TRELLINE hoses
Catalogue 2012
Trelleborg group, leader of elastomers

Trelleborg is a global industrial group whose leading positions are based on advanced polymer technology and in-depth applications know-how.
Trelleborg develops high-performance solutions that seal, damp and protect in demanding industrial environments.
The Trelleborg Group had annual sales 2011 of just over SEK 29 billion (EUR 3.3 billion), with around 21,000 employees in over 40 countries.
The Trelleborg share has been listed on the Stockholm Stock Exchange since 1964 and is listed on the NASDAQ OMX Nordic List, Large Cap. www.trelleborg.com.

The Group comprises 3 business areas:

- Trelleborg Sealing Solutions
- Trelleborg Engineered Systems
- Trelleborg Wheel Systems

Trelleborg Oil & Marine Hoses

Trelleborg Oil & Marine is the leading supplier of innovative and field-proven large-bore flexible bonded hoses for crude oil, chemicals, and LPG/LNG offshore transfer applications.

Trelleborg Oil & Marine provides full service worldwide through global life cycle – engineering studies, delivery of complete solutions (hoses and ancillary equipments), on-site supervision, and recommendations for installation, maintenance and repairs.

Trelleborg Oil & Marine is a technology and innovation driven company that makes flexible bonded hoses with unrivalled and undisputed performance. Our products are designed and built with cutting edge solutions used in tire and aerospace industry, with high resistance to extreme operating environments and severe fatigue conditions.

The acquisition of a Brazilian company in 2011 in Sao Paulo enlarged and completed the range of products and technologies. In Brazil, the business focuses on specially designed oil hoses for floating and submarine applications in order to answer the strongly growing local offshore oil and gas extraction industry.

⇒ Trelleborg Oil & Marine provides a wide range of products specifically designed for demanding applications with long service life and high level of reliability:
  - KELLINE hoses – GMPHOM 2009 certified
  - SEALINE hoses – OCIMF 1991 certified
  - REELINE hoses – GMPHOM 2009 and API 17K certified
  - TRELLINE hoses – GMPHOM 2009 and API 17K certified
  - FLEXIBLE WATER INTAKE hoses – API 17K certified
  - CRYOLINE LPG/LNG hoses

One team, two world class factories, in France and Brazil, serving the global Oil & Gas transfer and offloading business

São Paulo, Brazil

Clermont-Ferrand, France
TRELLINE hoses

TRELLINE system has been originally jointly developed by Trelleborg and SBM Offshore in the 2000's for specific deepwater offloading applications.

TRELLINE is a bonded flexible hose for dedicated made-to-measure project, adapted to a large range of applications: OOL (oil offloading line/deep offshore), flowline, shallow water, CALM buoy.

This system, for long service operation, from 10 to 25 years and in diameters up to 36", pioneers the use of bonded hoses to provide the cargo transfer link.

For most deepwater applications, TRELLINE system renders the use of rigid steel pipelines or flexible unbonded long length systems obsolete. It is economic and easily installed, requiring minimal equipment.

As of today Trelleborg has built over 1000 TRELLINE hoses and executed several API 17K certified projects all over the world.

Diameter
Whereas the maximal inner diameter for usual unbonded hoses is 16” or 24”, the inner diameter of TRELLINE bonded hoses can be extended up to 36” if required with significant impact on the pressure drops and the number of lines.

Pressure drop
Due to its smooth bore, the pressure drop in TRELLINE hoses is minimal and therefore the booster pump capacity on the FPSO can be reduced or removed.

Transportability
TRELLINE hose sections can be transported using conventional transport means, as opposed to large carrousels required for unbonded flexible lines.

Installation
TRELLINE assembling operation is possible onshore or directly offshore, horizontally (rotating trolleys) or vertically (specific platform), requiring light installation means in any case. TRELLINE hose sections are easily inspectable and replaceable.

Onshore or offshore, there is no need of specific, expensive or heavy equipments.

Offshore repair
Due to the fact that TRELLINE system consists of hose sections, offshore repair is both practicable and cost efficient.

Cost
The combination of capital, transportation and installation costs makes TRELLINE solutions commercially very attractive compared to competitive systems.

This is especially the case if the overall oil offloading terminal is optimized ‘around’ TRELLINE solution.

Delivery
The delivery time of TRELLINE hoses can be shorter than other systems.

Service life
TRELLINE solution is designed on request for a long service life, i.e. from 10 to 25 years.

Performance
TRELLINE hoses have been qualified according to demanding requirements of API 17K standard leading to dedicated products with undisputed performances.

● High resistance to fatigue.
● High thermal insulation properties.
● Corrosion free solution.

Design pressure
The structure is designed according to environmental conditions and configuration.
TRELLINE is a reinforced bonded flexible hose made of rubber, steel ring reinforcement, integrated bending stiffener and steel armor cables reinforcement, end-fitted with a unique integrated gasket flange system.

TRELLINE comes in sections of usually 12 meters, which are bolted together in situ, either in horizontal or vertical assembly configuration.

TRELLINE hose is available in submarine or floating configuration and meets the most stringent requirements of API 17K specification.
Reinforced flange and integrated bending stiffener (IBS)
Nippleless flange design, the reinforced flange associated to the integrated bending stiffener give a perfect bending stiffener decreasing, avoiding loads and stress concentration and consequently reducing the fatigue and increasing the service life of the hose.

