

# SURETY

Across buoyancy, protection  
and insulation product design,  
development and delivery

[balmoraloffshore.com](http://balmoraloffshore.com)



BALMORAL



A TRUSTED  
PARTNER TO  
THE OFFSHORE  
ENERGY SECTOR

# ARE YOU SEEKING SURETY IN BUOYANCY, PROTECTION OR INSULATION SOLUTIONS?

**Established in 1980, Balmoral has an enviable reputation across the world for product design, development and delivery.**

With 500+ people based at our purpose-built 250,000ft<sup>2</sup> facility in Aberdeen, we build successful relationships with clients working with them from concept development and advice through to product design, manufacture, testing, delivery and support.

All managed in-house to give total safety, quality and scheduling control.

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We help clients solve their technical challenges

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# OUR PROPOSITION

**Balmoral is a trusted partner to the offshore energy sector.**

We offer unrivalled technical expertise, a vast project track record, evidence-based buoyancy, protection and insulation product solutions. This, combined with an open approach to stakeholder engagement, ensures success.

Proprietary laboratory, hydrostatic and mechanical testing facilities enable us to research, identify and develop cost effective materials across a spectrum of applications. We continue to make significant investments in the most comprehensive syntactic, composite and polymer processing facilities the sector has ever seen.

Providing services from concept development through detailed design, toolmaking, manufacturing and testing our products are used by the oil and gas, offshore wind and defence sectors in the deepest and most hostile waters of the world.

# OUR VALUES

## **Customer focus**

Leading and working together as a team to deliver high quality products on time at the best possible price with no surprises

## **Respect**

Treating clients and colleagues as we wish to be treated ourselves, with respect and decency

## **Integrity**

Reliability, flexibility, honesty, openness and fairness. Supporting clients and colleagues at all times with a focus on the common end goal

## **Accountability**

Being proactive in setting and achieving objectives. Taking responsibility in one's role and enhancing the company reputation at all times

## **Innovation**

A commitment to the company's philosophy of innovation, continuous improvement and clear communication, internally and externally

## **Motivation**

Maintaining a focus on aligning efforts and energy to achieve common goals, ie, successful projects. Constantly seeking to add value

# OUR HISTORY

Established in 1980 by chairman and managing director, Jim Milne CBE, Balmoral Group is a privately-owned company comprising several operating divisions.

Our entrepreneurial approach has helped secure a number of prestigious industry awards over the years, including three Queen's Awards for International Trade.

Our technological innovation has resulted in a number of industry 'firsts', notably a hybrid buoyancy/insulation material that was used on the deepwater fields offshore Angola; the development of deep and ultra-deepwater syntactic foams used widely in the pre-salt fields offshore Brazil and a nature-inspired product for the drilling sector that integrates a low drag vibration and suppression system into riser buoyancy modules.

We continue to lead our market-sector and our multi-disciplined engineering and technical teams seek to broaden our horizons with a focus on materials development, product innovation and complementary market opportunities.



**2001**

Distributed buoyancy used on deepest ever project, Deepwater Spirit in GoM, 9687ft



**1980**

A company proud of its heritage in the North-east of Scotland, Balmoral Group was established with four employees.

Early contracts were awarded by BP and Shell for GRP spar buoys.

**2020**

Balmoral celebrates 40 years of industry innovation

**40**  
1980-2020



**2018**

Balmoral Subsea Test Centre launched by Duke of Rothesay



**2015**

Third Queen's Award for International Trade



**1993**

Phase two of Balmoral Park initiated (to locate Webco, Marine, R&D, GRP, Rotomoulding)

Highlights



# ACCREDITED, COST EFFECTIVE, SAFE SOLUTIONS

We boast an extensive track record in some of the most onerous operating conditions in the world. As the industry continues its journey into deeper waters Balmoral differentiates itself by providing fully accredited, safe and highly cost effective design and manufacturing solutions.

In March 2013 the American Petroleum Institute (API) released specifications 17L1 for flexible pipe ancillary equipment and 17L2 recommended practice for flexible pipe ancillary equipment.

The API 17L specification stipulates the minimum requirements for the design, material selection, manufacture, documentation, testing, marking and packaging of flexible pipe ancillary equipment including buoyancy modules, clamping systems, bend stiffeners and restrictors.

The API standard covers all materials, design, testing and manufacturing methodologies used in the system to provide uplift to 4.65Te at water depths to 10,000ft.

To achieve Bureau Veritas approval in line with API 17L standards Balmoral successfully completed an 11-month development programme that consisted of four phases: quality audit; design review; material qualification; inspection and testing.



**“ Clients should enquire whether or not their supplier is accredited in line with API standards to ensure the optimum products and services for their project are provided.**

## HSEQ

Balmoral acknowledges the importance of health and safety and is committed to providing a safe and healthy working environment for its employees, subcontractors and visitors, on and off-site.

We are members of the British Safety Council, holding 4-star certification, and operate a management system certified to ISO 45001.

## QUALITY ASSURANCE

Our stated aim is to become the first choice supplier in our sector and we are committed to providing products and services that exceed client expectations.

A key objective is the implementation and continuous improvement of a quality management system that is certified to ISO 45001:2018 / ISO 9001:2015 and in adherence to the American Petroleum Institute's specification for marine drilling riser equipment: API 16F.

# MANUFACTURING

We are constantly developing our operations to retain our place at the cutting edge of the buoyancy, protection and insulation product solutions market.

Now offering even more efficiency and automation, the facility has been re-designed and laid out to provide consistently high quality fit-for-purpose products on a continuous basis.

Comprising comprehensive syntactic foam processing capabilities and an advanced polyurethane moulding facility we also produce our own macrospheres and run dedicated marine anti-fouling and rotational moulding operations.



## Toolmaking, steel fabrication and machining

An in-house operation supports the demand for high quality rotational moulding tools, steel fabrication and machining requirements. This service means that we are in total control of these time-critical processes and don't rely on external suppliers or out-sourcing.

Not only does this ensure delivery schedules are met it also means that costs are kept under very strict control; time and cost savings that ultimately benefit our clients.

## Syntactic production and curing

The combination of hollow glass microspheres and a resin matrix, known as syntactic foam, is central to any buoyancy manufacturing operation. Balmoral operates a fully automated system that provides syntactic material of a consistent quality which is critical to the manufacture of high performance buoyancy and insulation products.

Our curing processes, supported by refined hardware to provide control over temperature, duration and cool-down times, means we have overcome product failure issues such as stress, material instability and brittleness that are experienced by traditional manufacturing methods.

This investment in production technology ensures top quality products that are exceptionally suited to the hostile deepwater environments commonly experienced by the offshore energy industry.

## Rotational moulding

Balmoral operates a highly developed in-house rotational moulding facility that produces the shells for many of our products including distributed buoyancy modules and modular buoyancy elements.

These shells are roto-moulded in medium density polyethylene providing a one piece, seamless product with no structural welds or inherent stresses. The manufacturing process is automated providing a high quality and consistent product.

This in-house capability affords the company complete control over material selection, dimensional tolerances and, ultimately, project scheduling.

## Production engineering team

Balmoral's production engineering team is responsible for creating and developing the company's manufacturing processes.

The team's approach to any process improvement or process installation is dependent upon the situation. Engineers are trained to utilise Lean Six Sigma principles and techniques for incremental changes or implementation of more radical, innovative changes utilising new technologies researched and identified.

