Wireless Well Solutions
CaTS™ Cableless Telemetry System
CaTS™ technology for **wireless reservoir monitoring** and **control** – delivering value throughout the well lifecycle.

The **accurate data** we provide from Advanced Reservoir Testing™ (ART) allows our customers to **reduce reservoir uncertainty** and **optimise** the field development plan.

- More than **150** CaTS gauges installed
- In more than **20** countries
- With more than **20** gauges installed in a single well with a point-to-point wireless transmission range of more than 12,500 ft successfully delivered
**CaTS™ Cableless Telemetry System**

Expro’s Cableless Telemetry System (CaTS™) is a field-proven, battery powered, wireless data transmission system that offers operators immense advantages in the monitoring and control of both new and existing wells.

CaTS™ can be used in any well monitoring application where real-time data is required. It can be run either in a completion mandrel or as a retrofit gauge option where it is conveyed and set on wireline.

Our goal is to be the market leader in the wireless telemetry and control business.

**Products:**
- CaTS DST Surface Readout (SRO) and data services
- CaTS Retrofit Gauge
- CaTS Large Bore Gauge Mandrel
- FlowCAT™ Retrofit Wireless Safety Valve

**Applications:**
- Drill Stem Test (DST) optimisation and diagnostics
- Production monitoring
- CaTS Advanced Reservoir Testing (ART) - reducing reservoir uncertainty during appraisal
- Well integrity monitoring – barrier verification and annulus monitoring
- Production optimisation in big-bore high-rate gas wells
- Wireless flow control
CaTS Cableless Telemetry System

Based on electromagnetic (EM) data transmission technology, the CaTS system transmits low frequency EM signals from downhole to surface, or surface to downhole, using the well’s tubing or casing as the transmission medium.

The system can be retrofitted into existing wells using either wireline or coiled tubing, or alternatively, may be completion deployed. CaTS transmits high-quality pressure and temperature information and has gained broad industry acceptance as a cost-effective, high-value solution to many of the long-standing problems of acquiring downhole data.

The retrofit instrumentation of the existing well stock provides a real-time ‘data to desk’ capability that enables the reservoir engineer to proactively manage the reservoir effectively and to optimise production. Having access to real-time data enables the early diagnosis of well production or integrity issues thus allowing remedial action to be taken promptly.

The addition of duplex functionality to CaTS means that it can receive as well as transmit data, this means that the telemetry can then be used for downhole control applications. The ability to communicate with and control downhole hardware without the need for a cable or control line is a significant enabling component of retrofit flow control and offers benefits in minimising the number of control lines and penetrators typically required for today’s advanced completions.

Features:

- Uses standard completion hardware
- Does not require a tubing string in the well to communicate along
- Extended periods of in-well operation up to 60 months are achievable
- Retrofit capability using wireline or coiled tubing, retrievable for battery replacement
- Multi-drop, multi-sensor, addressable in-well
- Provides real-time BHP/BHT ‘data to desk’
- Readily deployed in complex well architectures – long-reach horizontal wells, abandoned subsea wells or zones, behind screens etc.
- Signal transmission is unaffected by the presence of cement or bridge plugs
- A completion-deployed CaTS mandrel variant enables full-bore well access and maximum flow rates to be achieved
# Technical specification

**CaTS 1¹¹/₁₆” wireless gauge**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td><strong>Technology owner</strong></td>
<td>Expro</td>
</tr>
<tr>
<td><strong>Product name</strong></td>
<td>CaTS™</td>
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<tr>
<td><strong>Signal type</strong></td>
<td>Electromagnetic</td>
</tr>
<tr>
<td><strong>Signal carrier</strong></td>
<td>Tubing / casing / earth</td>
</tr>
<tr>
<td><strong>Transmission range</strong></td>
<td>&gt;12,500 ft subject to well &amp; formation parameters</td>
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<tr>
<td><strong>Pressure range</strong></td>
<td>0 – 10,000 psi (0-15,000 psi optional)</td>
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<tr>
<td><strong>Pressure transducer</strong></td>
<td>Quartz crystal</td>
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<tr>
<td><strong>Pressure accuracy</strong></td>
<td>±0.025% FS psi (i.e. ± 2.5 psi for a 10K transducer)</td>
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<tr>
<td><strong>Pressure drift specification</strong></td>
<td>Max. 0.02% of full scale per year (i.e. 2psi / year for a 10,000 psi range transducer)</td>
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<tr>
<td><strong>Temperature range</strong></td>
<td>-20 to 125°C</td>
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<tr>
<td><strong>Temperature accuracy</strong></td>
<td>±1°C</td>
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### Pressure

