Perfect pre-comissioning for subsea umbilicals

John Grover, EnerMech, discusses advanced techniques for subsea umbilical pre-commissioning in deepwater oil and gas expansions.

As the oil and gas industry ventures into increasingly complex and deepwater environments, the expansion of subsea production systems has become more prevalent. These expansions typically involve the addition of new wells, flowlines, and umbilicals, which must seamlessly integrate with existing infrastructure. In deepwater projects – often beyond depths of 1000 m – this integration presents unique challenges, particularly during the pre-commissioning phase of subsea umbilicals.

To address these challenges, EnerMech has developed and commercialised innovative subsea umbilical testing techniques that cater to the demanding conditions of such environments.

Understanding umbilicals

Subsea umbilicals are vital for transporting fluids, electrical power, and communication signals between surface facilities and the subsea production systems. Typically, these umbilicals are complex assemblies containing multiple fluid cores, electrical cables, and fibre optic lines. The fluid cores are designed to transfer various critical substances, including:

- Hydraulic fluids for operating subsea equipment.
- MEG (mono-ethylene glycol) or MEG/water blends, often used for hydrate inhibition.
- Production chemicals like corrosion inhibitors or kinetic hydrate inhibitors, essential for maintaining the integrity of subsea wells.

In the initial installation phase of a subsea production system, these fluid cores are pressure tested and connections verified from the surface using portable test units. However, in the case of brownfield expansions—where new infrastructure is added to an existing field – both ends of the umbilical are terminated subsea, making surface-based testing impossible. This necessitates a new approach to ensure the integrity of subsea connections, particularly in deepwater environments where water depths can range from 900 – 2200 m.

A dual approach to umbilical testing

EnerMech has responded to the growing demand for reliable subsea testing solutions by developing two distinct techniques tailored to different project requirements. These techniques are specifically designed to address the unique challenges of deepwater umbilical testing, including high pressures, the need for ultra-clean fluid delivery, and the logistical complexities of operating at extreme depths.

Subsea Test Pump (STP) powered by ROV

The first technique involves the use of a self-contained, ROV-powered Umbilical Subsea Test Pump (USTP). This system, configurable with up to three pumps and three fluid reservoirs, is ideal for testing shorter umbilicals or flying leads where the volume to pressurise (VTP) is relatively small. The USTP system is deployed to the seabed, where the customer's ROV connects the testing equipment to the umbilical via a hot stab connection. The same ROV simultaneously provides hydraulic

power to the USTP. The entire testing process is controlled remotely, allowing for real-time monitoring of pressure and leak integrity. This method is particularly effective when the fluid volume required for testing is manageable, making it a preferred choice for smaller-scale applications.

There are two parallel systems on-board the USTP to allow testing of both umbilical hydraulic & chemical lines. Each system has an independent pump, which is powered by the ROV hydraulics, via a custom hot stab – options exist to run the pumps either separately or both at the same time. One stream is used to inject typically MEG, and the other for hydraulic fluids.

All parts of the system are flushed to the required cleanliness levels before use – for critical hydraulic fluids this includes flushing to the stringent ISO. The USTP is then flow tested and sampled on deck to show compliance, prior to deployment.

The USTP has the umbilical test fluids located onboard the frame in two pressure-compensated barrels. Each barrel holds approximately 170 l of umbilical fluid. The umbilical fluids are filtered to the required cleanliness value before being pumped into liner bags fitted in the compensated barrels. Where more than two different fluids are required or if the higher subsea storage capacity is needed, the STP can be connected to a separate subsea storage chemical basket.

Each system is protected from over pressurisation with on-board pressure reducing valves (PRVs). The tests pressures are recorded on dedicated data loggers for each system that can be viewed in real time and downloaded when required through the optical uplink system. A subsea Keller gauge is also fitted to each system as a back-up data logger that provides a visual display of the pressure in each system in real time.

The optical Uplink system consists of a sender unit located on-board the STP and a receiver unit located on-board the ROV. The ROV Optical Link unit sends real time information, through the ROV umbilical, to a system laptop situated in the ROV control room. This allows for the ROV operators to instruct on stopping/starting/varying pressurisation rates.

