PROVEN STRENGTH
200 years of experience in development and manufacturing of strong products have proven the strength of Lankhorst
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Lankhorst Ropes is a member of the Royal Lankhorst Euronete Group. With more than 200 years of experience and 1,250 employees we are a worldwide innovative group with fully equipped production sites and R&D departments, located in The Netherlands, Portugal, Greece and Brasil, equipped for the production of a wide range of products in maritime and offshore ropes, technical yarns, fishing gear, Pure® composites, recycling and moulding material.

In July 2012, the Royal Lankhorst Euronete Group was acquired by WireCo WorldGroup, of Kansas City, Mo, USA. WireCo WorldGroup is the global leader in manufacturing, engineering, and distributing wire rope, wire rope assemblies, synthetic rope and electromechanical cable. With true global reach, WireCo WorldGroup can deliver the right products for your equipment and application no matter where your worksite might be.

Lankhorst Ropes is divided into three divisions: a Maritime Division with sales offices in The Netherlands, United Kingdom, Spain, United Arab Emirates, Brasil and Australia, an Offshore Division which trades in the name of Lankhorst Euronete Portugal S.A. and operates from Maia and Viana do Castelo (Portugal), and a Heavy Lifting Division. Lankhorst Ropes also trades steel wire ropes for offshore applications from WireCo WorldGroup manufacturing units.

In order to support the business, Lankhorst Ropes carries strategic stock in Houston (USA), New York (USA), Los Angeles (USA), Fujairah & Dubai (UAE), Cape Town & Durban (South Africa), Rotterdam (Holland), Panama and Singapore, and has service points in Bilbao (Spain), Brisbane (Australia) and Rio de Janeiro (Brasil). Lankhorst Ropes continuously strives for improved product performance, customer satisfaction and product innovation. Lankhorst Ropes has been certified according to ISO 9001:2000.

This brochure covers offshore ropes used in Single Point Mooring and Tandem Mooring applications.

**Location**

The new Lankhorst Ropes site of 6000 m² is located in Viana do Castelo, Portugal and became operational in September 2012. It is the most modern factory in the world dedicated to production of ropes for the offshore industry. Positioned near the port of Viana do Castelo, the facility is well suited to produce heavy deepwater mooring ropes.

**Offspring International Ltd (OIL)**

Formed in 1991 to provide a unique and dedicated service to the offshore industry worldwide. Specialising in offshore mooring systems, OIL is able to evaluate any application and provide the correct solution to meet client specifications.

From individual components to complete turnkey packages, OIL’s experience and reputation for excellence positions them at the forefront of today’s marine specialists. In addition to their own product portfolio, OIL is the worldwide agent for Lankhorst Ropes – Offshore Division, regarding deep water mooring and single point mooring systems. All equipment supplied by us is supported by its principals’ total commitment to quality. All products are approved by the leading classification societies and supplied with the appropriate certification.

We offer complete project management, ensuring correct and total integration of each system, helping to eliminate operating risks and ensuring targets are met.

We operate under ISO 9001:2008 and other industry related quality management systems, complying with all relevant safety and ecological standards, balancing the needs of man and environment.
Total System Management

We offer a comprehensive designed package, tailored to suit individual location requirements and water temperatures. We concentrate on operational performance, reliability, safety and ontime delivery.

Our bespoke packages can incorporate:
- Mooring hawsers
- Pick-up and Messenger ropes
- Chafe chains
- Support buoys
- Shackles
- Associated fittings
- Load monitoring equipment
- Marine hose and ancillary equipment

Materials

In the manufacture of our mooring system hawsers, we carefully select premium quality yarns of multifilament nylon, HT polyester and blended fibres. For Submerged Turret Loading and recovery systems, we also use Dyneema® fibres. Hawsers can be supplied with Integral Flotation system and/or PU encapsulation for increased durability and operational cost savings.

Construction

We manufacture in Double Braid, Circular Braided (GAMA 98®) and conventional eight strand constructions.

Double Braid is constructed with a separate outer braided sheath and inner braided core. The balanced flexible construction, distributes the weight and strength equally between the sheath and braided core.

