Champlain Hudson Power Express, Inc.
Case 10-T-0139

Request No.:	DPS-61	Date of Request:	September 9, 2010
Requested By:	Jeremy Flaum	Reply Date:	September 20, 2010
Subject:	Cable Installation Methods	Witness:	Alan Prior

REQUEST:

In areas where there is little or no unconsolidated sediment and bottom bathymetry is highly irregular (such as the stretch from 346+00 to 350+00 along the East River), describe methods for installing and securing the proposed cable.

RESPONSE:

A preliminary review of the stretch from 346+00 to 350+00 along the East River where there is little or no unconsolidated sediment and bottom bathymetry is highly irregular and the cable will be protected with a Uraduct or similar product to protect it from the irregular (rocky) bottom. After placement along the bottom, it will then be covered with a Flexiform Mattress to further protect it and to maintain its position (The product brochures are attached to this response).

The recently completed Marine Route Survey is being reviewed by a cable installation specialist. This review will provide a better understanding of the physical installation requirements and environmental impacts along the marine route necessary to provide additional information in response to the above question. The scope of work for this review is to determine the following from the marine route survey:

- Recommended burial depth for the marine route.
- Recommended installation procedures (water jet / plough / concrete matting).
- Recommended vessel for each of the installation measures at each location (dynamically positioned/ anchored).

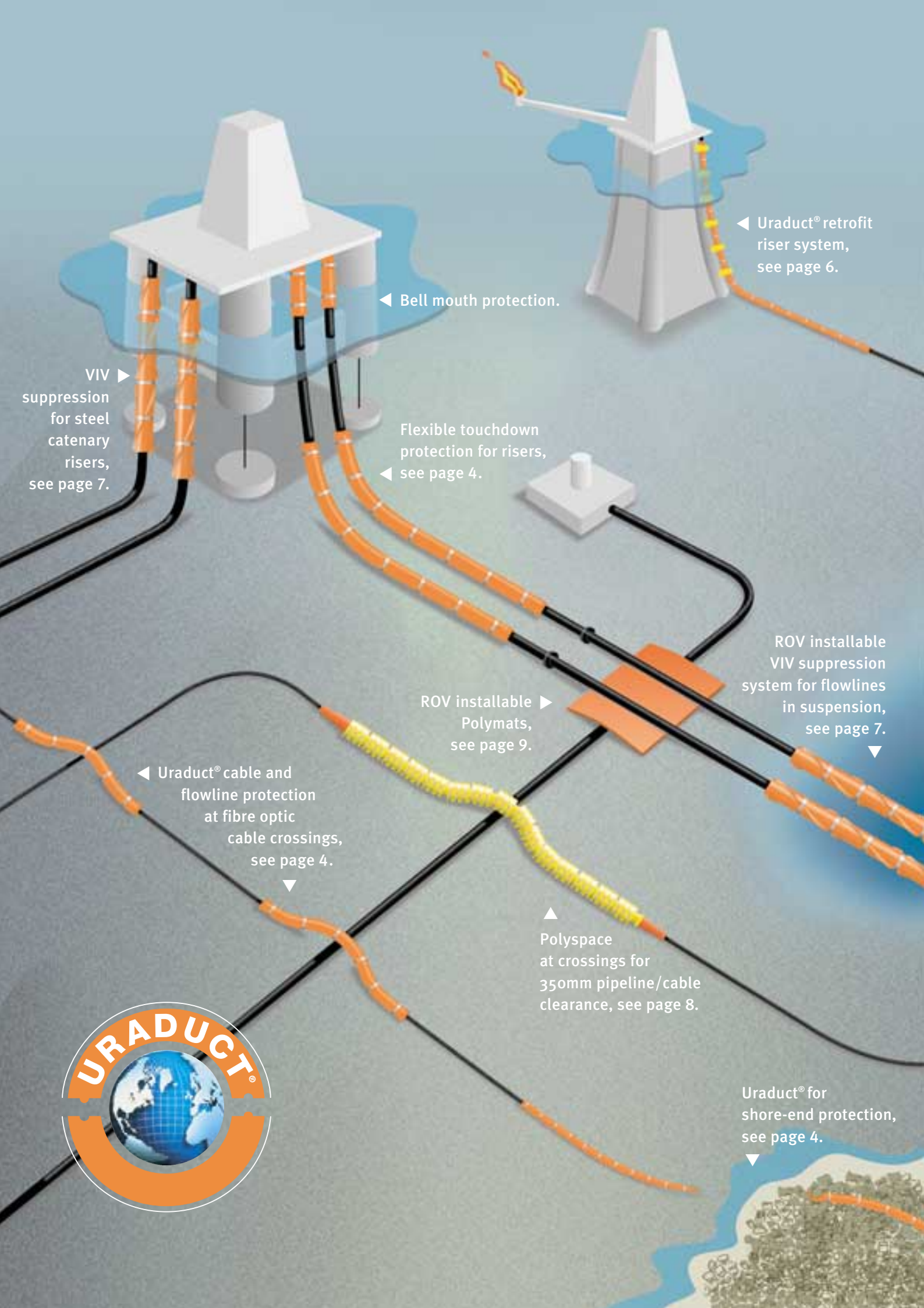
It is estimated that this study will be completed in the second half of October 2010.