The team works closely with production, R&D, engineering and technical personnel to ensure a connected and consistent company-wide approach to process improvement.

# PERSONNEL DEVELOPMENT

Balmoral's commitment to training and development is firmly established. There is recognition within the company that highly motivated and achievement-focused teams are an asset while also promoting confidence and pride within individuals.

All training attainments are recorded, along with appropriate certificates, to allow easy identification and tracking of operator competencies.

# PROJECT MANAGEMENT

With extensive experience of managing the design, manufacture and despatch of buoyancy, protection and insulation product solutions, Balmoral's project management team works closely with clients to ensure projects are delivered on time and on budget.

As members of the Association of Project Management, our team operates to recognised global competency standards from order placement through to delivery.



# OPERATING SECTORS

**With a global footprint we offer accredited field-proven product solutions that are designed to save you time and money without compromising on safety, quality or performance.**

We encourage early dialogue to secure optimum technical benefits and operate in an open and transparent way. This means that our evidence-based solutions are an integral part of your project and help drive down total cost of ownership.

Regular survey feedback tells us that we are getting this right: clients frequently describe Balmoral as innovative, creative and proactive; collaborative and trustworthy; accountable, diligent and rigorous while being supportive, responsive, agile and helpful.

We may challenge you from time to time and hopefully inspire you to think differently – all with a common goal in mind as we appreciate that you are focused on your responsibilities and deliverable objectives.

We want you to feel confident and secure in your choice of project partner and promise to keep you informed, engaged and supported throughout your experience with us.



### **Oil and gas**

Having cut our teeth in the North Sea and been part of the industry since the 1980s Balmoral has evolved into a trusted partner to the global offshore oil and gas sector.

As an independent company, our reputation is built on providing the very best product solutions to our clients' challenges which is achieved by our vertically integrated approach.

We frequently work on FEED and pre-FEED concepts with clients, seeing them through development, trials, engineering design, manufacturing, testing and, finally, delivery. We even follow that up with a dedicated after-sales technical support line.



### **Renewables**

We are fully committed to the offshore renewables sector offering a range of product package solutions for both fixed and floating offshore wind projects. Our dedicated renewable energy team, from tendering to technical, manufacturing and testing personnel, is highly experienced and offers fully integrated services.



### **Defence**

With a design and manufacturing history stretching back 40 years, Balmoral leads the market in buoyancy, advanced composites, insulation and elastomer product solutions. With a solid engineering and technical background, supported by lean modern manufacturing and testing facilities in Aberdeen, UK, we offer fully integrated services from concept and materials development to design, manufacturing and testing.

Products include:

- Advanced composites mouldings
- Bend restrictors and stiffeners
- Subsea asset protection systems
- ROV/AUV buoyancy
- Surface/subsurface buoyancy
- Low density deepwater foam systems
- Thermal insulation
- Hydrostatic and mechanical testing



# BALMORAL DISCOVERY UNIT



**A significant differentiator at Balmoral, as an independent company, is the ability to invest in continuous research and development programmes.**

We identified the advantages to be achieved by nurturing an innovative development capability and culture that expands the focus beyond the immediate expectations of clients and their current requirements.

Our dedicated R&D resource, known as the ‘Balmoral Discovery Unit’, continually broadens our horizons focusing on supported markets, product/materials solutions and routes-to-market.

The Balmoral Discovery Unit is a collaboration of highly experienced individuals from the company’s product research and development facility, polymer and composites material laboratories, process engineering department and subsea test centre.

The Unit was created to proactively and reactively deliver technical solutions to industry challenges. Client confidence can be assured as all development projects are delivered through state-of-the-art facilities and driven in accordance with recognised industry methodologies, including API RP 17Q, which control activities through ‘technology readiness levels’.

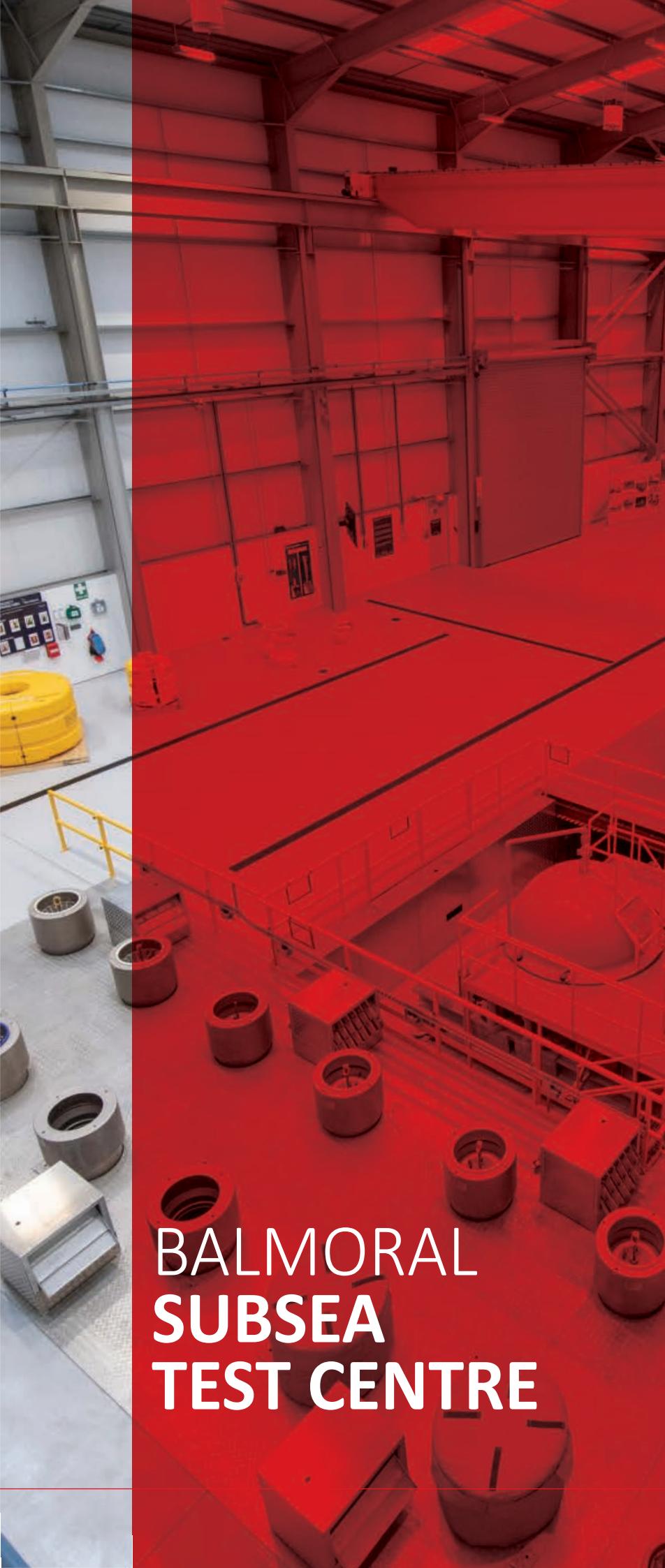
Supported by contemporary 3D modelling, finite element analysis, CFD, lab and testing facilities, the Balmoral Discovery Unit is committed to a policy of continuous innovation while delivering a personalised service at all times.

