

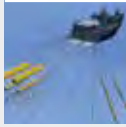


Performance at every level

Trelleborg Offshore
Products and solutions 2018

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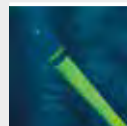
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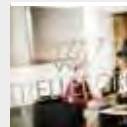
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Core Capabilities

Trelleborg is a world leader in engineered polymer solutions that seal, damp and protect critical applications in demanding environments. Its innovative engineered solutions accelerate performance for customers in a sustainable way. Using advanced polymer material technology, Trelleborg Offshore provides high integrity solutions for the harshest offshore environments. Trelleborg Offshore specializes in the development and production of polymers and syntactic foam, for all levels of the offshore industry. Our goal is to perform at every level to deliver innovative and reliable offshore solutions that maximize business performance to meet your needs.

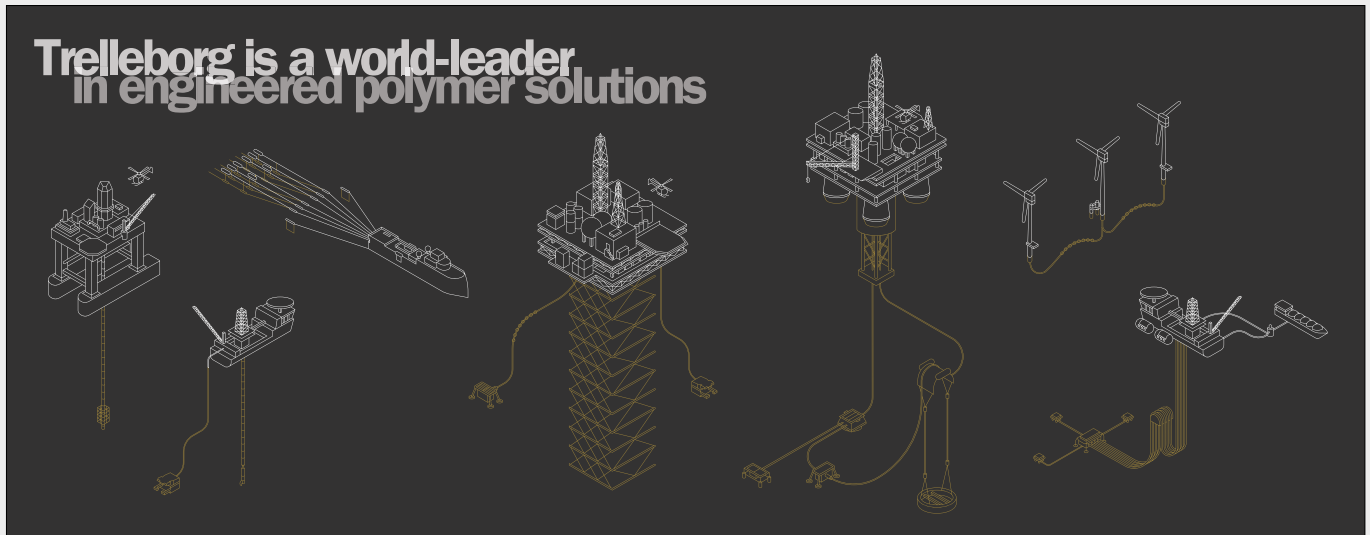
Innovation

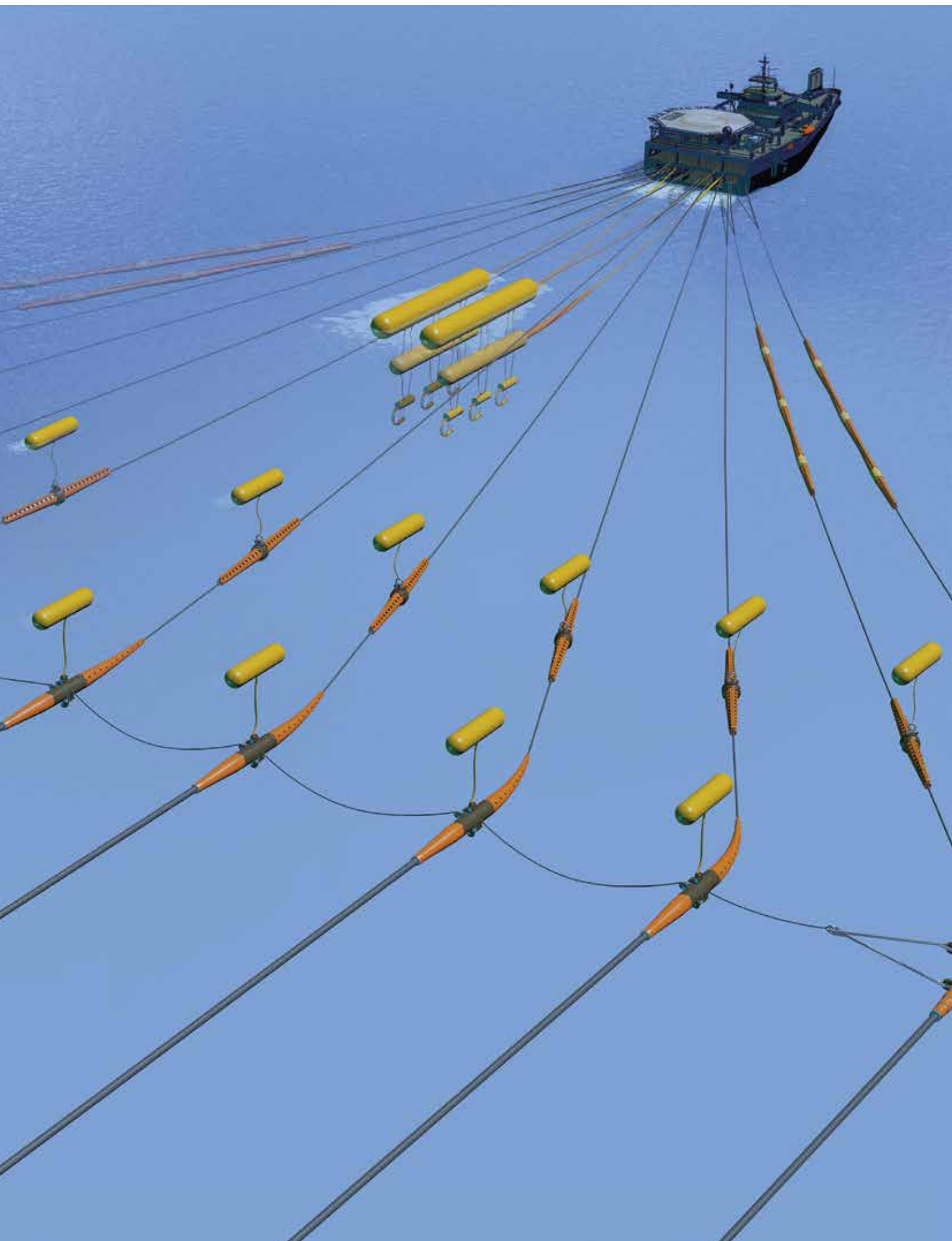
With a long-standing commitment to the development of innovative polymer and syntactic foam-based solutions, Trelleborg Offshore provides superior engineered solutions serving the harshest and most demanding offshore applications. Trelleborg Offshore specializes in the development and production of polymer and syntactic foam based seismic, marine, buoyancy, cable protection, thermal insulation and rubber-based fire protection solutions for the offshore

industry. Highlighting our commitment to R&D activity, Trelleborg Offshore carries out research development programs in partnership with industry bodies such as SINTEF and collaborates with several schools, colleges and universities providing research and degree project assistance. Thanks to our industry leading R&D activity, Trelleborg Offshore is widely considered the supplier of choice for many key industry OEMs, contractors and operators.

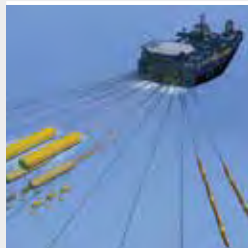
Expertise

Always keen to share our vast knowledge and application expertise with customers to help them accelerate their performance, now and in the future, we offer comprehensive engineering support from conception to completion of every project. This includes the training of customers on the capabilities of Trelleborg's portfolio of polymer solutions and engineering support throughout a customers' bid for a project (however large or small). In addition to providing expertise in polymer solutions for every kind of offshore application, we control the whole supply chain including design, manufacture, testing and installation to ensure the delivery of what you need, when you need it.





Seismic



Trelleborg Offshore excels in the design and development of superior polymer engineered solutions for the harsh and demanding environments of international seismic and oil and gas markets.

Seismic Bend Control Solutions - Where any flexible tubular connects to a structure, normal movement during operation or forces incurred during installation can cause catastrophic failure of the tubular at the termination point. Our seismic bend control solutions reduce this damage.

Seismic Cable Handling - Seismic towed arrays are carefully designed to maximize survey efficiency. To enable the towed array to be set up correctly, it is necessary to attach various buoys, cross chains etc. To ensure the integrity of the towed array, these connection points must provide a secure and safe method of attachment.

Towing Attachments and Ancillaries - Seismic towed arrays undergo significant loading during operation. The towing forces from the vessel combine with drag from the sea and lateral loads from diverter and cross chains. These complex loads need to be correctly controlled to ensure that the seismic array operates correctly.

Protecting seismic survey cables

Where any cable or hose connects to a structure, normal movement during operation (dynamic loading) or forces incurred during installation and retrieval (static loading) can cause catastrophic failure of the cable or hose, at the termination point. The failure mode can be through collapse, rupture of internal lines or even rupture of the external layers leading to escape of the contents to the environment. This can happen as the result of a single event or be caused through fatigue damage over time.

Bend limiting devices are provided to protect the cable or hose from these situations and perform the following functions:

- Maintain the manufacturers recommended minimum bend radius (MBR) during the life of the project
- Provide a suitable load path from cable or hose, to fixed structure
- Reduce point loading at the termination to an acceptable level

Bend Stiffener

The Bend Stiffener acquired its name because the conical shape gradually increases the overall stiffness of the cable or hose in order to prevent over bending at the termination point. Manufactured from elastomeric material, a bend stiffener is suited to the constant wave and current induced motion of dynamic installations but can also be used for static applications.

Bend Stiffeners are project specific and fully engineered to accommodate the defined tension and angle combinations as Trelleborg Offshore strive to perform at every level to meet the customers' needs. The two types of Bend Stiffeners are split and non-split bend stiffeners. These are offered in a variety of attachment methods, such as brackets, flanges & slide-on.



Dynamic Bend Stiffener



Split Bend Stiffener and Gun Array Bend Stiffener

Examples and benefits of some of these are below:

Split Bend Stiffener

- Fully split to allow bolt-on installation after termination
- Completely field installable and replaceable
- Improved resistance to general wear and tear in offshore operations
- Customizable mounts
- Adaptable to a number of towing attachment assemblies
- Fully spoolable

Air Hose Bend Stiffener

- Slide on design
- Attached via band strap
- Profiled internal interface detail
- Simple attachment method, no termination machining required
- Cost effective solution for small air hoses

Dynamic Bend Stiffener

- Provides localized stiffness to the cable or umbilical to maintain minimum bend radius
- Customizable mounts
- Adaptable to a number of towing attachment assemblies
- Customized design to meet customer load and angle combinations

Safe deployment of cables

Seismic towed arrays are carefully designed to maximize survey efficiency. To enable the towed array to be set up correctly, it is necessary to attach various buoys, cross chains etc. To ensure the integrity of the towed array, these connection points must provide a secure and safe method of attachment.

Trelleborg Offshore designs and manufactures specialist cable handling solutions to meet the exacting demands of marine seismic customers. Using our expertise in understanding the difficulties associated with working in such demanding conditions, our seismic cable handling solutions ensure the safe management and deployment of cables.

The cable handling solution range includes Super Boots, Cumberland Grips and Cumberland Sliders to meet your needs.



Cumberland Grip

The Cumberland Grip is generally used on seismic survey towed cables or as an ocean bottom cable system for anchor weight attachment.

Benefits of a Cumberland Grip include:

- Safe attachment of moderate load diverters and tow points to armored or sheathed cables
- Integrated friction grip clamp and bend stiffeners to control cable curvature
- Provides uniform grip over entire length
- Fully split to allow easy attachment
- Fully spoolable with yoke removed



Cumberland Slider

The Cumberland Slider stabilizes large multi cable towed array systems during turning and alignment maneuvers.

Benefits of Cumberland Sliders include:

- Easy movement over cable with clearance bore
- Provides cable protection under sliding conditions
- Sacrificial tip wear pad inserts
- Fully spoolable with yoke removed



Super Boot

The Super Boot is generally used on a seismic lead-in cable that must be linked at intervals to a parallel tow wire. It can also be used for protection of cables when floats are attached at certain points along a heavy tow cable.

Benefits of Super Boots include:

- Safe coupling for sheathed or armored cables at mid-length
- Integrated friction grip clamp and bend stiffeners to control cable curvature
- Protection against over bending and chafing
- Fully spoolable with bridle and yoke removed

Protecting seismic survey cables

Seismic towed arrays undergo significant loading during operation. The towing forces from the vessel combine with drag from the sea and lateral loads from diverter and cross chains. These complex loads need to be correctly controlled to ensure that the seismic array operates correctly.

Trelleborg Offshore designs and manufactures specialist towing attachments. Using our expertise in understanding the difficulties associated with working in demanding conditions, our towing attachments help protect the seismic survey cables from over bending and to increase the local stiffness of cables at the attachment point.

Our product line of towing attachments includes Lead-in Bend Assemblies, Umbilical Tow Point Protectors and Connector Mounted Assemblies.



Lead-in Bend Assembly

The Lead-in Bend Assembly or Umbilical Tow Point Protector is used as an attachment point on seismic survey cables for towing applications. The assembly protects the cable from over bending by increasing the local stiffness of the cable at the attachment point. A Lead-in Bend Assembly allows for assembly over a pre-terminated cable and is generally used on seismic survey lead-in cables to attachment towing chains, paravane type diverters or flotation.

Advantages of a Lead-in Bend Assembly include:

- Oversized bore bend stiffener with color coded packers to suite numerous cable sizes
- Allows for assembly over pre-terminated cable
- High grip capacity on the lead-in cable
- Ideal attachments for diverter and tether head



Umbilical Tow Point Protector

The Umbilical Tow Point Protector is specifically designed to aid attachment of a tow point to the gun umbilical. Advantages of the Umbilical Tow Point Protector include:

- Helical rods to ensure integrity of the gun umbilical
- Helical rods and olive arrangement ensure that the tow point has significant grip capacity



Helical Rod System

Connector Mounted Assembly

The Connector Mounted Assembly is designed for mounting onto the Lead-in or Streamer Connector and meets the different protection requirements. Advantages of the Connector Mounted Assembly include:

- Principle application as per lead-in assembly
- Internal clamp profile to suite termination
- Full cable strength attachment point

Protecting seismic survey cables

Improving safety for cable handling is one of the ways Trelleborg Offshore performs at every level to ensure we protect people, the environment and infrastructure investments. Our towing ancillary equipment is designed to increase efficiency and improve safety during usage.



Helical Rod System

The Helical Rod System is a robust set of helically twisted wires, supplied with end caps so that no sharp edges are present on the outer surface of the cable.

Advantages of Helical Rod Systems include:

- Localized abrasion resistance to cable
- Increased grip capacity by spreading the load over a greater area of cable
- Superior grip capacity at connection point when used in conjunction with Tow Point Protectors

Information needed to specify Helical Rod System:

- Cable diameter and tolerances
- Required length of rods (typically 2 m or 3.6 m sets), larger lengths are available
- Galvanized or Stainless Steel



Multiple Ballast Weight Assembly

The Multiple Ballast Weight Assembly provides a secure and easy to handle ballast for attachment to lead-in cables. Typical ballast weights are 75 kg, 100 kg and 150 kg, although ballast weights can be tailored to your needs.

Advantages of Multiple Ballast Weight Assemblies include:

- Secure attachment to lead-in cable
- Integral bend stiffeners ensure load is spread over the length of the unit
- Lead-free ballast solution

Information needed to specify Multiple Ballast Weight Assembly:

- Cable diameter and tolerances
- Cable outer jacket material



Drilling & Downhole



Serving the drilling and downhole market for well over forty years, Trelleborg Offshore has an extensive range of reliable, cutting edge polymer engineered products and solutions.

Drill Riser Buoyancy - The drill riser provides a conduit for the drill string and drilling fluids from the ocean floor to the rig. This has significant weight which must be supported by its own structure and ultimately by the drilling vessel. In order to reduce this weight in water to a more manageable amount, discrete buoyancy units are fitted along the length of the riser.

Riser Attachments & Ancillaries - Designed to complement the rigid Drill Riser Buoyancy Modules (DRBMs) so that there is a comprehensive level of support while ensuring a seamless installation of the riser system.

Riser Protection - Protects people, structures and equipment from all types of fire and corrosion in the offshore environment, as well protecting the riser itself. In the demanding environment offshore it is paramount to ensuring on-board safety.

Crushable Foam Wrap - Designed to be installed around the inner drill casing which is then immersed within the annulus fluid. As the pressure of the annulus fluid increases, the Crushable Foam Wrap will collapse at a pre-determined pressure/temperature combination, allowing expansion of the annulus fluid and dispersing any potentially destructive pressure increases.

Crushable Foam Wrap

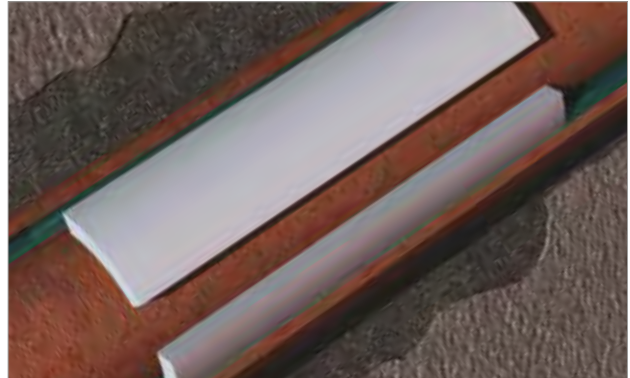
Preventing excessive pressure

When subsea wells are completed, liquid becomes trapped at fairly low temperatures between the outer wall of one casing string and the inner wall of another – in the casing annulus. Heat generated during production operations can cause the trapped fluids to expand and potentially create pressures in excess of 10,000 psi.

If not managed, annular pressure build-up (APB) induced loads can compromise well integrity during production, either by collapsing the inner casing or bursting the outer one.

The most effective mitigation solution for APB is to allow the fluid trapped within the casing annulus to expand, when critical pressure levels are reached. Crushable Foam Wrap from Trelleborg Offshore is installed in the trapped annulus during well construction and it is designed to collapse before any potentially dangerous pressure occurs, allowing the trapped fluid to expand. Trelleborg offer a wide range of syntactic foam grades, available to fit a variety of annular geometries, to cater for the protection of all wells, in virtually any combination of temperature and pressure. Crushable Foam Wrap is a proven engineered solution for APB mitigation with more than 20 years of successful application for the major operators in the O&G industry.

Crushable Foam Wrap from Trelleborg Offshore is a rigid polymeric material which has a closed cell foam micro structure allowing for collapse of the foam within a specified temperature and pressure band as dictated by the expected well conditions.



Crushable Foam Wrap panels shown during installation.

In the start-up phase, the materials remain intact, with no significant volume change. If conditions reach certain preset limits the syntactic foam undergoes a progressive and significant collapse, preventing excessive overpressure and thus protecting the steel casing.