Name of Person
Preparing Response: Alan Prior

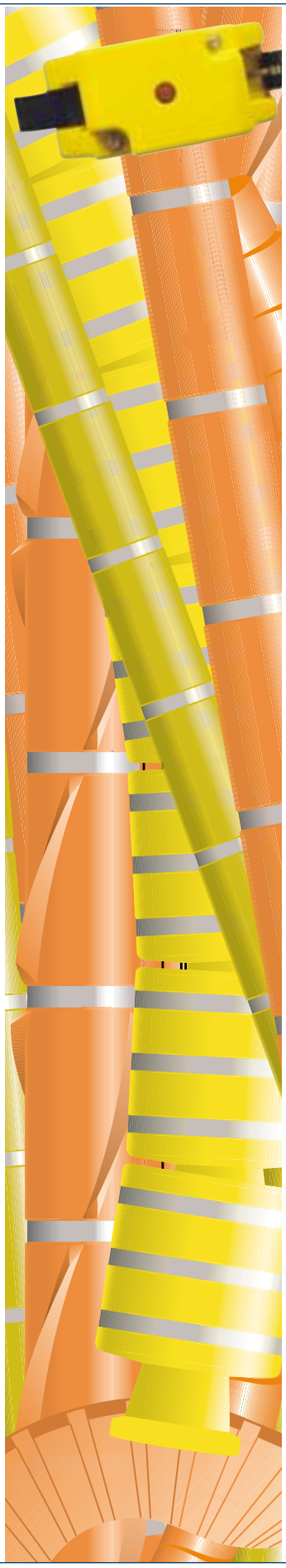
Date: September 20, 2010

CRP MARINE

CABLE AND FLOWLINE PROTECTION


◀ Uraduct® retrofit riser system, see page 6.
◀ Bell mouth protection.
VIV ▶ suppression for steel catenary risers, see page 7.
Flexible touchdown protection for risers, ◀ see page 4.
ROV installable VIV suppression system for flowlines in suspension, see page 7. ▼
ROV installable ▶ Polymats, see page 9.
◀ Uraduct® cable and flowline protection at fibre optic cable crossings, see page 4. ▼
▲ Polyspace at crossings for 350mm pipeline/cable clearance, see page 8.
Uraduct® for shore-end protection, see page 4. ▼
URADUCT®

CONTENTS



COMPANY PROFILE

Description

The CRP Group comprises two main trading divisions, CRP Marine and CRP Polymer Engineering, both acknowledged world leaders in their respective fields for designing and manufacturing a wide range of polymer products.

CRP Marine, the major division of the CRP Group, is one of the most well known and respected manufacturers of surface and subsea buoyancy, foam fendering and technical mouldings for the oil and gas industry worldwide.

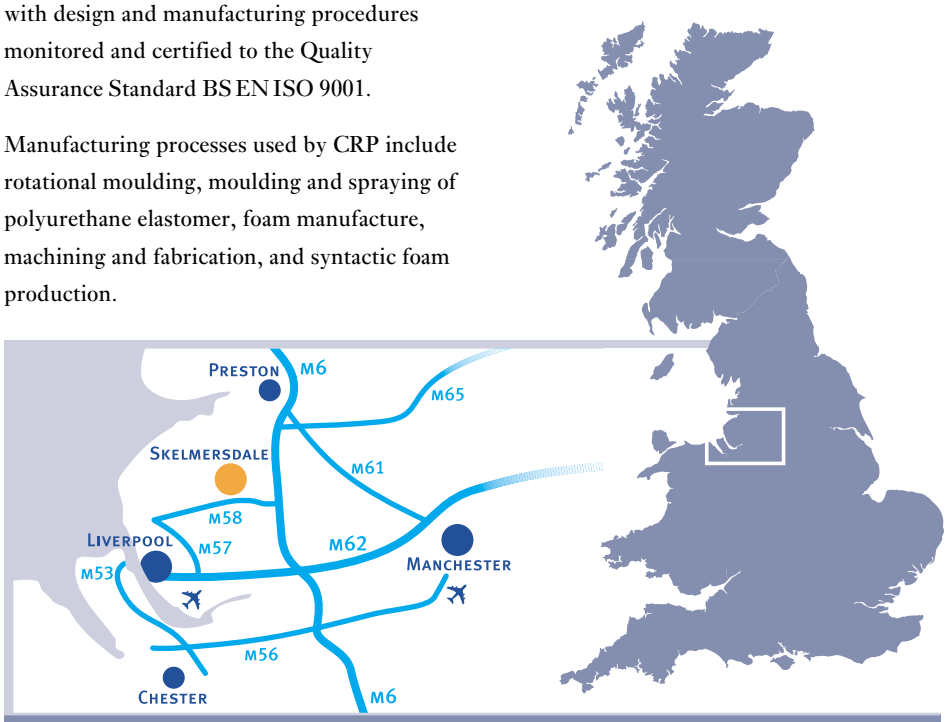
With over twenty years design and manufacturing experience CRP Marine have a track record in the offshore industry which is second to none.

Facilities

CRP Marine is located in a purpose built factory and office complex covering 16,000 square metres at Skelmersdale in Lancashire, England.

The factory houses some of the latest and most modern plant and process equipment available, with design and manufacturing procedures monitored and certified to the Quality Assurance Standard BS EN ISO 9001.

Manufacturing processes used by CRP include rotational moulding, moulding and spraying of polyurethane elastomer, foam manufacture, machining and fabrication, and syntactic foam production.



CRP Group Ltd situated in the heart of England.

CRP Group Ltd headquarters and factory complex.

Research and development

The CRP Group prides itself on its ability to offer clients a comprehensive service which will provide a complete solution to their requirements.

Many of these requirements can be met with existing technology, but as the marine industry continues to develop ever increasing demands are being placed on men, materials and equipment.

Not only must CRP be able to satisfy the immediate needs of the industry but it must anticipate future demands. The CRP Group has invested in highly qualified engineers and chemists who can analyse problems, assess requirements and develop solutions. This work is supported by the provision of comprehensive facilities where analysis, research, development and testing of materials, products and systems ensure that the results from our specialists satisfy both present and future requirements.

One of the latest CAD work stations used for product design.

Quality assurance at every stage of production.

Design engineering

CRP Group, being approved to BS EN ISO 9001 for its entire product range, employs the latest computer aided design (C.A.D.) facilities. These are manned by externally trained operators using exclusively written and specifically targeted software which covers the most demanding of requirements.

Health & Safety and environmental control

Health & Safety is given a high priority in the CRP Group and as such is incorporated into all company activities. Our policy is contained in a comprehensive Health & Safety Manual which details the principles of the company's health and safety management system.

Risk assessment is a key feature of the system to which both materials and work activities are subject. Materials are evaluated using a quantitative rating system and work activities are assessed on the material, equipment, work practices and processes involved.

Health & Safety inspections and audits are another important scheduled activity ensuring a constant review of workplace safety and the monitoring of control measures. CRP is committed to continual improvement in order to maintain a healthy and safe working environment. This is sustained by dedicated Health & Safety managers and supervisors, qualified to introduce measures which meet both current and future legislation.