## OUR CUSTOMER JOURNEY



**“ Technical competence and qualified products, others just don’t have the same competence. There is a requirement for technical compliance – once past that, price is the next most important thing.**

# BALMORAL SUBSEA TEST CENTRE



**We operate the industry's most comprehensive, accessible and commercially available hydrostatic and mechanical testing facility for the subsea, renewables, defence and oceanographic sectors.**

### Hydrostatic testing

Upgraded vessels, 5, 20 and 40 tonne lifting cranes, remote monitoring software and procedures are in place offering independent testing for all types of subsea equipment to 7000msw (700bar) equivalent.

Standard tests include:

- Uplift determination
- Water ingress
- Instrumented buoyancy loss
- Hydrostatic compression and creep
- Hydrostatic collapse
- Bulk modulus
- Buckle arrestment performance
- Subsea controls testing
- Valve testing

### Mechanical testing

Balmoral's multi-purpose load rig performs the following tests:

- Axial and lateral slip loads to 60t
- Static loading and 3-point bend to 100t
- Bend restrictor/stiffener load to 10t
- Bend restrictor locking radius measurement under load
- Compression and shear testing on companion cylinders to 200t and tensile testing to 150t
- Dropped weight and swing arm impact testing
- Lifting point/insert load testing

### Development and test laboratories

Due to the complexities of bespoke project testing, stringent customer specifications and compliance to standards such as API 17L1, Balmoral continually invests in state-of-the-art laboratory test equipment to ensure these requirements are satisfied.

This programme of investment ensures we retain total control over time schedules, test conditions and methodologies used to fulfil customer requirements.

Our technical team works from custom designed and purpose built laboratories in a state-of-the-art temperature and humidity controlled environment that is fully furnished with a wealth of chemical, thermal, hydrostatic and mechanical test equipment.

### Cable protection system testing

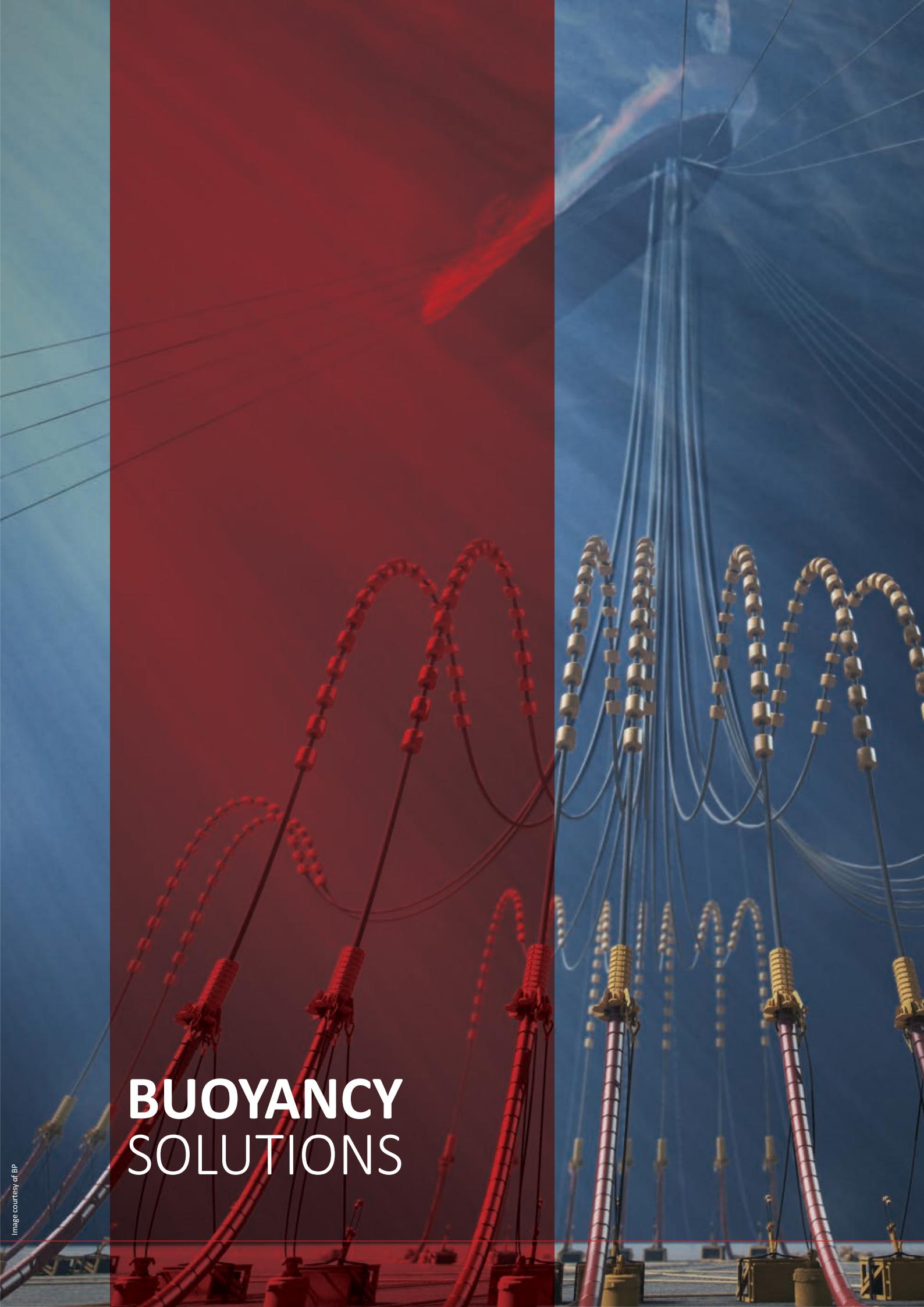
We operate a fully comprehensive test rig for offshore wind-related products. The rig comprises full scale winches, test tower, monopile and J-tube to simulate tow-in and tow-out installation processes.

The test procedures have been designed to validate the installation envelope of cable protection systems and provide installers with detailed processes to assist in minimising vessel down times.

The test centre conducts individual component tests to validate bending and axial stiffness, load, bending, curvature, axial, operational and safety performance.

Offering full analysis and transparency of all test results, clients can be confident that their products or systems are fully validated and verified for use.





# BUOYANCY SOLUTIONS

# DISTRIBUTED BUOYANCY

Dynamic offshore applications normally involve a floating production facility or terminal connected to another floating facility or fixed structure.

In these situations, flexible pipe and umbilicals require buoyancy to reduce topside or tension loads and assist in achieving particular configurations which include steep, lazy, W-wave and pliant.

Balmoral distributed buoyancy modules generally consist of an internal clamping system and syntactic foam buoyancy elements. The buoyancy elements are supplied in two halves incorporating a moulded internal recess that is configured to transfer the forces from the buoyancy to the clamp and subsequently the flexible.

We provide high quality, consistent modules - fully accredited by Bureau Veritas to API 17L standards - which result in low water absorption and compression throughout deployment and service.



## Installation times

Proprietary installation tools are supplied with our distributed buoyancy modules which dramatically reduce installation times. When properly deployed a pair of Balmoral DBMs can be fully installed in under six minutes. The benefits of faster installation times have a significant positive impact on overall total cost of ownership.

## Design, engineering and materials

The densities and composition of the modules are based on operational requirements such as hydrostatic pressure, uplift, water ingress, flexible diameter, length, etc.

