

TE'S SOLUTION FOR MV POWER CONNECTION IN HARSH OFFSHORE ENVIRONMENTS

For Ships, Rigs, Platforms

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Abstract

This Whitepaper has been developed to highlight the unique challenges facing the modern marine industry as it seeks to ensure a reliable supply and distribution of power to its vessels.

While many aspects of the shipbuilding and offshore landscape are rapidly evolving, the need to find products that perform reliably in harsh conditions is a much older, and ongoing, challenge.

Some of the solutions that TE Connectivity has developed in response to these needs are introduced here. TE has a proven history of serving marine industries and can draw on decades of design experience.

Specifically, this paper looks at medium voltage power system solutions for marine and offshore industries, considering both their applications and their benefits.

1. Demands on MV Power Systems and their Connections in the Modern Marine and Offshore Industry

The marine industry has moved from the 'Sail Age' through the 'Steam Age' and is now well into the 'Electricity Age'.

With the rapid development of the shipbuilding and offshore industry, we can now reflect on several key trends that have emerged in the power systems for ships and platforms.

MORE CRITICAL

Electrical power is the main source of power for ship propulsion and offshore facility operation.

LARGER SCALE

The scale of power systems in ships/platforms has increased from 10MW to 100MW.

HIGHER VOLTAGE

A growing number of higher voltage power systems (7.2-24kV) are being employed in ships and offshore facilities. The voltage of some power systems can even be up to 35kV.

Faced with these challenges, customers in the marine and offshore industries have highlighted new requirements for their power systems and products, including:

- A reliable supply and distribution of electrical power. This is critical for the propulsion, operation, control, efficiency, monitoring, communication and safety of vessels, rigs and platforms.
- The ability to operate in harsh environments with high humidity, saline pollution, wide-ranging temperatures and the potential for the adverse effects of corrosion.
- Power connections and components must have effective moisture sealing, electrical insulation and protection. This calls for high performance products and materials that are proven to withstand the harshest operating environments.

The increased complexity of modern vessels and platforms has led to higher power demands and a range of technological and environmental challenges for the marine industry. For this reason, all applications must meet and exceed all expectations of reliability.

2. TE's History and Experience in the Marine and Offshore Industry

By 1974, there was a team at Raychem dedicated to the support of marine/offshore customers, focusing on their needs and product requirements. The team was involved in a wide variety of projects, including the Forties Field platform project from a well-known British oil and gas company. These platforms had adopted an unusual construction technique involving the use of an exceptionally large quantity of cable accessories.



With the expansion of offshore oil exploration and production, an ever-widening customer base helped to foster an advanced understanding of the specific needs of this market. This knowledge and the experience gained by a partner division in supplying products dedicated to naval applications since the '60s, led to the development of products for the commercial marine market. Shipbuilding companies around the world are now using these products.

The military market also employs many of the same high performance cable accessories that are used for similar applications in the commercial marine/offshore markets. The demand for specialist vessels continues to grow, including more efficient and larger bulk carriers, oil tankers, oil service vessels and car carriers.

2.1 Customized Solutions

Occasionally, innovative solutions are required for special circumstances, such as the employment of cable joints offshore.

TE Energy has supplied thousands of MV joints and terminations with marine certificates, commencing in the '70s and continuing to this day.

TE Energy remains committed to investing in new product design and research & development for the offshore marine, oil and gas industries, adapting to ever-changing environments and meeting demanding challenges.

Additional consideration will continue to be given during product design to ensure that products are installed quickly, easily and cost-effectively without the need for special equipment or procedures.

3. TE's MV Power Connection Solution for Marine and Offshore Applications

There are a number of electrical marine and offshore applications requiring attention to ensure reliability including:

- MV Cable Accessories
- Cable Repairs
- Busbar Insulation
- Anti-moisture Sealing

3.1 MV Cable Accessories

MV Terminations

MV terminations are widely used for connecting cables to equipment such as motors, generators, switchgears and transformers. They perform a vital function, ensuring the reliability of power systems at ever-increasing voltages on ships, rigs and platforms.