Having recognised the importance of environmental protection CRP have an established environmental policy and management system based upon BS EN ISO 14001.

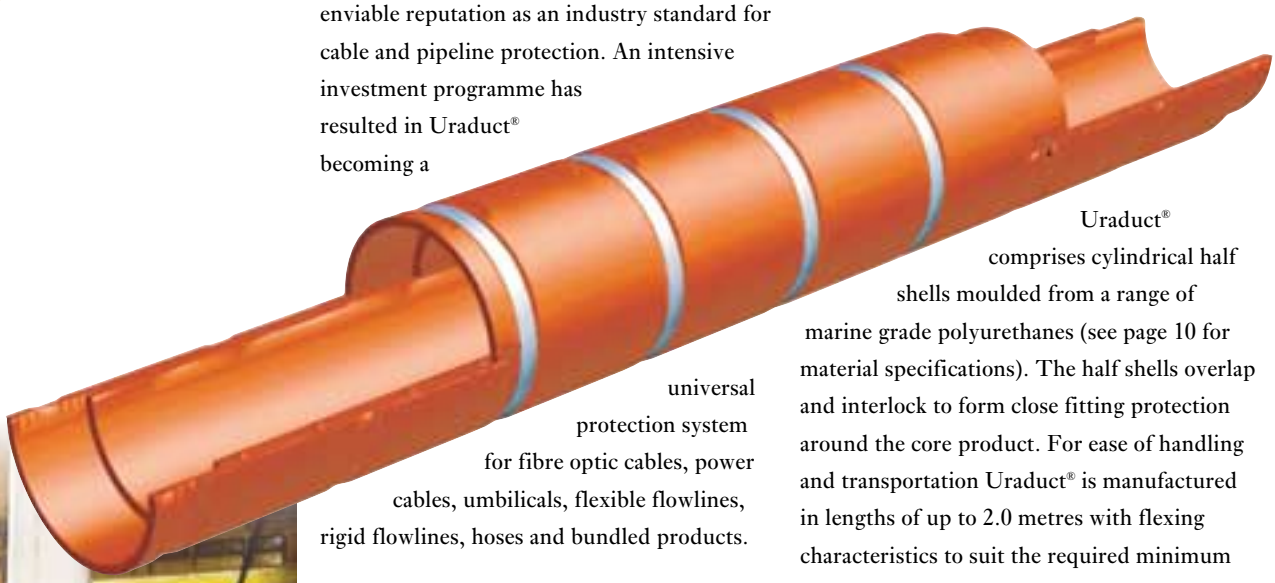
Overall the aim is to assess existing and proposed new activities with regard to environmental protection.

The company employs a trained and qualified officer to ensure compliance with these important regulations

URADUCT® - *the universal protector for impact and abrasion resistance.*

Uraduct®, a patented product designed and developed by CRP Marine, has established an enviable reputation as an industry standard for cable and pipeline protection. An intensive investment programme has resulted in Uraduct® becoming a universal protection system for fibre optic cables, power cables, umbilicals, flexible flowlines, rigid flowlines, hoses and bundled products.

In areas where additional protection is required, e.g. rocky seabed, touch down locations, shore landings or cable/pipeline crossings, Uraduct® provides an extremely good technical and cost effective protection solution in comparison to alternative methods such as rock dumping or concrete mattressing.



Uraduct® comprises cylindrical half shells moulded from a range of marine grade polyurethanes (see page 10 for material specifications). The half shells overlap and interlock to form close fitting protection around the core product. For ease of handling and transportation Uraduct® is manufactured in lengths of up to 2.0 metres with flexing characteristics to suit the required minimum bend radius of the product or ancillary shipboard lay equipment. Uraduct®, a custom made system, is manufactured to suit the core product with internal diameters ranging from 15mm up to 650mm.

"Uraduct® is a custom made system, which is manufactured to suit the product it is protecting..."

Touchdown protection on to a flexible riser for BP Schiehallion.

Uraduct® used in conjunction with CRP's bend restrictors on a flexible riser.

The half shells are secured in place using pre-cut corrosion resistant banding typically manufactured from titanium or alloy 625 (see page 12). The banding is located in recessed grooves that not only ensure a smooth external profile allowing passage through cable engines etc, but also eliminate the need to measure the band spacing. The assembly of the system is quick and efficient being applied simultaneously with product installation; a major benefit to weather dependent industries such as the Oil & Gas and Submarine Telecommunications industries. Uraduct® also differs from many alternative protection methods in that it becomes an integral part of the cable or pipeline and is a fully tested system with a proven track record, details of which can be supplied on request.

Its extensive use in the Oil & Gas Industry by most leading oil companies has made Uraduct® an automatic choice for aiding crossing agreement acceptance where Submarine Telecommunication Cables or Power Cables cross existing pipelines or cables. Uraduct® has been specified on an ever-increasing range of projects, from flexible riser touchdown over coral seabed to protection of small fibre optic cables where burial cannot be achieved.

Although Uraduct® was primarily designed for harsh offshore conditions, many of our customers now appreciate how the protection properties of Uraduct® can also meet the needs of land based projects where operating conditions can be just as onerous.

The versatility, material variety, and bespoke manufacture ensures Uraduct® assists customers, to technically fulfil their operational cable & pipeline protection requirements. No other protection method can deliver the level of all round protection combined with the economic benefits associated with a Uraduct® installation.

Pre-installed Uraduct® on a fibre optic cable passing through cable engines and plough

"Uraduct® provides an extremely good ... solution in comparison to ... rock dumping or concrete mattressing."

Effective protection for bundled products.

URADUCT® *- retrofit riser system*

In response to the increasing number of cables requiring access to offshore platforms, CRP developed the Uraduct® Retrofit Riser System, which comprises of Uraduct® and dedicated locating clamps. This system provides a very cost-effective solution where access to a platform is not possible via existing 'J' or 'I' tubes. Prior to CRP'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. In the past this has prevented marginal installations proceeding. With the introduction of the Uraduct® Retrofit Riser System, substantial cost savings along with improved installation times have resulted in a number of projects coming to fruition which previously would not have been the case.