For high temperature applications, the foam composition is tailored to accommodate the effects of high ambient and line temperatures ensuring the design is fit for purpose in any condition.

Our largest distributed buoyancy module to date provided 5.65Te uplift and was in excess of 3m long by 2m diameter. The modules were supplied with high performance clamps.

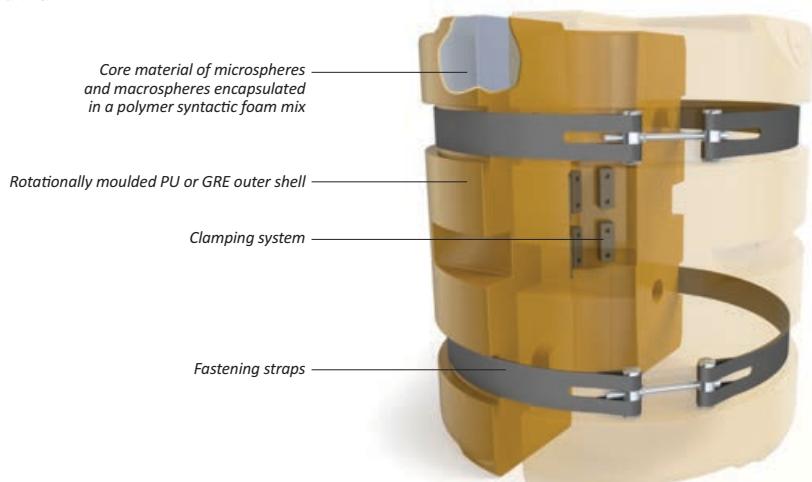
## External finishing

Finishing options of rotationally moulded polyethylene, polyurethane elastomer or GRE external skins are available offering the following benefits:

- Abrasion and impact resistance
- Marine growth resistance
- High visibility pigmentation
- Customised graphics option

“

*The products they supply are critical so having an interface with Balmoral ultimately determines our success.*



## Clamping options

As the requirement for flexibles and steel catenary risers (SCR) progresses into ever deeper waters, the performance of the clamping systems required to maintain the buoyancy, ballast or tethers in position has changed significantly.

The range of variables encountered through the design life of the clamp includes variation in diameter due to changes in internal pressure, flexing of the flexible/SCR as well as temperature and tension fluctuation.

Whilst the clamps are fitted directly onto the outer layers, and this is typically the critical interface for steel catenary risers, when dealing with flexibles they are normally required to transfer the clamping load through the outer layers to the internal armour layers. This transfer is designed to prevent slippage caused by in-service and deployment loads where the lowest coefficient of friction occurs with an acceptable safety factor.

Balmoral has designed a unique generation of clamps to ensure optimum performance across varying operating conditions.



### High performance clamp

This patented one-piece solution is designed for high clamping load situations to resist the axial movement of large buoyancy and ballast modules.

It is designed to control the contact pressure onto the flowline allowing the accommodation of large diameter expansion/contraction due to its low stiffness and excellent spring properties and is installed directly onto the flexible or SCR using a specialist tool allowing accurate loads to be generated whilst minimising installer fatigue.

Recent developments have adapted this solution to provide increased contact areas between the clamp's rubber pads and the flexible/SCR. This provides a more even load and distributes the clamping pressure across a larger area leading to smaller, more cost effective, clamps.



### Standard clamp

The patented three-piece device is designed to clamp directly onto flexible pipes, umbilicals and SCRs to prevent the module assembly from sliding along the length of the flexible/SCR whilst allowing the module to rotate freely.

This clamp is best suited for umbilical or small diameter flexible pipes where low clamping pressures are required.

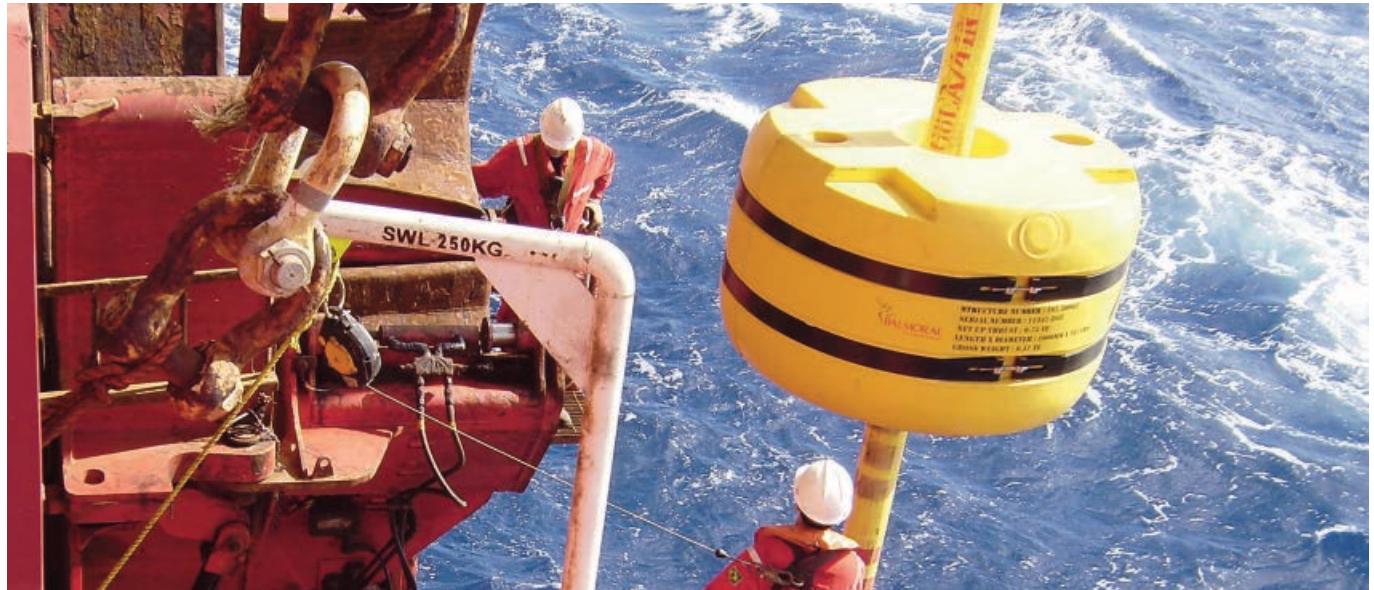


### Integral clamp

This option removes the need for a separate clamping system by attaching directly onto flexible flowlines, rigid pipelines, umbilicals and risers.

Custom designed pads placed within the recess of the module accommodate flexible or SCR diameter expansion and contraction while generating consistent clamping loads to resist slippage.

Balmoral's patent protected integral clamped modules and installation methods can be installed using hydraulic cylinders, removing the need for manual bolting of modules and minimising installer fatigue.



## Buckle mitigation buoyancy

If a pipeline is carrying high temperature product it is inevitable that expansion will occur along the steel pipe. Although the pipe may expand in diameter, most occasions see the pipe increase significantly in length. If both ends of the pipe are fixed this longitudinal expansion can potentially transform into a buckle situation with catastrophic results.

To mitigate this phenomenon design engineers incorporate pre-determined buoyant zones along the pipeline so that expansion, or buckle, is allowed to take place in a safe and controlled way. These buoyancy modules are designed to maintain their integrity as the pipeline "bends" during installation and operation.

