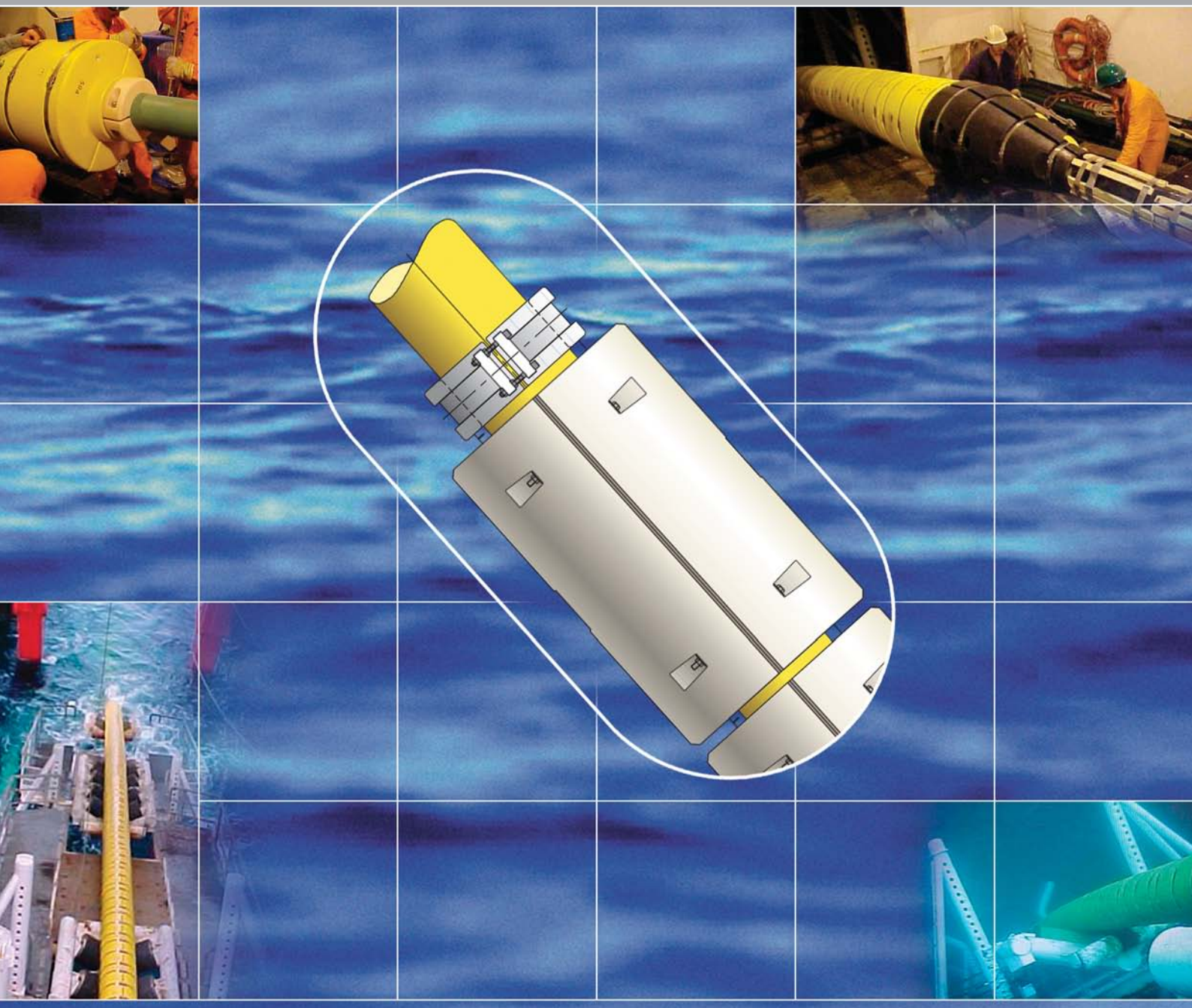
TRELLEBORG

Flowline Buckling Mitigation Buoyancy

Engineered Systems



CRP

Proven to Perform

Introduction

With over 30 years of experience, Trelleborg CRP has become a leading designer, manufacturer and supplier of thermal insulation, buoyancy and cable protection solutions to the Offshore, Marine and Telecommunication industries.

As a result of a continuous policy of product innovation, Trelleborg CRP embarked upon a number of material diversifications including syntactic foam, a material used in the construction of subsea buoys, ROV buoyancy and thermal insulation systems, which precipitated the company's entry into the offshore market.