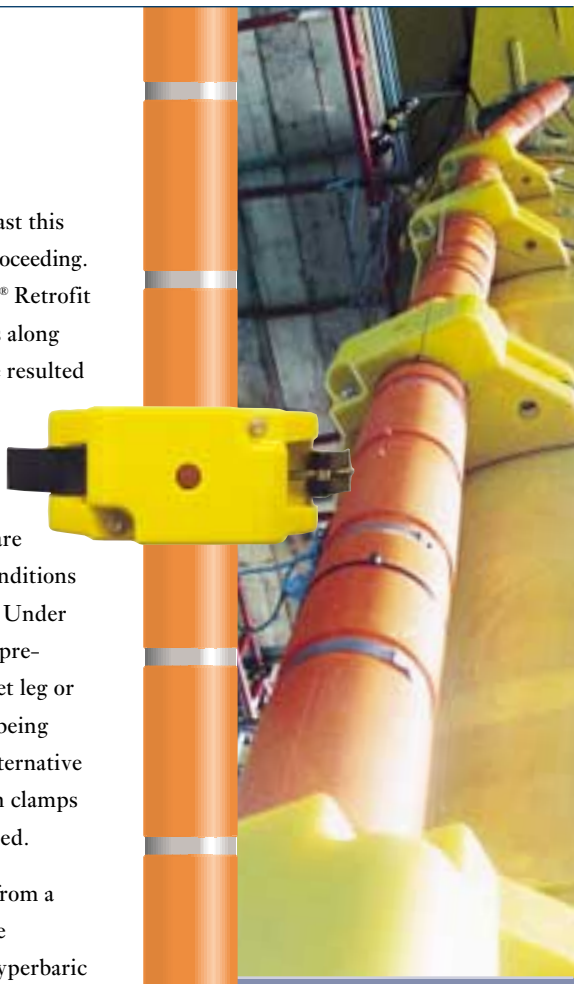
The securing clamps for this system are designed to withstand the extreme conditions experienced on offshore installations. Under normal circumstances the clamps are pre-installed on to a suitable existing jacket leg or riser at regular intervals, the spacing being dependent on environmental data. Alternative designs are available for single or twin clamps where multiple cables are to be installed.

The clamp bodies are manufactured from a high performance, rigid, marine grade polyurethane elastomer. No special hyperbaric welding equipment is required as the clamp bases are secured by means of a Polyloop™ high strength Kevlar/EVA coated strap and highly corrosion resistant metallic tensioning assembly, typically manufactured in Zeron 100 or titanium.

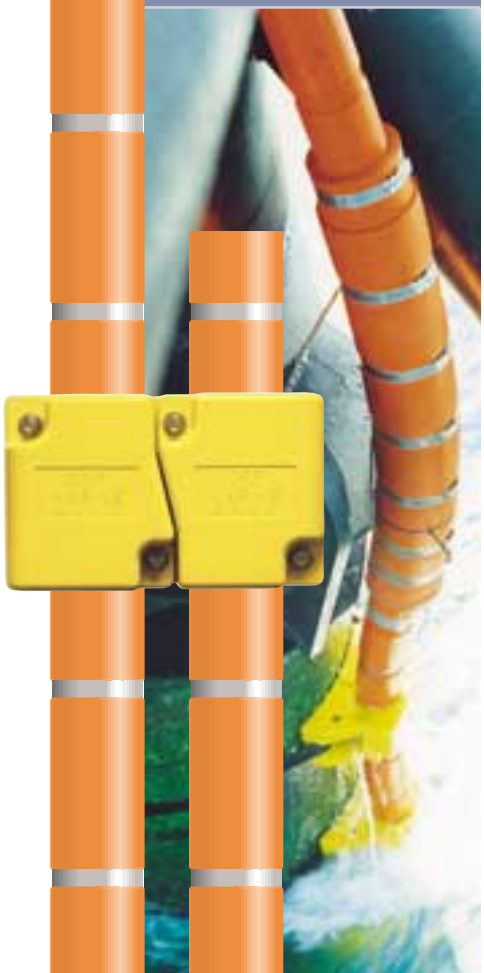
CRP's Uraduct® Retrofit Riser System has been successfully installed on platforms off the coast of Trinidad, in the Gulf of Arabia, and in the North Sea. This trend is set to grow with particular relevance to submarine fibre optic cables and interplatform power cables.

"...cost savings along with improved installation times have resulted in a number of projects coming to fruition which previously would not have been the case."

Installation of CRP's Uraduct® retrofit riser system on Shell Leman BH Platform in the North Sea



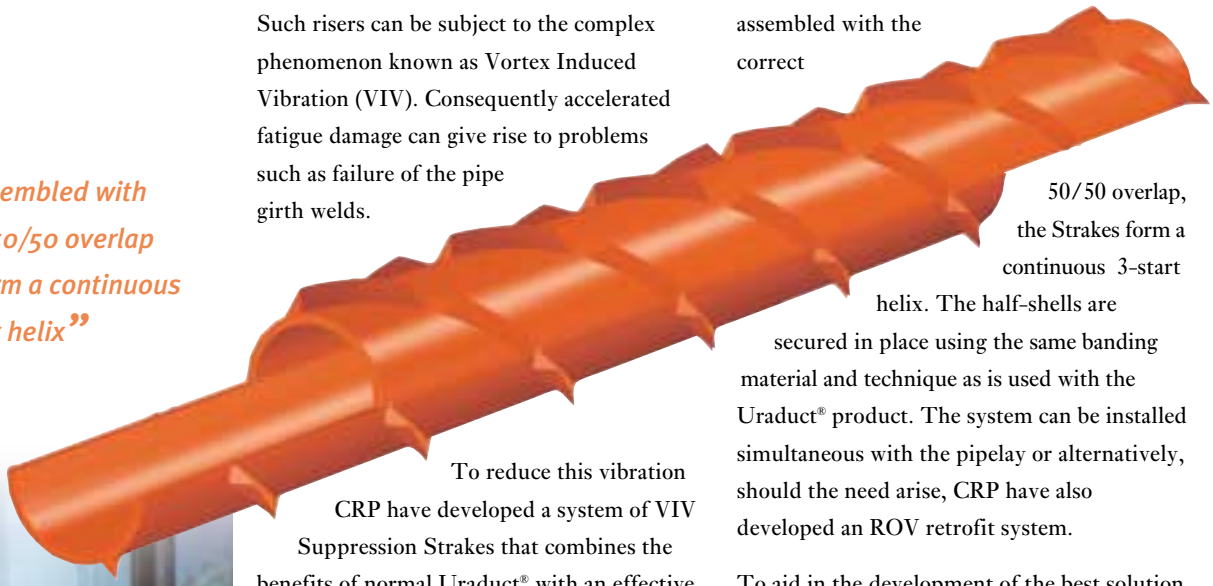
Pre-installed clamp bases on to jacket leg reduces installation time.