<table>
<thead>
<tr>
<th><strong>CaTS gauge resolution</strong></th>
<th>Standard configuration:</th>
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<tbody>
<tr>
<td></td>
<td>0.1 psi transmitted</td>
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<tr>
<td></td>
<td>0.01 psi stored on tool</td>
</tr>
<tr>
<td>Optionally, high resolution (0.01 psi) pressure data can be transmitted to surface</td>
<td>1.0°C transmitted</td>
</tr>
<tr>
<td></td>
<td>0.1°C stored on tool</td>
</tr>
</tbody>
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### Temperature

- Typically 1 to 5 years, but depends on well parameters and number of data transmissions
- 11¹¹/₁₆” or 2¹¹/₈” (depending on battery selection)
- Corrosion resistant alloy
- 100,000 data sets
Applications

CaTS for production monitoring

Optimisation of the oil or gas production process requires knowledge of the bottomhole producing pressure. Monitoring of the production process using surface measurements requires approximations to be made and from which inefficiencies in production can result.

Retrofit of CaTS into existing production wells provides a cost-effective solution to achieving high accuracy, long-term monitoring, leading to improved production efficiency and longer well life.

CaTS retrofit process

CaTS can be retrofitted into the well using standard slickline services. The gauge is typically suspended below a gauge hanger set in a nipple profile, or alternatively can be set below a bridge plug. Where monitoring of several discrete zones in a given well is required, multiple CaTS gauges can be installed with the signals being multiplexed downhole, then decoded at surface by a multi-channel receiver.

Signal pick-up at surface is achieved simply by making an electrical connection to the wellhead. The signal is collected, decoded and stored in the topside receiver located at the wellsite. Where there is no electrical power supply available onsite, the topside receiver can be powered by solar panels.

Where real-time ‘data to desk’ is required by the client, the topside receiver can be interfaced to the client’s SCADA system or alternatively, a stand-alone GSM link can be put in place. When the downhole battery packs are depleted, the gauge can be retrieved to surface, the packs replaced and the gauge re-run.

Benefits of real-time data

Where an operator may have to monitor production performance from a field of tens or even hundreds of wells on a daily basis, it simply isn’t practical to visit each wellsite every day. By retrofitting CaTS into a selection of key wells in different segments of the reservoir and setting up real-time CaTS data transmission to the office, it is possible to receive vital early warning signs of pending production or well integrity problems. Using CaTS enables a proactive approach to be taken to minimise downtime and maximise production.
Over 20 years of research and development

Real-time ‘data to desk’ capability
Applications
Advanced Reservoir Testing™ (ART)

Reducing reservoir uncertainty

During exploration and appraisal drilling campaigns, critical decisions regarding future field development planning sometimes have to be taken based on very limited data sets. Uncertainty regarding reservoir connectivity and compartmentalization is one of the biggest risks the operators have to contend with during any hydrocarbon prospect and field development evaluation.

This uncertainty can be reduced by maximizing the time spent on appraising the prospect, but the pressure on minimizing rig time and cost reduction often results in appraisal activity being terminated prematurely. The value of reservoir data that leads to better decision making regarding recovery factors and field development plans is substantial and CaTS Advanced Reservoir Testing can help to provide this critical data.

Well testing beyond abandonment – a cost-effective solution

CaTS can be installed into an appraisal well at the end of a drill stem test and used to monitor the reservoir response, potentially for several years after well abandonment. By using the abandoned appraisal well as a long term monitoring asset it is possible to record any interference effects resulting from production or injection events in the adjacent field area. This data provides very high value information about the reservoir continuity and connected volumes between several remote well locations.

CaTS can also be applied in those situations where a long term pressure build-up (PBU) may be required to accurately characterise the reservoir or to identify far boundaries; continuing to accurately monitor the PBU for months or even years after the rig has departed the location.

By installing a CaTS system in the well at the time of well abandonment, and without in any way compromising the integrity of the abandonment, it is now possible to acquire high-quality reservoir pressure and temperature data for periods of up to five years beyond abandonment. Data from the abandoned well is transmitted from reservoir depth to the seabed using CaTS wireless technology, where it is stored in a CaTS remote subsea receiver for subsequent upload to a supply vessel passing overhead using through-seawater acoustic communications.

