STRENGTH IN DEPTH

SINGLE POINT MOORING.

Lankhorst Offshore

OIL & GAS

WireCo WorldGroup
LANKHORST OFFSHORE...
STRENGTH IN DEPTH

Lankhorst Offshore is a world leader in the development, engineering and manufacture of synthetic fibre ropes for single point mooring offloading systems, deepwater mooring, fibre rope deployment systems, riser and mid-water arch tether systems, single point mooring offloading systems and floating offshore wind turbines.

Innovation is at the heart of our business. We are committed to setting the standard for performance and reliability in the most demanding offshore environments. Our strengths in engineering and technical know-how are matched by an in-depth knowledge of offshore applications stretching back over more than 200 years.

Lankhorst Offshore continuously strives for improved product performance, customer satisfaction and product innovation. As part of WireCo® WorldGroup, the world’s leader in manufacturing, engineering, and distributing wire rope, synthetic rope, specialized assemblies, wire products and electromechanical cable, we draw on extensive research and testing facilities at WireCo® WorldGroup’s Global Synthetics R&D facility in Portugal. Here we have an on-going research program into mooring and deployment rope materials and constructions, designed to support offshore energy companies in meeting ever more demanding project and environmental challenges.

We have fully equipped production sites and R&D departments, located in Portugal and at our sister company Lankhorst Euronete Brasil Indústria e Comércio Ltds (LEB), with capabilities to produce a wide range of offshore ropes.

Lankhorst Euronete Portugal has been certified by Lloyd’s Register Quality Assurance and Lankhorst Euronete Brasil by Bureau Veritas Certification according to ISO 9001:2015.

Lankhorst Offshore trades under the names of Lankhorst Euronete Portugal S.A. (LEP) and Lankhorst Euronete Brasil (LEB).
LOCATIONS
The most modern factories in the world dedicated to production of ropes for the offshore industry:

Portugal
The Lankhorst Offshore site of 6,000 m² is located in Viana do Castelo, Portugal and became operational in September 2012. It is the most modern factory worldwide dedicated to the 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. Next to this facility we have factories in Maia and Paredes. The company entered the deepwater tether market in 1998. The recent commissioning of a new reel take-up stand brings our capacity to handle single piece weights of up to 250 tonnes gross (rope and reel).
Brazil
The production facility of Lankhorst Euronete Brasil covers around 10,000m² in an 17,000m² property in the industrial site of Queimados in Rio de Janeiro with easy access to the ports of Rio de Janeiro and Sepetiba. The company started production of deepwater mooring ropes in 2012. Production capacity was doubled in 2015 with the addition of a complete new production line using state-of-the-art machinery.

THE MOST MODERN FACTORIES IN THE WORLD DEDICATED TO PRODUCTION OF ROPES FOR THE OFFSHORE INDUSTRY

FACILITIES
The factories are dedicated to the design, production and testing of offshore mooring ropes and specialty products such as deepwater installation ropes. Modern production and testing equipment permits all the following activities to be undertaken in-house:

- Stranding of base yarn into strands
- Braiding or twisting of strands into sub-ropes
- Application of soil ingress filters
- Production of braided jacket material (twisted yarn / cut resistant tape)
- Closing (over braiding) of sub-ropes into mooring ropes
- Length Measurement System (LMS) under tension up to 30 tonnes
- Length marking under tension in 75 m increments
- Axial (anti-twist) line marking
- Full scale proto-type testing
  - Break strength testing up to 1,200 tonnes
  - Tension-tension fatigue testing
  - Stiffness and elongation testing
  - Simulation of installation and “What If” scenarios.
  - Cut resistant jacket testing
  - Linear density testing.