URADUCT® VIV - *suppresses vortex induced vibration*

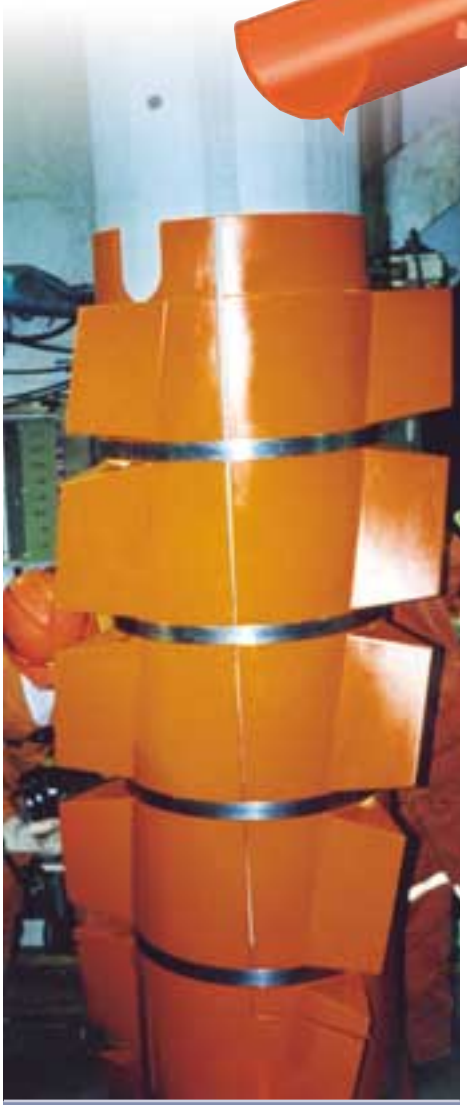
"When assembled with the correct 50/50 overlap the strakes form a continuous 3-start helix"

In deep water riser applications, the use of steel catenary risers is being increasingly considered. Such risers can be subject to the complex phenomenon known as Vortex Induced Vibration (VIV). Consequently accelerated fatigue damage can give rise to problems such as failure of the pipe girth welds.

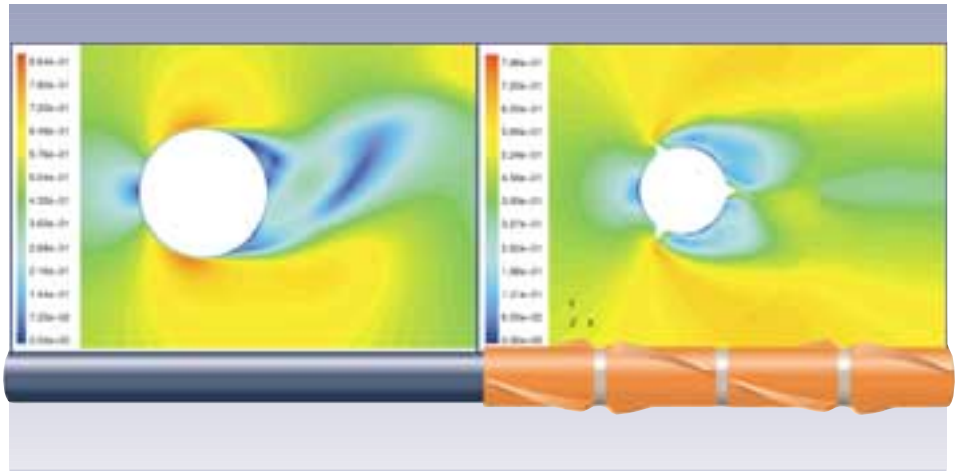


To reduce this vibration CRP have developed a system of VIV Suppression Strakes that combines the benefits of normal Uraduct® with an effective VIV Suppression profile. The system is extremely cost effective in relation to alternatives and is based on the same overlapping and interlocking concept of CRP's proven Uraduct® protection system. The VIV Suppression System consists of interlocking half-shells moulded in manageable lengths that incorporate helical strakes with a triangular profile. The mouldings can be manufactured using the same polyurethanes as detailed on page 10 so the impact and abrasion characteristics of the system are comparable with those of Uraduct®. When assembled with the correct 50/50 overlap, the Strakes form a continuous 3-start helix. The half-shells are secured in place using the same banding material and technique as is used with the Uraduct® product. The system can be installed simultaneous with the pipelay or alternatively, should the need arise, CRP have also developed an ROV retrofit system.

To aid in the development of the best solution for any given installation, CRP has invested in Computational Fluid Dynamic (CFD) software to generate the best strake geometry for the VIV Suppression System. The software provides a valuable tool in fine tuning the VIV System design to suit any given set of environmental data for a specific project. CRP can also utilise their extensive moulding and material experience, and factory capacity to provide VIV systems manufactured to customer's designs. Further details are available on request.



Installation of VIV suppression strake.



Fluid flow animation showing the effect on a pipe with and without CRP strakes. CRP can now undertake full analysis of all VIV problems using CFD software.

