

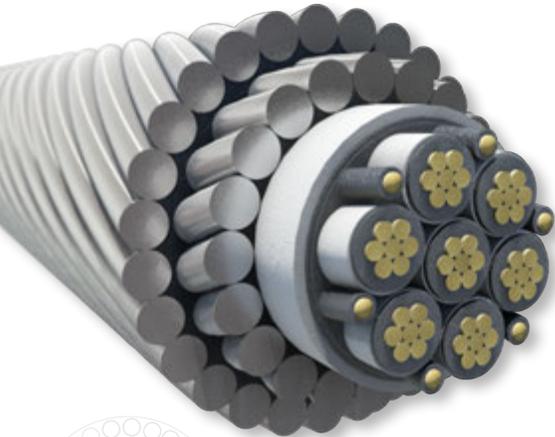


TuffLINE

Torque-balanced
composite wireline cable

TuffLINE

TuffLINE* torque-balanced composite wireline cable introduces new capabilities in wireline data acquisition with unprecedented improvements in safety, efficiency, reliability, and sticking avoidance.



TuffLINE 18000 composite cable is torque-balanced, crush-proof cable for operations with up to 18,000-lbf tension.

Applications

- Deepwater and ultradeepwater wells
- Extended-reach and complex-trajectory wells
- Deepwater wells with rig-up constraints for capstan operations
- Reservoir sampling and pressure measurement involving extended station times with long and heavy toolstrings

Benefits

- Increased safety for high-tension operations with risk mitigation and prevention
- Improved wireline logging efficiency from fewer runs of heavier, longer tool combinations and avoidance of drillpipe conveyance
- Reduced cable maintenance and related transportation logistics
- Greater sticking avoidance through minimized risk of fishing operations and associated NPT
- Increased deepwater rig-time savings with no cable seasoning required

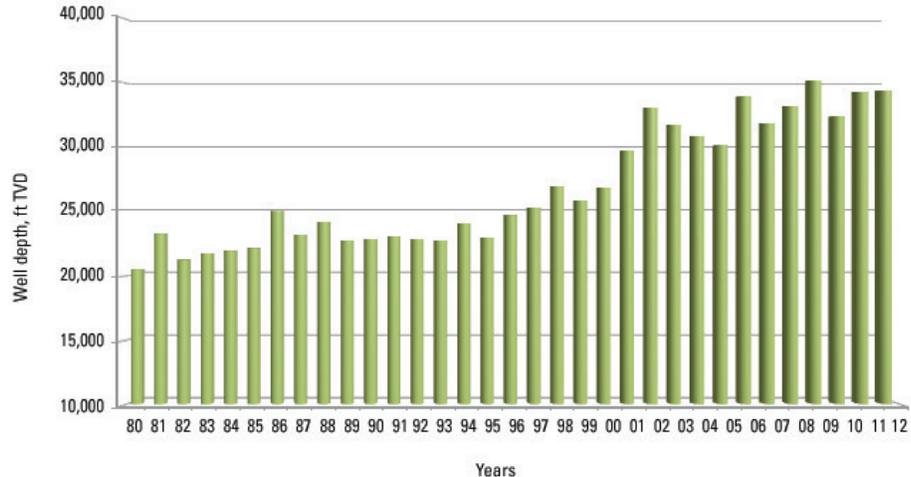
Deepwater and ultra-deepwater challenges

As deeper reservoirs come into play worldwide, wells today can exceed 36,000 ft, 30,000 psi, and 500 degF. In these challenging conditions, wireline conveyance—in particular, the cable—becomes the most critical component of wireline operations with numerous concerns:

- High tension—With heavy strings in deep and complex-trajectory wells, the cable logging tension can exceed 15,000 lbf.
- Prevention and mitigation of tool sticking—The latest conveyance technology allows pulls up to 22,000 lbf.
- Long, heavy toolstrings in deep wells—Longer wireline tool combinations can reduce the number of wireline descents in a well to save rig time, but the cable must sustain a significant increase in electrical power and telemetry requirements.