OFFSPRING INTERNATIONAL LTD (OIL)
Offspring International is the worldwide agent for Lankhorst Offshore single point mooring systems. Formed in 1991, OIL consists of a dedicated team of mooring professionals, who together have over 150 years’ experience in the design, supply and deployment of single point mooring systems. It offers complete project management; this ensures correct and total integration of each system, helping to eliminate operating risks and ensuring targets are met.
LANKHORST OFFSHORE IN SINGLE POINT MOORING

Lankhorst Offshore is a leading supplier of Single Point Mooring (SPM) systems, setting the standard for quality, reliability and performance for offtake systems. Designed to withstand a wide range of offloading environments typical of both oil terminals and Floating Production Storage and Offloading (FPSO) vessels, Lankhorst SPM systems are used worldwide.

All SPM systems are bespoke packages incorporating mooring hawsers, pick-up and messenger ropes, and chafe chains. Together with support buoys, shackles and associated fittings and ancillary equipment. Lankhorst Offshore SPM hawser and ancillary equipment meet or exceed the latest OCIMF Guidelines for such systems, namely the OCIMF 2000 “Guidelines for the Purchasing & Testing of SPM Hawsers” and OCIMF 2018 “Guidelines for Offshore Tanker Operations”.

Lankhorst Offshore mooring hawser constructions are optimised for not only strength but also energy absorption and fatigue performance. We can assist operators to maximise hawser service life and reduce cost-of-ownership by conducting residual strength testing of used / retired mooring hawsers to better understand hawser behaviour and performance in specific field operations. In this way, terminal operators are better equipped to determine the appropriate hawser for the mooring system and hawser retirement criteria.

LANKHORST EFFECTIVE SINGLE POINT MOORING SYSTEMS ARE USED WORLDWIDE
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
• Ancillary equipment.

Load monitoring equipment and marine hoses can be supplied via Offspring International Ltd.

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 an integral flotation system and/or PU encapsulation for increased durability and operational cost savings.

Rope construction
We manufacture in double braid (DOUBLE BRAID 32/64), circular braided (GAMA 98®) and conventional eight strand DOUBLE BRAID constructions.

DOUBLE BRAID conventional 32/64 strand construction with a separate outer braided (64 strands) sheath and an inner braided core (32 strands). 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.

ASTRALINE® based on conventional 8 strand construction manufactured from polyester in combination with polyolefin fibres.

Quality and 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 2000/2018 Guidelines.
Technical support services
As part of our total commitment and 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 1,200 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” and OCIMF 2018 “Guidelines for Offshore Tanker Operations”. Our technical department is committed to ongoing testing, development and optimisation of rope designs.
EQUIPMENT SELECTION

Mooring hawsers
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

HAWSER CONFIGURATIONS

Single leg type mooring hawser

Grommet type mooring hawser
Rope with an inner braid of hollow structure manufactured in a separate operation serves as the core, while a cover (outer braid) is braided over it in a second operation. The conventional construction has 32 strands on the inner core and 64 strands on the cover. It is 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 to absorb the enormous dynamic forces generated at SPM’s. The weight of either the inner braid or the outer braid shall not exceed 55 % of the total weight of the rope as per ISO 10554.

Lankhorst DOUBLE BRAID hawser ropes have been fully prototype tested and are manufactured, inspected and supplied in accordance with the OCIMF 2000 “Guidelines for the Purchasing & Testing of SPM Hawsers”.