GAMA 98® is constructed from high efficiency sub-rope cores laid parallel within an outer braided jacket. Each sub-rope is computer monitored during production to ensure all sub-ropes have equal tension and length. The outer jacket is essentially non load bearing.

Quality & Design

Continuous research and practical field experience, combined with the latest CAD technology have kept us at the forefront of the technological advancement in the design and manufacture of cost effective, safe offshore mooring systems.

All Single Point and Tandem mooring systems are project designed and custom built under rigorous quality assurance conditions which conform to appropriate classification requirements and / or OCIMF 2000 Guidelines.

Technical Support Services

As part of our total commitment to protecting our reputation for quality and service, our Sales Engineering support team is charged with providing invaluable technical support to all our customers. A far reaching service, this can extend from advice given over the telephone regarding the most suitable system for your individual requirements, to visiting operational terminals around the world, with recommendations given at first hand to ensure the most cost effective solutions to in-service problems.

The latest Computer Aided Design and DeskTop Publishing technology allow us to produce “As Built” drawings and fully documented manuals for any mooring system to accompany the QA and/or independent inspection authority certification.

Our Technical Department, responsible for research, design and development, product engineering and quality data management, is manned by highly qualified engineers and inspectors. In addition to a fully equipped chemical laboratory for forensic analyses, we have direct access to in-house computer controlled testing equipment to evaluate, reverse bend, elongation, abrasion, tensile loading of yarn and fibre ropes with a load capacity up to 1200 tonnes.

OCIMF

We can supply a full range of products manufactured and supplied in strict accordance with the OCIMF 2000 “Guidelines for the Purchasing and Testing of SPM Hawsers”. Our technical department is committed to ongoing testing, development, optimisation of rope designs, which is an ongoing process.

Dyneema is a registered trademark of Royal DSM N.V.
When selecting hawsers, terminal operators should take into account not only strength but also energy absorption and fatigue performance. Detailed information can be found in the OCIMF 2000 ‘Guidelines for the Purchasing and Testing of SPM Hawsers’.

The NWBS (New Wet Break Strength), energy absorption and fatigue performance of hawsers will deteriorate during service under the influence of factors such as service life, cyclic load history, hawser type, construction, environmental conditions, damage and stowage arrangements between use. Terminal operators should take these factors into account when determining the appropriate hawser for the mooring system and hawser retirement criteria.

Chafe Chains
Each mooring hawser should terminate at its shipboard end with a chafe chain. The standard recommend size of the chafe chain has been established at 76mm based on the diameter of the material forming the common stud links. Terminal operators should select the appropriate chain by taking into account the designed SPM mooring arrangement, SWL required and the properties of the chain grade selected. Typically chafe chains form a single chain of approximately 8 metres or more in length, composed of 76mm stud link chain. If through-type chain support buoys are utilised the length of the chain may have to be increased. Each chain should terminate, at the shipboard end with an oblong plate for connecting the chain to the pick up rope bow shackle.
Weak Links
Weak links, if fitted, should be selected such that the recommended bow chain stopper, chafe chain, hawser or connection to the SPM do not constitute the weakest yield strength of MBL component of the entire system. Weak links, if fitted, should be designed, manufactured and tested under a certification scheme.

Support Buoys
When the berth is unoccupied, each chafe chain may be supported by flotation devices. One method is to use a swivel ended type support buoy that is connected by a short length of chain to the end link of the chafe chain, adjacent to the hawser. Another method is to use a through type chain support buoy. Support buoys should have reserve buoyancy equivalent to at least 20% of the weight in air of the material to be supported.

Pick-up / Messenger Rope
The pick-up rope is connected to the ship end of the chafe chain and typically consists of 150 metres of floating rope (generally polypropylene based) complete with an eye at each end. The rope can vary in length from 120 – 180 metres, and in diameter from 64 – 80 mm. At some terminals where the pick-up rope is not kept connected to the chafe chain when the berth is unoccupied, differing arrangements may be employed to facilitate connection / disconnection of the pick-up rope.
TYPICAL OFFTAKE SYSTEM

Typical Dual Hawser Configuration

HAWSER CONFIGURATIONS

Single leg type mooring hawser

Grommet type mooring hawser
Rope with a braided sheath over a braided hollow core (also called 2 in 1 and Braidline).