Benefits:

- Easy to handle and install, chemically inert material
- Onsite installation available
- Honeycomb microstructure allows collapse of the foam to take place and remain intact
- May be placed anywhere within the trapped annulus
- Allows easy circulation of drilling fluids
- Collapse after the maximum operating temperature is reached
- Reduced risk of cracking
- Proven track record

CFW INSTALLED PROJECTS

Operator	Name of the Field	Location
BP	Machar 1, II, III	North Sea
BP	Mad Dog	Gulf of Mexico
Shell	Ram Powell	Gulf of Mexico
Total	Akpo	West Africa
Tullow oil	TEN	Ghana
Repsol	BM - C33	Brazil
Weatherford	Eni	North Sea

Drilling and syntactic products

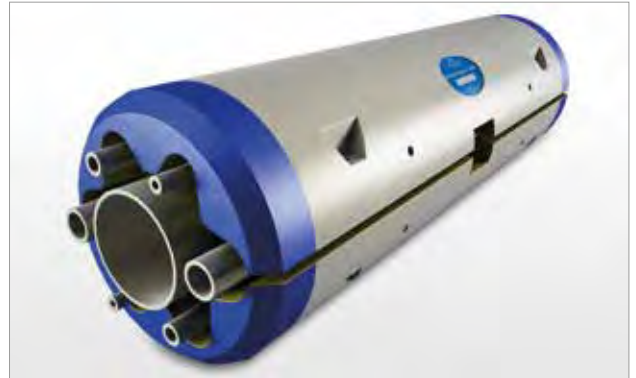
In offshore drilling operations, the drill riser provides a conduit for the drill string from the ocean floor to the rig. However, this adds significant weight which must be supported by its own structure and ultimately by the drilling vessel. Reducing overall weight in water to a manageable amount is critical in expanding exploration and resource recovery to ultra deepwater fields.

Trelleborg Offshore offers Drill Riser Buoyancy Modules (DRBM) to safely overcome these operational challenges. The DRBMs are fitted along the length of the riser to reduce the weight of the drilling riser to a manageable level. We work with our customer at all stages of the project life cycle to ensure all project requirements are met or exceeded.

Drill Riser Buoyancy operates in the harshest of marine environments. These challenging conditions can have a detrimental effect on Drill Riser Buoyancy resulting in cracked or broken buoyancy elements. To safely mitigate these hazardous conditions, Trelleborg Offshore developed the Ultra M.I.S. (Module Integrity System) range of Drill Riser Buoyancy. The Ultra M.I.S. system is a safety system which ensures a damaged buoyancy element can be safely recovered and repaired and also provides a significant increase in mechanical strength to ensure robust and reliable performance.



To provide you with performance at every level, we offer a wide range of riser ancillaries designed to complement our Drill Riser Buoyancy Systems. These include RiserGuard, Riser Shims, Stop Collars, Installation Hardware, Riser Grommets & Polykap protectors.



Benefits:

- Enhanced safety – Ultra M.I.S.
- Increased mechanical strength
- Optimized uplift

RiserGuard

Bare riser protection systems

In offshore drilling operations, the drill riser provides a conduit for the drill string from the ocean floor to the rig. However, the bare drilling riser (riser which does not have DRBM – Drilling Riser Buoyancy Modules installed) also requires protection. Replacing traditional metallic solutions for protection of risers with a composite based modular design increases performance by weight reduction and improves safety during handling, storage and drilling operations.

RiserGuard provides complete protection of bare riser joints and external lines during handling, storage, and drilling operations. They are specifically designed to protect the drilling riser from impact damage when running or retrieving through the moon pool area, or during handling operations in the riser storage bay.

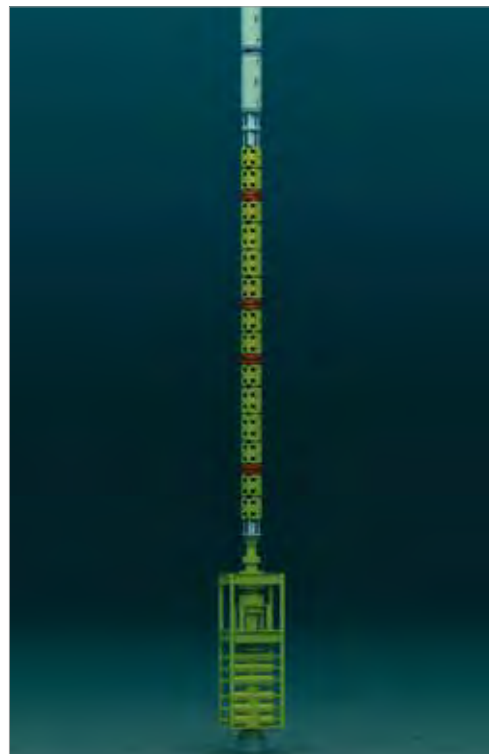
Stackable RiserGuard

Stackable RiserGuard is a solution for rigs with limited storage space and allows stacking of various types of riser joints. It provides the same protection and handling characteristics as standard RiserGuard while adding strategically spaced molded polyurethane sections between the RiserGuard which transfers the load between bare joints and deck storage area. This provides the capability to efficiently store various types of riser joints while preserving valuable deck space.

Riser Shims

Riser Shims support bare joints in critical areas of the riser joint. They are installed at intervals on the riser joint and constructed to the same external configuration as the buoyancy, facilitating the stacking of bare joints. Riser Shims do not provide full joint protection but offer an economic protective solution.

To provide you with performance at every level, we offer a wide range of riser ancillaries designed to complement our Drill Riser Buoyancy systems & Bare Joint Protection systems. These include Stop Collars, Installation Hardware, Riser Grommets & Polykap protectors.



Benefits:

- Complete protection of bare riser joint and external lines
- Same OD & geometry as buoyancy
- Light weight material (neutrally buoyant/free flooding in seawater)
- Excellent abrasion and impact resistance
- Stackable

Helically Grooved Buoyancy

Drill riser buoyancy VIV suppression

Helically grooved buoyancy is the result of a joint development between Trelleborg Offshore and Diamond Offshore Drilling to integrate vortex-induced vibration (VIV) suppression and drag reduction with drill riser buoyancy, increasing rig efficiency without compromising on safety or structural integrity.

Helically grooved buoyancy design dimensions are optimized to ensure uncompromised uplift while effectively eliminating riser motions and higher levels of drag in onerous offshore current environments compared to traditional riser buoyancy. The minimal removal of material associated with the grooves corresponds to only a 2-3% buoyancy loss, which can easily be recovered through the manufacturing process by selecting lower density materials.

The new multi-functional design integrates VIV suppression and drag reduction technology into DRBM equipment from the time of manufacturing eliminating the requirement of ancillary suppression equipment, alleviating complicated and time intensive riser running and retrieval procedures. In addition, reductions in riser motions due to VIV limit the number and magnitude of strain cycles transferred to subsea equipment, in turn, decreasing fatigue loading and extending the service life of wellhead and conductor/casing equipment.

Joint handling times and running methodologies during riser deployment and retrieval are equivalent between Helical Grooved Buoyancy and traditional buoyancy designs, resulting in increased personnel safety, higher efficiency and a more robust solution compared to traditional VIV mitigation equipment.

Applications:

- Marine Drilling Risers • Intervention Risers
- Jumpers • Long Pipeline Spans
- Production Risers • Umbilicals
- Flow Lines • Power Cables



Benefits:

- Expanded connected riser drilling & non-drilling operating envelopes
- Increased vessel transiting speeds with a drilling riser deployed
- Decreased riser and BOP excursion after disconnect
- Increased maximum allowable current conditions for riser deployment, retrieval, and hang-off operations
- Increased fatigue lives for the drilling riser and subsea equipment
- Increased Personnel safety during riser deployment and retrieval over other ancillary VIV mitigation equipment
- Simplified riser running procedures
- Decreased demand on vessel station keeping propulsion systems



Analysis and simulation

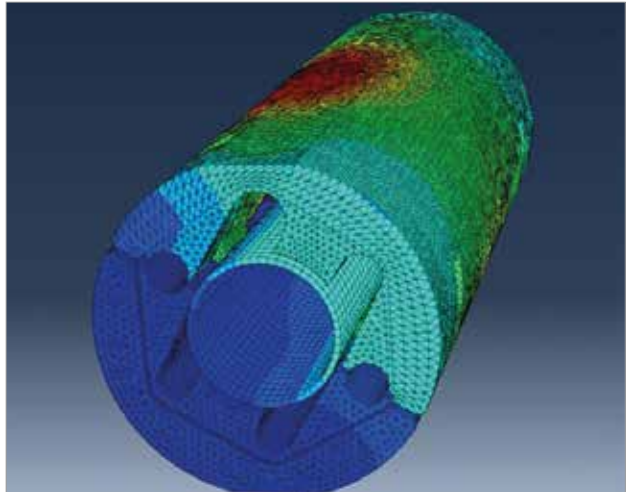
Refinement of concept, feasibility, and design through numerical modelling using computational fluid dynamics (CFD) and finite element analysis (FEA) allows Trelleborg Offshore to incorporate requirements for product performance, development, and operation life cycle maintenance throughout all stages of development. Incorporating this ability with increased communication and collaboration with drilling contractors and E&P operators in the front end design phase is resulting in the increase of equipment and technology that provides focused solutions to specific industry challenges.

Computational Fluid Dynamics

Through the use of CFD, Trelleborg Offshore is collaborating with industry partners in developing new solutions for combating offshore equipment loading due to high current conditions. Product design and equipment configuration can be efficiently assessed prior to manufacturing operations to ensure the optimization of product vortex-induced vibration (VIV) suppression and drag reduction, translating to less stress on the equipment.

Local & Global Finite Element Analysis

Detailed FEA allows Trelleborg Offshore to optimize equipment design through geometrical configurations, material make up, fastening solutions, and overall discrete and system performance. This vastly increases the success of new technology developments while simultaneously reducing the development life cycle and upfront investments, which enables Trelleborg Offshore to provide effective solutions to the client at much lower costs.



Product Performance Assessments

Trelleborg Offshore extends the experience and capabilities of the in-house engineering analysis and simulation team beyond the office setting to a diversified variety of product qualifying trials.

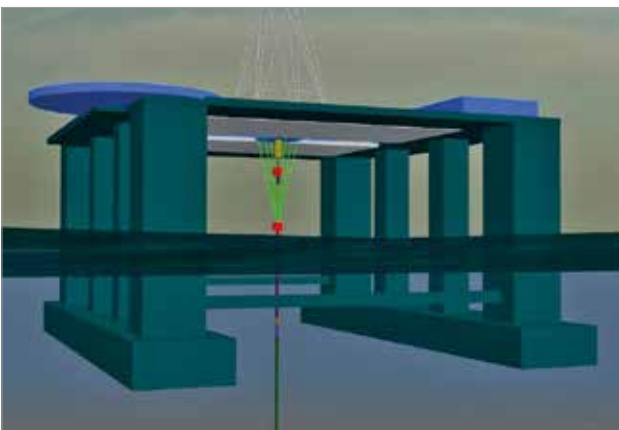
During this stage of the design all of the collaborative input and innovation of Trelleborg Offshore and our industry partners and clients is verified and validated. Data obtained during laboratory testing provides the necessary information quantifying the performance of new technology developments and validating numerical models for future equipment advancements.

Applications:

- New Product Development
- Equipment Performance Studies
- System Integration Optimizations

Benefits:

- Cost savings
- Increased service life
- Multi-functional designs
- Rapid development cycle



Drilling and Downhole Application:

Engineering design, analysis and simulation

Project

Trelleborg Offshore was asked to manufacture and supply a protection system for an umbilical crossing associated with Vashishta and S1 Development Project for an EPCI customer. The protection system is intended for subsea umbilical applications, at a location where the umbilical crosses over the two existing 14" pipelines 35m apart. The targeted design life is 20 years in approximately 700m water depth.

Product and Service

Urduct™ was identified as the most appropriate solution for the umbilical protection. Trelleborg's Urduct™ product design team proposed two designs that met the requirement for minimum separation of 150 mm and 300 mm between the umbilical and existing pipelines. To ensure the technical requirements for the umbilical crossing protection system were met, Trelleborg's engineering analysis and simulation team performed a series of global finite element analyses to validate the design which included:

- Umbilical stability analysis at the crossing location to ensure the stability of the umbilical along with the protection system meets DNV-RP-F109 requirements during the installation and operation phases, particularly when subject to hydrodynamic loading
- Umbilical crossing analysis to determine the naturally laid free span length at either side of the crossing over existing pipelines. The final radius of the umbilical crossing configuration with the installed protection system after laying on top of the 14" gas pipeline meet the umbilical's minimum bend radius requirement
- Umbilical free span VIV (Vortex Induced Vibration due to sea bottom current) analysis to identify if the natural free span length has potential VIV occurrence concern



Calculated Free-Span Configuration for 300mm separation design



Challenges and Solution

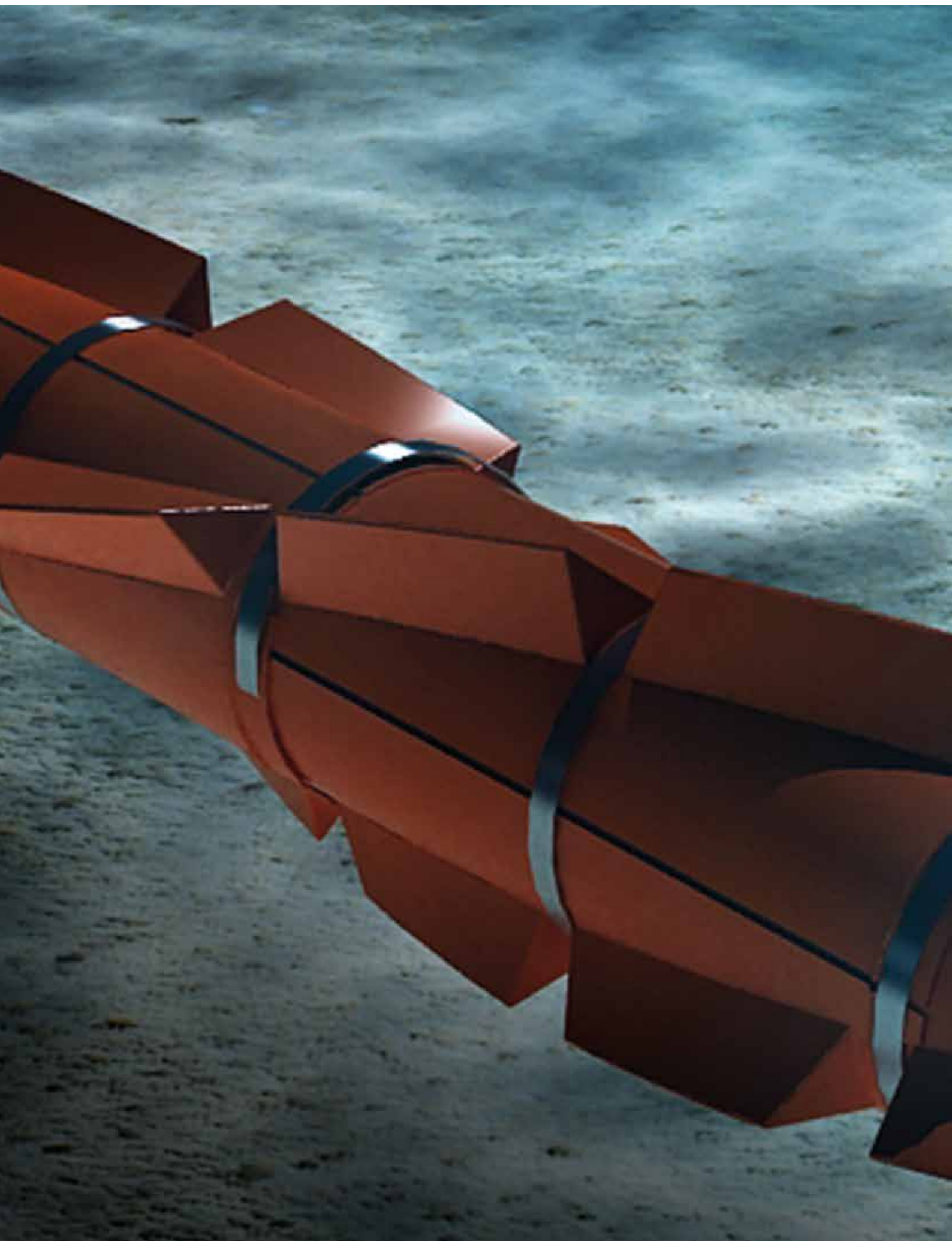
The biggest challenge of the project was the very tight product delivery timeframe, which required rapid execution of product design and engineering analysis to ensure sufficient time for manufacturing. The engineering analysis and simulation team quickly arranged resources, prioritized the project and provided quick response to all the client's inquiries. The engineering analysis team also performed design optimization analyses and coordinated with product design team to ensure best solutions were offered to the customer.

Through the analysis, potential VIV occurrence was identified due to the onerous sea bottom current in 100 year return period. Trelleborg presented the study findings to the client and proposed VIV suppression strakes as a replacement of Urduct™ to avoid vibration damage to the umbilicals.

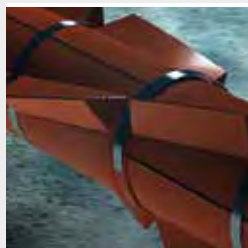
The rapid turn-around of the comprehensive analysis and the recommended Trelleborg VIV suppression solutions allow the client to progress with the original umbilical installation plan and avoided the necessity of revising the field installation design.



FEA model



Subsea



From subsea mooring to buoyancy, Trelleborg Offshore boasts an extensive range of innovative solutions, serving the subsea sector.

Bend Control Solutions - Where any flexible tubular connects to a structure, normal movement during operation or forces incurred during installation can cause catastrophic failure of the tubular at the termination point. Our bend control solutions reduce this damage.

Buoyancy - In floating production scenarios, pipelines such as flexible risers, cables and umbilicals are often required to be held subsea in specific geometric configurations designed to prevent over utilization of the system.

Cable and Flowline Protection - With an ever increasing global requirement for data and product transfer, and the necessity for transfer networks to run through ever harsher environments, the demand for highly advanced cable and flowline protection grows.

Clamping Solutions - A pipeline laying operation may have a requirement to simultaneously lay a small diameter service line or umbilical. During the installation, to ensure that the secondary lines are adequately supported between surface and seabed, they may be attached to the main pipeline using a clamp arrangement.

ROV/AUV/HOV Buoyancy Systems - Buoyancy systems are being used in deeper water depths. The need for low density materials which enables a high buoyancy with reduced volumes, makes it ideal for inclusions with the frame structure of these vehicles.

Thermal Insulation - Thermal insulation is necessary to avoid formation of hydrate plugs and wax build-up in subsea structures. The build-up begins when the oil/gas composition temperature is not maintained and begins to cool. Without thermal insulation the cold seawater rapidly cools down the oil, forming hydrate/wax blockages making it impossible for a safe flow.

Bend Restrictor

A bend limiting device

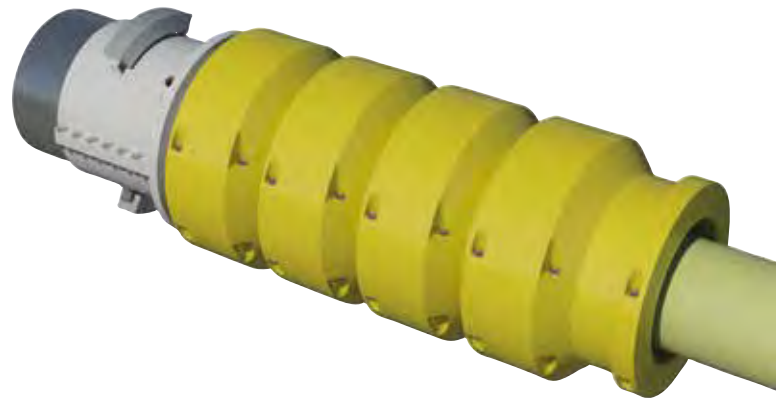
Where any flexible tubular connects to a structure, normal movement during operation (dynamic loading) or forces incurred during installation and retrieval (static loading) can cause catastrophic failure of the tubular at the termination point. The failure mode can be through collapse, rupture of internal lines or even rupture of the external layers leading to escape of the contents to the environment. This can happen as a result of a single event or be caused through fatigue damage over time.

