OEM'S INCREASINGLY DEMANDING 10 YEAR WARRANTIES OVER 10 YEAR DESIGN-LIVES

Many nations have prioritised control of territorial waters and stepped up their investment in submarine and anti-submarine fleets. Older platforms are increasingly subject to life extension programmes whilst future submarines are being designed with ever more complex combat systems and operational capabilities.

This drive towards increased submarine capacity is accompanied by a marked shift in how the backbone infrastructure is considered. Changing demands are driving fresh thinking and a demand for high reliability in cable systems which then deliver the performance promise of the sonar and combat system over the whole operational life of the submarine.

Historically considered almost a commodity, inboard and outboard cabling has been left to Prime Contractors to scope and install. With a growing recent history of serious failures in service, OEMs are demanding greater importance be attached to the supporting architecture. Cabling increasingly recognised as the central nervous system of any platform.

What has effected this changed approach?

Lessons learned extend back over half a century and across multinational programmes with astute engineers now reaching out to subject matter experts to provide the specialist knowledge lost from many navies. With perhaps one of the most significant step changes relating to cable jacket materials.

The majority of submarine cables have either polyethylene or polyurethane jackets. Each material has unique advantages and disadvantages, their effective use depending on in-depth knowledge of those properties.

The depth of knowledge required for getting it right first time, every time, has been significantly diluted since the 1960s, when the core technology was proven and established in UK submarines for the first time.

Invented in 1933, Polyethylene (PE), is a difficult to work with thermoplastic, bringing a unique combination of excellent dielectric characteristics (particularly at high frequencies), high electrical resistance, low moisture permeation, and low water absorption - as evidenced by the man-made plastic pollution across the world's oceans - PE does not degrade over time.

Cable-grade polyethylene is inert in the ocean, it delivers orders of magnitude better insulation resistance that other materials, and this performance does not degrade at higher operating temperatures. Crucially, PE does not absorb water or moisture over time as other materials do, which is what makes it the only jacket material that can be relied on to deliver 30+ year sealing performance.

Despite the numerous benefits of PE, it is notoriously difficult to process, atomically bond and amalgamate - as widely reported by the USA's General Dynamics as early as the 1970s (Haworth, 1973) and remains a challenge today. Successful atomic amalgamation bonding has only ever been delivered by one specialist manufacturer for the naval defence market since the late 1960's in the UK. Ever since, it has been the cable of choice for the Royal Navy and Commonwealth fleets and is reflected in their Defence Standards.

Where PE material chemistry could not be mastered, a thermoplastic Polyurethane (PU) jacket was used in substitution. PU is a viscous elastomer, which means it has greater elasticity than PE and this offers different performance and properties but it does not carry the inherent advantages of PE.

PU is not suitable as an electrical insulation material but has some outstanding properties for cable sheathing, making it a suitable jacket material for high performance electrical cables in challenging environments. PU sheathing is extremely wear-resistant and mechanically tough – it's very difficult to cut or tear. It also has excellent ageing resistance against environmental humidity, ozone, UV radiation and microbes. A useful characteristic of PUR as a sheathing material is its anti-kink properties, making it an ideal choice for flexible and retractable cables.

However, PU is hygroscopic - it absorbs moisture at a rate of between 0.3% and 1% by weight, which increases as temperature rises. More rapid PU insulation resistance degradation in ships' bow sonar cables has been observed when used for active sonar in the warm waters of the Gulf. The US Navy utilised PU cabling accepting the limited life expectancy of their cables in return. For the US Navy PU necessitates replacement every maintenance cycle, which can be as often as every seven years.

PE or PU?

The two materials continued to vie for selection by platform designers until recently, when the electrical properties, reliability and durability of PE have become more greatly prized.

Even US manufacturers are now revisiting PE in a bid to deliver the cable system life enjoyed by the Royal Navy, which reports cable systems delivering designed functionality after over 30 years in service.

R F Haworth "General Dynamics (Groton Ct Electric Boat Div) Handbook of pressure-proof connector and cable harness design", Naval Research Laboratory, Orlando January 1973

The economics of considering through life cost

The Royal Netherlands Navy is the first in the world to apply through life costing to the initial build of its new boat in the Walrus class replacement.

Separation of initial capital investment and operational costs into different government funding schemes and budgets has traditionally disguised the cost of replacing failing cables, allowing poor technical selections to be made based on initial economy but carrying a lifetime of replacement burden and repair costs which fail to deliver value for money. Manufacturers profiting from poor product supply.

