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Reduced size, improved performance

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Compact cables help compact work-class ROVs plumb the depths

As the world of offshore exploration and production changes, more and more companies engaged in offshore activities are looking for remotely operated vehicles for drill support, surveying and light construction activities. Traditionally, there was a choice between large and powerful hydraulic-based ROVs or small and limited power electric units.

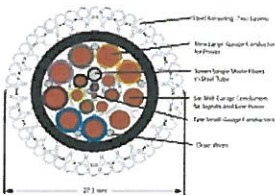
SMD, headquartered at Wallsend, Tyne and Wear, UK, is one of the world's largest designers and manufacturers of work-class and specialist subsea remotely operated vehicles and other remote intervention equipment for harsh environments. The company aims to bridge this size and capability gap with the new ultra-compact Atom work-class ROV. To accomplish its dual goals of improved performance and reduced weight/size, SMD teamed with TE Connectivity in developing lighter, more robust umbilical cables. This collaborative effort enabled SMD to provide future-oriented technology to its customers and end users in the Atom ROV.

The new Atom ROV is an ultra-compact ROV that is comparable in size to high-end electric units but offers improved work-class capabilities. The base system is less than 2000mm long by 1500mm wide by 1500mm high and weighs in at a light 1500kg for the base unit. The hydraulic powered unit accepts a wide range of tools to make it easily adaptable for different needs.

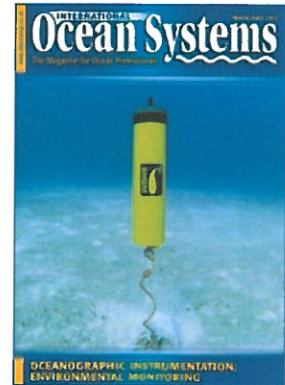
"As exploration and production companies evolve to smaller ships and rigs, there is increasing interest in compact work-class ROVs," explains Mark Collins, manager for the ROV business stream at SMD. "Deck space is limited. The Atom work-class ROV gives operators a space-saving unit, but with capabilities beyond those of comparably sized electric units, offering 50 per cent more thrust and twice the tooling capability."

The Atom work-class ROV can be fitted with a variety of manipulators, grabbers, survey equipment and other tools. It offers up to 100hp of hydraulic power, with 36hp available for tools.

“Figure 1. SMD's Atom work-class ROV heralds a new class of hydraulically powered devices, with a compact size to make it a great solution for space-constrained smaller vessels”



“Figure 2. The space-saving umbilical from TE Connectivity maintains excellent mechanical properties while providing signal”



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and power to the Atom.

work-class ROV”

SPACE-SAVING BENEFITS

Saving valuable deck space involves more than the ROV unit itself. SMD engineers worked with the Rochester Cable business unit of TE Connectivity to create a lighter, smaller umbilical cable. "When you are talking about umbilical cables that can be thousands of metres long, considerable deck space must be allocated for the reel," says SMD's Collins. "Any reduction in cable diameter will reduce the size of the winching equipment. Similarly, smaller diameter translates to lower weight."

Reducing the cable size is not a trivial matter. Packaging the required elements in an umbilical assembly involves protecting them both mechanically and environmentally. At the same time, the design should be no larger or heavier than necessary and should be flexible to accommodate the movement of the ROV.

An umbilical cable for remotely operated vehicles needs to meet a range of mechanical and environmental requirements not commonly experienced in other applications. At deepwater levels, temperatures are typically between 0°C and 3°C. Pressures are also a concern. At 2000 metres, the pressure of ocean water exceeds 2900psi (2000N/cm²). Add in the long lengths of the cables and the need to withstand twisting and other movements, and you can see the tensile loads on the cable are quite challenging.

The cable also serves as a lift cable, meaning that it must be able to support the 1500kg-plus weight of the TMS and work-class ROV and withstand the dynamic loads of daily operations. The design challenge is to manage the tradeoffs between achieving a mechanically robust cable and minimising size and weight.

CUSTOMISATION OF ROV UMBILICAL CABLES

As a leading supplier of umbilicals and other cables for subsea applications, TE Connectivity brought considerable experience to the SMD project. "Most of our cables are custom designed to meet the requirements of a customer's application," says Mark Casselton, product manager for Marine and Offshore Cables at TE Connectivity. "Application requirements tend to be unique, both in terms of the types of components in the umbilical and in the mechanical and environmental needs. Umbilicals have various combinations of fibre optics, power, signal and working loads."

A high-performance umbilical cable typically contains multiple types of elements to handle power, control, video and telemetry. Thus you will find a mixture of larger conductor power cables, twisted-pair and multiconductor elements, coaxial cable and fibre optic cable in various combinations to meet the specific needs of the application.

As the capabilities of the ROV increase, the power needs of the ROV also increase. While conventional wisdom dictates that thicker insulation be used as power handling increases, new materials and new processing methods have overturned such wisdom.

THIN-WALL TECHNOLOGY: RUGGEDLY SMALLER

One key to reducing the size and weight of the cable is through the use of thin-wall jacketing and insulation materials. Thin-wall technology is well established in the military and aerospace industry, which offers many of the same demands for rugged performance as deepwater applications. Thin-wall insulation has excellent abrasion resistance, excellent thermal stability over a wide temperature range and electrical properties required for power-carrying applications. With thin-wall-insulated wires, it becomes possible to add additional conductors to the umbilical without increasing its size, and thereby provide more power to the ROV.