Bend limiting devices are provided to protect the tubular from these situations and perform the following functions:

- Maintain the manufacturers recommended minimum bend radius (MBR) during the life of the project
- Provide a suitable load path from tubular to fixed structure
- Reduce point loading at the termination to an acceptable level

Bend Restrictors

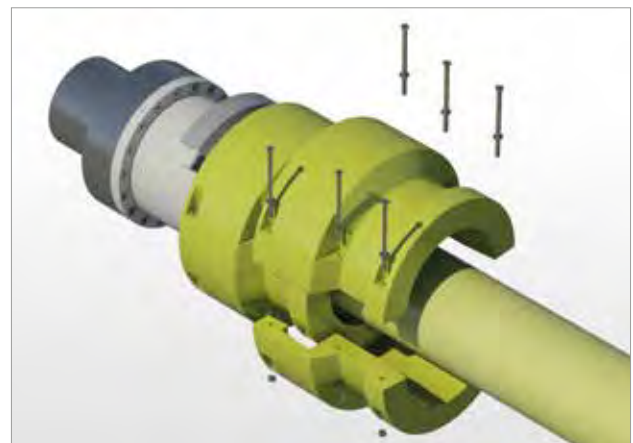
Bend restrictors are used to protect flexible pipelines from overbending and buckling during their installation or operation phase where static loads are generated. The system comprises a number of interlocking elements that articulate in 3 dimensions when subjected to external loads. At a designed radius the elements mechanically lock to form a semi rigid curved structure that will not move further.



Once the elements lock together the bending moment present is transferred through the elements to a specially designed steel interface structure then into the adjacent rigid connection. To provide the performance at every level, Trelleborg Offshore will design the bend restrictor elements based on supplied information and configure the termination steelwork to suit the project needs.

Benefits:

- A split design allows installation of the restrictor after pipe termination
- Ease of installation onshore and offshore
- Light weight in water, reducing the loading on the pipe
- Increased durability



Bend Stiffener

Bend protection in dynamic environments

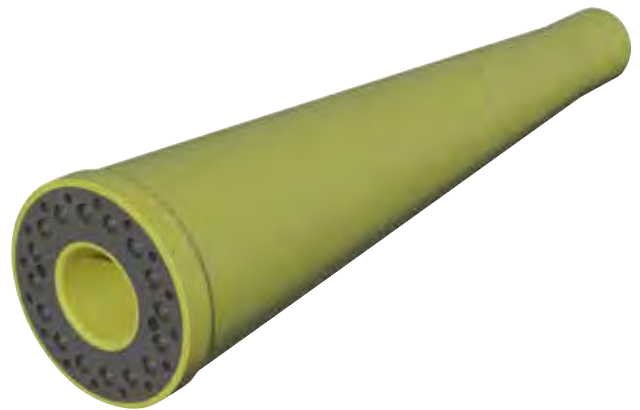
Where any flexible tubular connects to a structure, normal movement during operation (dynamic loading) or forces incurred during installation and retrieval (static loading) can cause catastrophic failure of the tubular at the termination point. The failure mode can be through collapse, rupture of internal lines or even rupture of the external layers leading to escape of the contents to the environment. This can happen as a result of a single event or be caused through fatigue damage over time.

Bend limiting devices are provided to protect the tubular from these situations and perform the following functions:

- Maintain the manufacturers recommended minimum bend radius (MBR) during the life of the project
- Provide a suitable load path from tubular to fixed structure
- Reduce point loading at the termination to an acceptable level

Bend Stiffeners

Bend stiffeners acquired their name because the conical shape gradually increases the overall stiffness of the tubular in order to prevent over bending at the termination point. Manufactured from elastomeric material, a bend stiffener is suited to the constant wave and current induced motion of dynamic installations but can also be used for static applications.



Bend stiffeners are project specific and to provide you with the performance at every level, Trelleborg Offshore will fully engineer the product to accommodate the defined tension and angle combinations.

Trelleborg Offshore's track record in the supply of bend stiffeners, specifically for dynamic applications, is extensive.

Diverless Bend Stiffener Connectors

For applications where termination of the tubular and bend stiffener is an issue or a retrofit solution is needed, Trelleborg Offshore has a range of diverless connectors available.

Benefits:

- Added local stiffness to the umbilical or flowline
- Limits bending stresses and curvature
- Prevents structure damage from overbending
- Reduces structure fatigue

Achievements:

- First dynamic bend stiffener supplied for service in 1994
- Over 1,000 dynamic bend stiffeners currently in service
- Bend stiffeners operating in locations around the world in ambient temperatures ranging from -20°C/-4°F to 50°C/122°F
- 100% track record with no failures in service
- Lloyd's Register Type Approval

Distributed Buoyancy Modules

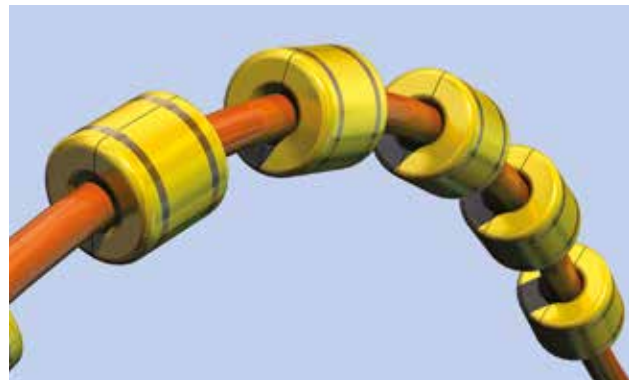
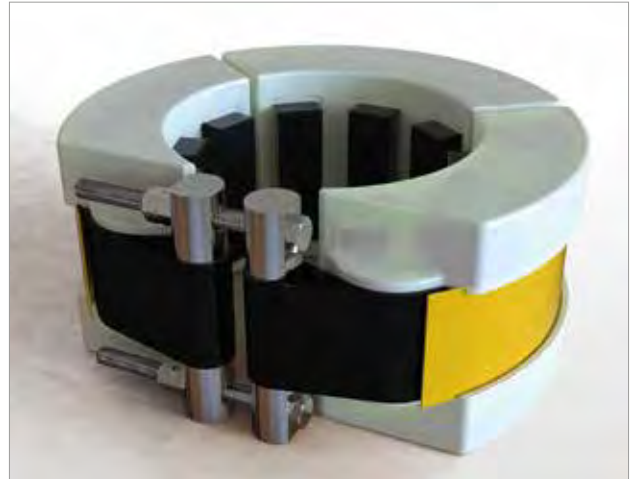
Tailored buoyancy solutions

In floating production scenarios, pipelines such as flexible risers, cables and umbilicals are often required to be held subsea in specific geometric configurations designed to prevent over utilization of the system. Although numerous configurations have been developed and implemented over the years, one favored method is to attach discreet buoyancy modules to the outside of the pipeline. The buoyant load must not migrate or degrade over the design life of the product.

Distributed Buoyancy Modules (DBMs) are typically used between a subsea structure and a surface vessel or platform. The clamping solution allows the DBMs to be fitted at any point along the length of the pipeline.

The two main functions of the DBMs are to provide uplift and maintain location along the riser. The uplift is generated by a two part buoyancy component. A clamp securely attaches the assembly to the desired location on the riser. The buoyancy segments are assembled to mechanically lock around the clamp and are secured with circumferential straps.

To provide the project performance at every level, the buoyancy system can be adjusted to operate in seawater depths from surface to 6,000m and beyond.



Benefits:

- Reduces top tension loads
- Maintain project specific riser configuration
- Fast, efficient and safe offshore installation procedure
- Compliant systems aimed at encapsulating large flowline tolerances and expansions/contractions
- Extensive subsea track record
- Industry qualified materials and geometry
- Comprehensive document and drawing package

J-Tube Seals

Preventing the loss of corrosion inhibitor

In the subsea environment pipe connections are at risk of corrosion, due to the level of acidity in the water. This corrosion reduces the stability of the pipeline, increasing the likelihood of leakage.

J-Tube Seals are used to prevent the loss of corrosion inhibitor solution used in the annulus between the host line and the J-Tube bore.

Diverless and Modular Design

The seal is secured to the host line by integral clamps. It can then be pulled into the J-Tube or I-Tube with the host line. Typically the seal will be installed in the J-Tube just behind the entry bellmouth.

Interference Fit

Polyurethane seal elements are used to provide an interference fit to the host line and the J-Tube bore. The interference fit provides the seal – no subsea activation is necessary.

Corrosion Inhibitor Retention

J-Tube seals are primarily used to prevent the loss of corrosion inhibitor within the J-Tube annulus.

Key Applications

- J-Tube
- Centralized action
- Ancillary attachment

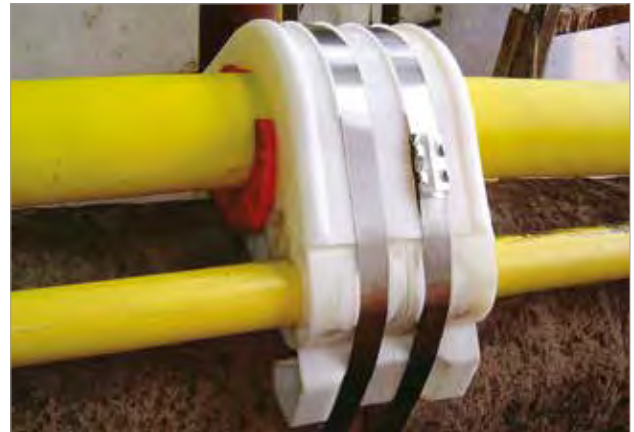
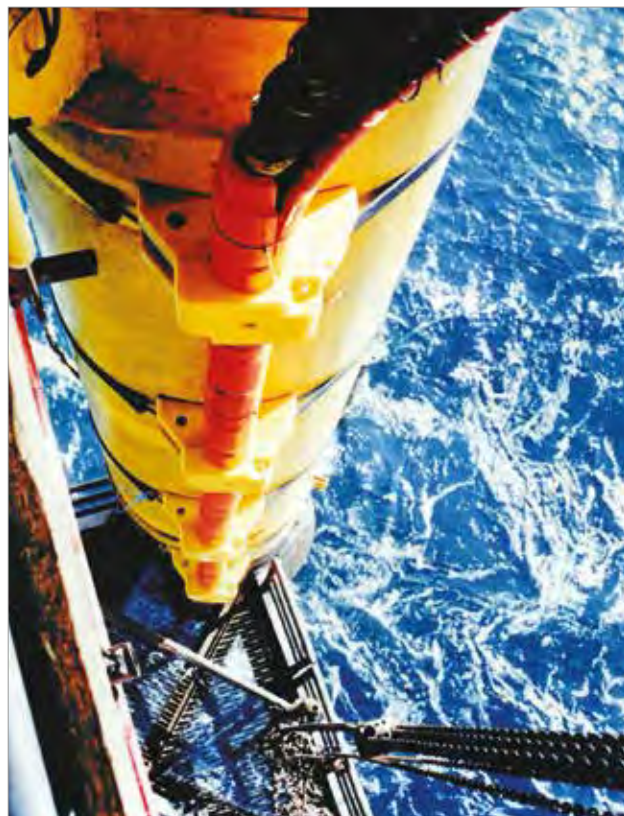


Clamping solutions for drill risers

There is often a requirement to run a secondary pipe or cable alongside a primary pipeline or down a jacket leg. In these scenarios Trelleborg Offshore can supply a comprehensive range of piggyback clamps or guides to suit all geometric and environmental requirements. Factors such as loading and quantity will be used by Trelleborg to determine which of the multitude of solutions best suits each case. A few of the solutions are described below.

Drill String Clamps

A rugged piggyback clamp manufactured from marine grade polyurethane can be supplied for tying together drill strings and umbilicals during drilling operations. The design of these clamps prevents any damage to the inside of casing pipes having only polyurethane coming into contact with them. The polyurethane has excellent impact and abrasion properties making it the right choice for this application. Due to the manufacturing process, large numbers of these clamps can be manufactured in a cost effective manner.



Riser Clamps

When a cable or pipeline is required to run up the side of a platform, the Trelleborg Offshore syntactic riser clamp or guide is well suited. Due to the complexity of a platform structure the location and fixing geometry of each clamp may vary considerably. Since each clamp is individually machined from Trelleborg's high grade syntactic foam, the exact geometric shape can be achieved for each location.

The corrosion resistant syntactic foam, kevlar straps and alloy tensioning assemblies guarantee a firm grip and a long operational life.

General Clamping

Trelleborg Offshore also manufactures piggyback clamps and guides from materials such as rubber, rigid polyurethane, steel and polypropylene in conjunction with alloy and titanium strapping. Since the demanding nature of the offshore environment is ruthless Trelleborg's vast experience and engineering skills ensure the right solution is provided for each project.

Benefits:

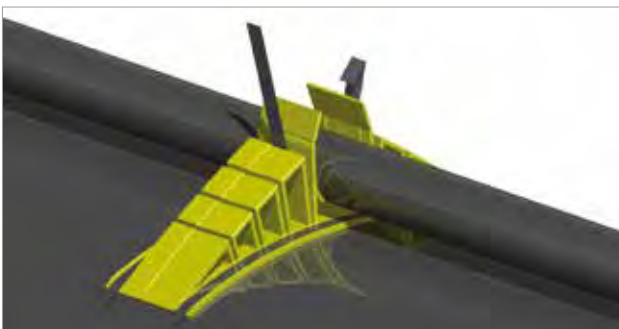
- Durable
- Corrosion resistant
- Excellent impact and abrasion resistance
- Long term service
- Quick installation
- Tough
- Adaptable design for all requirements

Clamping solutions for the pipeline

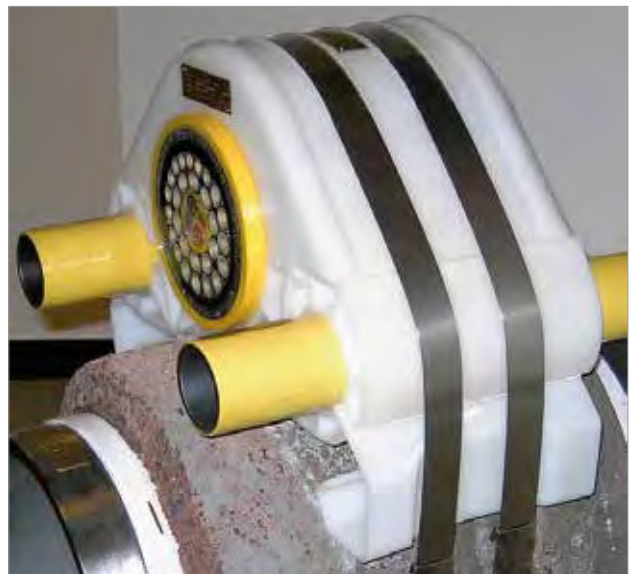
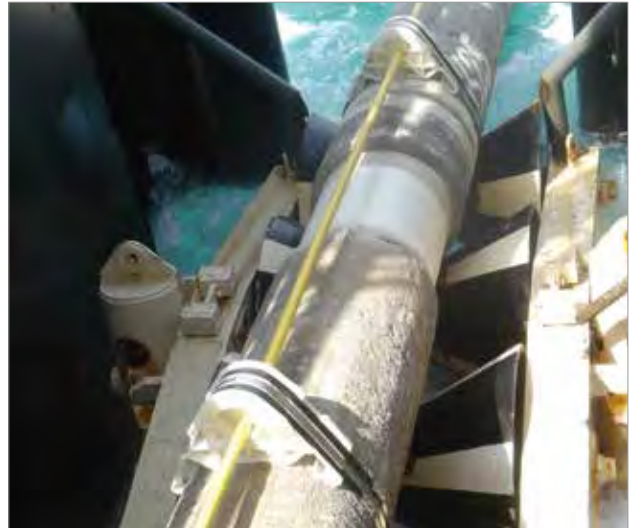
A pipeline laying operation may have a requirement to simultaneously lay a small diameter service line or umbilical. During the installation, to ensure that the secondary lines are adequately supported between surface and seabed, they may be attached to the main pipeline using a clamp arrangement. This attachment method is known as piggybacking.

An advanced Piggyback System (APBS) is a pair of “snap-together” two-piece injection molded marine grade polypropylene saddles. The pieces are fixed in position by a highly corrosion-resistant Alloy 625 circumferential banding strap. It also has a sealing assembly using a unique technique to ensure no movement in the seal.

For post installation of the secondary line the diver-friendly piggyback guide was designed to improve safety. The guide uses edge treated banding and an updated fastening system which eliminates sharp edges reducing the risk of cuts to the diver. The innovative design reduces handling and improves installation efficiency and time enabling significant cost savings while increasing diver safety.



Post installation clamp



Advanced piggyback system

Benefits:

- Durable
- Easy installation of the secondary line
- Excellent impact and abrasion resistance
- Long term service
- Light weight
- Minimal creep
- Minimal deformation
- Tough

Eccofloat®

Syntactic foams

Trelleborg Applied Technologies manufactures a range of high performance, low density syntactic foam for deep sea buoyancy applications.

These composite foams provide ultra low densities by selecting only the highest specification hollow glass microspheres, called Eccospheres®, and combining them within a rigid, high strength resin system. The syntactic foam is typically cast into blocks and then is used to prepare large buoyancy modules that can be readily shaped to conform to hull contours and outfitted for installation in the forward and aft free-flood areas of submarines.

Oceanographers also depend on syntactic foams to suspend instrumentation in deep ocean studies. For these applications, the syntactic foam is used in either block form or custom molded shapes for installation in manned and unmanned submersibles such as the legendary Alvin and Jason vehicles that were used to discover and explore the Titanic.

Trelleborg Applied Technologies produces various grades of syntactic foams, called Eccofloat®, to meet our customers broad range of requirements.

TG Grade syntactic foams are lightweight and economical for building manned and remote operating vehicles. The foams are also used to manufacture mine neutralization systems because of their zero magnetic and sea-water comparable acoustic signatures.

Applications include hydroplanes, rudders, trim adjustment modules for submarines and specialized applications such as acoustic windows due to the material profile and ability to significantly improve sonar functions.



EL Grade epoxy syntactic foams are the material of choice for manufacturing manned and unmanned submersibles because of their density range and ability to withstand exposure to diesel fuels and hydraulic fluids.

DS Grade syntactic foams combine lightweight glass Eccospheres® with multifunctional epoxy resin to produce ultra-high strength-to-weight materials for high-performance, deep sea applications including manned and unmanned submersibles.

Eccofloat® Product Sizes

Eccofloat® TG and EL Grades are available in the following dimensions:

6 x 12 x 12 in (152.4 x 304.8 x 304.8 mm)

6 x 12 x 24 in (152.4 x 304.8 x 609.6 mm)

6 x 19.5 x 29.5 in (150 x 500 x 750 mm)

Eccofloat® DS Grade is available in the following dimensions: 4 x 12 x 18 in (101.6 x 304.8 x 457.2 mm)

Certifications

Trelleborg Applied Technologies is ISO 9001 certified.