There is a growing requirement in deepwater applications for rigid flowlines to perform under high temperature/high pressure conditions. Large cyclic changes in temperature and pressure cause expansion of the flowline that can result in the occurrence of lateral or upheaval buckling. Flowline system engineers therefore need to consider this potentially damaging phenomenon in their analysis and ways of mitigation.

An increasingly favourable mitigation solution is to establish spans of least resistance along the flowline to allow buckles to occur in known and controlled conditions. These sections of least resistance can be created via the addition of distributed buoyancy, designed to reduce the self weight of the flowline and friction against the sea bed.

Trelleborg CRP Flowline Buoyancy Solutions

Trelleborg CRP's extensive buoyancy design experience encompasses the following:

- Operation at depths of up to 7000m.
- Tower and S Lay installation methods.
- Clamping onto thermally insulated pipelines.
- Abrasion/load consideration during installation and service.
- Bend radii/stiffness of pipe.
- ≈50°C (outer pipe) and storage temperature.
- A design life of 25 years and over.

Buoyancy can be applied to the flowline in various forms, for example as half shell modules or as a direct cast-on coating. The decision as to which solution is best suited will depend on thorough consideration of the design parameters as follows:

- Buoyancy requirement per metre and overall length of coverage.
- Water depth.
- Flowline characteristics – diameter, MBR etc.
- Flowline coating characteristics – thickness, contraction, creep, frictional coefficients.
- Installation method – J-Lay or S-Lay.
- Installation and service loads acting upon the buoyancy.
- Is the pipe reeled or jointed?
- Pipe installation speed.
- Seabed conditions – what does the abrasion resistant coating need to withstand?
- Number of buckling cycles.
- Allowable stiffness of flowline – buoyancy is designed to avoid adding unacceptable stiffness to riser.
- Corrosion protection.
- Design life.

Installation Methods

All components are designed for rapid and straightforward installation. The quantity of components required is minimised and include encapsulated fasteners and alignment dowels for rapid and accurate fit up with less likelihood of dropped objects.

A bespoke buoyancy solution is designed and provided in consideration with the client's pipe installation method, vessel space and handling restrictions.

Materials and Manufacture

A typical flowline buoyancy arrangement will comprise of buoyancy elements held in position on the flowline using clamps.

All Trelleborg CRP Flowline Buoyancy systems utilise the following materials:

Syntactic foam core

The buoyancy elements of each system have a composite syntactic foam core. This material has three main components:

- **Base polymer**
- **Glass microspheres**
- **Macrospheres**

The resulting material exhibits low water absorption and hydrostatic compression and is eminently suitable for extended subsea service. The syntactic foam has a nominal density which varies according to the specific water depth of the application.

Typical densities are as follows:

MSW (m)	Density (kg/m³)
200	325
500	420
1000	480
2000	500
3000	530

Buoyancy skin

The syntactic foam core is protected from impact and abrasion using a proven skin system that Trelleborg CRP have developed on their drill riser and Uraduct cable & flowline protection products. The principal material components used are Glass Reinforced Plastics (GRP) and high grade polymers. These materials can be adapted to include marine growth and anti-foul protection if required.

Clamps

Holding the buoyancy in position on the flowline is critical to the overall flowline system performance. Trelleborg CRP have several clamping technologies available to use, their selection dependent on the installation and service conditions and the flowline coating properties. These range from carbon steel clamp arrangements for non insulated flowlines through to composite clamp arrangements, using elastic materials such as titanium, rubber and GRP for insulated flowlines where the outer diameter of the thermal coatings can vary significantly during service.

Metallic components

Metallic components materials are selected for both their mechanical performance and resistance to corrosion. Typical materials are Inconel, Super Duplex, Titanium and CP protected carbon steel.

Trelleborg CRP Flowline Buoyancy systems use steel and aluminium mould tooling processes and are manufactured on Trelleborg CRP's sites in Skelmersdale, UK and Houston, Texas, USA.





Testing

Testing and product development are at the heart of Trelleborg CRP's material advances and product solutions. Whether this be within the laboratories, full scale testing or ongoing research and development, testing is a major focal point for Trelleborg CRP.

Trelleborg CRP believe that continuous and extensive testing is the only way to remain at the forefront of material development and continue to offer solutions that expand production possibilities and improve operating efficiency.

Testing for Trelleborg CRP Flowline Buoyancy systems encompasses the following:

- Material testing.
- Fit-up and assembly testing.
- Load testing – axial, lateral and bending.
- Hydrostatic testing.
- Abrasial testing.
- Weight and buoyancy measurement.

Facilities

Trelleborg CRP have all the necessary equipment and personnel to conduct a wide range of materials testing and factory acceptance testing. All products and materials are subjected to a rigorous programme of qualification and process control.

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