Material: NYLON
Construction: Double braided ropes are constructed by braiding a sheath over a braided hollow core. They have 32 core strands and 64 sheath strands with an equal number of left and right hand providing a perfectly torque free rope.

Double Braid is acknowledged as the best rope construction manufactured to absorb the enormous dynamic forces generated at SPM’s.

Manufactured, inspected and supplied in accordance with the OCIMF 2000 “Guidelines for the Purchasing & Testing of SPM Hawsers”

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Other sizes are available on request

These data are for guidance purposes only and are subject to change without prior notice
HAWSER DATA - GAMA 98® (PARALLEL STRAND) CONSTRUCTION

Rope in which components are laid parallel to each other within an outer braided jacket (also called circular braided). The jacket is non-load bearing.

Material: NYLON
Construction: The GAMA 98® ropes are made from high efficiency sub-rope cores laid parallel within an outer braided jacket. Each sub-rope is computer monitored during manufacture to ensure all sub-ropes have equal tension and length. The GAMA 98® has become the industry standard for FPSO/FSO offtake mooring hawser arrangements.

Manufactured, inspected and supplied in accordance with the OCIMF 2000 “Guidelines for the Purchasing & Testing of SPM Hawsers”

<table>
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Other sizes are available on request

These data are for guidance purposes only and are subject to change without prior notice.
Material: COMPOSITE YARNS (POLYESTER HIGH TENACITY / POLYVER)

Construction: Astraline® is an 8-strand multiplait constructed rope, comprising of a polyver® core and a high grade polyester cover. This composite yarn has been proven to give excellent performance in resisting abrasion.

Manufactured, inspected and supplied in accordance with the OCIMF 2000 “Guidelines for the Purchasing & Testing of SPM Hawsers”.

Rope construction of two pairs of stands with right hand twist and two pairs of left hand twist, braided together in such a way that pairs of strands of opposite twist overlay one another.

These data are for guidance purposes only and are subject to change without prior notice.
SPM Hawkers typically manufactured from nylon (SG 1.14) will not float naturally in seawater. A hawser which sinks will foul the catenary moorings of a CALM buoy or other subsea equipment. We have a range of flotation methods.

- Lace-on hawser floats
- Integral hawser flotation
- Tubular floats

Please ask us for detailed data sheets on the below flotation types.

### Lace-on hawser float

The integrity of the mooring hawser depends on the floats sustaining hawser buoyancy. All our floats feature a double outer layer manufactured from high abrasion resistant ballistic nylon cloth. All seams are double stitched from heavy denier yarn using a locking stitch, so yarn breakages cannot lead to an unzipping effect. The floats utilise high quality 48 kg/m³ 100% closed cell polyethylene foam, and high quality eyelets exceeding Shell pull test standards. Additionally these floats can be polyurethane elastomer coated on the outside.

<table>
<thead>
<tr>
<th>No. Of Pockets</th>
<th>Single Hawser (mm)</th>
<th>Grommet Hawser (mm)</th>
<th>Nett Buoyancy (kg)</th>
<th>Approx. Dry Wt (kg)</th>
<th>Width Dimension (mm)</th>
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**NOTE:** Width dimension is taken when the float is laid out flat and foams are installed. Measured under a pre-load of 2.5kg. All floats are approximately 1065mm in length.
**Integral Flotation**

It has been reported by operators using mooring hawsers with conventional lace-on floats, that during the lifetime of the hawser the floats tend to suffer damage and can be ripped away from the rope. This can be costly to the operator having to secure replacement floats and organise maintenance crews to replaced damaged / missing floats. Our Integral Flotation system overcomes these issues, and in addition offers many other operational benefits.