### DOUBLE BRAID 32/64

<table>
<thead>
<tr>
<th>diameter mm</th>
<th>size in</th>
<th>weight kg/100m</th>
<th>NDBS kN</th>
<th>NWBS kN</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>10</td>
<td>388</td>
<td>1,724</td>
<td>1,498</td>
</tr>
<tr>
<td>88</td>
<td>11</td>
<td>482</td>
<td>2,117</td>
<td>1,840</td>
</tr>
<tr>
<td>96</td>
<td>12</td>
<td>562</td>
<td>2,450</td>
<td>2,129</td>
</tr>
<tr>
<td>104</td>
<td>13</td>
<td>662</td>
<td>2,861</td>
<td>2,486</td>
</tr>
<tr>
<td>112</td>
<td>14</td>
<td>762</td>
<td>3,269</td>
<td>2,841</td>
</tr>
<tr>
<td>120</td>
<td>15</td>
<td>883</td>
<td>3,760</td>
<td>3,267</td>
</tr>
<tr>
<td>128</td>
<td>16</td>
<td>1,024</td>
<td>4,326</td>
<td>3,759</td>
</tr>
<tr>
<td>136</td>
<td>17</td>
<td>1,144</td>
<td>4,804</td>
<td>4,174</td>
</tr>
<tr>
<td>144</td>
<td>18</td>
<td>1,285</td>
<td>5,362</td>
<td>4,660</td>
</tr>
<tr>
<td>152</td>
<td>19</td>
<td>1,426</td>
<td>5,918</td>
<td>5,143</td>
</tr>
<tr>
<td>160</td>
<td>20</td>
<td>1,606</td>
<td>6,625</td>
<td>5,758</td>
</tr>
<tr>
<td>168</td>
<td>21</td>
<td>1,747</td>
<td>7,175</td>
<td>6,235</td>
</tr>
</tbody>
</table>

Other sizes are available on request.

New Dry Break Strength (NDBS) and New Wet Break Strength (NWBS) data are for guidance purpose only and are subject to change without prior notice.

### ELONGATION:

Load vs. immediate extension of DOUBLE BRAID 32/64 NYLON.
GAMA98®

PARALLEL STRAND

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. Lankhorst GAMA98® hawsers have become the industry standard for FPSO/FSO tandem offtake mooring arrangements. Lankhorst GAMA98® hawser ropes have been fully prototype tested and are manufactured, inspected and supplied in accordance with the OCIMF 2000 “Guidelines for the Purchasing & Testing of SPM Hawser”.

ASTRALINE®

8 STRAND MULTIPLAIT

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.

Material: Composite yarns (polyester high tenacity / polyolefin)

Construction: ASTRALINE® is an 8 strand multiplait constructed rope, comprising Lankhorst special polyolefin blend inner yarns and high grade polyester yarns. This composite yarn has been proven to have excellent abrasion resistance performance.

Lankhorst ASTRALINE® hawser ropes have been fully prototype tested and are manufactured, inspected and supplied in accordance with the OCIMF 2000 “Guidelines for the Purchasing & Testing of SPM Hawser”.

New Dry Break Strength (NDBS) and New Wet Break Strength (NWBS) data are for guidance purpose only and are subject to change without prior notice.

<table>
<thead>
<tr>
<th>diameter mm</th>
<th>size in</th>
<th>weight kg/100m</th>
<th>NDBS kN</th>
<th>NWBS kN</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>10</td>
<td>398</td>
<td>1.798</td>
<td>1.705</td>
</tr>
<tr>
<td>88</td>
<td>11</td>
<td>497</td>
<td>2.239</td>
<td>2.124</td>
</tr>
<tr>
<td>96</td>
<td>12</td>
<td>590</td>
<td>2.680</td>
<td>2.542</td>
</tr>
<tr>
<td>104</td>
<td>13</td>
<td>696</td>
<td>3.119</td>
<td>2.958</td>
</tr>
<tr>
<td>112</td>
<td>14</td>
<td>782</td>
<td>3.557</td>
<td>3.374</td>
</tr>
<tr>
<td>120</td>
<td>15</td>
<td>892</td>
<td>4.103</td>
<td>3.892</td>
</tr>
<tr>
<td>128</td>
<td>16</td>
<td>1,029</td>
<td>4.649</td>
<td>4.409</td>
</tr>
<tr>
<td>136</td>
<td>17</td>
<td>1,163</td>
<td>5.138</td>
<td>4.874</td>
</tr>
<tr>
<td>144</td>
<td>18</td>
<td>1,286</td>
<td>5.790</td>
<td>5.492</td>
</tr>
<tr>
<td>152</td>
<td>19</td>
<td>1,437</td>
<td>6.441</td>
<td>6.109</td>
</tr>
<tr>
<td>160</td>
<td>20</td>
<td>1,602</td>
<td>7.091</td>
<td>6.725</td>
</tr>
<tr>
<td>168</td>
<td>21</td>
<td>1,756</td>
<td>7.902</td>
<td>7.495</td>
</tr>
</tbody>
</table>

New Dry Break Strength (NDBS) and New Wet Break Strength (NWBS) data are for guidance purpose only and are subject to change without prior notice.

