Schlumberger has developed an extensive range of technologies and services that meet the variety of technical, logistical, and regulatory conditions operators face today.
The Decommissioning Challenge

The combination of ageing fields and government directives is driving a significant increase in well and installation abandonment related activities. Operators around the world are investigating and implementing innovative technologies and methods that enable them to fulfill business and regulatory requirements in a responsible and cost-effective manner.
The Integrated Well Abandonment Service

Schlumberger has developed an extensive range of innovative technologies and services that meet the variety of technical, logistical, and regulatory conditions operators face today. The Integrated Well Abandonment (IWA) service uses this range of Schlumberger technologies and processes, many of which have been used in this type of project for decades, to offer an integrated approach to well abandonment.

Schlumberger IPM (Integrated Project Management) has extensive experience in integrating services, providing engineering expertise, and managing a complete supply chain for oil and gas projects worldwide. IPM makes use of the Schlumberger portfolio of technologies and services, combining third-party activity where required, to offer the full scope of abandonment services—from reservoir-related to surface installations.
Experience

- Industry-leading technologies across the well abandonment workscope
- Environmentally responsible recovery and management of all fluids
- Track record of successful well abandonment campaigns in diverse conditions

Competence

- Flexibility to provide any required level of service integration and/or coordination
- Adaptable well engineering, tailored according to each well type and condition
- Certified project managers and dedicated, cross-trained crews

Cost-efficiency

- Statutory compliance at minimum cost
- Fit-for-purpose technologies for all well types and conditions
- Rigless operations and multiskilled teams
- Overcoming tubing collapse access and integrity issues
- HLV-deployed plug and abandonment (P&A) rig to replace platform rig
Technical challenges

The solutions to technical challenges in abandonment are diverse, but typically include:

- multiple annulus cement logging tools
- reduced-length plugging techniques (using new materials/techniques)
- qualifying mobile shales as an isolation barrier
- avoidance of section milling/removal with improved remediation techniques
- if section milling/removal is required, innovative and improved techniques are employed
- solving the completion cable/control line challenges in situ or with removal
- complex well tubing, casing, and conductor recovery
- automated/integrated rigless well (P&A) equipment spreads
- overcoming tubing collapse access and integrity issues
- identifying and addressing causes of casing annulus pressure
- HLV-deployed P&A rig to replace platform rig
- improved barrier verification.
Leveraging a complete range of technologies to meet the challenges

The industry has been abandoning wells for nearly as long as it has been drilling them, with many technologies and services well established. Among the most common are fishing, milling, cementing, cement evaluation, explosives operations, and fluids management.

Today, however, the wells and environments where abandonment and decommissioning are required are increasing in complexity, both technically and economically. The Schlumberger IWA service encompasses the entire Schlumberger organization to draw on the technologies, services, and people that will best fit your project needs. No two IWA service offerings are the same; each combination of our resources will be a unique and considered package, specific to your project’s requirements.
## Project Management and Engineering

- Well abandonment design
- Integrated project management
- Third-party management

## Conveyance and Measurements

- Wireline intervention services
- Slickline services
- Coiled tubing services

## Mechanical Services

### Perforating:
- Wireline perforating
- Coiled tubing perforating
- Slickline perforating

### Tubulars:
- Fishing services
- Section milling
- Abrasive perforating
- Casing cutting
- Impact tools
- Conductor removal

### Barriers:
- Cementing services
- Bridge plugs
- Inflatable packers
- Wireline plugs

## Environmental Services and Equipment

### Fluids:
- Solids control
- Viscous pills
- Fluids disposal

### Cementing:
- Cementing equipment
- Cementing technology

### Topside equipment:
- Lift mast
- Rigless systems
To see the range of Schlumberger technologies, services and products available to meet your project’s challenges, visit www.slb.com/techbriefs. TechBriefs provide a series of concise, one-page summaries of Schlumberger technologies, explaining operational applications, with key specifications.
A selection of relevant technologies that might be applied within the IWA service follows.
FlexSTONE HT Advanced High-Temperature Flexible Cement Technology

Technology summary
FlexSTONE HT* advanced high-temperature flexible cement technology provides cement blends that offer lifelong zonal isolation in HPHT oil and gas wells. By enabling the set cement to conform to the changes that occur during the drilling, production, and abandonment phases of the well, the technology helps to reduce or eliminate well maintenance and remediation costs.

For example, the cement system can preserve isolation during stimulation treatments, reduce the risk of annular pressure buildup during a well’s producing life, and extend the productive life of wells in tectonically charged areas. Cement plugs using FlexSTONE HT technology enhance security in uneconomic wells that need to be permanently abandoned. Each slurry is individually designed for the specific well application, and has mechanical properties matched to the downhole stress environment likely to be encountered.