The ROV operator controls the rate of pressurisation by increasing or decreasing the hydraulic flow to the on-board pump. On completion of the test, the data can be uploaded to the laptop for client acceptance, without the need to recover the unit to the surface. Once the test has been accepted, the STP can be reconfigured to conduct the controlled depressurisation of the tubes on test to the specified abandonment pressures before disconnection of the test flying lead and recovery of the STP to the surface.

On-board the STP, the controlled depressurisation is conducted through a flow control device/orifice plate. The flow control device is sized for each umbilical system, and calculated based on actual requirements, volume/bar and pressure, and prevents excessive depressurisation rates of the umbilical tubes.

Figure 1. **EnerMech Twin-Pump Umbilical STP Unit Front & Rear View (showing twin fluids).**

Twin single-section composite downlines

The second technique, for projects involving larger umbilicals or when significant volumes of testing fluid are required, EnerMech utilises twin single-section, self-supporting composite downlines. These downlines are deployed from the surface to the subsea end and are specifically designed to handle different types of fluids – one line for hydraulic fluids and the other for MEG-based fluids. The composite construction and smooth-bore ensure that the downlines maintain the required cleanliness standards and structural integrity under high-pressure conditions. This approach is not only suitable for testing umbilicals but can also be used to test flowlines flooded with potable water or a MEG/water mix.

For the downline option, the fluids and pumping system are located on the marine vessel (PSV / LCV etc.) meaning there is no restriction on volumes and types of fluids that can be provided.

The twin composite downlines have some unique benefits including:

- Suitable for most applications: each downline is 1500 m long x 0.75 in. ID. Larger / longer composite lines can be provided for custom projects.
- High pressure: 10 000 psi (690 barg) MAWP.
- Single-section and self-supporting: custom umbilical sheathing increases longitudinal load capacity to 7000 kg.
- Collapse resistant: external collapse pressure of 100 bar / 1000 m with option to use EnerMech EFPS surplus-valve system for deeper operations.

The downline system has been successfully deployed over 20 times, with typical deployment and recovery times of around 1 hour to WD of up to 1350 m.

Strategic advantages and industry impact

The choice between these two techniques depends on various factors, including the volume of fluid required for testing, the specific project needs, and the customer's operational preferences. The ROV-powered STP system is favoured for smaller operations where mobility and ease of deployment are critical, while the composite downline technique is better suited for extensive systems requiring larger fluid volumes.

EnerMech's ability to offer these specialised testing solutions has allowed the company to carve out a niche in the subsea testing market. By strategically investing in the necessary equipment – such as the composite downlines, which represent a significant financial commitment – EnerMech has ensured they can meet the demands of this specialised field.

Meeting evolving client needs with operational expertise

EnerMech's success in subsea umbilical testing has been driven by a motivation to adapt to client needs in real-time, rather than through traditional R&D methods. Operational teams have responded to client demands by repurposing existing technology, such as adapting subsea testing units initially used for pipeline pressure testing to accommodate fluid reservoirs and clean pumps for umbilical testing. This pragmatic approach has allowed EnerMech to quickly bring effective solutions to market, meeting the evolving demands of the industry.

This is a strategy replicated on a global scale with the ability to tailor services to specific client requirements, whether for projects in West Africa or Australia, highlighting a commitment to operational excellence and customer satisfaction.

In the coming years, as deeper and more challenging environments are tackled by the oil and gas sector, the need for reliable subsea umbilical pre-commissioning solutions will grow. EnerMech's innovative approaches to subsea testing offer a proven method for ensuring the integrity of critical subsea infrastructure.

By having two different methods which can be applied to different scenarios, both new developments and brownfield expansions are completed with the highest standards of safety and reliability.

Table 1. Comparison of the benefits of both systems

Key benefit	Umbilical STP	Composite downline
Large fluid volumes	No	Yes
Multiple subsea tests	Yes	No
Fluid change-over whilst deployed	Yes	Yes
Ability to handle nitrogen injection	No	Yes
System can remain in place subsea between operations	Yes	No
Remain mobilised during weather events	Yes	No
Independent of ROV hydraulic water supply	No	Yes

Figure 2. Powered hose reel with EnerMech twin composite downlines installed.