<table>
<thead>
<tr>
<th>diameter mm</th>
<th>size in</th>
<th>weight kg/100m</th>
<th>NDBS kN</th>
<th>NWBS kN</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>10</td>
<td>397</td>
<td>1.373</td>
<td>1.373</td>
</tr>
<tr>
<td>88</td>
<td>11</td>
<td>480</td>
<td>1.657</td>
<td>1.657</td>
</tr>
<tr>
<td>96</td>
<td>12</td>
<td>571</td>
<td>1.943</td>
<td>1.943</td>
</tr>
<tr>
<td>104</td>
<td>13</td>
<td>671</td>
<td>2.294</td>
<td>2.294</td>
</tr>
<tr>
<td>112</td>
<td>14</td>
<td>778</td>
<td>2.652</td>
<td>2.652</td>
</tr>
<tr>
<td>120</td>
<td>15</td>
<td>893</td>
<td>3.024</td>
<td>3.024</td>
</tr>
<tr>
<td>128</td>
<td>16</td>
<td>1,016</td>
<td>3.373</td>
<td>3.373</td>
</tr>
<tr>
<td>136</td>
<td>17</td>
<td>1,147</td>
<td>3.830</td>
<td>3.830</td>
</tr>
<tr>
<td>144</td>
<td>18</td>
<td>1,286</td>
<td>4.284</td>
<td>4.284</td>
</tr>
<tr>
<td>152</td>
<td>19</td>
<td>1,433</td>
<td>4.788</td>
<td>4.788</td>
</tr>
<tr>
<td>160</td>
<td>20</td>
<td>1,587</td>
<td>5.292</td>
<td>5.292</td>
</tr>
</tbody>
</table>

New Dry Break Strength (NDBS) and New Wet Break Strength (NWBS) data are for guidance purpose only and are subject to change without prior notice.
HAWSER FLOTATION

Single point mooring hawsers 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. Lankhorst Offshore has a range of flotation methods.

- Lace-on hawser float
- Integral hawser flotation
- Tubular float

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 utilize 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.

INTEGRAL FLOTATION

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 may be 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 hawser service life.
- 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 reduces the effects of 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.

LACE-ON HAWSER FLOAT

<table>
<thead>
<tr>
<th>number 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>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>80 - 96</td>
<td></td>
<td>6.0</td>
<td>0.8</td>
<td>385</td>
</tr>
<tr>
<td>4</td>
<td>104 - 128</td>
<td></td>
<td>8.0</td>
<td>1.0</td>
<td>480</td>
</tr>
<tr>
<td>5</td>
<td>136 - 152</td>
<td>80 - 96</td>
<td>10.0</td>
<td>1.3</td>
<td>575</td>
</tr>
<tr>
<td>6</td>
<td>160 - 184</td>
<td>104 - 112</td>
<td>12.0</td>
<td>1.4</td>
<td>670</td>
</tr>
<tr>
<td>7</td>
<td>192</td>
<td>120 - 128</td>
<td>14.0</td>
<td>1.7</td>
<td>765</td>
</tr>
<tr>
<td>8</td>
<td>136 - 144</td>
<td>16.0</td>
<td>1.9</td>
<td>860</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>152 - 168</td>
<td>18.0</td>
<td>2.1</td>
<td>955</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>176 - 184</td>
<td>20.0</td>
<td>2.3</td>
<td>1,050</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>192</td>
<td>22.0</td>
<td>2.5</td>
<td>1,145</td>
<td></td>
</tr>
</tbody>
</table>