How it works
By combining cement flexibility (low Young’s modulus) with a linear expansion on setting that is up to four times greater than that of conventional cements, FlexSTONE HT technology improves resistance to cement sheath cracking and microannulus development. Slurry rheology and set-cement mechanical properties are customized by controlling the solid volume fraction and using engineered particle-size distribution to accommodate the predicted stresses.
Numerical analysis modeling with CemSTRESS* cement sheath stress analysis software is used to predict the stresses that the cement sheath will experience over the life of the well. The software then models the mechanical performance of cement systems under changing well conditions, quantifying ranges of values for individual parameters that will avert cement sheath failure.

The complementary SlurryDesigner* cement blend and slurry design software helps to design a cement system that keeps the Young’s modulus below the stress level predicted to induce failure. The predicted set-cement properties can then be used as inputs to CemSTRESS software to further optimize the robustness of a particular cement system.

**Typical applications**
- Reliable cement plugs for HPHT well abandonment
- Lifelong zonal isolation in HPHT wells

**Key specifications**

The density range is 10 to 20 lbm/gal US [1.2 to 2.4 kg/L].

FlexSTONE HT technology can be used at downhole temperatures up to 250 degC.

In temperatures below 150 degC, the FlexSTONE* advanced flexible cement technology is normally used.
Technology summary

LIVE* digital slickline services enhance the quality and safety of slickline operations through two-way digital communication between a surface acquisition and control system and a range of battery-powered downhole intervention tools. Advantages include continuous and accurate depth correlation, dynamic control of downhole tools, and surface readout (SRO) to confirm downhole actions and the success of the job before pulling out of hole.

Cable tension and toolstring shock, deviation, and movement are all measured by a downhole basic measurement cartridge (BMC) and monitored in real time at the surface. In addition, accurate and precise depth correlation is available through gamma ray and digital casing collar locator (CCL) measurements. This cartridge also manages the telemetry. Downhole pressure and temperature data are also available when a pressure gauge is run as part of the toolstring. These capabilities can be harnessed when run in conjunction with tools for mechanical, remedial (setting, sealing, perforating), and measurement services. Each sensor’s data is sent, via telemetry, to the surface and is also recorded in memory.

How it works

A digital slickline has an integral coating for digital telemetry and is deployed using a slightly modified standard slickline unit and pressure control equipment. Digital slickline services retain
the minimal footprint and logistical ease (size and weight), operational efficiency (conveyance speeds, crew size), and reduced environmental and operational risk (no grease injection for pressure control) that are inherent to slickline operations.

The BMC provides power to all the sensors, as well as the telemetry to send data from each sensor to the surface at the proper rate. It also receives control signals from the surface transceiver. Downhole data is transmitted to surface in real time, where it is captured and displayed. In addition, the surface system sends commands to activate downhole tools.

**Typical applications**

- Mechanical operations such as drifting, pulling, and shifting
- Sealing zones for maintenance on standard and monobore completions, including those with damaged nipples
- Securing wells containing a damaged or nonexistent control line
- Setting downhole components, including plugs and cement retainers, without explosives
- Perforating, punching tubing, and cutting for pipe recovery
- Running production logs with SRO for a complete range of combinable sensors, from quartz pressure to water holdup

**Key specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature rating</td>
<td>300 degF [150 degC]</td>
</tr>
<tr>
<td>Pressure rating</td>
<td>15,000 psi [103.4 MPa]</td>
</tr>
</tbody>
</table>
ReSOLVE Instrumented Wireline Intervention Service

Technology summary
The ReSOLVE* instrumented wireline intervention service sets new standards for success in well intervention operations through real-time monitoring of tool activity and operational progress, dynamic tool control, and verified downhole actuation. Sensors in the family of downhole tools and high-speed, bidirectional telemetry eliminate the reliance on estimates and assumptions associated with conventional “blind” intervention methods.

How it works
Four different tools can be assembled on the basic configuration of the telemetry and control modules. The ReSOLVE anchor tool uses innovative anchor grips to minimize tubing damage when set. Once anchored, the actuator can be extended and retracted multiple times to reliably apply a controlled axial force of up to 45,000 lbf to shift a well component. Displacement and applied force are set by surface parameters and continuously measured to validate the operation.

Paired with the ReSOLVE anchor and linear actuator, the ReSOLVE selective universal shifting tool (UST) radially extends profile keys that engage selected completion components but remain compliant to navigate the well geometry. The UST enables multiple shifts in any direction in a single run, to one component (e.g., a sliding sleeve) or many. The ReSOLVE nonexplosive setting tool is hydraulically powered, providing a large force for setting plugs and packers.
**ReSOLVE Instrumented Wireline Intervention Service**

With real-time confirmation of the applied force and a variable setting speed, the tool is a reliable, low-risk alternative to explosives. These tools are conveyed on wireline by gravity or by tractors. The seamlessly integrated TuffTRAC* cased hole services tractor drives the ReSOLVE milling tool forward. The AutoMill* control system can automatically adjust weight on bit (WOB) through the tractor to maintain constant bit torque to maximize milling progress and prevent or recover from stalls.