Mooring hawsers incorporating our Integral Flotation system are wrapped in closed cell buoyancy foam, ensuring sufficient reserve buoyancy is calculated into the construction to support the hawser in seawater. This is covered with an over braided jacket. Additionally this can be polyurethane elastomer coated to enhance abrasion characteristics of the assembly.

**Benefits of Integral Flotation:**

- Integral Flotation system does not need to be replaced / maintained during the hawser lifetime, eliminating the need for spare floats and expensive maintenance crews.
- The construction of the Integral Flotation system enhances the abrasion resistance of the hawser to external mechanical damage, ie. Floating hose flanges.
- At CALM buoys where the hawsers maybe left floating in the water between offtakes, the Integral Flotation system reduces the amount the rope will flex with the wave action. This reduces internal yarn-on-yarn abrasion damage and can help to increase retirement programmes.
- Ropes left floating in the water between offtakes are subject to ‘water wash’ through the rope, which over time will remove the unique marine finishes applied to modern day synthetic fibres to reduce abrasion / fatigue damage internally. The Integral Flotation system with polyurethane elastomer coating restricts water wash.

**Tubular float**

In cases where long service life with minimal maintenance is required, we recommend the use of our Tubular Floats. These are available in varying lengths and diameter to suit. Tubular floats are stiffer than the fibre rope, so flexing may occur at the exit points from the floats. The longer the float length, the greater the flexural concentration. Therefore we do recommend a larger quantity of short length floats, as opposed to a smaller quantity of longer length floats.
### Cast SPM Hawser Thimble

**Material:**
- Cast steel
- Stainless steel

**Finish:**
- Galvanised (mild steel)
- Self coloured (stainless steel)

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These data are for guidance purposes only and are subject to change without prior notice.

### Tubular Hawser Thimble

**Material:**
- Mild steel

**Finish:**
- Galvanised / Plastic coating on request

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These data are for guidance purposes only and are subject to change without prior notice.
Bellmouth Hawser Thimble

**Material:**
- Mild steel
- Stainless steel

**Finish:**
- Galvanised (mild steel)
- Self coloured (stainless steel)

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<td>1000</td>
<td>758</td>
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<td>266</td>
<td>245</td>
<td>290</td>
<td>135</td>
<td>236</td>
</tr>
</tbody>
</table>

For connecting to a special shackle, dimension K can be revised to suit.

Heavy Duty Hawser Shackles

**Material:**
- Forged high alloy steel
- Quenched & tempered

**Finish:**
- Galvanised / painted

<table>
<thead>
<tr>
<th>Rope Size</th>
<th>A (mm)</th>
<th>B (mm)</th>
<th>C (mm)</th>
<th>D (mm)</th>
<th>E (mm)</th>
<th>Weight (Kg)</th>
<th>SWL Tonne</th>
<th>Proof Load Tonne</th>
<th>MBL Tonne</th>
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<td>178</td>
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<td>265</td>
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<td>259</td>
<td>250</td>
<td>482</td>
<td>612</td>
</tr>
</tbody>
</table>

*These data are for guidance purposes only and are subject to change without prior notice.*
SUPPORT BUOYS & PICK-UP BUOYS

Swivel End Type Buoy

Our range of chain support buoys have a typical reserve buoyancy of 900kg up to 5000kg – but our flexible manufacturing process allows us to produce products to suit our customers exact buoyancy requirements. The buoys can be supplied with swivel eyes top and bottom, or with a chain through / locking plate arrangement. We also supply pick-up buoys with reserve buoyancy of up to 500kg.

Chain Through Type Buoy

<table>
<thead>
<tr>
<th>Nominal Dimensions</th>
<th>Nominal</th>
<th>Reserve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Length (mm)</td>
<td>Overall Length (mm)</td>
<td>Body Diameter (mm)</td>
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<tr>
<td>1550</td>
<td>2096</td>
<td>1300</td>
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<tr>
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<td>2890</td>
<td>1950</td>
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</tbody>
</table>

Spherical Type Pick-up Buoy

<table>
<thead>
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<th>Nominal Dimensions</th>
<th>Nominal</th>
<th>Reserve</th>
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</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>Overall Length (mm)</td>
<td>Body Diameter (mm)</td>
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<tr>
<td>660</td>
<td>950</td>
<td>660</td>
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</tbody>
</table>
We can supply a full range of OCIMF compliant Chafe Chains, as well as customer bespoke assemblies configured to individual operator specifications.