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 1,100mm in length.
HAWSER THIMBLES AND SHACKLES

CAST SPM HAWSER THIMBLE

Material:
Cast steel
Stainless steel

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

<table>
<thead>
<tr>
<th>rope size inch</th>
<th>A mm</th>
<th>B mm</th>
<th>C mm</th>
<th>D mm</th>
<th>E mm</th>
<th>F mm</th>
<th>G mm</th>
<th>K mm</th>
<th>X mm</th>
<th>Y mm</th>
<th>weight kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>11”-13”</td>
<td>530</td>
<td>320</td>
<td>270</td>
<td>175</td>
<td>132</td>
<td>157</td>
<td>477</td>
<td>170</td>
<td>105</td>
<td>105</td>
<td>52</td>
</tr>
<tr>
<td>14”-15”</td>
<td>655</td>
<td>476</td>
<td>357</td>
<td>258</td>
<td>154</td>
<td>183</td>
<td>598</td>
<td>200</td>
<td>116</td>
<td>124</td>
<td>83</td>
</tr>
<tr>
<td>16”-18”</td>
<td>795</td>
<td>542</td>
<td>380</td>
<td>283</td>
<td>184</td>
<td>212</td>
<td>721</td>
<td>252</td>
<td>136</td>
<td>140</td>
<td>118</td>
</tr>
<tr>
<td>19”-21”</td>
<td>940</td>
<td>657</td>
<td>457</td>
<td>348</td>
<td>209</td>
<td>261</td>
<td>880</td>
<td>309</td>
<td>158</td>
<td>177</td>
<td>315</td>
</tr>
<tr>
<td>22”-24”</td>
<td>1.043</td>
<td>814</td>
<td>575</td>
<td>410</td>
<td>244</td>
<td>298</td>
<td>867</td>
<td>360</td>
<td>180</td>
<td>200</td>
<td>406</td>
</tr>
</tbody>
</table>

TUBULAR HAWSER THIMBLE

Material:
Mild steel

Finish:
Galvanised / Plastic coating on request

<table>
<thead>
<tr>
<th>rope size inch</th>
<th>A mm</th>
<th>B mm</th>
<th>C mm</th>
<th>D mm</th>
<th>E mm</th>
<th>H mm</th>
<th>weight kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>12”</td>
<td>521</td>
<td>416</td>
<td>250</td>
<td>194</td>
<td>144</td>
<td>140</td>
<td>46</td>
</tr>
<tr>
<td>15”</td>
<td>625</td>
<td>539</td>
<td>282</td>
<td>194</td>
<td>144</td>
<td>168</td>
<td>74</td>
</tr>
<tr>
<td>18”</td>
<td>734</td>
<td>640</td>
<td>336</td>
<td>219</td>
<td>169</td>
<td>194</td>
<td>126</td>
</tr>
<tr>
<td>21”</td>
<td>829</td>
<td>780</td>
<td>374</td>
<td>219</td>
<td>169</td>
<td>219</td>
<td>176</td>
</tr>
<tr>
<td>24”</td>
<td>924</td>
<td>915</td>
<td>421</td>
<td>273</td>
<td>201</td>
<td>245</td>
<td>272</td>
</tr>
</tbody>
</table>
**BELLMOUTH HAWSER THIMBLE**