The battery powered CaTS wireless gauge is typically deployed into the well on either slickline or coiled tubing, or externally mounted on a tailpipe below a production packer. In a live well situation, it can be hung off below an abandonment plug set inside the below-packer tailpipe. Further barriers/cement plugs can then be set above the bridge plug in accordance with accepted well abandonment legislation. The use of standard completion equipment during the final well abandonment process streamlines the procedure and adds minimal time to the normal well abandonment operation. The absence of any cables penetrating packers/bridge plugs or the cement, which could potentially present a leak path for reservoir fluids, ensures that the pressure integrity of the abandonment is not compromised.

The fact that this can all be achieved without having to mobilise a rig at some later date to re-intervene the well, offers significant cost savings compared with using conventional cabled or memory-type pressure monitoring technology.
Features:

- No requirement for a tubing string or completion to be installed in the well, meaning that the well can be permanently abandoned with no requirement to re-enter the well.
- CaTS signal transmission is not affected by cement plugs, bridge plugs or by cemented pipe.
- CaTS can be installed into the well cost-effectively using conventional wireline or coiled tubing equipment and procedures.
- Any in-well cable arrangement represents a potential leak path; CaTS has no in-well cabling meaning that the integrity of the well abandonment is not compromised.
Applications
Production optimisation in high-rate gas wells

With the global hydrocarbon industry progressively moving towards a greater emphasis on gas production, the latest trend towards large bore completion designs makes traditional cabled reservoir monitoring technologies difficult, if not impossible, to apply effectively. CaTS offers a monitoring solution for high-rate gas wells that can allow the production to be optimised.

CaTS as a deep-set monitoring solution

The trend for completion designs in high productivity gas well developments typically includes the provision of a large bore production liner that may extend for several thousand feet above the reservoir. Use of a large bore liner prevents the placement of traditional cabled-type monitoring systems (permanent gauge systems) close to the producing sandface.

This means that a cabled monitoring system must be located several thousand feet away from the flowing sandface, which due to the gravity head difference and frictional pressure drop, introduces a significant uncertainty into the accuracy of the measurement and how it relates to the actual sandface flowing pressure.

A large bore CaTS mandrel, suitable for deployment in 9 5/8” casing/liner has been developed. When conveyed as part of a lower completion assembly, this can be positioned in close proximity to the producing sandface and then transmits the data through the casing or production liner to a pickup point located higher up in the well and somewhere above the production packer. The signal is then relayed to the seabed via a CaTS downhole signal pick-up and conventional 1/4” encapsulated cable located in the annulus.

At the seabed the signal is collected and processed in a CaTS subsea receiver, which is interfaced with the subsea electronics module of the tree provider to provide real-time data direct to the client’s network.

Where high-rate gas wells are being produced on drawdown constraint, having an accurate measurement of the sandface flowing pressure enables the operator to optimise the well production. Pressure transient analysis using data collected from close to the reservoir is more representative than data collected several thousand feet higher in the wellbore resulting in the operator gaining a better understanding of the reservoir.

Features:
- In drawdown constrained wells, having access to high accuracy flowing pressure measurements at the producing sandface enables the drawdown to be optimised and the flow rate to be maximised
- The data can be used to tune the lift curve correlations
- Pressure transient analysis performed on build-up data collected at the producing sandface provides more representative values for permeability and skin than for a remotely located cabled gauge
- Intelligent Well Interface Standardisation (IWIS) compatible CaTS subsea receiver
Retrofit installation of multiple wireless flow control valves
The ability to retrofit wireless flow control devices into wells’ through-tubing is an attractive option in several differing scenarios. Using the CaTS duplex communications capability, Expro’s FlowCAT™ offers a flow control solution that does not require a cable or control line to function and that can deliver benefits in both the brownfield and the intelligent well environments.

In the brownfield environment, producing every last drop of the hydrocarbon reserve is a key priority. In an attempt to access ‘stranded’ reserves, it is becoming common practice to use Through-Tubing Rotary Drilling (TTRD) to drill a lateral off the existing motherbore to tap into remote pockets of oil and gas that are not being produced by the main wellbore. Under such circumstances, being able to control flow from the lateral, independent of the main bore, presents some technical challenges. Since CaTS is a wireless solution that does not require a cable, then it is possible to communicate instructions to a flow control valve that has been retrofitted into the lateral by sending signals from the topside, down the main bore and into the lateral. In cases where the metallurgy of the motherbore and lateral are not physically connected, a ‘short-hop’ wireless communication technique to bridge the gap is now available.