In a typical 25-year design life, buckle mitigation modules may travel over 15km of sea bed as the pipe oscillates through expansion and contraction. For this reason the external shell must be highly abrasion resistant and materials such as polyethylene, elastomer or GRE are ideally suited to this purpose.

## Jumper buoyancy

Balmoral jumper buoyancy comprises two rotomoulded polyethylene half shells with integral clamping devices and is used to provide uplift on connecting sections of subsea pipe or flowlines.

The modules can be produced with or without moulded helical strakes and are injected with high performance syntactic foams tailored to meet exacting performance, strength and installation requirements.

Modules with moulded strakes are used where vortex induced vibration (VIV) challenges need to be addressed.



## DISTRIBUTED BUOYANCY INNOVATIONS

### Standardised buoyancy modules

Balmoral developed a range of modular based products which maximise uplift and maintain the same design ethos of its bespoke buoyancy solutions. Working with standard clamping systems Balmoral provides a range of incremental buoyancy modules using standard foam systems from 0-3000msw.

These ready made solutions provide cost effective options and are typically considered where time and budget constraints are of utmost importance.



### VIV straked integral clamped buoyancy

When using cylindrical pipes with traditional buoyancy in deepwater systems, vortex induced vibration (VIV) can be a catastrophic issue. Traditional distributed buoyancy modules typically use internal clamps that can potentially spin round the axis of the clamp which is unsuitable for VIV shedding.

We have designed a product to reduce excess weight and mitigate the effects of VIV on the riser and, when combined with the company's patented integral clamping device and installation methods, offers a unique solution.



### Piggyback buoyancy systems

Balmoral's buoyancy range generally uses symmetrical buoyancy modules sharing the same axis as the flexible or SCR. For when this is not possible, due to the deployment method over a stinger/roller, we developed a piggyback clamped buoyancy design for use on steel catenary risers.

This prevents the buoyancy module enduring excessive compressive loads as a result of the weight and tension loads applied by the riser during deployment.



### Integral clamp LDV distributed buoyancy

A major drawback to traditional strakes is increased drag relating to the fin diameter. We were inspired by nature, and the sea turtle in particular, to develop a low drag VIV suppression system that, combined with the company's patent protected integral clamp system, provides a highly effective alternative to traditional strake systems.



# DRILL RISER BUOYANCY

Drill riser buoyancy provides uplift while reducing the submerged weight of the riser joints. This helps to minimise top tension and prevent stress in the riser as well as reducing loadings during deployment and retrieval of the blow-out preventer (BOP) stack.

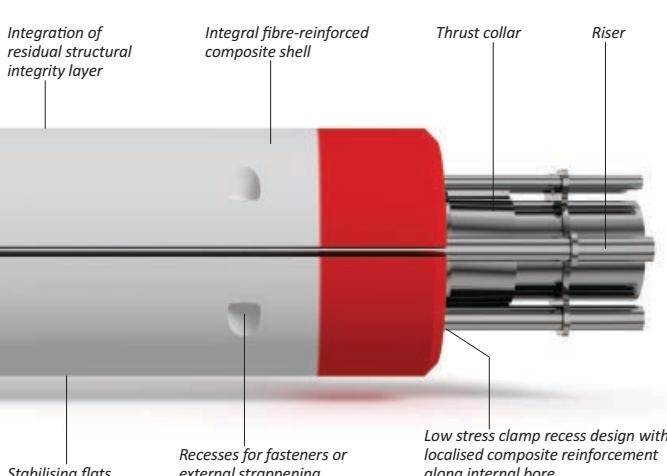
Drilling risers extend from the BOP to the drilling vessel with their primary function being the provision of fluid communications between the well and the vessel while supporting choke, kill and auxiliary lines. Balmoral consistently manufactures high quality modules while its in-house hyperbaric test centre offers test facilities to 7000msw equivalent.



## Dressed riser joint

Balmoral drilling riser buoyancy modules are fitted around the riser with moulded apertures accommodating auxiliary lines and riser clamps.

The vertical lift of the syntactic modules is transferred to the riser by a thrust collar fitted to the riser pipe below the upper coupling. A matching collar is normally installed at the lower end of the assembly to facilitate the transfer of the module weight during handling.



## Drill riser buoyancy up to 12000ft

### DuraFloat® and DuraFloat RIS™ (Residual Integrity System)

The demands placed on drilling riser buoyancy have increased dramatically as the industry continues its exploration and development of ever deeper waters.

Similarly, the requirement for ultra-safe modules has grown in response to the extreme conditions which are now commonplace in today's operating environments.

Balmoral's design team was tasked with the development of a high performance ultra-safe riser buoyancy system to accommodate and perform in the most arduous of conditions. The team created a specialised riser buoyancy series, DuraFloat RIS, comprising a high impact protective skin and residual integrity system.

Significantly, DuraFloat RIS is designed to minimise the risk of cracking and fracture while delivering safe high performance uplift.

Buoyancy plays a critical role in the dynamic performance of the riser string and DuraFloat RIS is an important step forward for the industry. Its contribution to safety and performance should not be underestimated.



## Drill riser buoyancy up to 15000ft

### DuraFloat Superlite™ and Superlite-X™

Having successfully developed its DuraFloat drill riser buoyancy to working depths of 12000ft, Balmoral recognised that further performance improvements were required.

Basing their work on the original DuraFloat system, Balmoral's technical and engineering teams developed a lighter syntactic material for use at operational extremes to 15000ft.

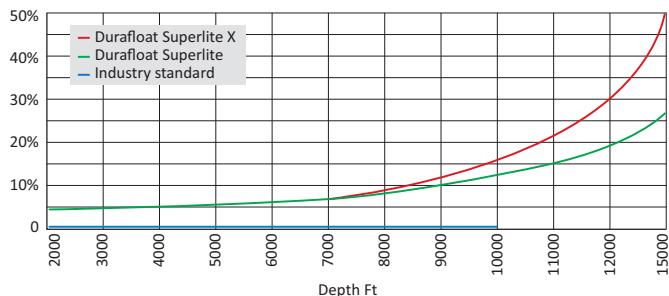
However, the essential increase in mechanical performance required to operate at these depths cannot be accompanied by a reduction in available buoyancy, and so foam density reduction was targeted alongside mechanical performance improvement.

The result of the R&D programme is DuraFloat Superlite and DuraFloat Superlite-X. With these latest additions, Balmoral now offers market-leading densities and performance levels across the entire spectrum of drilling operations.

All Balmoral DuraFloat and DuraFloat Superlite modules feature a number of advanced performance-related benefits including:

- Extreme impact resistant shell
- Anti-fracture reinforcement
- Enhanced flexure resistance
- Improved stacking and storage capability
- Localised recess reinforcement

In simple terms, more uplift is provided for the cost when specifying DuraFloat Superlite and DuraFloat Superlite-X.



## Common product features

### External finishing

Drilling riser buoyancy operates in extreme conditions and must withstand harsh and constant handling. Durafloat modules benefit from an integral composite epoxy skin that delivers a robust impact resistant performance.

### API 16F

Balmoral Durafloat RIS modules are designed, manufactured and tested in full accordance with API 16F.