Continuous inner liner and integrated gasket
The continuous rubber inner liner and the integrated internal and external gaskets at both ends offer a full sealing solution, allowing no migration of the product in the hose body.
In addition to this gasket technology advantages (no risk of bad positioning during installation, no influence of the bolt tension, no risk of gasket extruding), flanges steel parts are protected with bonded rubber to prevent contact with conveyed fluid and sea water.

Steel armor cables reinforcement
TRELLINE hoses exclusively use steel cables layers derived from truck and plane tire technology.
The hose reinforcement steel cables are directly linked within the flanges and each flange is embedded inside an integrated bending stiffener.
The main carcass is made of steel cable layers wounded at the angle of equilibrium and withstands normal pressure rating.
Permanent elongation is nil, providing evidence of the excellent elasticity of the hose body, and resulting in highest resistance to fatigue.

The reinforcement carcass is made of steel cable layers overlaying a thick rubber filling, increases the resistance to tension loads and protects the main carcass from eventual excessive loads.

Steel ring reinforcement
For a better resistance to tension loads, high external differential pressures or extreme bending loads, steel ring reinforcements are incorporated within the two carcasses.
These rings are made of high strength steel allowing them to retain their original body shape even when hoses are subject to extreme stresses.

Outer cover
The outer cover is made of high abrasion resistance rubber and incorporated nylon breaker.
This structure prevents the hoses from cut propagation in case of accidental damage.

Collars
Collars permit to add buoyancy modules and to adjust the configuration of the submarine offloading line.
OCIMF vs API 17K
OCIMF has been issued by oil companies to provide technical requirements to ensure the satisfactory performance of flexible bonded hoses commonly used at offshore moorings.

OCIMF is based on technical recommendations and tests and is therefore not suitable to study the capability of a hose system to withstand the static and dynamic loads that occur on offshore terminals.

API 17K (specification for bonded flexible pipe) has been issued to introduce new requirements regarding:
- design methodology,
- characterisation of the materials,
- hydrodynamic and fatigue analysis.

Main interests of the standard API 17K
Materials properties and performances have been measured and documented including fatigue behaviour (SN curves).

Complete design methodology for computation of stresses/strains inside the hose structure has been qualified through full scale destructive testing including fatigue.

Process mastery from raw material purchasing to the final product acceptance test is guaranteed thanks to internal quality standards.

Complete methodology to demonstrate the reliability of a bonded flexible hose solution on a marine configuration has been qualified by Bureau Veritas.

OOL mid-water self suspended
Methodology principle

The design methodology applied is conform to the API 17K specification requirements.

Hoses resistance and internal components stresses/strains are assessed by both analytical formulas for simple loads and by complex finite element models (FEM) for combined loads. These numerical tools have been extensively checked and validated through full scale static, dynamic and fatigue tests.

As oil offloading lines require longer service life and experience higher tension loading and deepwater depth (i.e. higher differential pressure), it was compulsory to go from OCIMF requirements to API 17K certification process. A design methodology has been therefore defined including a fatigue analysis and its review for approval by a third party. A comprehensive qualification test program has been carried out in order to obtain API 17K certification by Bureau Veritas for a full field design life.

The API 17K Type Approval Certificate has been delivered for TRELLINE system from 6” to 26” and design pressure up to 100 barg.
**TRELLINE optional tests**

On request, additional tests can be performed:

<table>
<thead>
<tr>
<th>Test</th>
<th>Objective</th>
<th>Example: results for PAZFLOR 18&quot; OOL</th>
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<tbody>
<tr>
<td>Ageing</td>
<td>The objective is to age the hoses in normal service conditions (type of oil, temperature, etc.) prior to the destructive tests.</td>
<td>Equivalent to <strong>20 years</strong></td>
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<tr>
<td>Tensile</td>
<td>The tensile (at break) test result shall be above the minimal guaranteed design value. This test can be performed on aged hose.</td>
<td>Performed on aged hose: <strong>4200 kN</strong></td>
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<tr>
<td>Collapse</td>
<td>The collapse test result shall be above the minimal guaranteed design value. This test can be performed on aged hose.</td>
<td>Performed on aged hose: <strong>24 barg</strong></td>
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<tr>
<td>Fatigue</td>
<td>The fatigue test result shall be above the minimal guaranteed service life with safety factor. This test can be performed on aged hose.</td>
<td>Performed on aged hose: <strong>&gt; 600 years of equivalent service</strong></td>
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<tr>
<td>Burst</td>
<td>The burst test result shall be above the minimal guaranteed design value. This test can be performed on aged hose and after another destructive testing (this is possible due to the decoupling of the function in TRELLINE structure design).</td>
<td>Performed on aged hoses and after other tests: <strong>&gt; 176 barg</strong></td>
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**TRELLINE specific accessories**

**Buoyancy module**

Buoyancy module are specifically designed and made for each project according to environmental conditions of use (depth, etc.).

**Bolting**

The bolting is fully calculated and checked to guarantee the tightening torque during all the service life of the system. A specific coating has been specially developed for TRELLINE connections. Additional protection caps can be used to provide a perfect sealing solution.