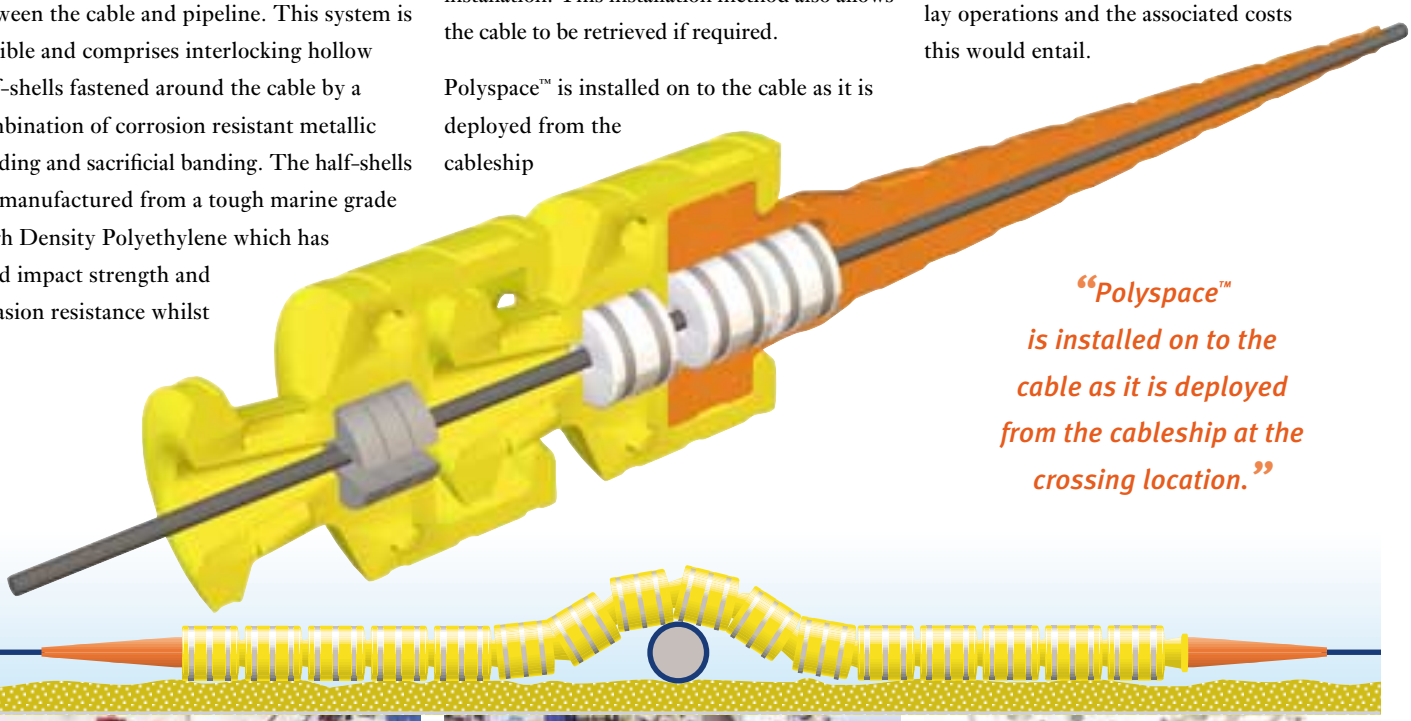
POLYSPACE™ - 350mm clearance at crossings

When laying subsea cables there may be a requirement to maintain a positive clearance between cables and existing pipelines at crossing points. Methods such as pre-lay rock dumping, concrete mattressing and steel structures are expensive, time consuming and difficult to place accurately. These options may also be unacceptable to the pipeline owner.

As a solution, CRP has developed Polyspace™, a product that generates a 350mm clearance between the cable and pipeline. This system is flexible and comprises interlocking hollow half-shells fastened around the cable by a combination of corrosion resistant metallic banding and sacrificial banding. The half-shells are manufactured from a tough marine grade High Density Polyethylene which has 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 90kg/m of additional submerged weight to suit the situation. 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. This installation method also allows the cable to be retrieved if required.

Polyspace™ is installed on to the cable as it is deployed from the cableship at the crossing location. The interlocking shells can achieve a bend radius of 1.5m to suit most cableship sheaves.

Polyspace™ therefore provides a cost-effective one-hit solution at pipeline crossings where this kind of clearance is a requirement. As this system becomes an integral part of the cable, additional problems associated with installing over a pre-laid 'bridge or separator' are negated. This is in addition to the obvious benefits of no pre-lay operations and the associated costs this would entail.



"Polyspace™ is installed on to the cable as it is deployed from the cableship at the crossing location."

Fitting of integral cable clamps.

Deployment of Polyspace over cableship sheave.

Shipboard trials for deployment and recovery of Polyspace.

POLYMAT™ - *blanket protection*

Polymat™ is a useful ROV installable mat that provides good general protection to cables and pipelines. The mat is sized and weighted to suit current ROV capabilities and payloads and is moulded from CRP's standard grade polyurethane material (see page 10). Polymat™ incorporates a barytes infill that provides additional weight to aid product stability on the seabed.

Polymat™ is moulded with grooves on one side to allow the mat to flex and closely fit the profile of the cable or pipeline. For ease of handling, holes are moulded along the edges of each Polymat™ to allow attachment for pickup ropes etc.

Depending on the size of the object to be covered the grooves can run along the length or across the width of the Polymat™. Each heavy duty, high density Polymat™ is circa 2.3m long x 1.5m wide x 25mm thick and is particularly suited to deepwater applications. This low cost product can be used to stabilise cables and cable bights on the seabed and to provide protection at cable crossing locations.

"ROV installable protection"

Example of Polymat deployed over pipeline.

SPIRAWRAP - *winds on to prevent further damage*

Spirawrap consists of discrete cylindrical sections formed from a continuously wound helix. The product is moulded in the same polyurethane material as Standard Density Uraduct® and is fitted by simply opening the structure and winding it around the cable to be protected. This can be done on site without the need for specialist tools. Applying tape, bands or fitting end clamps prevents subsequent movement. Due to the ease of installation, Spirawrap is particularly suited to installation by diver and is also suited to providing temporary protection; for example, preventing abrasion at the cableship sheave during a cable repair.

"Protection of the product around a tight bend radius"

Used on short runs of cable liable to abrasion e.g. ROV or plough control umbilicals where impact or abrasion can occur. Mostly considered for small diameter cables up to 40mm OD where a tight bend radius of 0.5m can be expected.

Spirawrap simply winds around the cable to provide fully flexible protection.