High-tension operational risks

Cable torque. Inherent to the structure of armored wireline cable, torque is the primary cause of premature high-tension cable breakage.



Maximum well depth recorded has increased over the past two decades.

- High tension and cable cycling lead to torque accumulation at sheaves and other pinch points, which in turn causes birdcages and ultimately cable breakage.
- After every high-tension trip in the well, torque relief maintenance in specialized cable shops is required for standard high-strength cables.

Ends-free cable breaking-strength safety margin. Although cable manufacturers specify the cable breaking strength for “ends fixed,”

meaning the ends of the cable cannot rotate, wireline armored cable spooled in a well has the tool end free to rotate. This “ends free” condition results in armor rotation and load imbalance between the inner and outer armor that cause the cable to break at a lower tension than specified.

Cable core crush and cold flow. High-tension spooling on the drum leads to cable crushing and electrical failure in addition to drum damage and potential catastrophic failure.



TuffLINE 18000 ultrastrength wireline cable: Torque-balanced, crush-free, high-temperature performance

TuffLINE 18000 composite cable integrates the breakthrough technologies of polymer-locked armors and crush-free electrical cable cores to effectively overcome the fundamental limitations of current armored cables. This unique combination is the latest advance pioneered by Schlumberger in over 40 years of designing and manufacturing cables, including 5 years of engineering development and testing of the polymer composite cable technology. TuffLINE cable is exclusively manufactured at the Schlumberger Houston Conveyance & Surface Equipment Center.

Torque-balanced cable

With its unique polymer locking of the inner and outer armors, TuffLINE 18000 cable is torque balanced, which means that it remains in a consistent state of low torque. Any torque buildup is negligible, which prevents birdcaging and premature cable breakage. The resulting benefits to deepwater operations are significant:

- Multiple high-tension operations can be conducted, including cycling and jarring, without compromising cable integrity.
- Maintenance trips to the cable shop are reduced by 80%.
- No cable swapping is necessary during extended logging operations.

Unprecedented breaking-strength safety margin

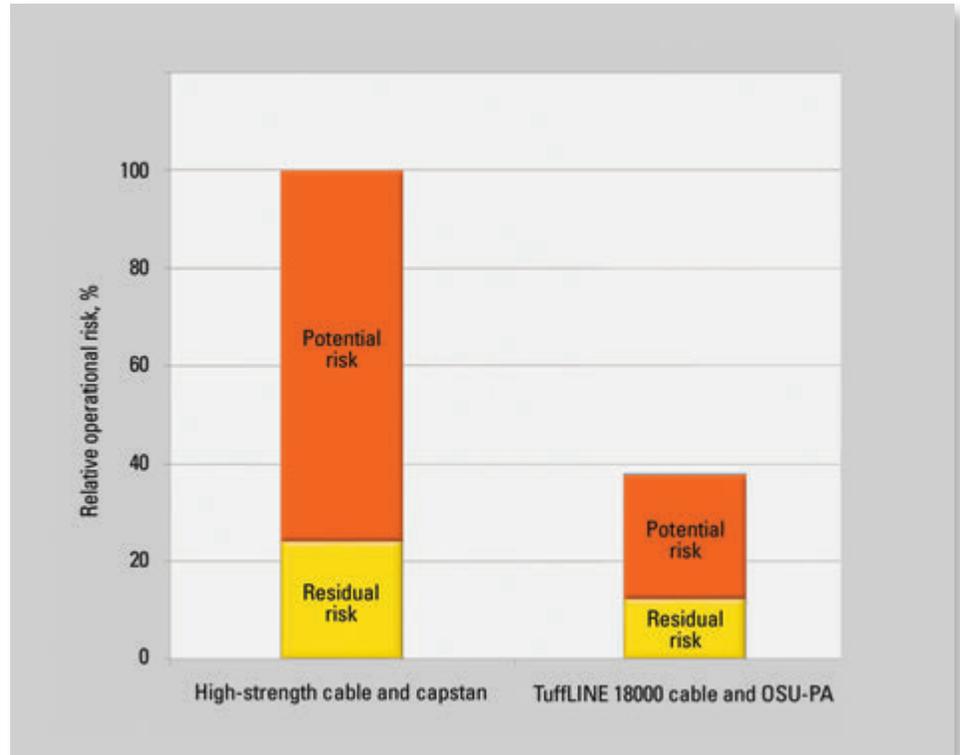
Because polymer locking of the armors prevents rotation, the cable is effectively in a permanent ends-fixed situation, which raises the ends-free breaking strength to 27,000 lbf. This is only 1,000 lbf below the ends-fixed breaking strength and has a breaking-strength safety margin of 9,000 lbf above the safe working load. At these values the risk of cable breakage resulting from accidental overpull above the safe working load is greatly reduced. In comparison, standard cables have a significantly lower ends-free breaking strength, along with a reduced safe working load and safety margin.