FlowCAT also has applications when the tubing retrievable downhole safety valves fail. There are many wells around the world today which are currently shut-in and not producing due to damaged control lines or failed safety valves. The cost of working over the well to replace the valve is frequently not justified and thus the wells remain shut-in. FlowCAT can be deployed via slickline as a replacement for a failed downhole safety valve. A signal is transmitted from surface which keeps the valve open. If the signal stops, or a ‘close’ command is received, then the valve closes and provides a fail-safe system.

**Features:**
- Retrofitted into the well using conventional wireline equipment and procedures
- A fail-safe valve controlled from surface using Expro’s well proven CaTS technology
- Non-elastomeric sealing faces for enhanced sealing and well safety
- Qualification testing completed in accordance with a modified ISO 10432 class 1 test procedure

**Benefits:**
- No wellhead modifications or recertification required
- Targeting six to twelve months between battery change outs
- Resettable from surface by the application of pressure
- Capable of withstanding high differential unloading across the sealing faces
New technology & innovation

Well integrity monitoring

Verification challenges of double barriers

The sealing integrity of the deepest barrier can be verified by the application of a differential pressure from surface and using surface pressure sensing equipment.

Due to the relatively small volume of fluid trapped between the upper and lower plugs, compared with the large volume of fluid above the plug, the application of pressure from surface, when used with surface pressure monitoring equipment, will not be able to verify the sealing integrity of the upper plug.

Using the e-line and Casing Collar Locator (CCL), used to deploy the upper plug, as a signal pick-up, a solution was identified that allowed the pressure from below the upper plug to be transmitted to surface in real time when the differential pressure test from surface was being applied.

A key element of achieving excellence in well integrity is about having the necessary barriers in place and being able to verify them. Using new wireless gauge technology, it is now possible to verify the sealing integrity of the upper plug in a dual barrier sealing arrangement.

Features:

- Uses standard completion hardware with no requirement for electrical penetrations through the plug and is not influenced by cement plugs
- Requires no additional components in the logging string – meaning no additional risks in tool performance or reliability
- Compatible with any third party e-line provider’s cable, CCL and plug setting tools, providing for flexibility in deployment options
- Plug setting and pressure sealing verification can be completed in a single run in hole, resulting in operational efficiencies
New technology & innovation
DST Surface Readout (SRO)

Expro has continuously developed its capability to acquire accurate and reliable high quality data, allowing the customer to make informed decisions quickly, effectively and efficiently.

Expro’s data acquisition services provide monitoring solutions that apply at all locations from sandface to burner tip, including the EDGE data acquisition system for surface process monitoring, precision quartz memory gauges for reservoir pressure and temperature data and the CaTS wireless surface readout (SRO) system, providing real time bottomhole data on demand.

The EDGE system captures both surface and downhole well data and collates the information into a single report format for our customers to review at, or remote from, the well site. EDGE features a complete visual/audible alarm system, which can be configured, with upper and lower limits, to alert the operator or perform shut-down operations when any abnormal conditions occur. It can monitor virtually any number of sensors, while simultaneously performing multiple operations on the data, both real-time and historic.

The CaTS system transmits data to surface in real-time using electromagnetic (EM) signals. Having access to SRO data provides confidence in the data quality and quantity, leading to early decision making and optimisation of the testing program duration.

The CaTS family of DST SRO products comprises:

- EXchange™ – 15k psi, 150°C full wireless to surface with relay stations
- EXtract 1™ – 10k psi, 125°C below packer sensor station with data retrieval via e-line intervention
- EXtract 2™ – 15K psi, 150°C below or above packer sensor station with data retrieval via e-line intervention

The CaTS EXchange™ wireless surface readout (SRO) system provides real-time bottomhole data on demand throughout the test.

Features:
- Uses the well-proven CaTS wireless communications technology
- High specification quartz crystal sensors
- Features dual redundancy throughout the system for enhanced reliability
- Dual purpose gauge features both SRO and memory functionality

Benefits:
- No need for wireline intervention to receive data at surface, reducing intervention risk
- Suitable for use in high H₂S/CO₂ harsh condition environments
- Compatible with onshore, jack-up and semi-submersible operations
CaTS has gained broad industry acceptance as a cost-effective, high-value solution to many of the long-standing problems of acquiring downhole data.
# Applications, features & benefits