"TE pioneered radiation cross-linked insulations. The Atom work-class ROV umbilical cable uses our SPEC 44 wire, which uses a thin-wall cross-linked polyalkene insulation," says Casselton. The result is a wire that can be 20 to 30 per cent smaller and 20 to 30 per cent lighter than a standard-wall counterpart - while still maintaining, or even improving on, the mechanical, electrical and environmental properties required for rugged subsea applications.

The final umbilical cable is only 27.2mm in diameter and has a nominal weight of 2460kg/km in air (or 1860kg/km in seawater). The small diameter yields a dynamic bend radius of 500mm.

Figure 2 shows a cross section of the 17-conductor, seven-fibre armoured umbilical cable for the SMD Atom work-class ROV. The main elements of the cable are:

- Seven single-mode fibres in a single steel tube (FIST); one of the fibres is for the main instrumentation, one is for HDTV and the rest are spares.
- Two conductors for cathodic protection.
- Six conductors for signal and power.
- Nine conductors for power.

The cables are concentrically arranged in three layers; this structure permits the cable to remain flexible and eases handling. The main armouring for the cable is two outer layers of steel wire.

TE Connectivity's Casselton notes that the thin-wall materials have benefits in addition to size and weight reduction. "The cores have a higher temperature rating. The electrical cores in the Atom ROV umbilical are rated to 150°C, well above the 90°C that is typical with other cables in the industry," he says. The higher temperature rating can further reduce the size of the cable by allowing smaller power conductors, since the current rating for a given cross sectional area of conductor is limited by heat generated. Allowable heat levels, in turn, are limited by the wire's insulation. Conversely, the higher temperature rating provides an extra safety margin.

While the higher temperature rating doesn't mean that the Atom ROV will be operating at higher temperatures, it does provide additional safety to deck hands. The cable is less likely to overheat in the event of a short circuit or other error. What's more, the high temperature rating can help extend the useful lifetime even when the cable is operated at lower temperatures.

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OPTICAL COMMUNICATIONS

Fibre optic cables are the obvious choice for carrying data over long runs of umbilical cable. The Atom ROV uses Gigabit Ethernet to send and receive data. The high data rates not only accommodate large amounts of data in real-time, but also reduce the number of copper conductors required for such data. Only two of the fibres are used for instrumentation, video and other control and monitoring needs. The rest are spares. Copper signal cables are used for the less data-intensive task of continuity monitoring. Power cables provide high-voltage to the instrumentation, telemanagement and power to the system.

Optical fibres are finding increased use in umbilical cables because of the increased bandwidth they offer over long distances. While fibres have high tensile strength to withstand longitudinal pulling, they can be easily broken or damaged if not protected correctly.

As a result, fibre optic cables typically have their own armouring. While aramid yarn - the same strength members common with other fibre optic cables - are used, more robust designs also use metallic armouring. The high hydrostatic application pressures can increase attenuation in a fibre. TE Connectivity offers three different approaches:

- Fibre in Steel Tube (FIST), which places the fibre in a solid stainless-steel tube to protect against hydrostatic pressures, high temperature effects and corrosive environments. FIST also offers high density packaging of multiple fibres in the tube and, of the three options, is the easiest to terminate;
- STEEL-LIGHT armouring, which uses strands of precisely sized plow steel concentrically arranged around the fibre buffer to protect the fibre from breakage;



- and ELECTRO-LIGHT armouring, which is similar to STEEL-LIGHT armouring but uses copper in place of steel. The copper can also be used for power to allow composite cables to be designed with a smaller outside diameter.

ADVANCED SIMULATION

Given the challenges of creating robust umbilical cables, designers use advanced simulation tools to analyse the mechanical and electrical performance. It is impractical to build multi-kilometre prototypes, so expertise in design and simulation are essential.

Current efforts in umbilical innovation are focusing on the cable's core, looking for ways to pack more functionality into the same or smaller space. The Rochester Cable group of TE Connectivity, for example, is working with thin-wall insulation and fibre optic packaging as key to next-generation cables.

SMALLER IS BETTER

The Atom work-class ROV opens new possibilities for underwater work by combining a smaller footprint with a high workload capacity. In reducing the size of the work-class ROV to that of a large electric unit, the Atom ROV saves deck space. SMD's Collins sees the thinner umbilical supplied by TE Connectivity as a natural match in reducing size, saving space and realising greater potential.

As the need increases for deepwater ROVs to support research and oil and gas exploration and production, umbilical cables are supporting the needs for robust performance. New technologies in insulation and optical packaging allow umbilical cables to supply more power to the ROV and to support the increasingly sophisticated capabilities. This translates into more capable deepwater devices with a wider range connected by a compact cable delivering more power and more data-handling capabilities.

With a degree in electrical and mechanical engineering and more than ten years in the oceanographic and oil and gas industry, Matthew White is sales manager for Subsea Cables for TE Connectivity's Global Aerospace, Defense & Marine business unit. You can contact him at mwhite@te.com.

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