- Chafe Chain A OCIMF 2007, 4th Edition – for use with full range of ship sizes
- Chafe Chain B OCIMF 2007, 4th Edition – for use with ships of 350,000 tonnes or less deadweight
- Chafe Chains A and B as per OCIMF 1993, 3rd Edition
- Weak links, Kenter shackles, Joining shackles, Delta plates etc.
- Topside SPM Bridle Assemblies

Typical Chain A / B configuration per OCIMF 2007. Chain manufactured, tested and inspected in accordance with IACS W22.

The number and size of chains used should be determined by the terminal operator after an analysis of the maximum mooring load. If necessary, weak links or quick release devices should be incorporated into the mooring system.

Our range of floating pick-up / messenger lines are based on our Lankhorst TIPTO® Brand ropes. These ropes exhibit high strength, excellent abrasion resistance and energy absorption properties, ensuring a long life-time. The low weight makes the handling on board easier. Lankhorst TIPTO® Brand ropes are supplied in high visibility yellow colour and have a specific gravity of 0.93 – self floating.

Lankhorst are able to supply Spunstaple Polypropylene floating pick-up / messenger lines if required, manufactured in 8-strand squareline construction. Please ask for details.
TESTING & TECHNICAL SUPPORT INFORMATION

Residual Hawser Strength Testing
We can assist operators to understand hawser behaviour and performance in specific field operations by residual strength testing of used / retired mooring hawsers.

Our fully equipped laboratories in Portugal have the capability to analyse mooring hawsers for condition, signs of internal abrasion damage or ingress of foreign particles, and perform residual break tests. This information will help operators to understand the hawsers in use at their terminal and make better informed judgements on current and future retirement programmes. Our engineers are able to offer advice and guidance on this. Customers are always welcome to witness testing of hawsers.

Lankhorst Ropes have participated in many Joint Industry Projects (JIP) and have been instrumental in helping to shape the industry and the rules / guidelines governing the use of fibre ropes in offshore applications. In addition to the JIPs, we also participate in privately sponsored research projects and other JIPs specifically related to Fibre Rope Mooring applications, Chain and Mooring Jewellery.

Technical Support Information
Our SPM sales and engineering team is always on hand to provide comprehensive customer care and technical support services. We are able to undertake site surveys and bespoke development work. Further technical information on our range of SPM associated products is available upon request by sending an email to spm@lankhorstropes.com

- Double Braid Nylon – Load v Extension data
- Double Braid Nylon – Fatigue (TCLL) data
- GAMA 98® - Load v Extension data
- GAMA 98® - Fatigue (TCLL) data
- OCIMF 2000 Form A Compliance Certificates
- Single Leg vs Grommet Hawser Configuration

- OCIMF Chafe Chain drawings / data sheets
- Pick-up rope / Messenger Line data sheets
- SPM Hawser Reference List
- SPM Technical Manual
- Operation & Maintenance Manual
- Synthetic Fibre Material & Rope constructions

Trial Fits
All assemblies and components are fully fitted prior to despatch from factory to ensure no interface issues once items arrive at site.
Marine terms and abbreviations are open to variation around the world, the following are used in all our literature and correspondence:

**BOW CHAIN STOPPER**
A mechanical device for securing chafe chains onboard a tanker.

**BRAIDED ROPE**
Rope constructed by braiding or interweaving strands together.

**BRAIDLINE OR DOUBLE BRAID ROPE**
Rope consisting of a hollow core of many braided strands enclosed in a cover of many braided strands.

**BREAKING LENGTH**
The length of rope, whose mass will equal that of its breaking strength.

**CBS**
Calculated breaking strength.

**CHAFE CHAIN**
A length of stud-link chain at the end of an SPM mooring hawser which passes through a ship's fairlead and is used to connect the SPM mooring hawser to the bow chain stopper of a tanker.