Applications:

- Terminations for applications include single core and three core varieties. Indoor and outdoor options are available for all kinds of cable types and constructions, from 7.2kV up to 42kV.
- Positive sealing of all interfaces is considered essential for the marine/offshore environment.
- A new, compact and high performance heat shrink termination (IXSU-F) is proving to be particularly popular within the marine/offshore industries as it provides a solution to the need for terminations to fit in small enclosures.
- The stress control layer also adheres to the cable insulation providing a complete moisture seal for the length of the termination. This offers maximum performance in the often humid and saline-polluted environments found in marine installations.

Benefits:

- Raychem heat-shrink terminations from TE Connectivity have an excellent, long-term service history and are widely used owing to their exceptional moisture resistance, small profile and performance in harsh conditions.
- The IXSU-F termination (**Figure 2**) is a one-piece design, which utilises an advanced, non-linear, Zinc Oxide-based stress control system, supplied as a hot melt mastic layer inside the red, non-tracking insulation tubing.

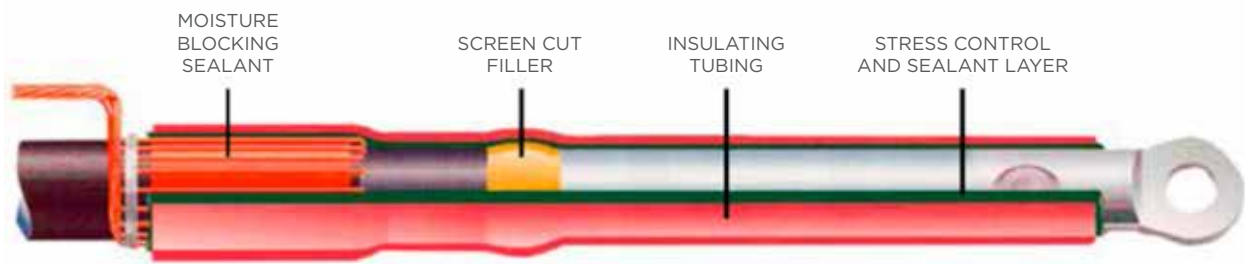


Figure 2.

An increased demand for shipboard power means more connections are required, but often in more restricted terminal boxes. This presents a demand for a short, low profile termination that may be installed on non-straight cables, as illustrated in **Figure 3**.

- There are times when an alternative technology offers advantages, for instance, on an operating platform or in an oil refinery where no flames are permitted.
- In these cases, a cold-applied termination is a viable option and can be employed as an alternative to a heat shrink product. **Figure 4**.
- There are advantages and disadvantages to both technologies and the correct product for the application should be selected.
- Care needs to be exercised with the handling of cold shrink terminations as they tend to be more vulnerable to mechanical damage.



Figure 3.

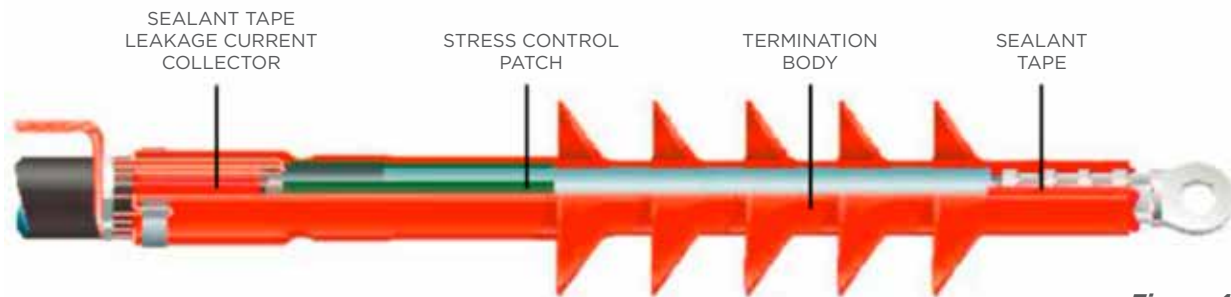


Figure 4.