### Attachment methods

Balmoral Offshore Engineering offers strapping with stainless steel axis bars and stud bolts as standard attachments between module and riser. Further options are available including through bolts located in reinforced pockets or stainless steel U-bolts with enclosed Kevlar strapping.

Dependent on riser geometry these options can be located within the pitch circle diameter (PCD) of the auxiliary lines thus reducing the transverse bending moment on the buoyancy module.

### Module stability

300mm flats are standard across the Durafloat range. This allows effective stacking in the yard and in the offshore operations environment.

A fully comprehensive handling and stacking manual is available from the company on request.

### Flexural pads

Flexural pads are built into BOE buoyancy modules at strategic locations to ensure that excessive bending loads are not transferred from the riser to the module when lifted in the horizontal plane.

### Module repair service

BOE offers a comprehensive global repair service for damaged buoyancy modules that includes repair of full breaks and rebuilding of missing sections.

The company's skilled buoyancy refurbishment technicians are available for field work at most locations worldwide.

# LOW DRAG VIV SUPPRESSION BUOYANCY

**Balmoral low drag VIV (LDV) suppression buoyancy is a result of the company's continuous innovation drive to provide clients with industry-leading technology to help reduce offshore operational costs.**

DuraFloat LDV (patent pending) technology integrates vortex induced vibration (VIV) suppression and drag reduction into drill riser buoyancy modules to increase rig efficiency without compromising on safety or structural integrity. The system minimises vessel down time, directly relating to significant cost savings.

The system is designed to provide optimum uplift values while offering up to 75% VIV suppression efficiencies which dramatically improve riser motion and drag in onerous subsea

current environments compared to traditional drill riser buoyancy.

The revolutionary hex design eliminates the need for ancillary suppression equipment and helps reduce time-consuming activities when running and removing drill stacks.

Additionally, it is recognised that reduced riser motion due to VIV suppression dramatically improves the fatigue performance of subsea equipment resulting in further cost savings by extending the service life of wellhead and conductor/casing equipment.

Three distinct products are available which utilise the LDV design, each tailored to provide maximum performance benefit.

## LDV analysis, validation and testing

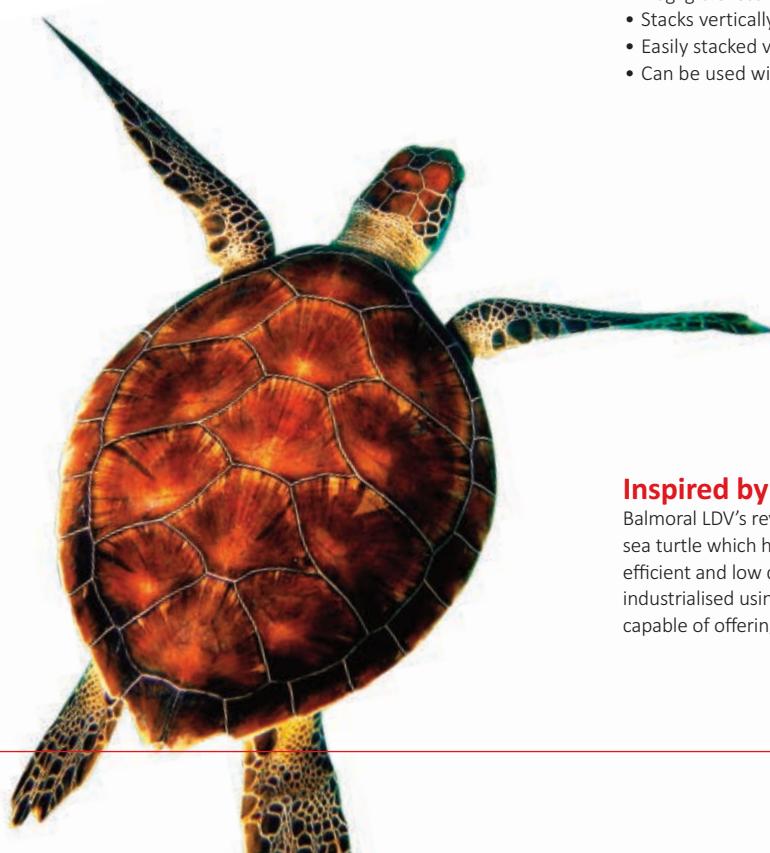
Extensive CFD and fluent modelling of the design was carried out, indicating up to 75% efficiency in VIV suppression and diminished drag by up to 33%.

Half scale tank testing was carried out at SINTEF Ocean that confirmed strong operating performance. Testing of the modules was the largest project the renowned test centre had ever undertaken; the parameters are detailed below:

- Test sample OD 0.611m. with an L/D ratio of 13
- Reynolds number ( $6 \times 10^5 - 3 \times 10^6$ ) with varying surface roughness ratios ( $1 \times 10^{-6} - 1 \times 10^{-4}$ )

Tests included:

- Fixed cylinder tests
- Free oscillation tests
- Forced motion test
- Flow visualisation trials



## Applications and benefits

### Applications

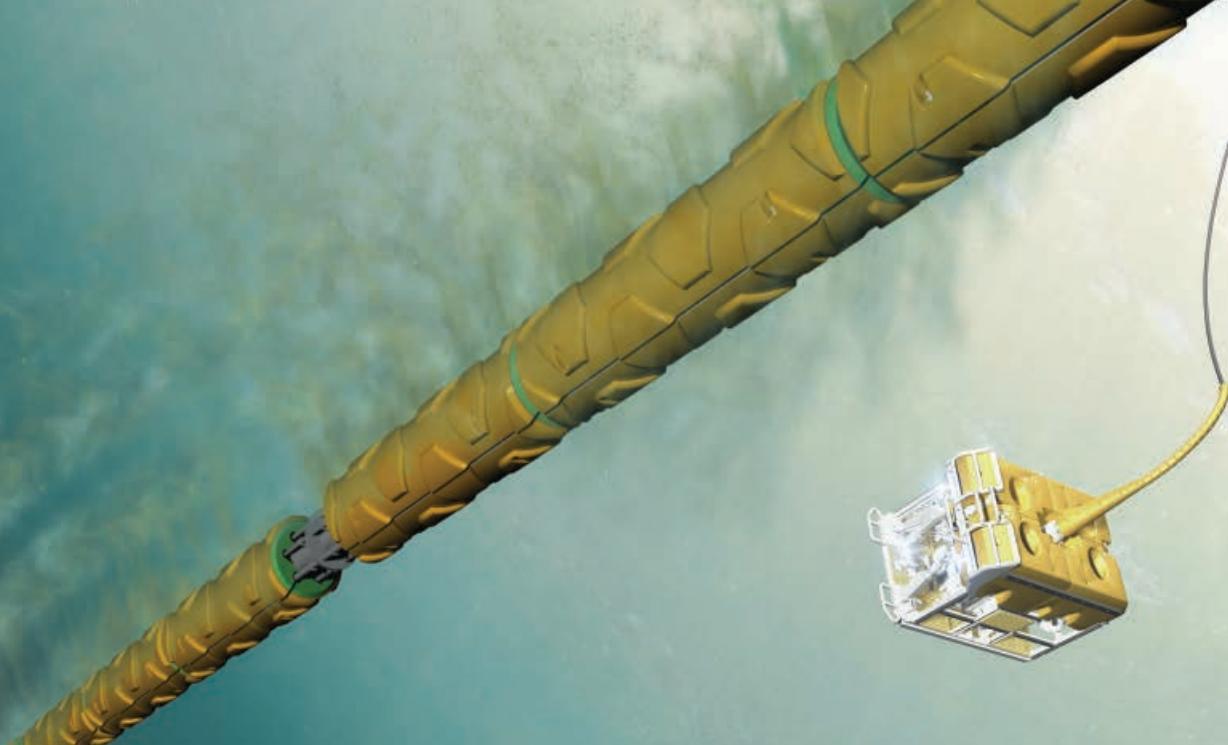
- Marine drilling risers
- Jumpers
- Long pipeline spans
- Production risers
- Umbilicals
- Flowlines
- Power cables
- Geometry can be utilised for traditional VIV strakes