ECCOFLOAT® PRODUCT	SERVICE DEPTH		DENSITY		SERVICE PRESSURE
	FSW	MSW	lbs/ft ³	kg/m ³	psi
TG-24/2000	6,560	2,000	24	385	3,000
TG-26/3000	9,843	3,000	26	416	4,444
TG-28/4000	11,811	4,000	28	448	5,846
TG-30/5000	16,430	5,000	30	481	7,307
TG-32/6000	19,716	6,000	32	513	8,768
TG-34/7000	22,900	7,000	34	544	10,164
TG-39/11500	38,000	11,500	39	639	16,872
EL-30/2000	6,750	2,000	30	480	3,000
EL-34/6000	20,000	6,000	34	544	9,000
EL-36/7300	24,000	7,300	36	576	11,000
DS-35/8130	26,700	8,130	35	560	11,888
DS-39/11500	38,000	11,500	39	624	16,872

Preventing abrasion damage

In the subsea environment ocean currents increase the chance of abrasive damage of supported lines within tubes. Over time this damage could put the connections at risk.

The centralizer's function is to allow any flexible or rigid line, or multiple lines, to be centered in an I-Tube, J-Tube, tunnel or larger diameter pipe.

Installation

Centralizers are installed onto the cable or pipe prior to deployment and pulled in as one unit.

Reduced Pull In Loads

Their low coefficient results in reduced installation loads when the line is being pulled in.

Abrasion Protection

Centralizers prevent the supported line from touching the inside of the tube into which they are being pulled, preventing abrasion damage.

Key Applications

To meet our customers' needs, our cutting-edge solutions can be used for the below applications:

- Cable
- Umbilical
- Pipeline
- Combinations of cables, umbilicals and pipes



Tri-Strakes™ Lite

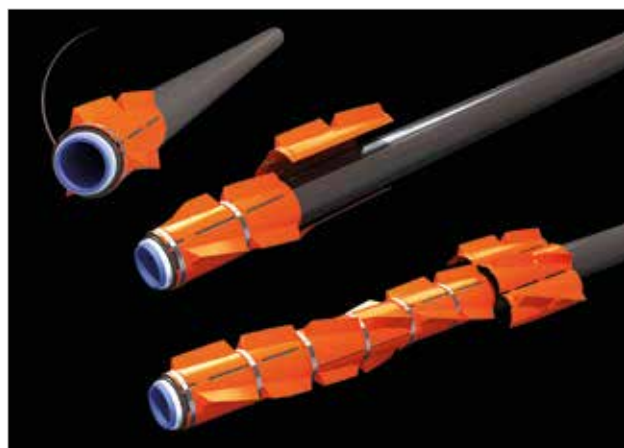
Stackable & lightweight vortex induced vibration suppression

Pipelines unsupported over free spans, such as steel catenary risers and rigid steel flowlines, are prone to vortex induced vibration (VIV) fatigue, which can cause serious performance issues such as pipe girth weld failure or premature pipe malfunction.

Developed in response to market demand, the Tri-Strakes™ Lite is a high quality, cost-effective VIV suppression system manufactured by Trelleborg Offshore. The system consists of overlapping and interlocking moldings, with three-start helical strakes to provide an effective triangular or trapezoidal strakes profile.

Working with polymers across a number of technologies and industries, Trelleborg Offshore was able to use insight and innovation to improve packing and handling factors using best-value engineered solutions. The innovative manufacturing process means that the Tri-Strakes™ Lite can be produced up to six times faster than systems manufactured using traditional techniques, ensuring shorter lead times.

To perform at every level, Trelleborg Offshore built up a wealth of in-house VIV knowledge through consultation with industry renowned hydrodynamicists, alongside computational analysis. Physical hydrodynamic testing combined with in-house impact, axial slip and load bearing capacity testing has produced a hydrodynamically efficient and load bearing capable product. All materials and geometries used are fully qualified for long term subsea use.



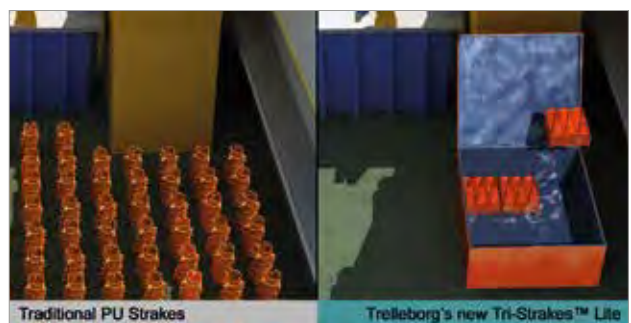
Installation of Tri-Strakes™ Lite



Each section of the system has been designed as a single, lightweight component, enabling quick and easy pre-install onshore or install offshore. The design permits the system to be stacked efficiently during shipping, ensuring more efficient and cost effective transportation and installation.

Features:

- Cost effective, high density packaging
- Light weight and easy to handle
- J-Lay load bearing capacity
- Temperature resistant up to 90 °C / 194 °F
- Qualified geometry and materials
- Quick installation
- Available in a wide range of colors



For a highly resilient vortex induced vibration suppression solution take a look at our Tri-Strakes™ Stinger product at:

www.trelleborg.com/offshore/tri-strakes-stinger

For a combination of the stackability of the Tri-Strakes™ Lite with the load resilience of the Tri-Strakes™ Stinger take a look at our Tri-Strakes™ Combi product at:

www.trelleborg.com/offshore/tri-strakes-combi

Tri-Strakes™ Stinger

Highly resilient vortex induced vibration suppression

In deepwater riser applications where the use of steel catenary risers (SCRs) is common, these risers can be introduced to the phenomenon of vortex induced vibration (VIV). This is caused by the regular shedding of vortices from the pipe when subjected to a steady current. The shedding of the vortices can “lock into” the resonant frequency of the pipe along a significant length and can cause the pipe to vibrate. VIV causes accelerated fatigue damage and can give rise to problems such as pipe girth weld failure or premature pipe failure. Other applications prone to VIV are rigid steel flowlines unsupported over free spans and major deepwater field developments requiring a large number of thermally insulated pipelines.

Trelleborg Offshore recognizes that this is an increasingly common problem and therefore, in order to suppress the damaging vibrations to an acceptable level, have put together a comprehensive design package which provides a successful VIV suppression system.

To perform at every level, Trelleborg Offshore built up a wealth of in-house VIV knowledge through consultation with industry renowned hydrodynamicists, alongside computational analysis. Physical hydrodynamic testing combined with in-house impact, axial slip and load bearing capacity testing has produced a hydrodynamically efficient and load bearing capable product. All materials and geometries used are fully qualified for long term subsea use.

To provide you with performance at every level, Trelleborg Offshore offers a range of VIV Suppression Strakes to meet your needs.



PU VIV Suppression Strakes

PU VIV suppression strakes combine the benefits of traditional cable and flowline impact and abrasion protection with an effective VIV suppression profile. The product is manufactured in marine grade polyurethane (PU).

Integral Strakes

Trelleborg Offshore is able to mold strakes profiles into many of its products during manufacture. This is ideally suited for thermal insulation shells, where strakes can be molded in, to provide effective VIV suppression.

For a stackable and lightweight vortex induced vibration suppression solution take a look at our Tri-Strakes™ Lite product at: www.trelleborg.com/offshore/tri-strakes-lite

For a combination of the stackability of the Tri-Strakes™ Lite with the load resilience of the Tri-Strakes™ Stinger take a look at our Tri-Strakes™ Combi product at: www.trelleborg.com/offshore/tri-strakes-combi

Tri-Strakes™ Combi

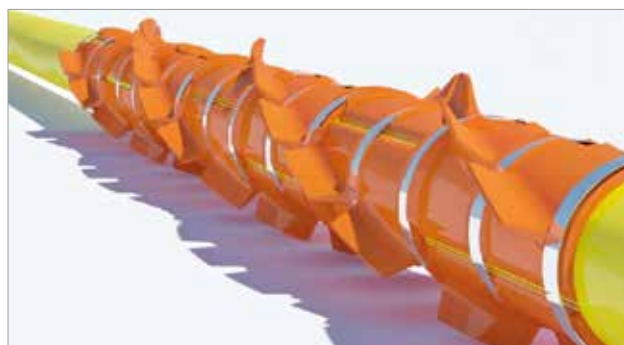
Resilient & stackable vortex induced vibration suppression

Pipelines unsupported over free spans, such as steel catenary risers and rigid steel flowlines, are prone to vortex induced vibration (VIV) fatigue, which can cause serious performance issues such as pipe girth weld failure or premature pipe malfunction.

Developed in response to market demand, the Tri-Strakes™ Combi is a high quality, cost-effective VIV suppression system manufactured by Trelleborg Offshore. The system consists of overlapping and interlocking moldings, with three-start helical strakes to provide an effective triangular or trapezoidal strakes profile.

Working with polymers across a number of technologies and industries, Trelleborg Offshore was able to use insight and innovation to improve packing and handling factors using best-value engineered solutions. The established manufacturing process means that the Tri-Strakes™ Combi can be produced up to three times faster than systems manufactured using traditional techniques, ensuring shorter lead times. The product is manufactured in marine grade polyurethane (PU), giving the benefits of traditional cable and flowline impact and abrasion protection with an effective VIV suppression profile.

To perform at every level, Trelleborg Offshore built up a wealth of in-house VIV knowledge through consultation with industry renowned hydrodynamicists, alongside computational analysis. Physical hydrodynamic testing combined with in-house impact, axial slip and load bearing capacity testing has produced a hydrodynamically efficient and load bearing capable product. All materials and geometries used are fully qualified for long term subsea use.



Each section of the system has been designed as a single, lightweight component, enabling quick and easy pre-install onshore or install offshore. The hinged design permits the system to be stacked efficiently during shipping, ensuring more efficient and cost effective transportation and installation.

Features:

- Cost effective, high density packaging
- Light weight and easy to handle
- Impact and abrasion resistant
- Moderate S-Lay and full J-Lay load bearing capacity
- Temperature resistant up to 60 °C / 140 °F
- Qualified geometry and materials
- Quick installation



For a stackable and lightweight vortex induced vibration suppression solution take a look at our Tri-Strakes™ Lite product at:
www.trelleborg.com/offshore/tri-strakes-lite

For a highly resilient vortex induced vibration suppression solution take a look at our Tri-Strakes™ Stinger product at:
www.trelleborg.com/offshore/tri-strakes-stinger

Uraduct®

Cable and flowline protection

With an ever increasing global requirement for data and product transfer, and the necessity for transfer networks to run through ever harsher environments, the demand for highly advanced cable and flowline protection grows.

Uraduct® is a protection system designed and developed to protect fiber optic cables, power cables, umbilicals, flexible flowlines, rigid flowlines, hoses and bundled products from abrasion and impact. Uraduct® can also be used to add ballast to cables and flowlines. It has established an enviable reputation as an industry standard for cable and flowline protection.

Benefits:

- Easy to handle and transport
- Custom made system
- Impact and abrasion resistant

Uraduct® +

For applications where pipelines or cables are to be subject to high levels of abrasion, Trelleborg developed Uraduct® +, which is considered to be the ultimate protection solution. Flexible pipes, power cables and fiber optic cables can be protected in any area where abrasion is considered to be a problem and stabilization cannot be achieved.



Uraduct® - Retrofit Riser System

With the increasing number of additional cables requiring termination to the offshore platforms and to provide you with performance at every level, Trelleborg designed the Uraduct® Retrofit Riser System, which comprises of Uraduct® and dedicated, high integrity locating clamps.

This system provides a very cost-effective solution where cable entry to a platform is not possible via existing 'J' or 'I' tubes. Prior to Trelleborg's Uraduct Retrofit Riser System the only alternative was to install new steel 'J' or 'I' tubes at great expense, compounded with time consuming and problematic installation.



Buoyant Uraduct®

Buoyant protection cable and flowline

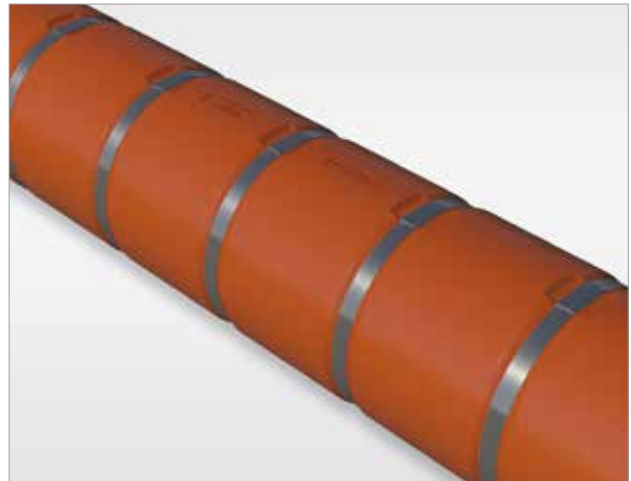
Demand is growing for highly advanced cable and flowline protection, as the global requirement increases for data and product transfer, through ever harsher environments. When lines cross each other on the seafloor, there is a potential risk of damage to the previously laid power cables or flowlines.

To prevent this damage, Trelleborg developed Buoyant Uraduct®, a protection system for subsea cables, umbilicals, flowlines and hoses. Based on the original Uraduct® design, Buoyant Uraduct® not only protects cables from abrasion and impact, it also reduces the excess weight of a subsea cable so that it will not crush other lines at crossing locations. Made from highly buoyant materials, Buoyant Uraduct® minimizes drag and lift, avoiding possible stability issues.

Buoyant Uraduct® is a suitable alternative to subsea crossing bridges and can be installed on the cable or pipeline before it is laid on the seabed.

Applications:

- Bundled products
- Fiber optic cables
- Flexible flowlines
- Hoses
- Power cables
- Rigid flowlines
- Umbilicals



Benefits:

- Abrasion resistant
- Custom buoyancy to customer specification
- Minimizes drag
- Field tested
- High impact resilient

The benchmark for wet insulation systems

Thermal insulation is necessary to avoid formation of hydrate plugs and wax build-up in subsea structures. The build-up begins when the oil/gas composition temperature is not maintained and begins to cool. Without thermal insulation the cold seawater rapidly cools down the oil, forming hydrate/wax blockages making it impossible for a safe flow. Thermal insulation materials are applied in order to prevent formation of these blockages during a shutdown scenario or during normal operations.

Rubber

Vikothersm® R2, a rubber based subsea thermal insulation. The system combines flexibility and robustness and gives protection for the lifespan of subsea installations. The three layer coating system provides HISC/corrosion protection and excellent thermal insulation properties.

Silicon

Vikothersm® S1 sets a new standard in insulation performance based on advanced, non-syntactic silicone technology. Vikothersm® S1 does not rely on glass microspheres giving it improved joint strength, increased heat capacity, long-term flexibility and resistance to hydrostatic collapse. It cures at room temperature without exposure to air with zero shrinkage.

Epoxy

Vikothersm® E1 and E2 are Epoxy syntactic foam systems. Combining an extremely high glass transition temperature with unprecedented resistance to hydrostatic crush pressures, these systems provide high strength, low conductivity insulation.

Polyurethane

Vikothersm® P7 is recognized as the benchmark by which other subsea insulation systems are measured. This non-mercury catalyzed solid polyurethane insulation system is compatible with a full range of application specifications. Advances in application techniques guarantee integrity and reliability.

Thermoplastic

Vikothersm® PP is a thermoplastic thermal insulation and corrosion protection system. The excellent



combination of resilience, thermal performance and chemical stability in the subsea environment has led to this system being used at extreme depth and at extreme temperatures. With an integral high quality FBE corrosion coating, the system can be applied as a thin film using spray techniques, or as a thick coating using injection molding technology.

Glass syntactic

Vikothersm® G3 is a non-mercury glass syntactic polyurethane insulation system. Vikothersm® G3 incorporates all the benefits of an elastomeric system, its thermal performance is enhanced. Vikothersm® G3 combines high performance with exceptional durability.

Polypropylene tape

Vikothersm® PT is a high strength, thermally insulating syntactic polypropylene tape which is suitable for deep sea application. Vikothersm® PT is typically used by deep sea flexible pipe manufacturers as part of its construction to maintain flow rates and reduce the possibility of wax and hydrate formations.

PHYSICAL PROPERTIES		
Products	Temperature limit hot/wet (°C/°F)	Depth limit (m/ft)
Vikothersm® R2	155/311	3,000/9,843
Vikothersm® S1	135/275	3,000/9,843
Vikothersm® E2	100/212	2,000/6,562
Vikothersm® P7	90/194	7,000/22,966
Vikothersm® E1	90/194	2,000/6,562
Vikothersm® PT	90/194	2,000/6,562
Vikothersm® G3	60/140	1,800/5,905
Vikothersm® PP	150/302	3,000/9,843

The benchmark for wet insulation systems

Vikothersm® E1 and E2 epoxy syntactic foam systems are part of the Vikothersm® insulation range. Combining an extremely high glass transition temperature with unprecedented resistance to hydrostatic crush pressures, these systems provide high strength, low conductivity insulation. Epoxy syntactic foams can tolerate an extreme range of temperatures and are ideally suited for hot wet service conditions. The thermal stability of these systems covers a wide range of temperatures. This means they can be effectively applied to extremely harsh subsea environments.



Vikothersm® PT is a high strength, thermally insulating syntactic polypropylene tape which is suitable for deep sea application. Vikothersm® PT is typically used by deep sea flexible pipe manufacturers and is spirally wound onto the pipe as part of its construction to maintain flow rates and reduce the possibility of wax and hydrate formation. The easy application of this material means that it can be applied in single or multiple layers depending on the required insulation levels.



Vikothersm® E1 and E2 Benefits:

- Thermal stability over a greater range
- Lower thermal conductivity
- Increased strengths
- Mechanical stability

Vikothersm® E1 and E2 Features:

- Operating temperature range from -25°C to +100°C / -13°F to +212°F
- Tensile strength +15MPa
- Low density systems
- Buoyant in sea water
- Suitable for high hot wet applications

Apply Vikothersm® E1 and E2 on:

- Doghouses
- Half shell insulation
- Bespoke applications
- Flange connections

Vikothersm® PT Benefits:

- Low thermal conductivity
- Flexibility and resistance to cracking, make it extremely durable
- Reduces processing costs
- Provides optimum cover against wax and hydrate formations
- Easy application

Vikothersm® PT Features:

- Thermal conductivity of 0.160 to 0.170 W/mK
- Operating temperature to 90°C / 194°F
- Tensile strength of 2.8 to 7.9 MPa
- Manufactured with hollow glass microspheres to lower the thermal conductivity
- Thicknesses of: 3.5mm – 7mm with a width of 50.8mm
- Delivered spools of 100 to 150 kgs

Apply Vikothersm® PT on:

- Risers and flow lines

The benchmark for wet insulation systems

Vikothersm® G3 is a non-mercury glass syntactic polyurethane insulation system. It can be applied across all geographical deep water oil and gas locations and its geometrical structure means it is qualified to meet a full range of application specifications. Not only does Vikothersm® G3 incorporate all the benefits of an elastomeric system, its thermal performance is top of the range. Offering a long-term insulation solution that is designed to last the duration of any subsea project, the Vikothersm® G3 combines high performance with exceptional durability.



Vikothersm® P7 insulation system has an industry track record spanning three decades and is recognized as the benchmark by which other subsea insulation systems are measured. It has long been the system of choice for hot wet applications and field joints. This non-mercury catalyzed solid polyurethane insulation system is compatible with a full range of application specifications. Advances in application techniques guarantee integrity and reliability. The system is fully qualified to meet a complete range of applications and is not restricted by geometry or applied thickness.