MV Cable Joints

Although cable joints are not used as widely as terminations in ships, they are sometimes requested in platforms and ship-repair (conversion), as an extremely critical connection in a power supply system.

Applications:

- MV joints for marine applications were first used four decades ago and have given excellent service, proving themselves repeatedly in harsh offshore environments.
- These are heat shrink products that are as simple to install as those used for onshore applications. The use of heat to install the product ensures that moisture is not trapped within the joint, and that any moisture that is present will evaporate during the installation process.

Benefits:

- MV joints can be used for repairs, maintenance, modifications or in new construction. They deliver benefits where the cost, time or complexity of a junction box is not appropriate.

Switchgear Connectors

Screened Separable Connectors (RSTI-L 24 kV rated for 630/800A) are increasingly being used for offshore applications as well as onshore, as more and more compact power distribution panels are employed in ships and platforms.

Figure 5 shows the accessories that enable HV electrical testing, and system grounding that requires only the back-plug to be removed.

To make it easy for maintenance, a test rod provides direct contact to the connector/equipment bushing and permits HV testing. A grounding adaptor replaces the back-plug and is available with either a 20mm or a 25mm ball end fitting.

Applications:

- These must be available with protection/sealing materials when used with three core cables, and also be suitable for two or three cores per phase.
- For convenient and safe operation and maintenance of equipment to which cables have been terminated with screened connectors, there must be provision for both testing and grounding and these should be quick and easy to employ.

Benefits:

- Those with silicone insulation, as shown here, are generally favored.



Figure 5.

3.2 Busbar Insulation

For the stable operation of power systems at any time, the insulation materials play an important role in both MV and LV equipment, where they are employed to insulate busbars and connections etc.

- The components shown in **Figure 6** are available in different forms to simplify installation of Sheets, Sleeves, Tapes and Covers.
- The electrical engineer must be aware of potential issues related to the tough environment that exists offshore.



Figure 6.

- Humid environments pose special problems. In **Figure 7**, PVC tape has been used for phase identification. The serious degradation shown highlights the need to use the correct materials or problems will inevitably occur, caused here by tracking.
- **Figure 7** shows corrosion on the copper lugs from the presence of moisture and acidic gases caused by the severe tracking of halogenated material (in this case, PVC). The termination material is undamaged.
- The extensive tracking of PVC tape applied over the cable cores is clearly evident. This potentially compromises the overall performance of the equipment, which can be easily avoided by not using PVC tape over the terminations.



Figure 7.

3.3 Cable Repairs

Occasionally, there will be issues where cables have been damaged during installation or operation. To control the risk of cable system failure, Raychem cable sheath repairs from TE Connectivity can be made for all cable types (MV, LV Communication, etc.).

- Cable sheaths will often have to be repaired where they have become damaged during installation.
- Heat shrink, adhesive-lined wraparound sleeves (**Figure 8**) have proven to be a convenient and permanent solution that avoids the costly and time-consuming replacement of cables with damaged sheaths.



Figure 8.

3.4 Anti-moisture Sealing

There are always potential sealing issues in marine and offshore applications.

Applications:

- These are resistant to all marine environments.
- Typical sealing products include panel feed-throughs, as shown in **Figure 9**. These are screwed into panels/bulkheads and employ heat shrink technology to seal to the cable sheaths.
- These are suitable for control, communications, signal and power wires, and cables of all types.



Figure 9.

Benefits:

- Sealing is always critical. Heat shrinkable materials have provided excellent, robust seals for cable entries and similar applications, such as the cable gland shown in **Figure 9**.
- An internal, heat-activated sealant ensures complete protection from moisture ingress.

4. Product Certifications for Power Connection Products for Marine and Offshore

To qualify for marine and offshore industry project tenders, it is necessary to have approved certifications from the relevant authorities in accordance with internationally recognized standards.

TE Energy continually maintains and expands the necessary industrial certifications for new and existing products. In addition, where specific approvals are required, these are also pursued and obtained.