### Benefits

- Significantly reduces VIV and drag when compared to conventional buoyancy
- Improved operational windows by allowing drilling in heavier seas
- Reduced drag and loads during deployment/recovery, riser disconnect and hang off
- Significant reduction in VIV fatigue damage
- Negligible loss of buoyancy
- Stacks vertically and horizontally
- Easily stacked vertically and horizontally
- Can be used with existing riser handling and storage equipment

## Inspired by nature

Balmoral LDV's revolutionary profile was inspired by the carapace pattern of a sea turtle which has been sculpted over millennia to provide an extremely efficient and low drag hydrodynamic structure. This natural phenomenon was industrialised using biomimetic engineering resulting in a man-made structure capable of offering VIV suppression and low drag performance.



### DuraFloat LDV

- Drilling riser buoyancy foam
- Modules are produced using proven manufacturing techniques
- Minimal buoyancy loss
- Operational to 4500msw



### DuraGuard LDV

- Retrofit option for existing drill riser buoyancy modules
- Significant cost savings via re-use of existing buoyancy
- Alternative to VIV strakes
- Improved handling and stacking
- Improved roller deployment



### Integral clamp LDV buoyancy

- Alternative to VIV straked production riser buoyancy
- Utilises patented integral installation methods



# RISER TOWER BUOYANCY

**Ultra-deepwater fields have generated a range of riser solutions to transport produced hydrocarbon fluids to a surface processing facility.**

Established solutions include steel catenary risers, flexible flowlines, single leg top-tension risers and hybrid riser towers. The last-named refers to multiple risers grouped around a single core pipe where the entire assembly is supported vertically by a massive buoyancy assembly.

Due to operational depths going to 2000msw+ most solutions require buoyancy to provide hydrodynamic stability and/or riser tension reduction.

## Hybrid riser towers

The hybrid riser tower typically comprises 4-12 individual risers grouped around a central core pipe anchored to the seabed and supported by a massive air can at the top.

Further to this tower-top air can, buoyancy is provided along the length of the bundle and on occasion at the upper and lower riser tower assemblies – URTA and LRTA respectively.

The primary purpose of the bundle, URTA and LRTA buoyancy systems is to facilitate surface tow-out, however the same buoyancy also contributes to the stability of the vertical HRT when in service.

With the field configurations, depths of reservoirs and relatively benign sea states found offshore West Africa, the hybrid riser tower (HRT) has assumed a dominant position.

Now, with the proven success of HRTs in West African projects, the same solution offers significant potential for other deepwater projects around the world.



## RISER TOWER BUOYANCY INNOVATIONS

### Riser tower buoyancy modules

Due to the significant buoyancy requirement on the tower itself we developed a new processing plant to produce our largest ever drill riser buoyancy style module at some 2.2m diameter, 5.2m long providing 6500kg of buoyancy per module.

With additional factors such as anti-rotation and anti-slip requirements, we combined technologies from our patented distributed buoyancy integral clamping solution with a drill riser buoyancy style module and, due to the length and physical size of the module, a dual position installation tool was developed followed by an arduous qualification and testing programme.



# SURFACE/SUBSURFACE BUOYANCY

We provide a range of surface/subsurface buoyancy products with a wide variety of fittings and accessories.

- Mooring buoys
- One-piece subsurface buoyancy
- Tri-buoys
- Oceanus floats
- Umbilical floats



## Anchor pendant buoys

Anchor pendant buoys are typically constructed from a rigid polyurethane foam core, cast around a central steel tension member reinforced with a glass reinforced polyester skin. The buoys are clad in a resilient polyethylene layer which is externally coated with a tough abrasion resistant polyurethane elastomer skin.

These units are suitable for deployment over the stern roller of anchor handling vessels.



## One-piece buoyancy

A range of one-piece subsurface buoys is available for service to 3000msw, with a proven track record on subsea projects.

These products are manufactured using a central tension member encapsulated within a syntactic foam core of varying densities to suit required depth ratings.

External finishes include rotationally moulded polyethylene, polyurethane elastomer and glass reinforced vinyl-ester.



## Mooring buoys

Our mooring buoy range is unique and was designed and developed in-house.

Two forms of standard mooring buoys are available, eg, cylindrical and rectangular in section.

Specials are available and usually based on a standard modular construction incorporating platforms, ladders, solar panels, electronic monitoring and lighting equipment.



## Tri-buoys

Tri-buoys offer a simple cost effective solution where additional buoyancy may be required as part of an installation operation or small permanent mooring.

The tri-buoys are finished either in GRP or elastomer and are supplied with central steelwork bearing a pad eye and swivel at either end.

Balmoral tri-buoys provide buoyancy of 125-175kg at 610-3050msw depth rating.



## Oceanus® floats

We created the Oceanus float to provide a range of readily available buoyancy units suitable for all ocean depths.

Oceanus floats comprise a high performance low density composite foam buoyancy core, encapsulated within a tough impact and abrasion resistant polyethylene shell and are supplied in a variety of colours with moulded-in client graphics where required.

Operating depth (msw)	Weight in air kg / Nominal buoyancy kg			
	OF1	OF2	OF3	OF4
1000	7.9 / 7.7	11.9 / 12.2	21.2 / 23.2	43.8 / 50.4
1500	8.1 / 7.5	12.3 / 11.8	22 / 22.4	45.6 / 48.6
2000	8.9 / 6.7	13.4 / 10.6	24.2 / 20.2	50.4 / 43.8
2500	9.2 / 6.4	14 / 10	25.4 / 19	53.1 / 41.1
3000	9.8 / 5.8	14.9 / 9.2	27 / 17.4	56.6 / 37.6
6000	10.6 / 5	16.2 / 7.9	29.6 / 14.8	62.3 / 31.9
Bore ØID mm	19.05	38.1	38.1	38.1

## Umbilical floats

Balmoral provides a range of floats to suit most control umbilicals. These floats comprise a pair of symmetrical half shells that are profiled to permit the line to flex within its specified bend radius.



Each float is manufactured using a low density composite foam core covered in a high performance impact and abrasion resistant polyethylene shell.

Our umbilical floats are hinged using two stainless steel latches and are designed to grip the umbilical by means of a natural rubber internal grommet.

Operating depth (msw)	Weight in air (kg)	Nominal buoyancy
1000	14.7	15.2
1500	15.9	14
2000	17.3	12.6
2500	18.1	11.8
3000	19.1	10.8

# MODULAR BUOYANCY

Balmoral developed its range of modular subsurface buoyancy products to include standardised "off-the-shelf" solutions.