Vikothersm® G3 Benefits:

- Low thermal conductivity
- Flexibility and resistance to cracking
- Enhanced joint strength over a broad range of products

Vikothersm® G3 Features:

- Operating temperature range from -40°C to +60°C / -40°F to +140°F
- Tensile strength +12MPa
- Thermal shock resistant
- Low thermal conductivity
- Elastomeric system
- Extremely durable

Apply Vikothersm® G3 on:

- Risers
- Subsea trees
- Manifolds
- Pipeline end manifolds (PLEMs)
- Pipeline end terminations (PLETs)
- Jumper and spool pieces
- All types of connections

Vikothersm® P7 Benefits:

- Increased durability
- High heat capacity and energy inertia
- Flexibility and resistance to cracking
- Enhanced joint strength over a broad range of products
- Suitable for application in all geographic locations

Vikothersm® P7 Features:

- Operating temperature range from -40°C to +90°C / -40°F to +194°F
- Tensile strength +19MPa
- Thermal shock resistant
- Elastomeric system
- Extremely durable system
- Limitless operating depth

Apply Vikothersm® P7 on:

- Risers • Subsea trees • Manifolds
- Pipeline end manifolds (PLEMs)
- Pipeline end terminations (PLETs)
- Jumper and spool pieces
- All types of connections

The benchmark for wet insulation systems

Vikothersm[®] PP is a thermoplastic thermal insulation and corrosion protection system that has a track record of over 30 years. The excellent combination of resilience, thermal performance and chemical stability in the subsea environment has led to this system being used at extreme depth and at extreme temperatures. With an integral high quality FBE corrosion coating, the system can be applied as a thin film using spray techniques, or as a thick coating using injection molding technology. Vikothersm[®] PP is typically used on pipes, bends, T-pieces, goosenecks and spools, but can also be used on a wide range of structures and special items.



Vikothersm[®] PP Benefits:

- Excellent hot-wet exposure tolerance
- High thermal capacity
- Limitless operating depth

Vikothersm[®] PP Features:

- Operating temperature -40 – 150°C
- Corrosion protection, mechanical protection and thermal insulation in one coating
- Excellent dimensional reliability
- Resistance to impact loads and cracking
- Thermal shock resistant
- Very low water uptake

Vikothersm[®] PP on:

- Bends, spools and T-pieces
- Jumpers
- Goosenecks
- Field joints
- Custom and engineered castings

Vikothersm[®] S1 sets a new standard in insulation performance based on advanced, non-syntactic silicone technology. Vikothersm[®] S1 does not rely on glass microspheres giving it improved joint strength, increased heat capacity, long-term flexibility and resistance to hydrostatic collapse. It cures at room temperature without exposure to air with zero shrinkage. Vikothersm[®] S1 is typically applied over anticorrosion coatings, using specialized application equipment.



Vikothersm[®] S1 Benefits:

- Increased thermal and hydrolytic stability
- Improved thermal conductivity and heat capacity
- Extremely flexible and resistant to cracking
- Superior joint strength

Vikothersm[®] S1 Features:

- Operating temperature range from -40°C to +135°C / -40°F to 275°F
- Tensile strength +5MPa
- Low thermal conductivity
- High elongation +300%

Apply Vikothersm[®] S1 on:

- Subsea trees
- Manifolds
- Pipeline end manifolds (PLEMs)
- Pipeline end terminations (PLETs)
- Jumpers and spool pieces
- Flange connections
- Insulation covers
- Dog houses
- Risers and flow lines

The benchmark for wet insulation systems

Vikothersm[®] R2, a rubber based subsea thermal insulation, has 30 years of experience built in. The system combines flexibility and robustness and gives protection for the lifespan of subsea installations. Our state of the art technology is designed to perform in extreme environments. The three layer coating system provides HISC / corrosion protection and excellent thermal insulation properties. The system is seawater, impact and creep resistant.



Vikothersm[®] R2 Benefits:

- Flexible and robust
- Unlimited coating thickness to meet any U-value requirement
- Hydrolysis resistant
- Good adhesion to metallic and non-metallic materials
- Excellent corrosion and HISC protection
- High specific heat capacity

Vikothersm[®] R2 Features:

- Operating temperature range from -49°C to +155°C / -56°F to 311°F
- High elongation at break > 200%
- Thermal shock resistant
- Elastomeric system
- Low density systems < 800 kg/m³
- Suitable for hot wet applications up to 155°C
- Inner layer provides corrosion / HISC protection

Apply Vikothersm[®] R2 on:

- Jumpers and spool pieces
- Tie in spools
- Manifolds
- Subsea XMT
- Risers and flow lines
- Pipeline end manifolds (PLEMs)
- Pipeline end terminations (PLETs)
- Joints
- Horizontal & Vertical Connection Systems (HCS & VCS)
- Insulation covers
- Dog houses
- Flange connections

Creating custom uplift

Trelleborg Applied Technologies developed an off-the-shelf range of subsea modular buoys, called Nano buoys, for moderate subsea uplift. Suitable for subsea equipment installation, each buoy core varies in density to suit individual project water depth needs. By simply adding or removing individual units from the nested flotation stack, uplift can easily be adjusted.

Nano buoys are engineered to offer a durable, short lead time option to complete our range of subsea buoyancy solutions. The unique nesting design of the individual buoyancy elements enables them to quickly assemble into a rigid structure with a specific uplift. The assemblies are held together and handled by using soft slings. The slings have numerous benefits including corrosion resistance, ease of handling, and no loss of buoyancy when compared to metal hardware. These soft slings are available for all assemblies to quickly and easily secure a nested buoyancy structure together for deployment.

Available in Nano and Nano-HP, both options are offered in a full depth range for maximum design versatility and are easily deployed strings of buoyancy elements. Nano buoys are manufactured from a combination of low density glass fiber macrospheres and syntactic foam, while Nano buoy HPs are manufactured from a low density carbon fiber macrosphere and syntactic foam. The core is then encapsulated in a high density polyethylene shell for impact and abrasion protection needed for the harsh offshore environment. Nano Buoy assemblies are available at depth ratings from 1,000 to 4,000 meters.

Nano buoy assemblies are available at depth ratings from 1,000 – 4,000 meters. The table below illustrates the uplift generated for a depth rating of 1,000 meters for a standard Nano buoy:

Assemblies	Depth Rating (M)	Standard Buoyancy (lbs +/- %5)	Upper Weight Limit (lbs)	Lower Weight Limit (lbs)
2 Ends	1,000	169	162	146
2 Ends + 1 Mid	1,000	262	262	236
2 Ends + 2 Mid	1,000	355	361	326
2 Ends + 3 Mid	1,000	449	460	416
2 Ends + 4 Mid	1,000	542	559	506
2 Ends + 5 Mid	1,000	635	658	596



Features & Benefits:

- Nesting design
- Easy to use slings
- Durable rotomolded shells
- Long life

Applications:

- Pipeline sleds
- Jumpers
- Suspended moorings
- Offshore installations

Subsea Spherical & Ellipsoidal Buoys

Accelerating design freedom

Trelleborg Applied Technologies manufactures a range of subsea spherical & ellipsoidal buoys, providing long term, stable buoyancy to arrays of underwater equipment. With a full line of buoyancy solutions from 100 meters to 6,000 meter water depths, these buoys are available in numerous sizes and shapes to ensure successful deployment and recovery during mooring expeditions.

With two geometries available, spherical or ellipsoidal, the buoys are low maintenance and extremely rugged to meet the harsh demands of both deepwater and coastal environments. Elliptical buoys are preferred for high current environments when low drag is necessary. Trelleborg's spherical and ellipsoidal buoys are fully able to integrate as a key component in mooring systems.

Trelleborg's established subsea buoys are manufactured from our proven HDPE (high density poly-ethylene) rotomolded shells, and filled with our in house microsphere and macrosphere fill system. Each subsea buoy is fully customizable for complete design freedom, to accommodate any size, uplift, structural components, or housing equipment needed within the float.



Features & Benefits:

- 100 to 6000 meter depth rated
- Spherical or low drag ellipsoidal geometries
- Custom through holes
- Low maintenance

Applications:

- Oceanographic mooring
- Subsurface mooring
- Acoustic Doppler Current Profiler (ADCP)
- Fixed installation

Standardized Buoyancy Modules

Customized uplift

Distributed Buoyancy Modules (DBMs) are typically used between a subsea structure and a surface vessel or platform to hold pipelines in a specific geometric configuration to prevent over utilization of the system. The two main functions of DBMs are to provide uplift and maintain location along the riser to hold the project specific riser configuration.

With this in mind, Trelleborg developed a new modular design for its DBM range, Standardized Buoyancy Modules. The modular design enables the customer to adapt uplift requirements as specified for each project. The modular buoyancy segments are designed to mechanically lock around the clamp, securely attaching the assembly to the desired location on the riser.

The Standardized Buoyancy Modules can be adjusted to operate in seawater depths from surface to 2,500 meters. The revolutionary design incorporates synthetic feet at the bottom of the finished assembly, which prevents damage and reduces vessel installation time.

Applications:

- Cables
- Flexible risers
- Umbilicals
- Jumpers
- Flowlines



Benefits:

- Custom buoyancy to customer specification
- Decreased top tension loads
- Ease of handling
- Maintains riser configuration
- Reduced lead time
- Reduced vessel installation time



Watch our
product video

Rotating Buoyancy Modules

Repeatable and predictable pipeline behaviour

Rotating Buoyancy Modules are used to mitigate buckling in seabed pipelines. Buckling occurs during start-up and shutdown sequences as the thermal fluctuations cause pipelines to expand and contract, leading to problematic buckling along its length.

Traditionally non-rotating cylindrical buoyancy modules have been installed along sections of the pipeline to reduce the weight and friction in that section and promote controlled bending. However in certain conditions the modules have displaced seabed material to build ridges (berms) that have then restricted the lateral movement that the modules were installed to promote.

With that in mind, Trelleborg developed Rotating Buoyancy Modules that roll on the seabed that thereby reduces lateral friction, berm creation and allows repeatable and predictable pipeline behaviour, eliminating rogue buckles and reducing axial walking in the pipeline. As a consequence it allows for project cost reduction as a lower quantity of buoyancy modules are used to create 'safe buckling zones'.



Applications:

- Seabed pipeline and flowlines

Benefits:

- Reduce project costs
- Predictable safe buckling zones
- Reduce berm creation
- Eliminate rogue buckles
- Reduce axial walking in the pipeline

Polymat™

Cable protection on the seabed

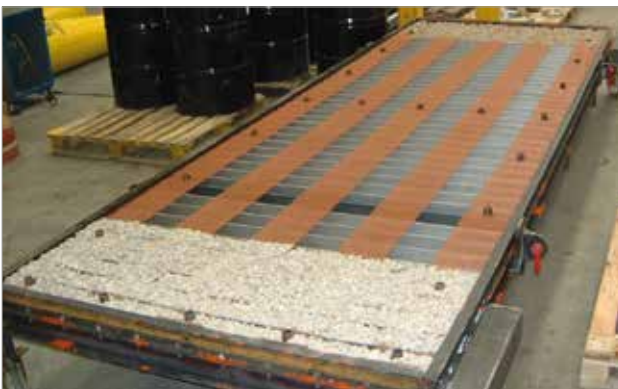
There are many existing subsea cables and pipelines on the seabed. When new cables are laid they often have to cross these existing lines. There is a risk of damage through abrasion or crushing if there is direct contact between the lines.

Polymat™ provides impact and abrasion protection along with Uraduct® for cable crossings. Polymat™ has been used to cover drill cuttings on the seabed to avoid abrasion and also used on drilling vessels/rigs in areas where the drill strings are stored as a 'floor' material.

Polymat™ is ROV installable and is particularly suited to deep water applications and can be used to stabilize cables and cable bights on the seabed whilst also provide protection at cable crossing locations.

Key Applications:

- Cables
- Cable crossing
- Pipes
- Seabed storage



Ballast and reinforcement inside the Polymat™



Polymats™ in position over a subsea pipeline

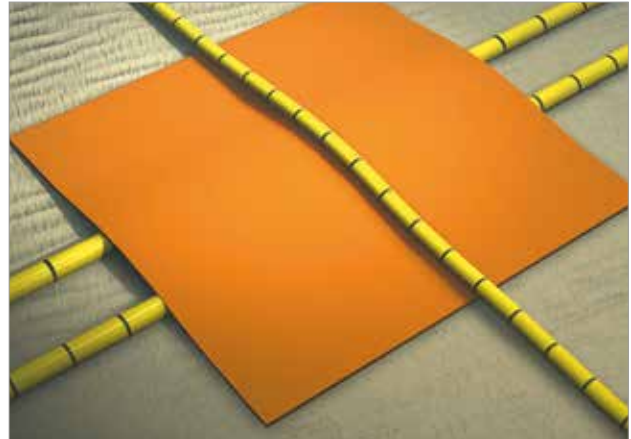


Illustration of a Polymat™ in position at a pipeline/cable crossing

Benefits:

- Polymat™ can be used at any water depth
- The polyurethane material is suitable for long term subsea application without degradation
- It can be used in place of concrete mattresses, specifically where impact or abrasion protection is the key design function. Polymat™ is not brittle like concrete
- For ease of handling, holes are molded along the edges of each Polymat™ to allow attachment for pick up ropes, etc.
- Polymat™ can incorporate a barytes infill that provides additional ballast to aid product stability on the seabed
- Polymat™ is molded with grooves on one side to allow the mat to flex and closely fit the profile of the pipeline
- Resistant to repeated impacts at same locations, unlike concrete

Cable protection on the seabed

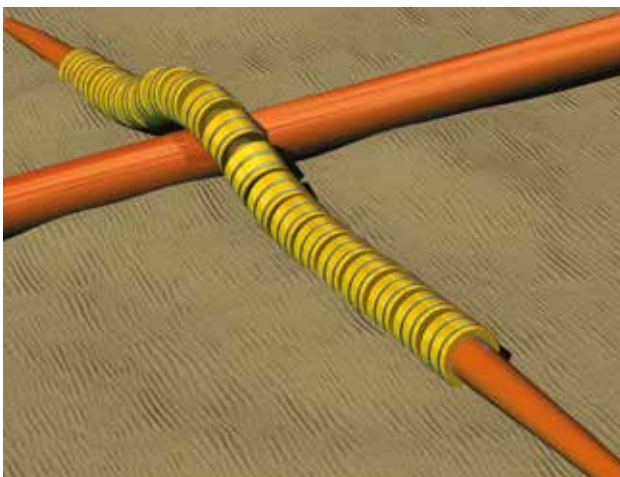
As more cables and pipelines are deployed there is an ever increasing chance that one cable will need to cross another. To minimise “noise” etc. being transmitted from one cable to another there is a requirement to have a minimum 350 mm standoff distance.

Polyspace was developed specifically to address the requirement to maintain a positive clearance between cables and existing pipelines at crossing points when laying subsea cables.

Polyspace is a product specifically designed to generate a guaranteed 350 mm clearance between a cable and a pipeline. This system is flexible and comprises interlocking hollow marine grade High Density Polyethylene (HDPE) half-shells fastened around the cable by corrosion-resistant metallic banding. Internal cable clamps are used to lock the Polyspace mouldings onto the cable at regular intervals and specific leading and trailing bending stiffeners can also be included with the system to prevent the cable exceeding the recommended minimum bend radius at any time during the installation.

Applications:

- Power cables
- Fiber optic cables
- Hoses
- Flexible Flowlines



Cable crossing on the seabed



Polyspace installation on offshore vessel

Benefits:

- The HDPE half-shells have good impact strength and abrasion resistance whilst offering UV stability
- Each moulding is free-flooding and can be supplied with a ballast system to provide up to 90 kg/m of additional submerged weight to suit the situation
- The cable can be retrieved if required
- Polyspace is installed onto the cable as it is deployed from the vessel at the crossing location. The interlocking shells can achieve a bend radius of 1.5 m to suit most cablesheep sheaves, therefore providing a cost-effective one-hit solution at pipeline crossings where clearance is a requirement
- The system becomes an integral part of the cable, therefore negating additional problems associated with alternative methods, which are expensive, time consuming and difficult to place accurately
- No pre-lay operations
- Alternative/competing solutions include rock dumping/ concrete mattresses and subsea “bridges”. For all of these methods installation must take place before the cable can be installed and need expensive vessel time to construct, especially in deep water
- Polyspace is not water depth dependent as it is free-flooding

Trimsyn™ & Trimlok™

High quality support syntactic floats

Trimsyn™ syntactic floats are manufactured using high performance syntactic foam and are floats which offer additional buoyancy in all marine applications, such as umbilical cable support, ROV trim buoyancy or as simple installation aids.

To streamline the attachment of Trimsyn™ floats, we developed the Trimlok™ umbilical clamp. Molded in a marine grade polyurethane elastomer, the clamp is sized to fit around a cable or umbilical, providing positive grip without damaging the structure of the umbilical.

Features & Benefits

Trimsyn™ syntactic floats and Trimlok™ attachments offer excellent features and benefits and are safe, efficient and easy to use. As the product is off the shelf stock orders and delivery are quick and easy.

Positive Connection

A large eyebolt swivel assembly allows the Trimlok™ to remain attached to the float by means of a karabiner and pendant wire.

Easy Installation

Trimlok™ eyebolt is suitably sized for operation by cold or gloved hands.



TRIMSIN™ SPECIFICATIONS

Type-Depth	Weight in air (kg)	Nett buoyancy (kg)	Nominal diameter (mm)
MTS-1000	10	8	300
MTS-2000	11	7	300
MTS-3000	12	6	300
TS1-1000	16	13	350
TS1-2000	17	12	350
TS1-3000	18	11	350
TS2-1000	25	25	430
TS2-2000	29	22	430
TS2-3000	31	20	430
TS3-1000	52	55	500
TS3-2000	57	50	500
TS3-3000	59	48	500

Subsea Application: BEND CONTROL SOLUTIONS

Deepwater performance in Brazil

The Petrobras P-58 FPSO, which operates on the Baleia Azul field in the Parque das Baleias area, north of the Campos Basin in Brazil, is moored 48 miles / 78 km offshore in a water depth of 4,593 feet / 1,400 meters, and is expected to last 25 years. Oil production, which commenced in March 2014, comes from 19 satellite wells connected individually to the unit.

State of the art solutions as standard

Trelleborg won a contract to provide 25 polyurethane (PU) vertebrae bend restrictor assemblies for static flowlines on the field development and production expansion of the Parque das Baleias oil field. Trelleborg was awarded the contract by leading flexible pipe manufacturer, NOV Flexibles, following the successful completion of a project to provide 83 polyurethane bend stiffeners for 6 and 4 inch / 15 and 10cm dynamic risers in the first phases of the project.

All the solutions were tested in accordance with NORSOK, DNV and customer specific standards.

Global expertise, local presence

In recent years, Trelleborg has prioritized expansion of its market coverage in selected countries outside Western Europe and North America, such as Brazil. The principal drivers include proximity to customers in expanding and profitable segments, following them in their globalization processes and developing local customer relationships.

Officially opened in September 2012, Trelleborg's facility in Brazil is located in the coastal city of Macaé, which is approximately 112 miles / 180 kilometers north of Rio de Janeiro. It develops, manufactures and supplies Trelleborg's complete offshore product portfolio, including a wide range of high performance polymer-based solutions for offshore topside and subsea oil and gas exploration, such as insulation tape and buoyancy products. To support offshore customers in their quest to reach greater subsea depths, the 7,000 meters squared / 75,347 feet squared facility boasts one of the largest hydrostatic pressure testing vessels in the world.