### Typical applications

- Opening and closing valves, shifting sliding sleeves and components below restrictions, pulling retrievable plugs, fishing
- Setting plugs, packers, and cement retainers without using explosives
- Milling scale, plugs, tubing restriction

### Key specifications

<table>
<thead>
<tr>
<th></th>
<th>Linear actuator</th>
<th>Setting tool</th>
<th>Milling tool</th>
<th>UST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output</strong></td>
<td>Basic configuration: wellbore pressure and temperature, head tension, collar locator, optional gamma ray</td>
<td>Anchor and linear force, anchor and linear displacement</td>
<td>Setting force</td>
<td>Bit torque, WOB, bit speed (rpm), relative bearing (tool orientation)</td>
</tr>
<tr>
<td><strong>Temperature rating, degF [degC]</strong></td>
<td>300 [150]</td>
<td>300 [150]</td>
<td>300 [150]</td>
<td>300 [150]</td>
</tr>
<tr>
<td><strong>Max. borehole size, in [cm]</strong></td>
<td>6.7 [17.02]</td>
<td>Configuration dependent</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Technology summary**

The Shortcut® deepwater plug and abandonment system is used in the abandonment process for subsea wells. Comprising a hydraulic pipe cutter, mud motor, Hydra-Stroke® bumper sub, P&A spear, bumper jar, and wellhead seal assembly retrieval tool, the system makes the entire operation of cutting and recovering casing feasible in a single trip.

The heart of the system is the spear, which can be engaged near the sever point to facilitate the cutting operation, then released and re-engaged at the top of the casing segment being removed to pull the casing to surface. Once the recovered casing is hanging in the rotary table, the spear can be released and the workstring racked out of the way, leaving the casing to be handled with greater safety and efficiency as it is removed from the wellbore.

**How it works**

The BHA is run in hole past the planned cut depth to sting the wellhead seal assembly retrieval tool into the wellhead, engage the casing hanger seal assembly or wear bushing, and pull it free. The seal assembly and retrieval tool are then pulled up into the riser, positioning the cutter at the predetermined cut depth.

Slight left-hand rotation while picking up causes the spear to engage the casing, and an overpull enables it to place the casing in tension near the cut point for faster cutting.
The mud pumps are brought online, activating the mud motor and opening the arms of the hydraulic pipe cutter to sever the casing. Once the casing is cut, the cutter arms are retracted. The bumper jar above and Hydra-Stroke bumper sub below the spear provide impact or jarring when required to free a section of casing. The spear disengages and the drillstring and BHA are tripped out of the hole until the spear is just below the wellhead. The spear is then re-engaged and the casing pulled to surface. With the casing in the rotary slips, the spear can be disengaged and the Shortcut system assembly racked back in the derrick.

**Typical applications**
- Subsea well abandonment operations where casing needs to be cut and removed
- Pipe recovery operations where multiple casing cuts may be required

**Key specifications**

<table>
<thead>
<tr>
<th>Casing size</th>
<th>9% to 13% in</th>
</tr>
</thead>
</table>
**Technology summary**

Large volumes of swarf—metal shavings, filings, and chippings that result from metalworking operations—can be generated during casing milling activities (e.g., during slot recovery and well decommissioning operations). This waste requires a reliable and efficient means of disposal at surface. The M-I SWACO swarf unit is a processing system for the separation of swarf waste from milling fluid. It comprises swarf-handling shakers, chutes for transferring the swarf to collection skips for disposal, and holding tanks and pumps for fluid processing.

**How it works**

The swarf unit is located close to the riser or the highest point of the flowline. Pipes or hoses linked to the riser below the bell nipple or to the flowline direct the milling fluid to the unit. The fluid passes over the swarf-handling shakers, which are fitted with screens of an appropriate mesh size to capture all solid waste before the fluid is returned to the active system. The swarf is directed to special cuttings chutes that feed collection skips placed below the handling unit. Milling fluid passes through the screens into a holding tank, from where it is either gravity fed or pumped back to the rig’s active system.
Swarf Unit

Typical applications
- Slot recovery operations on offshore installations where there is a need to mill casing before sidetracking
- Casing milling activities associated with asset recovery and platform decommissioning operations at the end of the effective field life

Key specifications
- Components vary but typically include isolation valves and piping, header box, shale shaker(s) with appropriate screens, cuttings collection boxes, collection ditch magnets, and milling fluid holding tank.
- Footprint is custom-designed, dimensions and weight vary.
- Unit is Zone 1 rated and fully compliant with UK and Norwegian certification standards.
- Operating capacity is in excess of 2 t/h.
- Offshore transportable lifting frame meets certification standard DNV 2.7-1.
- Power requirements vary.
- Rig air requirements are 6 to 7 bar (600 to 700 kPa).
No two IWA service offerings are the same; each combination of our resources will be a unique and considered package, specific to your project’s requirements.
The IPM Difference

- Execution Excellence
- People and Process
- Technology
- Commercial Alignment

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