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

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

<table>
<thead>
<tr>
<th>rope size</th>
<th>A (mm)</th>
<th>B (mm)</th>
<th>D (mm)</th>
<th>E (mm)</th>
<th>F (mm)</th>
<th>G (mm)</th>
<th>H (mm)</th>
<th>K (mm)</th>
<th>weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10” - 12”</td>
<td>400</td>
<td>640</td>
<td>480</td>
<td>195</td>
<td>166</td>
<td>147</td>
<td>175</td>
<td>86</td>
<td>75</td>
</tr>
<tr>
<td>15” - 16”</td>
<td>440</td>
<td>746</td>
<td>608</td>
<td>248</td>
<td>193</td>
<td>172</td>
<td>196</td>
<td>105</td>
<td>110</td>
</tr>
<tr>
<td>18” - 21”</td>
<td>454</td>
<td>844</td>
<td>660</td>
<td>300</td>
<td>228</td>
<td>205</td>
<td>204</td>
<td>118</td>
<td>135</td>
</tr>
<tr>
<td>22” - 24”</td>
<td>450</td>
<td>1,000</td>
<td>758</td>
<td>400</td>
<td>266</td>
<td>245</td>
<td>290</td>
<td>148</td>
<td>236</td>
</tr>
</tbody>
</table>

**HEAVY DUTY HAWSER SHACKLE**

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

**Finish:**
- Galvanised

<table>
<thead>
<tr>
<th>thimble 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>
</tr>
</thead>
<tbody>
<tr>
<td>11” - 13”</td>
<td>70</td>
<td>76</td>
<td>160</td>
<td>360</td>
<td>165</td>
<td>59</td>
<td>60</td>
<td>90</td>
<td>300</td>
</tr>
<tr>
<td>14” - 15”</td>
<td>80</td>
<td>90</td>
<td>220</td>
<td>390</td>
<td>178</td>
<td>85</td>
<td>85</td>
<td>127.5</td>
<td>425</td>
</tr>
<tr>
<td>16” - 18”</td>
<td>90</td>
<td>100</td>
<td>254</td>
<td>430</td>
<td>210</td>
<td>122</td>
<td>110</td>
<td>165</td>
<td>550</td>
</tr>
<tr>
<td>19” - 21”</td>
<td>100</td>
<td>114</td>
<td>290</td>
<td>480</td>
<td>235</td>
<td>170</td>
<td>130</td>
<td>195</td>
<td>650</td>
</tr>
<tr>
<td>19” - 21”</td>
<td>125</td>
<td>133</td>
<td>300</td>
<td>600</td>
<td>265</td>
<td>282</td>
<td>200</td>
<td>300</td>
<td>1,000</td>
</tr>
<tr>
<td>22” - 24”</td>
<td>130</td>
<td>146</td>
<td>333</td>
<td>720</td>
<td>305</td>
<td>349</td>
<td>225</td>
<td>337.5</td>
<td>1,125</td>
</tr>
<tr>
<td>15”</td>
<td>115</td>
<td>125</td>
<td>254</td>
<td>400</td>
<td>238</td>
<td>203</td>
<td>250</td>
<td>482</td>
<td>612</td>
</tr>
<tr>
<td>18”</td>
<td>105</td>
<td>120</td>
<td>285</td>
<td>500</td>
<td>228</td>
<td>205</td>
<td>200</td>
<td>330</td>
<td>498</td>
</tr>
<tr>
<td>18”</td>
<td>125</td>
<td>130</td>
<td>220</td>
<td>500</td>
<td>238</td>
<td>248</td>
<td>250</td>
<td>482</td>
<td>612</td>
</tr>
<tr>
<td>21”</td>
<td>115</td>
<td>125</td>
<td>254</td>
<td>520</td>
<td>238</td>
<td>244</td>
<td>200</td>
<td>330</td>
<td>498</td>
</tr>
<tr>
<td>21”</td>
<td>125</td>
<td>130</td>
<td>285</td>
<td>480</td>
<td>260</td>
<td>274</td>
<td>250</td>
<td>482</td>
<td>612</td>
</tr>
</tbody>
</table>
The Lankhorst Offshore range of chain support buoys has a typical reserve buoyancy of 900kg up to 5,000kg – but our flexible manufacturing process allows us to produce products to suit 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.
**CHAFE CHAINS AND FLOATING PICK-UP / MESSENGER LINES**

### CHAFE CHAINS

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 & B in accordance with latest OCIMF 2018 Guidelines, 1st edition
- Chafe chain A, B & C in accordance with OCIMF 1993 Guidelines, 3rd edition
- Weak links, Kenter shackles, Joining shackles, Delta plates, etc.
- Topside SPM bridle assemblies

Typical Chain A / B configuration per OCIMF 2018. Chain manufactured, tested and inspected in accordance with IACS W22.