MATERIALS *- compounds fit for purpose*

The Uraduct® range inclusive of VIV, Polymat™ and Spirawrap is manufactured using a wide range of polyurethane elastomer compounds with a variety of mechanical and physical properties to suit different field applications. These compounds have a proven track record in a marine environment and have been arrived at after extensive research, testing and trials to provide the optimum performance.

Standard grade polyurethane

This is the industry standard material for Uraduct® offering excellent abrasion and mechanical protection for a wide range of applications in a cost-effective manner. This material has a specific gravity of 1.12 g/cm³ and therefore does not add any significant seabed weight to the full installation.

High density polyurethane

Where additional on bottom stability is required a specifically formulated high density polyurethane is available. This material has a specific gravity of 2.3 g/cm³ and offers an equivalent in-water weight to concrete. Uraduct® manufactured in this grade of polyurethane can be applied where installed cables will be exposed to high seabed currents and additional weight will be beneficial.

MATERIAL SPECIFICATION (typical material properties) *Test method

	Standard density	High density	Super heavy weight	Super abrasion resistant	Buoyant/Thermal
Tensile strength	11 MN/m² (*BS 903 pt A2)	18 MN/m² (*BS 903 pt A2)	26 MN/m² (*BS 903 pt A2)	26 MN/m² (*BS 903 pt A2)	6.5 MN/m² (*BS 903 pt A2)
Elongation @ break	275% (*BS 903 pt A2)	500% (*BS 903 pt A2)	430% (*BS 903 pt A2)	430% (*BS 903 pt A2)	60% (*BS 903 pt A2)
Split tear strength	35 KN/m (*ASTM C518-85)	28 KN/m (*BS 903 pt A3)	84.7 KN/m (*BS 903 pt A3)	84.7 KN/m (*BS 903 pt A3)	40 KN/m (*ASTM D624-73)
Shore hardness	80 - 85 A°	80 A°	83 - 88 A°	83 - 88 A°	88 - 93 A°
Specific gravity	1.12 g/cm³	2.3 g/cm³	3 g/cm³	1.15 g/cm³	0.7 g/cm³

Uraduct® bend test on a flexible flowline.

Super heavy weight Uraduct®

In addition to the individual polyurethane compounds mentioned, CRP has developed a super heavyweight Uraduct® that combines the excellent abrasion resistant qualities of the high abrasion resistant polyurethane with the added weight of lead. Lead inserts are encapsulated in each Uraduct® half-shell during the moulding process. This is done in such a way as to maintain the flexibility of standard Uraduct®. The ratio of lead to polyurethane can be varied to give an average SG of 3 g/cm³ and above. This product is ideal for stabilising submarine fibre optic cables at crossings, for shore landings, and for touch down ballast of umbilicals or flexible risers, and in general for areas where high seabed currents are expected. The added stability due to the weight and high abrasion characteristics of the polyurethane delivers a Uraduct® system that can be applied at the most demanding locations.

Special grades and colours

Generally, standard grade is supplied in orange, high density in mustard, super heavyweight in black and buoyant/thermal grade in yellow. CRP are also constantly researching and developing special polyurethanes to satisfy the evolving requirements of our customers. For specific projects Uraduct® can be manufactured using a variety of harder or softer grades of polyurethane.

Super abrasion resistant polyurethane

Where the installation requirements call for a very high level of abrasion resistance, dynamic contact with coral or rocky outcrops for example, very high abrasion resistant polyurethane is available. With a similar SG to standard grade material of 1.15 g/cm³ this polyurethane can be utilised, not only to provide excellent impact protection, but also to extend the life of the core product in areas where specific abrasion problems have been recognised.

Buoyant/Thermal grade

For applications where additional buoyancy is required, a buoyant grade of polyurethane is available with a SG of approximately 0.7 g/cm³. Uraduct® manufactured from this material has been used to provide impact and abrasion protection on cable pull-in operations to reduce the pulling forces required by providing a reduced combined Uraduct® and cable weight per metre. This elastomer also exhibits thermal insulation properties where hydrocarbon temperatures need to be maintained on rigid and flexible pipelines.

Impact test on to a Uraduct® protected flexible flowline.

Test for suitability of Polyspace to match cableship sheave radius.

Uraduct® abrasion test against an anchor chain.

BANDING - and band application tools

"CRP banding is supplied in precut lengths complete with preformed seals, therefore saving valuable installation time."

Manual hand held banding tools for diver or topside installation.

32mm pneumatic tensioning and sealing tool in operation for fast and efficient installation.

The unprecedented success of CRP's Uraduct® Cable Protection System has led to an ever-increasing growth in expertise and experience in supplying, supporting and installing banding. This expertise has been recognised by a number of our customers who are increasingly looking to CRP to satisfy they're specific banding requirements for various applications.

CRP can supply Titanium, Alloy 625, Stainless Steel, and carbon steel bands of various grades, all with full material certification. It can also supply Carilon bands manufactured from a high performance polymer specifically developed for marine conditions and offered as an alternative to lightweight banding on smaller sizes of Uraduct®.

As part of the rigorous testing that Uraduct® has undergone, CRP has from time to time commissioned independent tests to confirm that the materials selected for CRP banding offer optimum corrosion resistance, tensile strength, and ease of application. This is why CRP has well founded confidence in the whole range of banding supplied and is able to suggest which banding material will be best suited to a given situation.

As standard, CRP banding is supplied in precut lengths complete with preformed seals, therefore saving valuable installation time. Banding is also supplied in coil form when requested.

CRP has continually invested in manual and semi-automatic banding tools to support banding application. These are maintained and serviced in house to very high standards, well aware that each tool is expected to function in some of the most difficult offshore conditions around the world. To aid fast servicing turn around, banding tool spares are kept on the shelf on site. This is backed up by a detailed database that tracks the current location of each tool on CRP's books and allows current tool stocks on site to be monitored at the touch of a button.

An additional service is offered where CRP personnel can travel to a customer's premises or to the point of installation to provide on site training in the use of the tooling and can suggest methods of maximising the efficiency of a given banding task. Alternatively a detailed instruction manual and training video is available.