Risk mitigation

Where continuous logging tensions are 13,000 lbf or lower, TuffLINE 18000 cable deployed using the OSU-PA modular heavy-duty offshore unit greatly improves performance and reduces operational risk over deploying high-strength cable using a capstan.

- Operational risk is significantly reduced by eliminating one component—the capstan.
- No seasoning for new cables saves 1 day of rig time.
- Cable can be cycled with multiple overpulls and no risk of breaking from the effects of torque.
- High breaking-strength safety margins apply in the event that cable is pulled beyond its safe working load limit.



TuffLINE 18000 cable deployed using an OSU-PA offshore unit reduces both potential and overall operational risk by more than 60% compared with conventional operations using high-strength cable and a capstan.

Crush-proof cable core

At tension higher than 10,000 lbf, conventional cable spooling on the drum leads to

- cable core crushing that causes cold flow and multiple electrical short circuits in a cumulative, irreversible process
- cable flattening under high tension that can also cause bending of the wireline drum flange and possible crushing of the drum core.

The conventional prevention approach is to apply a complex tension-relief system in which the capstan is used to reduce winch spooling tension to below 10,000 lbf.

TuffLINE 18000 cable incorporates a multi-layered core that is crush-proof. Cold flow and the permanent deformation it causes are further prevented by the polymer locking of the armors. Spooling tensions of 13,000 lbf and higher are possible without requiring use of a tension-relief capstan or having to resort to time-consuming pipe-conveyed operations.

Long, heavy toolstrings comprising multiple tools and sensors

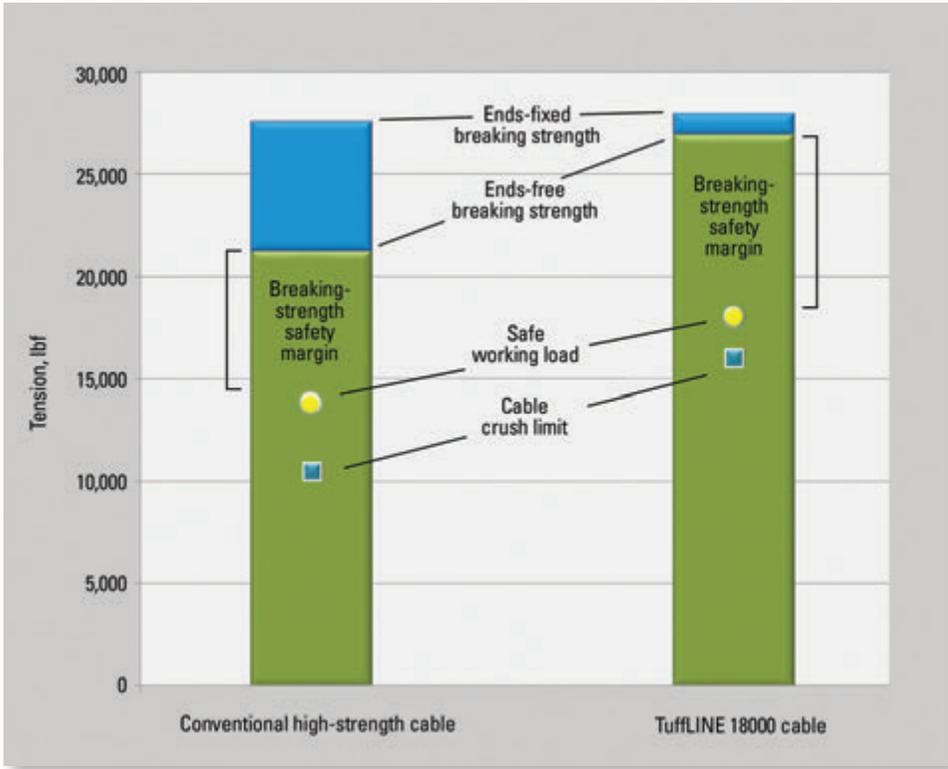
Unlike industry standard high-strength cables, TuffLINE 18000 cable has 18 AWG gauge wires, enabling higher power and telemetry capabilities to support significantly larger tool combinations in deeper wells. Combining tools reduces the number of descents in the well, saving an average of 12 h or more per trip on a deepwater rig.