**CIRCULAR BRAIDED ROPE**
Rope consisting of multiple parallel laid load-bearing cores, enclosed in a non-load bearing braided jacket.

**CONVENTIONAL TANKER**
An oil tanker equipped for regular trading and not specially designed or adapted for loading at offshore terminals requiring specialised mooring or bow loading equipment.

**DISPLACEMENT**
The mass of water in tonnes displaced by a vessel at a given draft.

**DWT**
Deadweight tonnage of a vessel at the maximum summer draft, expressed in tonnes.

**EIGHT STRAND ROPE**
Rope construction of two pairs of strands with right hand twist and two pairs of strand with left hand twist, braided together in such a way that pairs of strands of opposite twist overlay one another.

**END FOR END SPLICE**
The joining of two ropes by means of a splice.

**FPSO**
Floating Production, Storage and Offloading unit.

**FSO**
Floating Storage and Offloading unit.

**GROMMET ROPE OR DOUBLE LEG HAWSER**
An assembly of rope spliced into an endless loop then two legs seized together to form a singl length. Ancillary equipment fitted as required.

**LAID ROPE**
Rope constructed by laying and twisting several strands together. The direction of the twist is opposite that of the strand twist. Common forms are three, four and six strand (with core).

**LINEAR DENSITY**
The weight per unit length of the rope.

**MAXIMUM SUMMER DRAFT**
Maximum summer draft for which the structural strength of the ship has been designed.

**MBL**
Minimum breaking load of a new mooring line or chain, as declared by the manufacturer. It does not include allowance for splicing (mooring line) or for wear and tear.

**MINIMUM YIELD LOAD**
The mooring load applied to a mooring fitting (eg. Bow fairlead, bow chain stopper) that, if exceeded, would cause permanent (plastic) deformation of the fitting, its components or foundations and, therefore, impair or otherwise compromise its continued safe use.

**MOORING HAWSER**
An assembly of rope and fittings, terminations, flotation aids and anti-chafe protection.

**NEW DRY BREAKING STRENGTH (NDBS)**
The average breaking strength of prototype ropes, which have not been exposed to water, and conditioned by 10 load cycles.

**NEW WET BREAKING STRENGTH (NWBS)**
The average breaking strength of prototype ropes that have been soaked in water and conditioned by 10 load cycles.

**OCIMF**
Oil Companies International Marine Forum, a London based organisation of marine representatives from SPM terminal operators, primarily oil companies.

**PU**
Polyurethane elastomer

**REFERENCE LOAD**
A nominal pre-tension load, approximately 1% of the breaking load, which is applied to the rope to remove slack when taking certain measurements.

**ROPE SIZE**
Is a number approximately equivalent to the nominal diameter measured in mm.

**ROPE STRENGTH FACTOR**
The ratio of the strength of the finished rope to the sum of the strengths of the rope yarns used to make the rope.

**SAFE WORKING LOAD (SWL)**
A load less than the yield or breaking load by a safety factor defined by a code, standard or good engineering practice.

**SHUTTLE TANKER**
An oil tanker specially designed or adapted for loading at offshore terminals requiring specialised mooring or bow loading equipment.

**SINGLE POINT MOORING (SPM)**
An integrated mooring arrangement for bow mooring a conventional tanker. For example conventional tanker bow mooring arrangements to Catenary Anchor Leg Mooring (CALM) system, Single Anchor Leg Mooring (SALM) system, FPSO or FSO.

**SINGLE ROPE ASSEMBLY**
An assembly of a single rope with terminations at each end. Ancillary equipment fitted as requested.

**SPLICED EYE**
A loop formed at the end of a rope and secured by interweaving the strands or braids.

**TANDEM MOORING**
A hawser-mooring arrangement between two vessels, either bow-to-bow or bow-to-stern. It is normally taken to mean a mooring arrangement between the bow of a conventional tanker and the stern of bow of a FPSO or FSO.

**TPC**
Polyester tubular cloth
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