Proven polymer performance

Using polyurethane restrictors brings a number of significant benefits when compared with steel. Installation and maintenance of the assembly is less time-consuming and more cost-effective, with significantly lower whole life cost, as plastic does not corrode or have to be protected using platings, paint and anodes. It also has a greatly reduced weight, making it neutrally buoyant in water. This means there is considerably less stress applied to the flowline and adjacent parts of the subsea structure during both installation and service.

To prevent pipes from overbending at the interface between flexible and rigid structures, Bending Restrictors are often installed. Trelleborg's bend restrictors are made up of a number of interlocking elements which react when subjected to an external load, locking together to form a smooth curved radius. This radius is chosen to be equal to or greater than the minimum bend radius of the pipe that it is applied to. Once the elements have locked together, the bending moment present is transferred into the elements and back through a specially designed steel interface structure into the adjacent rigid connection, therefore protecting the pipe from potentially damaging loads.

"Securing this contract is another major achievement in an important growth region for Trelleborg. As well as recently opening a new manufacturing facility in the heart of Brazil's oil and gas community, Macaé, steel restrictors have been the status quo for riser projects in offshore Brazil for many years and having our proven polyurethane technology adopted for a major contract in the area is very encouraging."

Richard Beesley

Business Group Director for Trelleborg Offshore in Brazil



Topside



Trelleborg Offshore designs, develops and manufactures a wide range of solutions for the topside market. In demanding industries and harsh environments, we can be relied upon in a variety of applications.

Flexible Piping System - Technological developments have revolutionized deepwater drilling and production in recent years and the need for high performance, robust and dependable topside solutions has never been greater. In an emergency it is paramount that the deluge system delivers water where it is needed at the correct pressure, no matter the situation.

Flexible Riser Protection - Protecting the flexible riser, significantly delays escalation of temperature rises in the steel in order to buy time to gain control of fire and shut down of systems.

Riser Protection - Protects people, structures and equipment from all types of fire and corrosion in the offshore environment, as well protecting the riser itself. In the demanding offshore environment it is paramount to ensuring on-board safety.

Topside Protection - Protecting topside equipment and structures provides time to evacuate people, close down critical equipment and for responders to gain control of the fire. Our Firestop™ material can be used for different topside applications to ensure safety comes first.

DryFoam™

Passive fire protection



Storing flammable liquids, particularly those with high vapor pressure, poses difficult challenges with respect to fire protection and vapor loss. DryFoam™ prevents full surface fires without the use of water. This is valuable wherever water is scarce and particularly in extreme cold or hot environments. DryFoam™ works continuously and is virtually maintenance free.

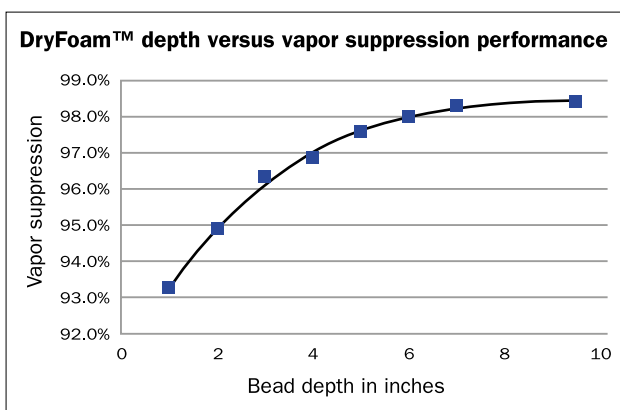
Trelleborg's UL listed DryFoam™ is the world's first passive non-water based product listed for full surface fire protection. The DryFoam™ beads can be applied directly on top of the flammable liquid where they float and continuously suppress vapors and thereby prevent a full surface fire. Alternatively DryFoam™ can be applied on top of an internal floating roof where the beads remain and provide full surface fire protection.

DryFoam™ can be used on most hydrocarbons including cryogenic LNG and LPG to mitigate vapor cloud scenarios using simple and passive methods.

DryFoam™ has US and international patents.

Applications:

- Sunken roofs
- On top of hydrocarbon liquids
- Storage tanks or barges
- Sumps
- Horizontal vessels
- Irregular shaped containers
- Rim seal or column void fill
- Floating roofs or seals



DryFoam™ in-situ



DryFoam™ post event

Benefits:

- Reduces vapor evaporation by 98%
- Reduces product loss
- Significantly mitigates vapor cloud scenarios
- Conforms to irregular shapes
- Reduced environmental impact
- Avoids water storage
- Easy to apply
- Not impacted by seismic activity

No Vapour Ignition

DryFoam™ also provides protection against full-surface fires in fixed flammable and combustible liquid tanks and repositories.

Elastopipe™

A flexible piping system

Technological developments have revolutionized deepwater drilling and production in recent years and the need for high performance, robust and dependable topside solutions has never been greater. In an emergency it is paramount that the deluge system delivers water where it is needed at the correct pressure, no matter the situation.

Regardless of explosions, impact from flying debris, project lifetime, or jet fire, the piping system needs to operate safely and effectively every time. Current rigid piping systems, whether metallic or fiberglass, have potential limitations including loss of pressure over time, increased corrosion potential, stress cracking, weakness against impact or explosion, and increased testing and maintenance costs.

Trelleborg offers a new way of piping with the first corrosion-free, explosion, impact, and jet fire resistant flexible piping system called Elastopipe™. This next generation system uses synthetic rubber instead of traditional materials and is the only piping material approved for offshore deluge systems that has survived sequential explosion, impact and jet fire testing. Elastopipe™ is a patented flexible piping system developed for transporting a variety of fluids and is available in two versions: Fire Resistant (FR) for fresh and seawater, and Fire and Oil Resistant (FOR) for hydrocarbons, solvents, additives, acids and hydrogen sulphide.

Elastopipe™ has been installed on offshore facilities globally since 1998. It is approved for use in 150lb systems and is rated up to 20 bar. Manufactured from reinforced synthetic rubber, Elastopipe™ is non-corroding and can withstand jet fire with a heat flux of 390kW/m² and temperatures above +1400 °C/+2552 °F for one hour. This makes it an ideal material choice for use in any critical piping system on offshore oil and gas installations and ships, as well as many other hazardous environments.

If replacing a deluge system, Trelleborg offers a temporary deluge system providing complete firewater coverage during demolition or installation activities. This combined with no hot work allows you to continue producing throughout the replacement process.



Elastopipe™ has been independently tested and certified by DNV, as well as approved by Lloyds, RMRS, ABS and the US Coast Guard.

Applications:

- Fire water distribution
- Utility systems
- Nitrogen distribution systems
- Drain water
- Chemicals and hydrocarbon transportation
- Foam systems

Benefits:

- 100% corrosion free
- Explosion, impact and jet fire resistant
- Lower total installation costs compared to rigid pipes
- Maintenance-free operation during 30 year lifespan
- Minimizes marine growth compared to traditional materials
- No welding or hot work
- Quick and easy to install
- Reduces water hammer
- UV resistant

FireNut™

Fire protection of nuts and bolts

In refineries, offshore oil installations or wherever hydrocarbons are transported, the pipes are flanged and held together with nuts and bolts. In case of fire, the flanges and pipes should maintain the same level of integrity to avoid escalation. Traditional protection is to capsule the whole valve and flanges in a fire-insulated metal box - a bulky, heavy and expensive solution. The box also creates challenges during inspection and maintenance. Trelleborg Offshore has developed a jet fire protection for bolted connections to extend service life in the event of a fire. It helps the bolts and flanges to maintain their level of integrity and avoid escalation.

The easy to install FireNut™ resists both jet fire and pool fire and is tailor made to accommodate almost any bolt size. The rigid and tough design means that FireNut™ has extremely good resistance to mechanical damage when installed.

FireNut™ is hand mounted by screwing it on to the bolt. It protects each bolt separately, allowing for easy inspection as well as lowering weight and occupying less space. The FireNut™ system simplifies installation, inspection and maintenance of flanges, increases efficiency and reduces costs.

It can be re-used after disassembly and does not require certified personnel for installation.

FireNut™ is based on Trelleborg Offshore's Firestop™ material, which combines extreme fire protection with other unique rubber capabilities. Trelleborg Offshore has delivered Firestop™ based products to the offshore industry for more than 30 years.



Easy, hand mounted installation

Applications:

- FireNut™ has been installed on a number of offshore constructions worldwide
- FireNut™ can be applied to both new and old bolts and flanges
- FireNut™ is a product that is not just restricted to offshore high pressure flanges, but can be used in any other context where bolt and nut protection is required.

Benefits:

- High resistance to blast, impact, ozone, UV, most solvents and seawater
- Jet- and hydrocarbon fire resistant up to 2 hours
- Excellent protection from HISC, corrosion, and mechanical damage and wear
- Easy installation, no maintenance and easy to inspect
- Long service life
- No hot work
- Weight and space savings
- Tailor-made to accommodate almost any bolt size
- FireNut™ comes in a number of sizes and variations, to ensure they are easy to install in all environments



Firestop™

Meets fire requirements in all industries

Firestop™ is a passive fire protection material used to protect personnel and equipment by minimizing fire escalation by providing time to evacuate people, close down critical equipment and for responders to gain control of the fire. The certified rubber based material protects structures from exceeding critical temperature limits.

The dampening, noise reducing, flexible nature of Firestop™ can also protect equipment from vibrations, collisions, explosions and even earthquakes. Firestop™ is tested to withstand a blast up to 2.1 bars and jet fire resistant for more than 2 hours.

The Firestop™ material can be tailor-made to suit any customer specific need. It can also be coated or extruded on pipes or structures, extruded as a specific profile, or molded as a component.

Firestop™ is designed to meet all fire scenarios including J120, J60, J30, H120, H60, H0, A60, A0, B30, and B15.

Applications:

The Firestop™ system can be supplied in various material combinations to meet your project specific requirements which may include:

- Fire protection
- Corrosion and HISC protection
- Mechanical protection
- Thermal insulation
- Antifouling



Benefits:

- 40+ years design life
- Excellent mechanical properties
- Explosion resistant
- Flame retardant
- Halogen-free
- No smoke or toxicity
- Oil & mud resistant
- UV, ozone and water resistant

Passive Fire protection

Risers are critical structures in the event of a fire, as hydrocarbons are transported inside the risers. Our Passive Fire Protection (PFP) rubber material Firestop™, significantly delays escalation of temperature rise in steel to provide time to evacuate people, close down critical equipment and for responders to gain control of the fire. Firestop™ is tested to withstand a blast up to 2.1 bars and jet fire resistant up to 2 hours. Type approved in accordance with ISO834-3 (HC Fire) and ISO22899-1 (Jet Fire).

Due to being in the harsh environment of the splash zone, the risers must withstand massive wear. The dampening and flexible nature of Firestop™ also protects equipment from corrosion, vibrations, movement, collisions, explosions and earthquakes.

In addition to do the application of rubber in our factory, we can also carry out the coating onsite by using Trelleborg Offshore's mobile factory, MPU. This reduces cost, time as well as enabling usage of local personnel.

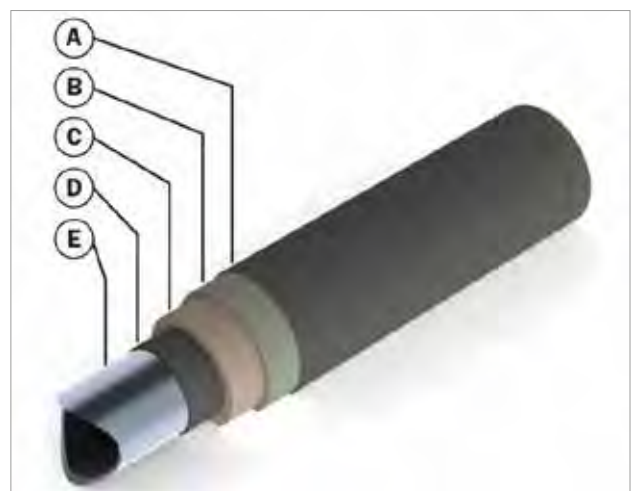
Firestop™ Riser PFP Benefits

- Combine blast, jet and pool fire protection
- Anti-fouling properties
- Maintain flexibility of the riser
- Impact resistant
- Excellent corrosion/HISC protection
- Maintenance free
- More than 30 years design life



Firestop™ Riser PFP Features

- Operating temperature range: -50 °C to +150 °C / -58 °F to +302 °F
- Elastomeric system
- Low generation of smoke and non-toxic fumes
- Ozone resistant (ISO 1431-1)
- Sea water resistant (ISO 1817)
- UV resistant
- Tested according to ISO 834-3 (Pool Fire) and ISO 22899-1 (JET Fire)
- Type Approval Certificate issued by DNV GL



- A: Mechanical protection
- B: Firestop - fire protection with reinforcement
- C: Firestop - fire protection/thermal insulation
- D: Corrosion protection
- E: Pipe

MPU

A Mobile Coating Facility

Trelleborg Offshore's Mobile Production Unit (MPU) is a mobile coating facility that can carry out onsite coating of Corrosion Protection, Thermal Insulation and Passive Fire Protection. The MPU performs at every level as it can be mobilized in a short time frame and transported all over the world.

The MPU consists of:

- Complete workshop with first aid kit and all consumables needed.
- Extruder container with possibility for side extrusion (straight pipes up to 12 meters), as well as production of profiles for coating complex geometries (bend, valves, flanges)
- Vulcanization containers for up to 20 meter pipes or other structures.
- Coating machine for Corrosion and Passive Fire Protection coating up to 20 meter pipes, robust and easy application process for use by local personnel.

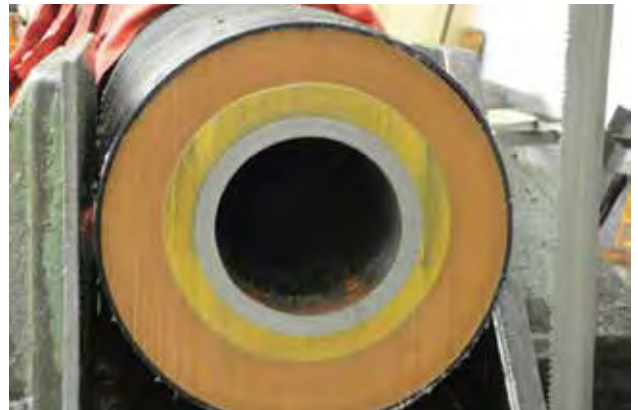
MPU can be used on, but not limited to:

- Jumpers and spool pieces
- Tie in spools
- Hand coating on bend
- Manifolds
- Risers and flow lines
- Pipeline End Manifolds (PLEM)
- Pipeline End Terminations (PLET)
- Joints, Field Joint Coating
- Connectors
- Subsea Xmas Tree (XMT)
- Flange connections

Thermal Insulation

Thermal insulation is necessary to avoid formation of hydrate plugs and wax build-up in subsea structures. The build-up begins when the oil/gas composition temperature is not maintained and begins to cool. Without thermal insulation the cold seawater rapidly cools down the oil, forming hydrate/wax blockages making it impossible for a safe flow.

Container 1	Extruder	20"
Container 2	Spindel station	20"
Container 3	Workshop/storage	20"
Container 4	Curing 1 (Heater)	40"
Container 5	Curing 2 (Extension)	40"



Passive Fire Protection

The Passive Fire Protection system contains our unique Firestop Technology and withstands all types of fire, including jet fire and is blast and impact resistant. Passive Fire Protection is used to protect personnel, assist emergency activity, buy time to gain control of fire and evacuate the area.

Corrosion Protection

Combating all kinds of severe corrosion has been a focus of our business for more than 60 years. Rubber is chemically resistant to most corrosive liquids, gases, salt water, ozone and UV-light; all corrosive agents commonly encountered in the offshore sector. Anywhere steel is exposed to corrosion it can be protected with a rubber lining.

Offshore installations producing oil and gas have a great need for protective coatings and linings so that they can operate safely and continuously for the life of the fields, up to 50 years.



Ensuring onboard safety

Safety on offshore oil and gas installations is of paramount importance, and having effective and reliable surface protection is vital to ensuring onboard safety. In the harsh offshore and onshore oil and gas industry, operators need the assurance that their surface protection delivers proven performance for their installations, without fail.

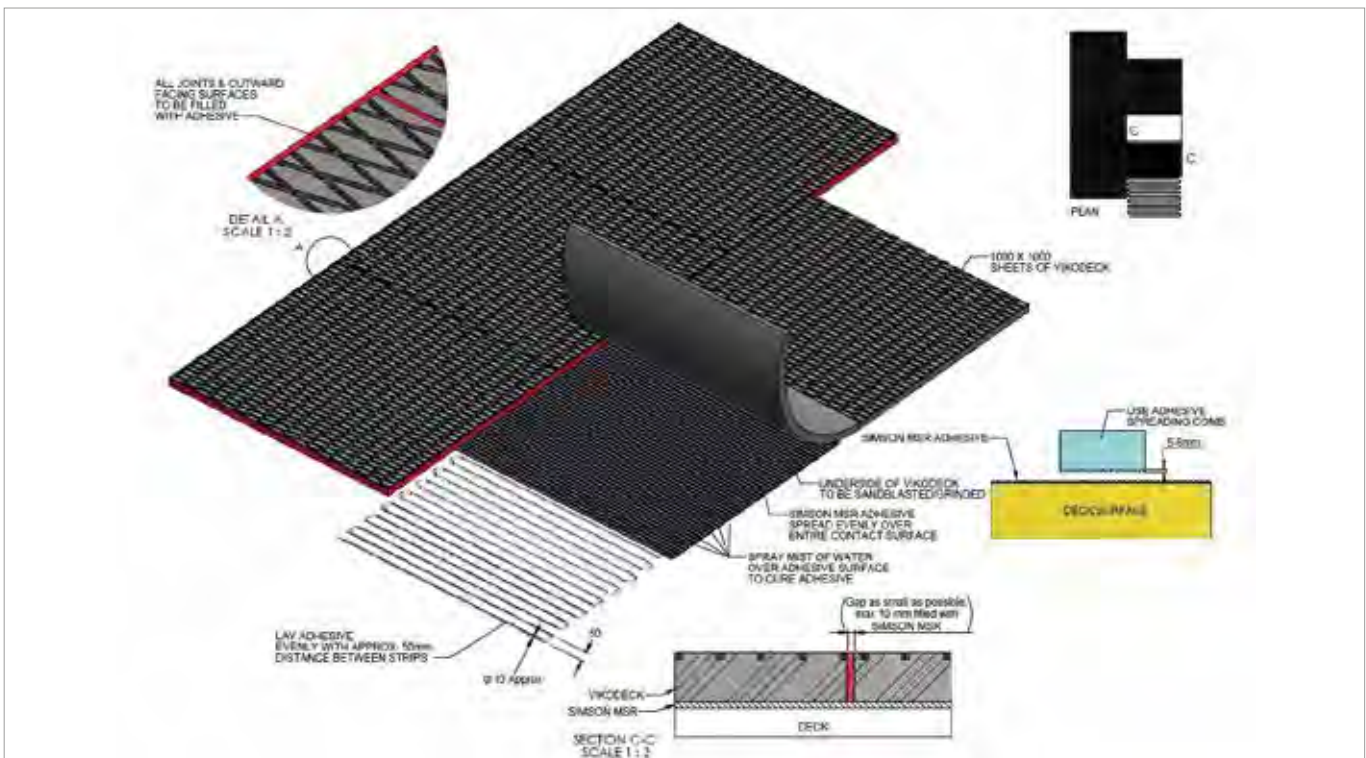
Vikodeck™ is designed to offer surface protection against blast, jet and pool fire in harsh offshore oil and gas environments. It can be tailored to withstand various chemical and mechanical conditions to provide you with performance at every level. In addition it is an excellent corrosion protection and provides anti-fatigue dampening support for the comfort and safety of your employees.

