosion
- Detection of scale build up in casing and tubing
- Correction of spinner derived fluid velocity for varying casing or open hole completion diameter
- Compatible with Ultrawire* tools
- Extended arms to increase range to suit customer request

Technical specifications

	PDC
Temperature rating	350 °F (177 °C)
Pressure rating	15000psi (103MPa)
Tool OD	1 11/16” (43mm)
Length	37.5” (953mm)
Weight	14.5 lbs (6.7Kg)
Accuracy	0.1” < 150 °C. 0.2” < 165 °C, 0.3” < 177 °C
Resolution	0.015” (0.38mm)
Measuring range	2 – 9”

Centralisers

Centralisers provide support and centering of logging tools in vertical, deviated, or horizontal wells. Various types of centralisers are available depending on well trajectory, with the four arm centraliser being better suited for horizontal wells or with array tools that require accurate centralisation in the well.

The six arm bowspring centraliser is best suited for open hole sections.

Technical specifications

	PRC001	PRC034	PSC
Centraliser type	3 arm Roller	4 arm Roller	Bowspring
Temperature rating	350 °F (177 °C)	350 °F (177 °C)	350 °F (177 °C)
Pressure rating	15000psi (103MPa)	15000psi (103MPa)	15000psi (103MPa)
Tool OD	1 11/16” (43mm)	1 11/16” (43mm	1 11/16” (43mm
Length	23” (584mm)	32.25” (819mm)	30.2” (767mm)
Weight	8 lbs (3.6Kg)	12.5 lbs (5.7Kg)	9 lbs (4.1Kg)
Operating diameter	2 7/8” to 9 5/8”	2 7/8” to 9 5/8”	2 7/8” to 9 5/8”
Centralising force	25 or 40 lbs	110 lbs	20 – 65 lbs

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Knuckle Joint

The Production Knuckle Joint (PKJ) has a universal ball joint, which allows a maximum of 10 degrees deflection in any direction.

Swivel Joint

The Swivel Joint (PSJ) is pressure balanced and oil filled to avoid any increase in seal friction at high ambient pressures and temperatures. The top and bottom sub-assemblies are linked by a shaft. This shaft is free to rotate on a set of bearings which accommodate both vertical and lateral forces, minimising rotational resistance.

Inclinometer / Accelerometer

The Inclinometer Accelerometer (PIA) measures the acceleration due to gravity with a range of ± 2g.with a corresponding inclination range from 0 to 180 degrees.

Technical specifications

	PKJ	PSJ	PIA
Temperature rating	350 °F (177 °C)	350 °F (177 °C)	350 °F (177 °C)
Pressure rating	15000psi (103MPa)	15000psi (103MPa)	15000psi (103MPa)
Tool OD	1 11/16” (43mm)	1 11/16” (43mm)	1 11/16” (43mm)
Length	6.5” (165mm)	10.87” (264mm)	12” (305mm)
Weight	3.7 lbs (1.7Kg)	6.2 lbs (2.6Kg)	4.4 lbs (2.0Kg)