<table>
<thead>
<tr>
<th>type</th>
<th>size mm</th>
<th>grade per IACS W22</th>
<th>SWL tonne</th>
<th>MBF tonne</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>76</td>
<td>R4</td>
<td>250</td>
<td>611.7</td>
</tr>
<tr>
<td>B</td>
<td>76</td>
<td>R3</td>
<td>200</td>
<td>497.8</td>
</tr>
</tbody>
</table>

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.

### FLOATING PICK-UP / MESSENGER LINES

Our range of floating pick-up / messenger lines are based on Lankhorst TIPTO® brand ropes. These ropes exhibit high strength, excellent abrasion resistance and energy absorption properties, ensuring a long service life. The low weight makes messenger line 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.

<table>
<thead>
<tr>
<th>circ. in</th>
<th>diameter mm</th>
<th>weight kg/100m</th>
<th>MBF</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>24</td>
<td>27.3</td>
<td>103</td>
</tr>
<tr>
<td>3 1/2</td>
<td>28</td>
<td>37.3</td>
<td>137</td>
</tr>
<tr>
<td>4</td>
<td>32</td>
<td>53</td>
<td>177</td>
</tr>
<tr>
<td>4 1/2</td>
<td>36</td>
<td>66</td>
<td>222</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
<td>75.6</td>
<td>269</td>
</tr>
<tr>
<td>6</td>
<td>48</td>
<td>109</td>
<td>378</td>
</tr>
<tr>
<td>7</td>
<td>56</td>
<td>149</td>
<td>508</td>
</tr>
<tr>
<td>8</td>
<td>64</td>
<td>194</td>
<td>651</td>
</tr>
<tr>
<td>9</td>
<td>72</td>
<td>246</td>
<td>814</td>
</tr>
<tr>
<td>10</td>
<td>80</td>
<td>305</td>
<td>992</td>
</tr>
</tbody>
</table>
Lankhorst Offshore has participated in many Joint Industry Projects (JIPs) and has been instrumental in helping to shape the industry and the rules governing the deployment 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@lankhorstoffshore.com

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 signs of internal abrasion damage or ingress of foreign particles, and to 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.

JIPs listed
- 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.
## GLOSSARY OF TERMS

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 a vessel’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**
The weight per unit length of the rope.

**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.

**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.

**SPICED 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.

**PTC**
Polyester tubular cloth

**PU**
Polyurethane elastomer

**OPC**
Offloading unit.
EFFECTIVE SINGLE POINT MOORING SYSTEMS

Lankhorst Offshore

LANKHORST EURONETE PORTUGAL, S.A.
Rua Fornos da Cal no 321
(near Avenida Do Cabedelo)
Darque
4935-226 VIANA DO CASTELO

Rua da CERFIL (Cap. Gramaxo)
4475-468 NOGUEIRA DA MAIA
PORTUGAL

T: +351 229 619 200

LANKHORST EURONETE BRASIL, INDÚSTRIA E COMERCIO LTDA.
Rua Minas Gerais 1920,
Distrito Industrial de Queimados
CEP 26.373-280 – Queimados
RIO DE JANEIRO
BRASIL

T: +55 21 2663 9000
E: spm@lankhorstoffshore.com

Worldwide sales agent for Single Point Moorings

OFFSPRING INTERNATIONAL LTD
Unit 8, Castle Court 2
Castlegate Way
Dudley, West Midlands, DY1 4RH
United Kingdom

T: +44 1384 453880
F: +44 1384 453888
E: mail@offspringinternational.com

WWW.LANKHORSTOFFSHORE.COM