<table>
<thead>
<tr>
<th>Product</th>
<th>Applications</th>
<th>Benefits</th>
<th>Features</th>
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<tbody>
<tr>
<td>Drill Stem Testing (DST)/Surface Readout (SRO)</td>
<td>Drill stem testing SRO P/T data</td>
<td>Uses proven wireless communication technology</td>
<td>High specification quartz crystal sensors</td>
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<td></td>
<td></td>
<td>No wireline intervention required, reduces risk</td>
<td>Dual redundancy for enhanced reliability</td>
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<td>Dual purpose gauge with SRO and memory capability</td>
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<td></td>
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<td>Operational flexibility</td>
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<tr>
<td>Advanced Reservoir Testing™ (ART)</td>
<td>Reducing reservoir uncertainty</td>
<td>No requirement for completion tubing in well</td>
<td>EM technology through tubing/casing communications</td>
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<td></td>
<td>Interference testing</td>
<td>Well can be permanently abandoned without compromising well integrity</td>
<td>Uses standard completion hardware</td>
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<td></td>
<td>Long term PBU</td>
<td>Installation requires minimal rig time</td>
<td>Zero signal attenuation due to cemented pipe, cement or bridge plugs</td>
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<td></td>
<td>Adds value to an existing well</td>
<td>Flexible deployment options</td>
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<tr>
<td>Large bore mandrel</td>
<td>Production optimisation in high-rate big-bore gas wells</td>
<td>Allows placement of deep-set monitoring systems close to the producing sandface</td>
<td>Wireless communications to the sandface gauge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accurate assessment of flowing and bottom hole pressure and temperature</td>
<td>Mandrel system deployed as part of the lower completion assembly</td>
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<tr>
<td></td>
<td></td>
<td>Optimised production</td>
<td>Full duplex communications, quartz sensor and battery pack</td>
</tr>
<tr>
<td>Well integrity</td>
<td>Pressure barrier verification</td>
<td>CaTS technology enables verification of the sealing integrity of the upper plug in a dual barrier sealing application</td>
<td>Uses standard completion hardware with no requirement for electrical penetrations through plug</td>
</tr>
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<td></td>
<td>Annulus monitoring</td>
<td>Annulus monitoring without penetrators</td>
<td>Not influenced by cement plugs</td>
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<td>Requires no additional components in the logging string</td>
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<td>Compatible with any third-party providers’ e-line cable, CCL and plug setting tools</td>
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<td>Operation completed by a single run in hole</td>
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<tr>
<td>Retrofit gauges</td>
<td>Production monitoring</td>
<td>Cost effective solution for high accuracy long term monitoring</td>
<td>Retrofittable using standard slickline services</td>
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<td></td>
<td></td>
<td>Resulting in improved production efficiency</td>
<td>Uses conventional suspension hardware</td>
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<td>Early diagnosis of well integrity issues</td>
<td>Capable of monitoring multiple zones in a well</td>
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<td>Real-time ‘data to desk’ capability</td>
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<td>Reusable gauges for prolonged reservoir monitoring</td>
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<tr>
<td>FlowCAT™</td>
<td>Wireless flow control</td>
<td>A retrofit wireless safety valve, a fail-safe surface controllable alternative to a storm choke valve</td>
<td>Fail-safe closed design</td>
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<td>Uses standard installation equipment and procedures</td>
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<td>Robust wireless telemetry technology</td>
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<td>Flexible depth setting using standard suspension devices</td>
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<td>Can be re-set from surface by applying pressure</td>
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</table>
Another world first was the subsea deployment of Expro’s CaTS in one of the Clair Ridge appraisal wells. This tool provides a unique insight into pressure across the field, helping to give BP and its partners a better understanding of Clair’s complex reservoir formations.

“...the CaTS data has already proven its value on one of the newly commissioned wells where produced water measurements at the xmas tree were outside the normal operating range. By having the CaTS data available, we were able to demonstrate this was a metering issue, allowing us to continue ramping up the well.”
Expro’s mission is **well flow management**. We provide services and products that **measure, improve, control** and **process** flow from high-value oil and gas wells, from exploration and appraisal through to mature field production optimisation and enhancement.

With a specific focus on **offshore, deepwater** and other **technically challenging environments**, we provide a range of mission critical services across **three key areas**:

- Well Test & Appraisal Services
- Subsea, Completion & Intervention Services
- Production Services

Our vision is to be the **market leader** in well flow management, using the industry’s best people, to deliver the highest standards of **safety, quality** and **personalised customer service**.

Expro’s **40+ years** of experience and innovation empowers the company to offer **tailor-made solutions** for customers across the energy sector. With 4,500 employees in over 50 countries, Expro offers a **truly global service solution**.
For further information on the Cableless Telemetry System, please contact:
wireless@exprogroup.com

or visit www.exprogroup.com