A list of our current certificates and approvals can be seen below:

Product Name	Classification Co.
MV Heat Shrink Termination	<ul style="list-style-type: none"> • Det Norske Veritas (DNV) • Germanischer Lloyds (GL) • Bureau Veritas (BV) • American Bureau of Shipping (ABS) • Registro Italiano Navale (RIN) • Lloyds Register of Shipping (LR) • Russian Marine Register of Shipping (RMRS)
MV Cold Shrink Termination	<ul style="list-style-type: none"> • Det Norske Veritas (DNV)
MV Heat Shrink Joint	<ul style="list-style-type: none"> • Det Norske Veritas (DNV)
LV Heat Shrink Joint	<ul style="list-style-type: none"> • Det Norske Veritas (DNV)
Screened Separable Connector	<ul style="list-style-type: none"> • Det Norske Veritas (DNV)
Insulation Bushing Boot	<ul style="list-style-type: none"> • Det Norske Veritas (DNV)
Heat Shrink Insulation Tubings	<ul style="list-style-type: none"> • Det Norske Veritas (DNV) • Germanischer Lloyds (GL)
Heat Shrink Wraparound Sleeves	<ul style="list-style-type: none"> • Det Norske Veritas (DNV) • Germanischer Lloyds (GL)
Insulation End Cap	<ul style="list-style-type: none"> • Germanischer Lloyds (GL)
Heat Shrink Breakout	<ul style="list-style-type: none"> • Germanischer Lloyds (GL)
Power Instruments	<ul style="list-style-type: none"> • Bureau Veritas (BV)

Figure 10 shows an example certificate for MV terminations. The certification covers different types of both Heat Shrink and Cold Shrink products, as well as versions from Europe and the US that meet the relevant local standards (i.e. IEC, IEEE, etc.).

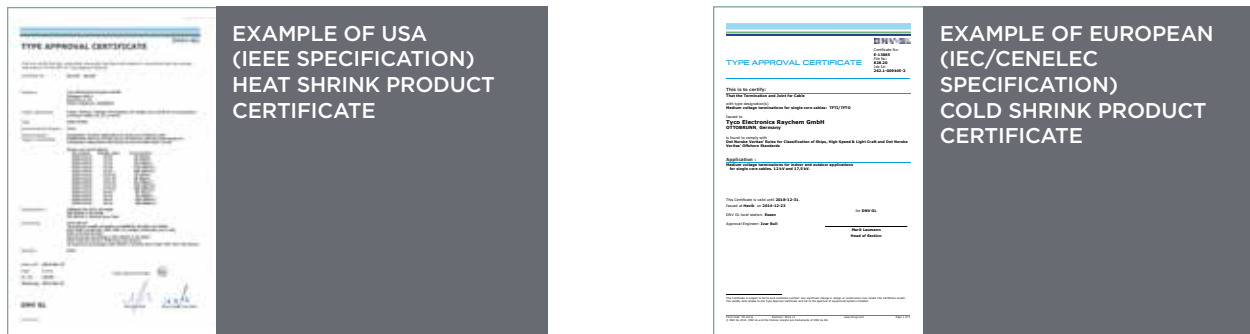


Figure 10.



5. System Reliability

In any marine or offshore operating environment, the reliability of the products is crucial. In addition to selecting the cable accessory with the correct voltage, size and construction, it is also vital to choose products that are proven to perform and deliver the expected full service life. Installation is another important consideration, and customers should look to partner with responsible suppliers that provide training for installers, helping to promote long-term reliable performance. There should also be ready access for engineers to suppliers' support personnel who are knowledgeable, experienced and suitably qualified.

Summary

Marine and offshore environments are among the hardest testing grounds for cable accessories, because of the harsh conditions that exist. The quality of the products is crucial, because reliable performance is essential.

TE Connectivity (TE) has built a reputation over many decades for the caliber of its products, as evidenced by both their proven service life and their adherence to global certifications.

Also, TE prides itself on the service and support offered to customers. Those organisations that work with TE receive all the benefits of a lasting partnership, not simply a service provider.