High-temperature operations

The high-temperature polymers used in the TuffLINE core and armors are rated for an operating temperature of 450 degF [232 degC], making TuffLINE 18000 cable suitable for hot reservoirs in deepwater operations.



Schlumberger manufactures a variety of proprietary cables.



TuffLINE 18000 cable offers numerous advantages over conventional high-strength cable that is similarly rated at 28,000-lbf breaking strength. TuffLINE 18000 cable will not break until 27,000-lbf tension (ends free) is attained, whereas the conventional high-strength cable can break at only 21,500 lbf. The safe working load of the standard high-strength cable is 14,000 lbf, 4,000 lbf less than that of TuffLINE 18000 cable. For conventional cable, crushing cold flow of the core occurs at about 10,000 lbf, whereas TuffLINE 18000 cable can spool up to 16,000 lbf without crushing or requiring use of a capstan tension-relief system.

Case Study



TuffLINE 18000 composite cable successfully logs at +10,000-lbf tension with multiple pulls up to 16,000 lbf

An East Mediterranean well had been deepened, and logging tension was expected to increase to more than 10,000 lbf. Capstan deployment was not possible because of limited time and deck space. The only conventional solution was to convey the wireline logging tools on drillpipe, which would require 5 additional days of expensive rig time.

Instead, TuffLINE 18000 composite wireline cable was deployed on short notice and the logging operation was successfully completed in 3 days' time. With multiple pulls up to 16,000-lbf tension and repeated cable cycling, tool sticking was avoided.



OSU-PA and OSU-PB 18,000-lbf offshore units

The OSU-PA is the Schlumberger flagship heavy-duty modular offshore unit, capable of pulling up to 18,000 lbf with 36,000-ft drum capacity for TuffLINE 18000 or standard high-strength cable. In combination with TuffLINE 18000 cable and the WDR-59 high-strength drum, the OSU-PA can provide continuous spooling of up to 13,000-lbf tension and instantaneous maximum pull for stick prevention and mitigation without a capstan. The OSU-PB version is a CE-marked offshore unit for Zone 2 operations.



OSU-PA

- Modular: power pack, logging cabin, and winch modules
- Capstan compatible
- 18,000-lbf DNV certified pull capability

TuffLINE

Specifications

	TuffLINE 18000 Cable
Ends-fixed breaking strength, lbf	28,000
Ends-free breaking strength, lbf	27,000
Safe working load, lbf	18,000
Temperature rating, degF [degC]	1 h: 465 [241] 24 h: 450 [232]
Cable OD, in	0.5
Cable weight, lbm/1,000 ft	In air: 416 In freshwater: 331
Max. (rms) voltage, V	Per helical conductor: 800 Center conductor: 1,250
Max. current, A	1.61



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