Band sleeves

For specific applications polyurethane band sleeves are available that provide an external sheath to the banding. The polyurethane displays the same high abrasion characteristics as the compounds used to mould the Uraduct® half-shells. The band sleeve has been specifically designed to ensure a totally smooth Uraduct® profile and stops any abrasive particles coming into contact with the band itself. A polyurethane cap that locks into place after the band has been tensioned and sealed also protects the seal area of the band.

Band sleeving and seal cap for extra abrasion protection.

CRP Marine has been supplying products to the offshore oil and gas, submarine telecommunications, submarine power cable and defence industries for over 25 years. Through the performance of these products in the field, we have built a reputation for quality.

Quality at CRP Marine is design engineering in which minute attention to detail is second nature.

Quality at CRP Marine is the selection of materials which possess the dynamics for optimum performance.

Quality at CRP Marine is the application of manufacturing processes which deliver products fit-for-purpose.

Quality at CRP Marine is commitment from the team of people who make it all happen.

We look forward to our customers benefiting from these same qualities for another 25 years.

CRP MARINE

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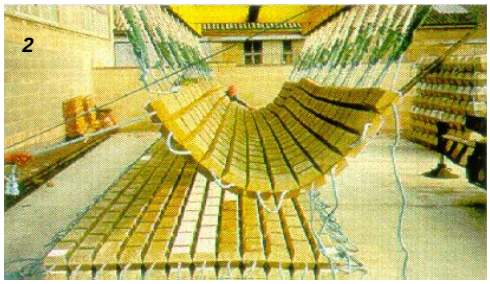
URADUCT®

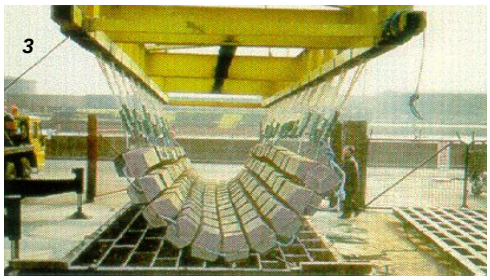
Protects the element inside from the elements outside

Photographs courtesy of:

Aramco.
AT&T.
BP Amoco.
British Telecom.
Coflexip Stena Offshore.
Etisalat.
Global Marine.
Petrobras.
Rockwater.
SAIC.
Seas/AS.
Stolt Offshore.
Shell UK Exploration & Production.
Wellstream.

SUBMAT FLEXIFORM





1. Completed 150mm thick mattress being lifted from mould.
2. Completed 300mm thick mattress being lifted from mould.
3. 150mm thick mattresses storage area.
4. 300mm thick mattresses in storage area.

Submat Flexiform is a low cost flexible concrete mattress developed as an addition to Submat's proven range of Submat bitumen mattresses which have been successfully utilised for protection of marine pipework for over three decades.

Introduced at the beginning of 1991, Submat flexiform has itself established an impressive track record with various projects successfully completed on time, full details of which are available upon request.

Flexiform consists of high strength concrete segments linked together with a network of high strength polypropylene ropes to form a continuous flexible concrete barrier.

Flexiform by virtue of individually profiled concrete segments is able to provide a high degree of flexibility in two planes and as such allows for complete protection in most applications i.e. straightforward pipeline cover, at pipeline bends intersections on trenched / untrenched pipelines, for counter-action to seabed scouring or where there are pronounced undulations in the seabed profile.

Flexiform can be installed with a simple quick release installation beam / frame which can be provided as an integral part of the order.

Submat Flexiform is designed to provide a high quality, low cost solution for protection / stabilisation of subsea pipelines / structures and conforms to the requirements of BS8110 'The Structural Use of Concrete'.

SUBMAT FLEXIFORM TECHNICAL DATA

STANDARD THICKNESSES

150mm, 300mm, 450mm

STANDARD DENSITY

2.4 Tonnes / Cubic Metre.

Lightweight and Heavy Density options are available from 1.8 - 3.6 Tonnes / Cubic Metre.

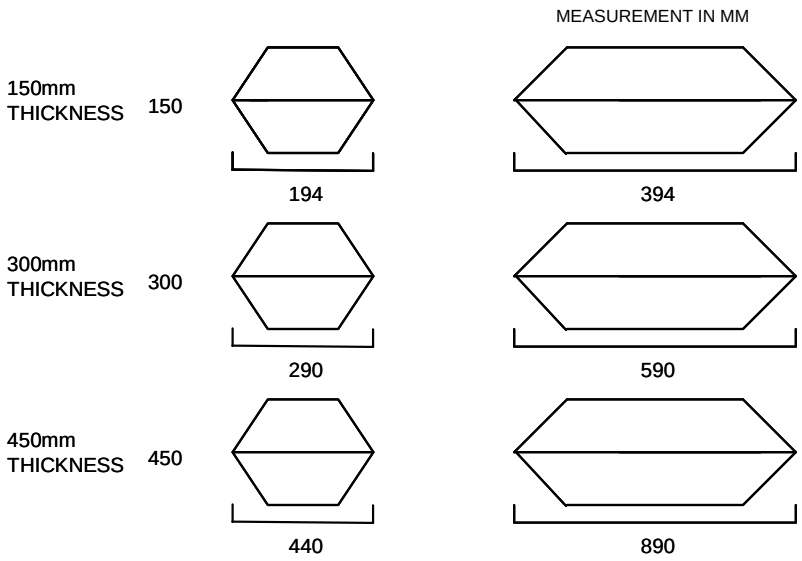
WEIGHTS (Standard Density Approx. Weights / m² Tonnes)

Thickness	In Air	Submerged
150mm	0.275	0.152
300mm	0.510	0.279
450mm	0.770	0.430

STANDARD MATTRESS SIZES

Standard mould sizes are 10m x 3m, plan area. Mattresses may be manufactured in any size within mould dimensions subject to standard block sizes. Mattresses in excess of standard mould sizes may be manufactured to order.

STANDARD BLOCK SIZES (N.T.S)



LIFTING ARRANGEMENT

Integral lifting loops connected to quick release frame as illustrated on front of sheet.

CONCRETE DESIGN SPECIFICATION

C40 / C50 - N/mm² @ 28 days

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