Benefits:

- Abrasion resistant • Blast resistant
- Can be painted • Flexible • Maintenance free
- No hot work required • Quick and easy to install
- Resistant to Ozone and UV light
- Seawater resistant • Sound dampening

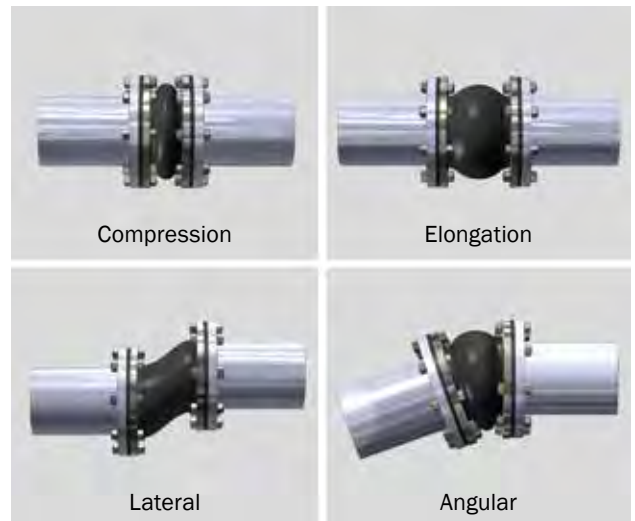
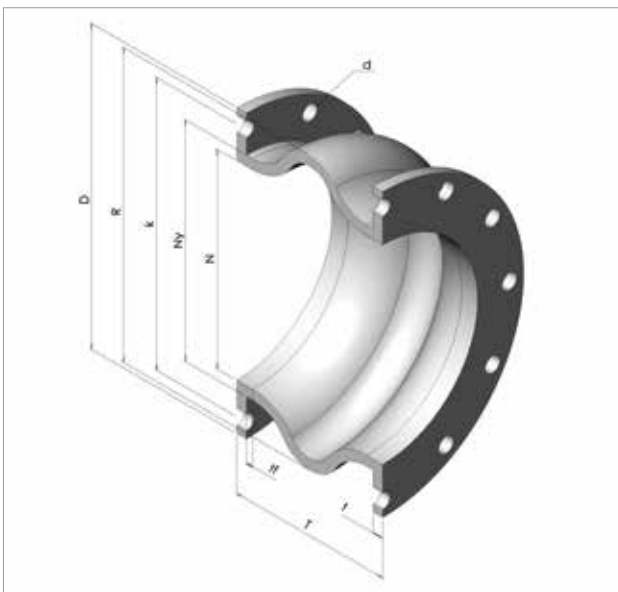


Vikodeck™ has been tested and can withstand cryogenic spills of cold liquids such as LNG and will regain its flexible properties following cryogenic exposure. It is normally delivered in one square meter sheets, but can be drilled, cut or shaped to fit the area of installation to suite any surface to provide you with performance at every level.



Best rubber pipe joint solutions

To prevent breakage on pipelines Trelleborg Applied Technologies Norway offers some of the most flexible ranges of expansion joints. With Norflex™ expansion joints you get the best rubber pipe joint solutions for your connections, tailored to desired lengths.



Benefits:

- Tension releasing
- Vibration absorbing
- Compensate for thermal elongation
- Ensure a tight seal
- Compensate for misalignment
- Sound dampening

The table below contains a range of dimensions related to a standard Norflex™ expansion joint. They can be custom built to different lengths or for different purposes, e.g. for handling vacuum or specifically for low or high working pressure. This will obviously cause some discrepancies in the listed values.

N mm	Ny mm	(R) mm	T mm	(t) mm	tf mm	DIN PN10				Weight (ca.)	
						D mm	k mm	n mm	d mm	Joint kg	w/alu. flanges kg
50	70	120	160	7	18	165	125	4	18	0,4	2
65	85	135	160	7	18	185	145	4	18	1	3
80	100	165	180	9	20	200	160	4	18	1,5	4
100	122	195	200	9	20	220	180	8	18	2	5
125	152	220	200	11	22	250	210	8	18	2,8	7
150	176	25	200	11	22	285	240	8	23	3	8
200	226	315	200	11	24	340	295	8	23	5	11
250	276	380	220	13	26	395	350	12	23	7	16
300	330	430	230	15	26	446	400	12	23	8	18
350	384	475	240	15	26	505	460	16	23	10	22
400	436	525	250	17	32	565	515	16	27	13	31
450	488	580	280	17	32	615	565	20	27	16	37
500	542	630	300	19	34	670	620	20	27	19	45
600	644	735	340	21	36	780	725	20	30	27	59
700	746	850	360	21	40	895	840	24	30	29	75
800	848	950	360	21	44	1015	950	24	33	35	107
900	956	1055	360	21	48	1115	1050	28	33	45	129
1000	1047	1155	360	21	52	1230	1160	28	36	50	152
1200	1242	1342	460	21	56	1455	1380	32	36	55	170

Drain Gully

Process deck fire integrity

To maintain the fire integrity between process deck modules, gaps and openings must be sealed to ensure the safety of onboard personnel during a fire event. Rubber drain gully systems designed by Trelleborg Offshore are installed between deck modules bridging any gap that exists between the structures.

The flexible sealing systems allows for misalignments, angular deviations and eliminate concentrations of stress while reducing vibration and dynamic loads between structures. The systems provide passive fire protection from all types of fires in the extreme offshore operating environments to ensure the safety of people, structures and equipment. While minimizing fire escalation, the rubber sealing systems provide time to evacuate personnel, close down critical equipment and give first responders additional time to gain control of the fire.

The flexible drain gully systems from Trelleborg Offshore are designed to be an alternative to ridged steel gutters onboard platforms and rigs on the process deck and other areas of the platform where the collection of fluids is a requirement. The system is designed to absorb all structural movements and also acts as a drainage system for possible spill and waste runoff from the process area and can be provided as either an open or closed collection system.

Drain gullies can operate as a simple collection system suitable for chemicals, produced waters and rinse water waste and can incorporate blast, jet fire and hydrocarbon pool fire protection as required. The flexible drain gully system is provided in pre-fabricated sections, engineered and designed to meet the exact requirements requested by the customer. They can be installed during the initial platform or rig construction or can be provided as a direct replacement for existing steel gutters. The system is bolted or welded onto offshore structures and can be easily adjusted on site when needed.



Applications:

- FPSO
- Platforms
- Rigs
- FLNG

Benefits:

- Flexible, durable material
- Rated to hydrocarbon and jet fire conditions
- Blast, chemical, UV, ozone and saltwater resistant
- Maintenance free
- 30+ year design life

Escape Tunnel Seal

Flexible safety

To maintain the fire integrity on an offshore installation during a fire, gaps and openings must be sealed to ensure the safety of onboard personnel. Rubber seal systems designed by Trelleborg Offshore are installed between openings bridging any gap that exists between structures.

The flexible sealing systems allows for misalignments, angular deviations and eliminate concentrations of stress while reducing vibration and dynamic loads between structures. The systems provide passive fire protection from all types of fires in the extreme offshore operating environments to ensure the safety of people, structures and equipment. While minimizing fire escalation, the rubber sealing systems provide time to evacuate personnel, close down critical equipment and give first responders additional time to gain control of the fire.

Escape Tunnel Sealing systems from Trelleborg Offshore provide a flexible joint for escape tunnels between rigid module sections on offshore structures such as rigs and platforms. The system allows structural movement of the escape tunnel between the modules during normal and adverse conditions while absorbing all structural movements. The blast, jet fire and hydrocarbon pool fire resistant system is suited for use on new build structures or during the modification of existing tunnels and is engineered to meet the exact requirements requested by the customer. Each escape tunnel seal can be customized and prefabricated to fit customer specific installations. The system is bolted or welded onto offshore structures and can be easily adjusted on site when needed.



Applications:

- FPSO
- Platforms
- Rigs
- FLNG

Benefits:

- Flexible, durable material
- Rated to hydrocarbon and jet fire conditions
- Blast, chemical, UV, ozone and saltwater resistant
- Maintenance free
- 30+ year design life

Linear Seal

Flexible joints

To maintain the fire integrity on an offshore installation during a fire, gaps and openings must be sealed to ensure the safety of onboard personnel. Rubber seal systems designed by Trelleborg Offshore are installed between openings bridging any gap that exists between structures.

The flexible sealing systems allows for misalignments, angular deviations and eliminate concentrations of stress while reducing vibration and dynamic loads between structures. The systems provide passive fire protection from all types of fires in the extreme offshore operating environments to ensure the safety of people, structures and equipment. While minimizing fire escalation, the rubber sealing systems provide time to evacuate personnel, close down critical equipment and give first responders additional time to gain control of the fire.

Linear Sealing systems from Trelleborg Offshore provide a flexible joint for any gap between rigid module sections on offshore structures such as rigs and platforms. The Linear seals are constructed using Trelleborg Offshore's unique multi-layer construction allows for different levels of protection on the inside and outside surfaces of the seals. As the system is flexible, it allows for relative movement between structures during normal and adverse conditions.

The linear seals are engineered to meet the exact requirements requested by the customer and are typically installed in the initial construction phase of the risers to the platform, but can be manufactured to allow for retrofitting on existing platforms. The system is bolted onto offshore structures and can be easily adjusted on site when needed. Linear seals can be rated for blast, jet fire, hydrocarbon pool fire or simply provide a weather resistant seal for operations in extreme conditions.



Applications:

- FPSO
- Platforms
- Rigs
- FLNG

Benefits:

- Flexible, durable material
- Rated to hydrocarbon and jet fire conditions
- Blast, chemical, UV, ozone and saltwater resistant
- Maintenance free
- 30+ year design life

Radial Seal

Riser penetration protection

To maintain the fire integrity on an offshore installation during a fire, gaps and openings must be sealed to ensure the safety of onboard personnel. Rubber seal systems designed by Trelleborg Offshore are installed between openings bridging any gap that exists between structures.

The flexible sealing systems allows for misalignments, angular deviations and eliminate concentrations of stress while reducing vibration and dynamic loads between structures. The systems provide passive fire protection from all types of fires in the extreme offshore operating environments to ensure the safety of people, structures and equipment. While minimizing fire escalation, the rubber sealing systems provide time to evacuate personnel, close down critical equipment and give first responders additional time to gain control of the fire.

As the steel risers are being routed through the various decks onboard a platform, there is a need to protect the penetration areas to maintain the fire rating of the area. Radial Sealing systems from Trelleborg Offshore provide a flexible joint between the riser and the deck area by attaching to the riser and caisson insuring a tight seal that is both weather and fire rated. The system allows structural movement of the risers during normal and adverse conditions. The radial seals are engineered to meet the exact requirements requested by the customer and are typically installed in the initial construction phase of the risers to the platform, but can be manufactured to allow for retrofitting on existing platforms. The system is bolted or banded onto offshore structures and can be easily adjusted on site when needed. Radial seals can be rated for blast, jet fire, hydrocarbon pool fire or simply provide a weather resistant seal for operations in extreme conditions.

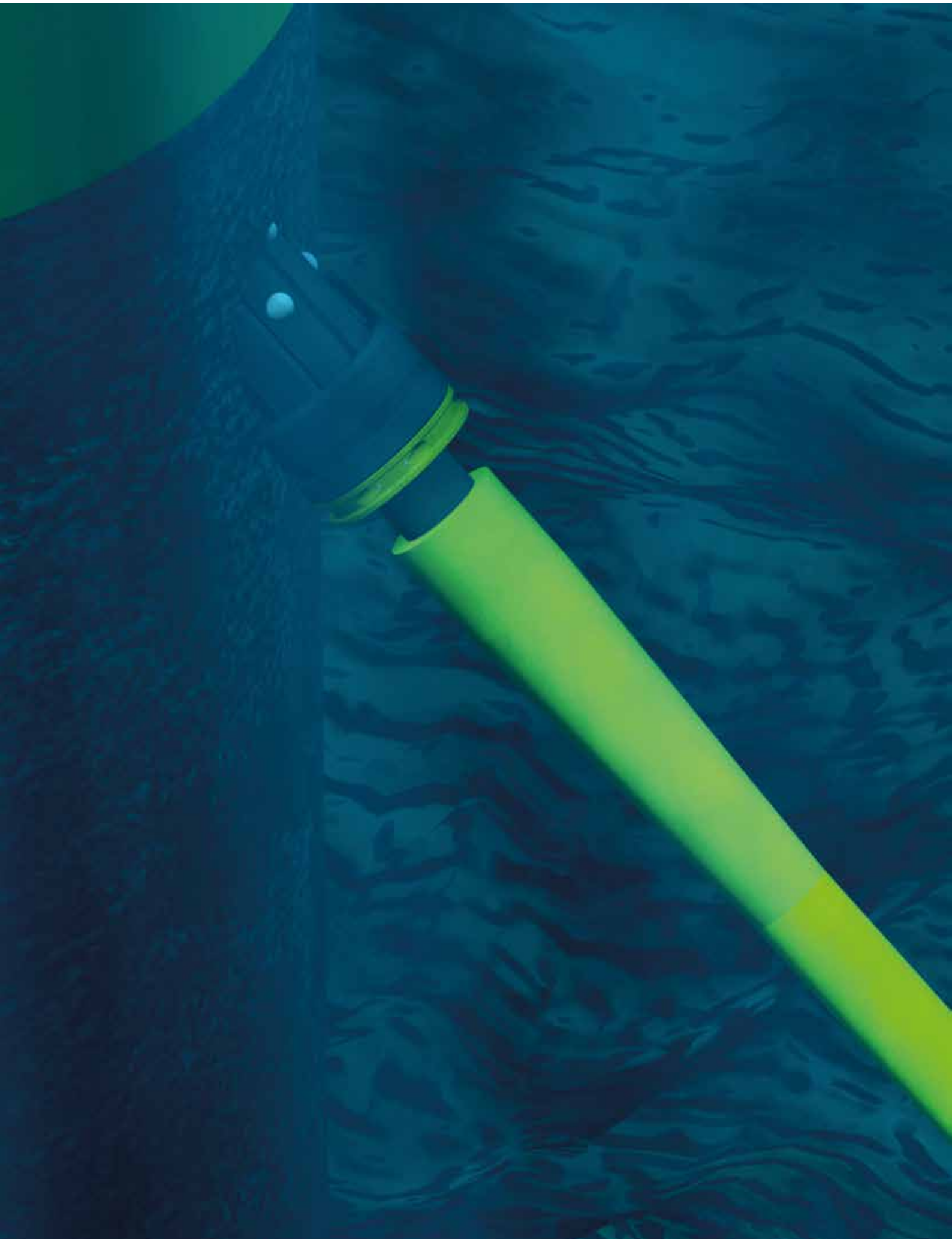


Applications:

- FPSO
- Platforms
- Rigs
- FLNG

Benefits:

- Flexible, durable material
- Rated to hydrocarbon and jet fire conditions
- Blast, chemical, UV, ozone and saltwater resistant
- Maintenance free
- 30+ year design life



Renewables



From cable protection products for the offshore wind sector, to bespoke buoyancy solutions for the wave and tidal sector, Trelleborg Offshore holds a long-standing commitment to serving the renewables market.

Renewable Bend Control Solutions - Where any flexible tubular connects to a structure, normal movement during operation or forces incurred during installation can cause catastrophic failure of the tubular at the termination point. Our bend control solutions reduce this damage.

Renewable Buoyancy - In floating scenarios, pipelines such as cables and umbilicals are often required to be held subsea in specific geometric configurations designed to prevent over utilization of the system.

Renewable Cable and Flowline Protection - With an ever increasing global requirement for data and product transfer, and the necessity for transfer networks to run through ever harsher environments, the demand for highly advanced cable and flowline protection grows.

Renewable Clamping Solutions - A cable laying operation may have a requirement to simultaneously lay a small diameter line. During the installation, to ensure that the secondary lines are adequately supported between surface and seabed, they may be attached to the main pipeline using a clamp arrangement.

NjordGuard™

Integrated protection system

NjordGuard™ is an innovative protection system designed and developed to protect offshore windfarm power cables in both monopile and J-tube applications.

Benefits:

- Diverless installation and removal
- Integrated system, with minimal assembly
- Smooth outer surface designed to reduce drag and snagging risk
- Utilizes API 17L certified Uraduct® material with class leading impact and abrasion resistance
- One design for monopile and J-tube installation
- Easily extendable and suitable for any diameter

Diverless Installation and Removal

In order to improve safety and reduce installation complexity, NjordGuard™ can be installed, removed, and reused without Remote Operating Vehicles (ROVs) or diver intervention.

Monopile and J-Tube Capable

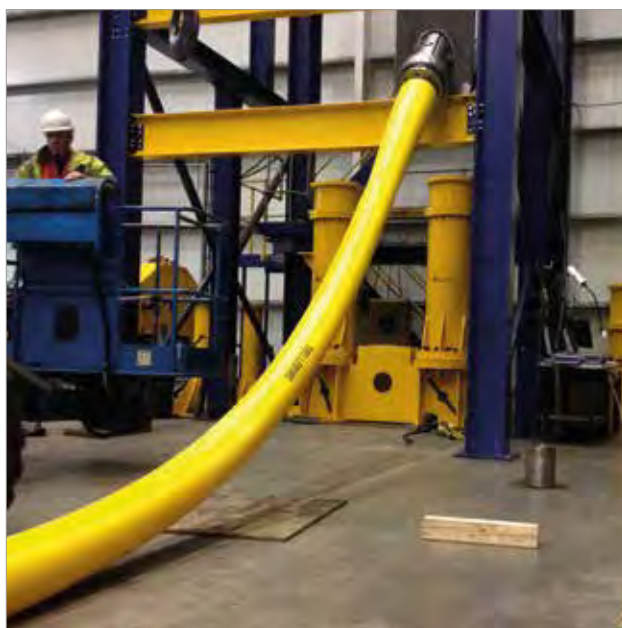
NjordGuard™ design permits both a monopile and J-tube installation for wind turbine generators and offshore substation platforms without procedural variation.



Schematic of NjordGuard™ installation in the monopile



Full-scale testing of Trelleborg's NjordGuard™ integrated protection system



Full-scale NjordGuard™ installation into a mock monopile, during testing

Integrated and Configured for Minimal Assembly Effort

NjordGuard™ requires only minimal assembly; the primary external dual stiffener is factory cast directly onto the connector. The internal stiffener can be supplied pre-assembled; only the external tail need be attached with Trelleborg's novel connection system (patent pending).

Approved Materials

NjordGuard™ uses API 17L certified Uraduct® material for both internal and external components. Uraduct® has an established reputation as the industry standard for cable and flowline protection.

Bend Restrictor

A bend limiting device

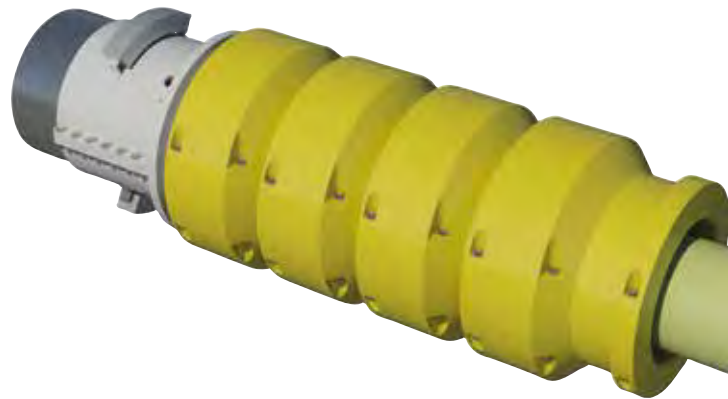
Where any flexible tubular connects to a structure, normal movement during operation (dynamic loading) or forces incurred during installation and retrieval (static loading) can cause catastrophic failure of the tubular at the termination point. The failure mode can be through collapse, rupture of internal lines or even rupture of the external layers leading to escape of the contents to the environment. This can happen as a result of a single event or be caused through fatigue damage over time.

