Oil companies depend on critical well data to make informed field development decisions. However, as drilling capabilities expand, so do the challenges of data acquisition. Deep water and complex well geometries force information-gathering technologies, including wireline operations, to adapt accordingly.

These extreme conditions push standard wireline operations and their conveyance systems to the limit. Longer cables and complex combinations increase both the logging tension and the surface contact area between the downhole tool housing and the wellbore. These circumstances create significant challenges.

Tool sticking, fishing operations, cable failure and drum damage cost time and money while also posing HSE risks. To avoid wireline-related incidents, companies must meticulously abide by costly and time-consuming procedures and requirements, including the possible deployment of additional tension-releasing equipment. The alternatives are not appealing: risking a catastrophic failure, sacrificing complete data collection or using a drillpipe conveyance method.

Alternative cable design
A close collaboration between Schlumberger and Total led to the first use of the TuffLINE 18000 cable. The operator used the design features of the new torque-balanced composite wireline cable to lessen logging tensions within safe limits at its ultra-deepwater West Africa well. Using this alternative cable lessened the tension to within acceptable limits, enabling complete data acquisition with minimum descents and time while simultaneously reducing operational, maintenance and safety risks.

A standard openhole wireline cable consists of a central conductor and six peripheral conductors shielded by a protective polymer jacket. Two helically wound galvanized steel armors (inner and outer) protect the core, provide mechanical strength and share the load. The armor strands bind neither to each other nor to the core, allowing free rotation and stretch. These opposite-wound armors create equal and opposing torque. However, the inner armor of a standard cable has fewer strands than the outer, thus limiting the overall cable strength and torque-balancing capability.

Due to the initial torque imbalance that can cause premature breakage, operators must season the cable. Although this breaking-in process uses hours of valuable rig time, it is necessary given that a new high-tension cable can experience a one-time permanent stretch of 15 m (50 ft). Once in normal operation, rig operators must adhere to both safe working load limits and cable swap guidelines. Despite following these procedures, numerous limitations and challenges remain.

The smaller mass of the inner armor results in a torque imbalance during standard cable tension cycling. This leads to an accelerated torque buildup that can potentially result in a premature break at the surface, causing thousands of feet of cable to drop into the well. Cable replacement also is necessary when armor stranding occurs.

Even without such a major incident, standard wireline cable requires onshore twisting maintenance after every high-tension operation. A tension-relieving capstan may also be required under high logging-tension situations, introducing additional operational and logistical risks.

The new Schlumberger-designed alternative cable addresses many of these limitations. The torque-balanced...
composite wireline cable eliminates armor strand movement by using polymer to lock the armors and core together. This increases the cable breaking strength by 4,000 pounds force (lbf) and the safety margin by 2,000 lbf as compared to standard high-tension cable. Polymer shielding also reduces the risk of cold flow while eliminating the need for seasoning. Due to its reduced torque accumulation, it has an increased cycling frequency and does not require onshore twisting maintenance as often.

The cable has fewer and smaller outer armor strands, reducing both the weight of the cable and the friction between the steel casing and wellbore (Figure 1). This both increases the maximum tension available at the logging tool and reduces the risk for tool sticking. Conversely, the wire conductors are larger, enabling 30% higher power and telemetry as compared to standard high-tension commercial cable.

**West Africa implementation**

Total experienced firsthand the benefits of this alternative cable at its West Africa deepwater well. The 5,400-m (17,716-ft) S-shaped well had a maximum deviation of 24 degrees at a depth of approximately 3,500 m (11,483 ft). A planning tool predicted that the logging tension in the 8¼-in. vertical section of the well would exceed the 10,000-lbf tension limit for standard cables and have a high risk of torque buildup and cold flow.

The operator considered, but rejected, three traditional tension-reducing options for the following reasons. A tension-relieving capstan would pose significant hardware availability and rig readiness issues in a short time frame. Drillpipe conveyance would add four days of rig time and millions of dollars in cost. Finally, additional descents using a lighter string weight and smaller sensor combination would require three additional days and increase the chance of missing critical well data.

A fourth option was pursued: Bring in the torque-balanced cable spooled on a standard drum and deploy on the existing rig winch unit. Since this cable does not require seasoning, data acquisition was not delayed. As predicted, use of the alternative cable lessened the logging tension and enabled complete data acquisition. Even though the operator deployed a heavier tool string, tension in the 8½-in. section never exceeded 9,400 lbf, substantially less than both the 10,700-lbf standard cable prediction and the 10,000-lbf critical limit (Figure 2). Calculations revealed that the effective friction coefficient of this alternative cable was 20% less than the standard high-tension cable.

Despite the lack of seasoning, permanent cable stretch was negligible. Depth accuracy, or repeatability, was within 2 in. between the two descents in a well section deeper than 5,000 m (16,404 ft). The company collected a complete set of data during eight descents without a single operational or HSE incident. During this time, personnel operated with an unprecedented 9,000-lbf safety margin and a safe working load limit of 18,000 lbf.

Using this alternative cable was a safer, quicker and more economical choice. In fact, a proprietary hazard analysis and risk control tool calculated a 60% reduction in potential operational and HSE risk as compared to a standard capstan-assisted high-tension conveyance operation.

**Additional applications**

This new alternative wireline cable has many applications in deepwater, ultradeepwater, extended-reach and complex trajectory wells. However, horizontal and highly deviated wells may require additional push or pull. That is when wireline conveyance tractors come into play.

Although not needed in the West Africa case, this alternative cable is compatible with the UltraTRAC all-terrain wireline tractor. This tractor eliminates the need for drillpipe conveyance of heavy wireline combination strings in wells deviated beyond the gravity conveyance boundaries with minimal time and risk. Together or alone, the cable and tractor expand wireline data acquisition while reducing operational, maintenance and HSE risks.