Failing cables have driven a thriving economy with some manufacturers able to produce cables time and again, replacing repeatedly as leaks occur and systems / platform failures result. With essential navigation, sonar and weapons systems repeatedly falling out of service – there's no other option but to replace cable sets.

Tired of being hostages to fortune and with Defence budgets across the world under pressure, astute naval engineers are now evaluating based on through life costs, looking for fit and forget solutions which remain reliable throughout the life of the platform.

There is now widespread acceptance of PE as the correct choice for cable jackets, with a second "sacrificial" PU jacket providing toughness for the most hostile of applications.

Here, pedigree cannot be created overnight and even where there is a desire to adopt the technology; refining processes, training up skills and growing the necessary expertise will likely take decades.

In the UK, a single company alone (SMI) has achieved capability approval for the production of PE pressure hull glands (PHGs), retaining this status continuously for over 24 years. No new entrants seemingly capable of satisfying the vigorous MoD requirements contained in DEF-STAN 08-171.

The issue stems from the complex mix of chemistry and complex manufacturing parameters built up over years of experience of bonding PE to surfaces of glands and connectors which are repeatedly submerged in seawater over as much as 30 years.

Failure of the bond or cathodic delamination of plastic would introduce leaks paths and render cables and their associated systems, inoperable.

PE cable mouldings will only successfully endure if atomic level chemical bonds between materials are established. This requires a careful balance of chemistry, high manufacturing temperatures, extraordinary pressure techniques and materials expertise. Much of the latter has been lost from the industry more generally, since the technology was developed fifty years ago. Many manufacturers have tried to perfect the process but year after year it's without success.

Where cables pass through the pressure hull on a boat it presents first level, critical safety considerations. Having a robust compliance, quality control, testing and approval system for the managed supply of such cables is essential to boat integrity.

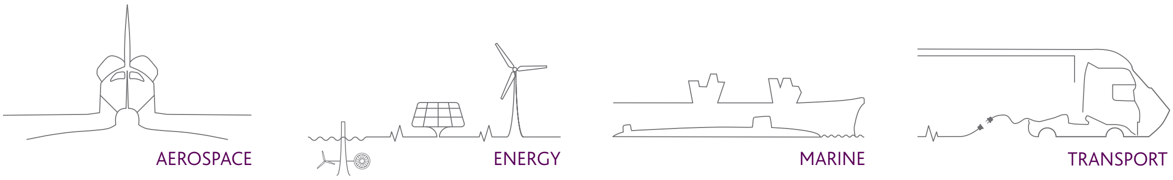
Connectorisation

Recent generations of submarines have seen designers explore the use of connectorised electrical hull penetrators (EHPs) for through hull transitions to support flexible manufacturing practice of modular build.

With boats of this design in service and the number of flooded cable failures increasing disproportionately, there is a movement away from this technology. Connectors inherently introduce additional potential failure points which can be avoided by using tried and tested gland technology. Multi gland penetrators offering the service density that EHPs looked to deliver can be configured for modular build but with the reliability of a technology successful for three decades.

So it's with an eye on through life cost that the astute designers of future platforms are drawing on a heritage of reliability, tens of thousands of installations with zero leaks. Encouraged to move away from a 10 year design life mentality, instead demanding 10 year Warranties and a guarantee of performance over the long term. Rightly, manufacturers are being asked not for rhetoric but assurances.

By designing in appropriate technologies and selecting right first time, every time….. manufacturers should be able to not only eradicate cable leaks, but plug porous defence budgets too.



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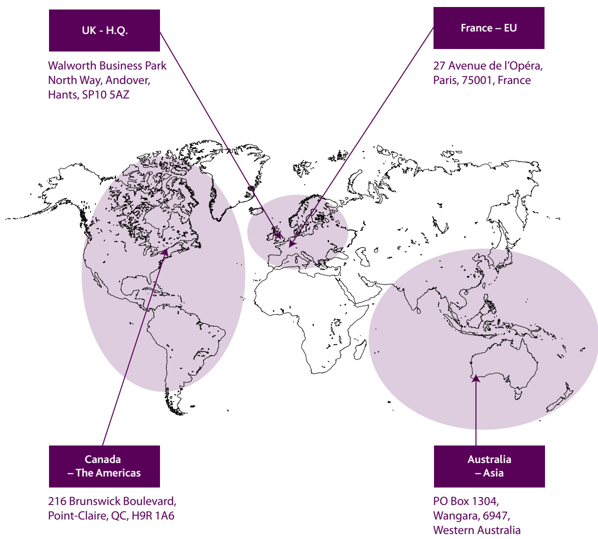

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