Bend limiting devices are provided to protect the tubular from these situations and perform the following functions:

- Maintain the manufacturers recommended minimum bend radius (MBR) during the life of the project
- Provide a suitable load path from tubular to fixed structure
- Reduce point loading at the termination to an acceptable level

Bend Restrictors

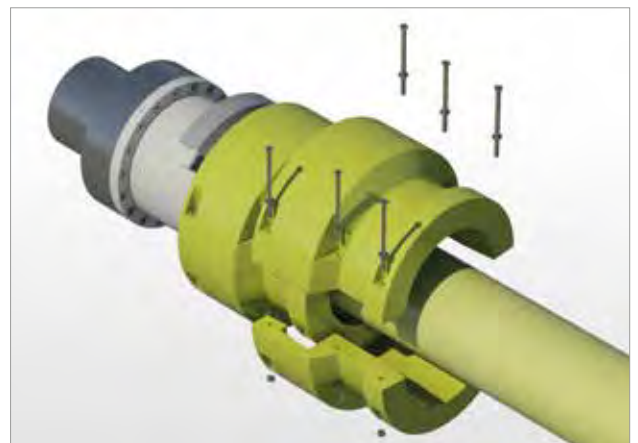
Bend restrictors are used to protect flexible pipelines from overbending and buckling during their installation or operation phase where static loads are generated. The system comprises a number of interlocking elements that articulate in 3 dimensions when subjected to external loads. At a designed radius the elements mechanically lock to form a semi rigid curved structure that will not move further.



Once the elements lock together the bending moment present is transferred through the elements to a specially designed steel interface structure then into the adjacent rigid connection. To provide the performance at every level, Trelleborg Offshore will design the bend restrictor elements based on supplied information and configure the termination steelwork to suit the project needs.

Benefits:

- A split design allows installation of the restrictor after pipe termination
- Ease of installation onshore and offshore
- Light weight in water, reducing the loading on the pipe
- Increased durability



Bend protection in dynamic environments

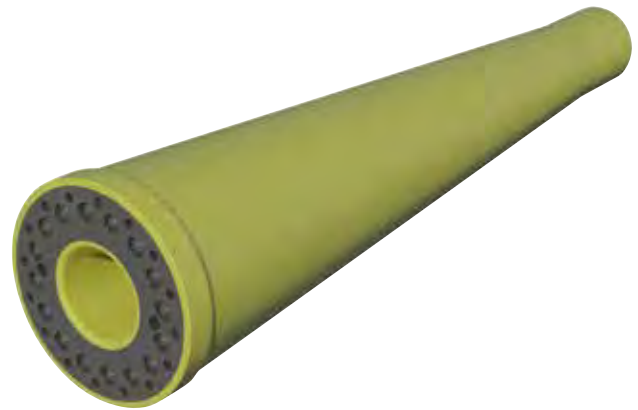
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- Maintain the manufacturers recommended minimum bend radius (MBR) during the life of the project
- Provide a suitable load path from tubular to fixed structure
- Reduce point loading at the termination to an acceptable level

Bend Stiffeners

Bend stiffeners acquired their name because the conical shape gradually increases the overall stiffness of the tubular in order to prevent over bending at the termination point. Manufactured from elastomeric material, a bend stiffener is suited to the constant wave and current induced motion of dynamic installations but can also be used for static applications.



Bend stiffeners are project specific and to provide you with the performance at every level, Trelleborg Offshore will fully engineer the product to accommodate the defined tension and angle combinations.

Trelleborg Offshore's track record in the supply of bend stiffeners, specifically for dynamic applications, is extensive.

Diverless Bend Stiffener Connectors

For applications where termination of the tubular and bend stiffener is an issue or a retrofit solution is needed, Trelleborg Offshore has a range of diverless connectors available.

Benefits:

- Added local stiffness to the umbilical or flowline
- Limits bending stresses and curvature
- Prevents structure damage from overbending
- Reduces structure fatigue

Achievements:

- First dynamic bend stiffener supplied for service in 1994
- Over 1,000 dynamic bend stiffeners currently in service
- Bend stiffeners operating in locations around the world in ambient temperatures ranging from -20°C/-4°F to 50°C/122°F
- 100% track record with no failures in service
- Lloyd's Register Type Approval

J-Tube Seals

Preventing the loss of corrosion inhibitor

In the subsea environment pipe connections are at risk of corrosion, due to the level of acidity in the water. This corrosion reduces the stability of the pipeline, increasing the likelihood of leakage.

J-Tube Seals are used to prevent the loss of corrosion inhibitor solution used in the annulus between the host line and the J-Tube bore.

Diverless and Modular Design

The seal is secured to the host line by integral clamps. It can then be pulled into the J-Tube or I-Tube with the host line. Typically the seal will be installed in the J-Tube just behind the entry bellmouth.

Interference Fit

Polyurethane seal elements are used to provide an interference fit to the host line and the J-Tube bore. The interference fit provides the seal – no subsea activation is necessary.

Corrosion Inhibitor Retention

J-Tube seals are primarily used to prevent the loss of corrosion inhibitor within the J-Tube annulus.

Key Applications

- J-Tube
- Centralized action
- Ancillary attachment



Preventing abrasion damage

In the subsea environment ocean currents increase the chance of abrasive damage of supported lines within tubes. Over time this damage could put the connections at risk.

The centralizer's function is to allow any flexible or rigid line, or multiple lines, to be centered in an I-Tube, J-Tube, tunnel or larger diameter pipe.

Installation

Centralizers are installed onto the cable or pipe prior to deployment and pulled in as one unit.

Reduced Pull In Loads

Their low coefficient results in reduced installation loads when the line is being pulled in.

Abrasion Protection

Centralizers prevent the supported line from touching the inside of the tube into which they are being pulled, preventing abrasion damage.

Key Applications

To meet our customers' needs, our cutting-edge solutions can be used for the below applications:

- Cable
- Umbilical
- Pipeline
- Combinations of cables, umbilicals and pipes



VIV Suppression Strakes

Minimizing vortex induced vibration

In deepwater riser applications where the use of steel catenary risers (SCRs) is common, these risers can be introduced to the phenomenon of vortex induced vibration (VIV). This is caused by the regular shedding of vortices from the pipe when subjected to a steady current. The shedding of the vortices can “lock into” the resonant frequency of the pipe along a significant length and can cause the pipe to vibrate. VIV causes accelerated fatigue damage and can give rise to problems such as pipe girth weld failure or premature pipe failure. Other applications prone to VIV are rigid steel flowlines unsupported over free spans and major deepwater field developments requiring a large number of thermally insulated pipelines.

Trelleborg Offshore recognizes that this is an increasingly common problem and therefore, in order to suppress the damaging vibrations to an acceptable level, have put together a comprehensive design package which provides a successful VIV suppression system.

The VIV problem has been analyzed by Trelleborg Offshore using Computational Fluid Dynamics (CFD) software and physical tow tank testing. The results were used to verify the design of the strake concept. Once the suppression strakes are applied, the profile of the VIV strakes practically eliminates periodic vortex shedding from the risers and flowlines. Our VIV suppression strakes are manufactured to order and can accommodate any likely riser or flowline diameter.

To provide you with performance at every level, Trelleborg Offshore offers a range of VIV Suppression Strakes to meet your needs.



Uraduct®

Cable and flowline protection

With an ever increasing global requirement for data and product transfer, and the necessity for transfer networks to run through ever harsher environments, the demand for highly advanced cable and flowline protection grows.

Uraduct® is a protection system designed and developed to protect fiber optic cables, power cables, umbilicals, flexible flowlines, rigid flowlines, hoses and bundled products from abrasion and impact. Uraduct® can also be used to add ballast to cables and flowlines. It has established an enviable reputation as an industry standard for cable and flowline protection.

Benefits:

- Easy to handle and transport
- Custom made system
- Impact and abrasion resistant

Uraduct® +

For applications where pipelines or cables are to be subject to high levels of abrasion, Trelleborg developed Uraduct® +, which is considered to be the ultimate protection solution. Flexible pipes, power cables and fiber optic cables can be protected in any area where abrasion is considered to be a problem and stabilization cannot be achieved.



Uraduct® - Retrofit Riser System

With the increasing number of additional cables requiring termination to the offshore platforms and to provide you with performance at every level, Trelleborg designed the Uraduct® Retrofit Riser System, which comprises of Uraduct® and dedicated, high integrity locating clamps.

This system provides a very cost-effective solution where cable entry to a platform is not possible via existing 'J' or 'I' tubes. Prior to Trelleborg's Uraduct Retrofit Riser System the only alternative was to install new steel 'J' or 'I' tubes at great expense, compounded with time consuming and problematic installation.



Protected performance for floating windfarm

This floating wind turbine project is truly unique. The project, which is being headed up by The Ministry of Economy, Trade and Industry in Japan, will be the world's largest floating wind farm once complete. Located 16 kilometers off the coast of the Fukushima Daiichi nuclear power plant, it is being developed in wake of the devastating earthquake and tsunami which hit Fukushima in March 2011.

The Fukushima Wind Farm project is a major milestone in the switch from nuclear to renewable for the region. The project, known as Fukushima FORWARD, is part of a bigger scheme to reconstruct the area. Trelleborg supplied the experimental phase one of this pioneering project with its high performance cable buoyancy and protection in 2013 and supplied additional high performance cable protection, for phase two of this prestigious project in 2014.

A pioneering project

Trelleborg was awarded the contract to supply the Furukawa Electric Company with its high performance cable buoyancy and protection in 2013, supplying a significant number of Distributed Buoyancy Modules (DBMs), Uraduct, Bend Stiffeners and Bend Restrictors for the experimental phase of this pioneering project.

In floating production scenarios, subsea electrical power cables are used to inter-connect wind turbines on offshore windfarms and also run between the substation (electrical hub of the windfarm) and the shore. Trelleborg's high performance DBMs are designed to secure, guide and protect these power cables from excessive movement and bending that could cause fatigue damage.

Building on success

In the wake of a successful phase one supply, Furukawa Electric once again turned to Trelleborg to supply a range of high performance cable protection, for phase two of this prestigious project.

In floating production environments, subsea electrical power cables are used to inter-connect floating structures on offshore windfarms and also run between the substation (electrical hub of the windfarm) and the shore. Trelleborg's high performance DBMs are



designed to secure, guide and protect these power cables from excessive movement and bending that could cause fatigue damage.

Trelleborg provided its distributed buoyancy modules (DBM), bend stiffeners with dynamic bend stiffener connectors (DBSC), Uraduct™ cable protection and bend restrictors to phase two of the project.

Proving punctual performance

The initial project is a five year trial in which different floating structures are tested prior to the main windfarm being constructed, with three floating wind turbines and one floating sub-station being tested as part of the experiment. Following its completion in 2020, it is estimated there will be further floating structures. The initial supply from Trelleborg is for cable buoyancy and protection for the first wind turbine.

This contract was just the latest for Trelleborg within the growing Renewables sector, following on from previous contract wins such as the Statoil Hywind project off the coast of Norway and the Windfloat project off the coast of Portugal. The second phase of this prestigious project depended on working to tight timelines. With the input of Trelleborg's specialist teams, all products were delivered exactly to schedule and in accordance with Furukawa Electric's strict deadline.

"Japan is very well suited for the offshore windfarm projects due to its steep coastal shelf and deep water, so it's extremely encouraging to see that area is fully embracing floating windfarm technology. As a leader in the field, we are confident that Trelleborg is well positioned to take advantage of this rapidly expanding sector."

John Deasey

Renewables Sales Manager at Trelleborg Offshore



Manufacturing Facilities



Local presence, Global reach – Trelleborg Offshore offers teams around the world to meet your requirements.

Email: Offshore@trelleborg.com

Website: www.trelleborg.com/offshore

Twitter: [@offshoreinsight](https://twitter.com/offshoreinsight)

LinkedIn: [Trelleborg Offshore](https://www.linkedin.com/company/trelleborg-offshore)

Boston, Massachusetts, US

Address: 24 Teed Drive, Randolph, MA 02368

Phone: +1 774 719 1400

1. *Established since 1948, Trelleborg Offshore, based in Boston, has the proven experience and expertise to solve our customers' challenges. Our areas of expertise include material development and we are an ROV center of excellence. Our main focus is in design, project management and manufacturing solutions for our customers, based on our material expertise.*
2. Office – 650 m²
3. Total site – 7,081m²
4. Workshops – 3,437m²

Houston, Texas, US

Address: 1902 Rankin Rd, Houston, TX 77073, USA

Phone: +1 281 774 2600

1. *Houston's proven technical capabilities are based on our product expertise of polymer and syntactic solutions. Our focus as a sales and engineering office is to design solutions to solve our customers' challenges.*
2. Office - 400 m²

Krokstadelva, Norway

Address: Kalosjegata 15, 3055 Krokstadelva, Norway

Phone: +47 32 23 20 00

1. *With over 120 years of experience our expertise has made us the largest producer of rubber products and solutions in Norway since the establishment in 1896. We employ dedicated and skilled personnel in the whole value chain. Our main focus is in material development, design, project management and manufacturing tailored solutions for our customer based on their needs.*
2. Office – 2,500 m²
3. Total site – 25,000 m²
4. Workshops – 21,000 m²
5. Storage – 1,500 m²

Macaé, Brazil

Address: Rua dos Flutuadores 120, Cabiunas Macaé, RJ, CEP 27970-020 Brazil

Phone: +55 22 2106 4040

1. *Opened in 2012 the local site supports the Brazilian oil and gas supply chain including operators, ship builders, construction contractors and equipment manufacturers. Based in Macaé, the facility has the capability of manufacturing Trelleborg Offshore's complete product portfolio from topside to seafloor.*
2. Office – 390 m²
3. Total site – 31,746 m²
4. Workshops – 6,150 m²
5. Storage - 19,038 m²
6. Testing and R&D - 310 m²

Retford, UK

Address: Trinity Park, Randall Way, Retford, DN22 7AX, UK

Phone: +44 (0) 1777 712500

1. *Our Retford team has proven experience and expertise in solving our customers' challenges. Our main focus is design, project management and manufacturing solutions for our customers based on our product and material expertise*
2. Office – 760 m²
3. Total site – 16,200 m²
4. Workshops – 6500 m²
5. Testing and R&D – 35 m²
6. Storage - 1000 m²

Rochdale, UK

Address: Eagle Way, Off Queensway, Rochdale, Lancashire, OL11 1TQ, UK

Phone: +44 (0) 1706 716610

1. *Established since 1969, Rochdale has proven experience and expertise in solving our customers' challenges. Areas of expertise are material development, machining and an ROV center of excellence. The facility operates 3, 5 and 7 axis CNC machine centers and has complimentary finishing facilities for PU, paint and composite coatings.*
2. Office - 650 m²
3. Total site – 7,081 m²
4. Workshops - 3,437 m²

Skelmersdale, UK

Address: Stanley Way, Skelmersdale, Lancashire, WN8 8EA

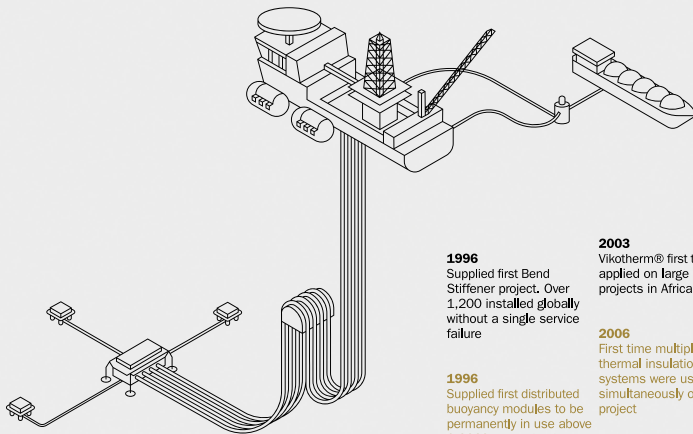
Phone: +44 (0) 1695 712 000

1. *Established since 1978, Skelmersdale has proven experience and expertise in solving our customers' challenges. Our main focus is in design, project management and manufacturing solutions for our customers based on our product expertise of bespoke composite and plastic solutions.*
2. Office – 2,050 m²
3. Total site – 52,000 m²
4. Workshops – 15,000m²
5. Storage - 26,650 m²
6. Testing and R&D - 900 m²

Email us on: Offshore@trelleborg.com

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Going the Distance: Connecting the past to the future



1950
First Syntactic Foam developed

1974
First corrosion protection was delivered

1970
First string of Drill Riser Buoyancy supplied to industry

1987
First subsea pipeline insulated with wet insulation in the world using Vikotherm® R1

1986
Thermal Insulation material Vikotherm® developed and launched. 3 nominations achieved at ONS this year

1997
First Flexible Pipeline thermal insulation covers delivered

1996
Supplied first distributed buoyancy modules to be permanently in use above 2,000ft water depth

1996
Supplied first Bend Stiffener project. Over 1,200 installed globally without a single service failure

1987
Supplied first Bend Restrictor project

1999
Supplied first distributed buoyancy modules to be permanently used for 6,000ft water depth

1998
Flexible piping system Elastopipe™ launched

1999
First installation of Elastopipe™

2008
Supplied Distributed Buoyancy Modules for the first floating wind farm

2006
Supplied first distributed buoyancy modules to be permanently used for 9,000ft water depth

2006
First use of thermal insulation to dissipate Vortex Induced Vibration (VIV) on a jumper application, increasing the thickness of insulation in specific locations to up to 9" thick to help shed the vortices

2006
First time multiple thermal insulation systems were used simultaneously on a project

2003
Vikotherm® first time applied on large scale projects in Africa

2012
Supplied buoyancy and cable protection for the world's largest floating wind farm

2012
First thermal insulation tape manufactured in South America

2012
First dynamic Bend Stiffener manufactured by Trelleborg in South America

2011
Drill riser buoyancy technology helps achieve a new record in deepwater drilling of 10,194 ft

2009
Designed and manufactured the world's largest Bend Stiffener standing at 37ft tall with a 4.134ft base diameter

2016
Delivered first helically grooved buoyancy string

2014
Completed delivery of flotation and first split bend limiting devices for the Mediterranean Subsea Water Pipeline, the world's first subsea floating water pipeline installed 820ft below the water level

2013
Drill riser buoyancy technology to help achieve a new record in deepwater drilling of 10,411ft

2017
Developed and manufactured first Rotating Buoyancy Module system for buckling mitigation for subsea pipelines

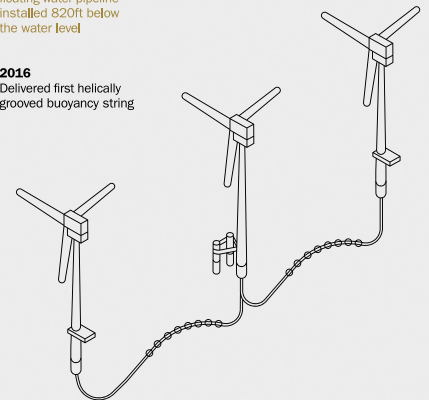
2016
Supplied first fully composite buoyancy specifically for use on Landing Strings during well construction operations

2016
First company to manufacture and supply polymeric Bend Restrictor in Brazil

2018
First company to manufacture and supply end fitting protection covers for subsea equipment in Brazil

2018
Developed and launched next generation Firestop™ passive fire protection material

2018
Delivered first NjordGuard™ Cable protection system to the Renewables Industry



1950

2000



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