Designed to offer a cost effective and rapid response to immediate buoyancy requirements, these buoys complement our existing range of products for use at 0-3000msw.

These modules incorporate 'flats' which provide easier handling and deck storage whilst improving robustness.

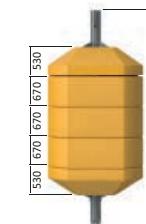
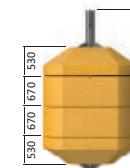
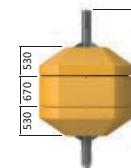
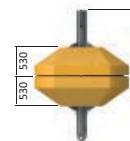
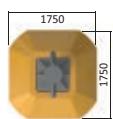


## Modular buoyancy range

Designed for use from 0-3000msw these buoys are used predominantly as suspended moorings or subsea markers. Balmoral modular buoyancy is highly adaptable and can be fitted with a comprehensive range of end fittings.

Our modular buoyancy utilises a range of tough, abrasion resistant core materials contained within a rotational moulded polyethylene shell. Other external finishes are available on request.

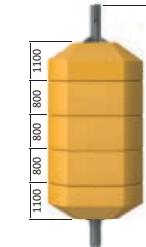
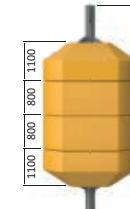
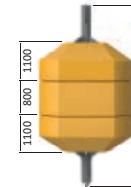
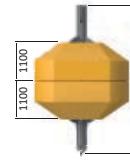
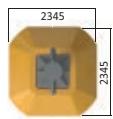
*Note: All weight in air and buoyancy values are nominal and subject to specific configuration. Buoyancy values can be increased with the addition of a thin mid module.*



**MB17 modular buoyancy general arrangements**

Weight in air (kg) Nominal buoyancy (kg)

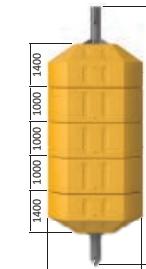
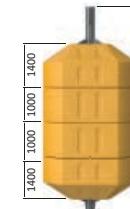
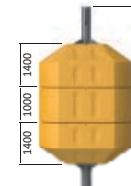
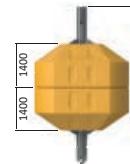
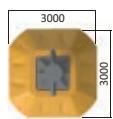
Surface	708	1695	975	3279	1241	4863	1507	6447
300msw	1333	1070	2104	2149	2875	3229	3646	4308
500msw	1405	999	2233	2021	3061	3042	3890	4064
1000msw	1422	912	2270	1880	3118	2848	3966	3815
1500msw	1520	815	2447	1703	3374	2592	4301	3481
2000msw	1634	701	2653	1497	4301	3481	4691	3091



**MB23 modular buoyancy general arrangements**

Weight in air (kg) Nominal buoyancy (kg)

Surface	1645	7061	2179	10597	2714	14134	3249	17670
300msw	4033	4673	5693	7083	7354	9494	9014	11905
500msw	4305	4401	6094	6683	7883	8965	9672	11247
1000msw	4394	4165	6227	6392	8060	8559	9893	10756
1500msw	4767	3792	6776	5813	8785	7834	10794	9855
2000msw	5203	3356	7417	5172	9632	6987	11846	8803



**MB30 modular buoyancy general arrangements**

Weight in air (kg) Nominal buoyancy (kg)

Surface	3457	16254	4518	23763	5579	31274	6640	38784
300msw	8915	10796	12348	15907	15836	21017	19296	26128
500msw	9537	10174	13271	15011	17005	19847	20739	24684
1000msw	9729	9529	13557	14160	17385	18791	21213	23421
1500msw	10582	8676	14785	12932	18988	17186	23192	21442
2000msw	11578	7680	16218	11499	20860	15316	25500	19134



## MB60 modular buoys

Used predominantly as support buoys and in suspended mooring systems Balmoral MB60 modular buoys are available in sizes ranging from 100-300 tonnes.

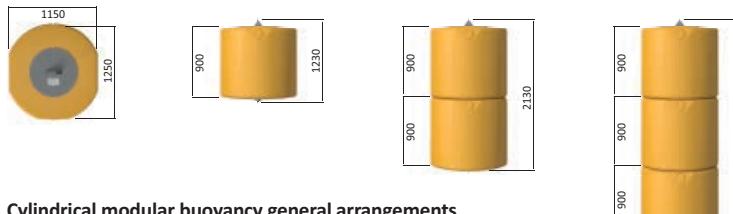
The rotationally moulded shells are filled with a resilient core material to provide long lasting practically maintenance free performance.

## Cylindrical modular buoyancy range

Designed to offer a cost effective and rapid response to immediate buoyancy requirements, the new buoys complement the company's existing range of products suitable for use from 0-2000msw.

*Note: All weight in air and buoyancy values are nominal and subject to specific configuration.*

*Buoyancy values can be increased with the addition of a thin mid module.*



### Cylindrical modular buoyancy general arrangements

Weight in air (kg) Nominal buoyancy (kg)

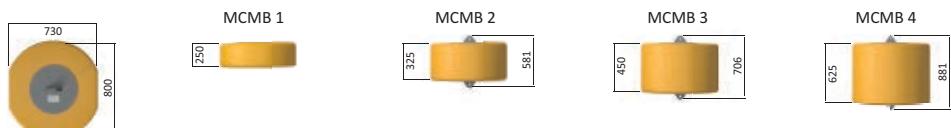
Surface	289	890	376	1819	463	2749
300msw	587	592	972	1223	1357	1855
500msw	621	558	1040	1156	1458	1753
1000msw	632	527	1063	1094	1493	1660
1500msw	679	480	1156	1000	1633	1521
2000msw	733	426	1265	896	1796	1358

## Mini cylindrical modular buoyancy range

Designed to offer a cost effective and rapid response to immediate buoyancy requirements, the new buoys complement the company's existing range of products suitable for use from 0-2000msw.

*Note: All weight in air and buoyancy values are nominal and subject to specific configuration.*

*Buoyancy values can be increased with the addition of a thin mid module.*



### Mini cylindrical modular buoyancy general arrangements

Weight in air (kg) Nominal buoyancy (kg)

Surface	99	77	103	108	109	158	118	229
300msw	130	46	144	67	167	101	199	149
500msw	133	43	148	62	173	95	208	140
1000msw	135	38	150	56	175	87	211	129
1500msw	139	34	156	50	184	78	224	116
2000msw	145	28	164	43	195	67	238	102



Weight in air (kg) Nominal buoyancy (kg)

115	202	126	283	131	324	135	354	141	405
187	130	224	185	242	212	256	233	279	267
195	122	235	174	255	200	270	219	294	252
198	112	239	160	259	184	274	202	300	233
209	101	254	145	276	167	293	184	321	211
222	88	272	127	297	147	315	161	347	186



Weight in air (kg) Nominal buoyancy (kg)

150	476	157	530	166	601	182	723
311	315	336	351	368	399	423	481
329	297	356	331	391	376	451	454
336	275	363	306	399	348	460	421
361	250	391	278	430	317	498	383
390	220	424	246	467	280	542	339

## Fittings

A wide range of steelwork is available to complement Balmoral Offshore Engineering's surface and subsurface products.

This includes crucifix, pad eye, round bar, swivel, double and single pin, keep plates and through-hawse end fittings.

## Buoyancy repairs

It is vital that repair and refurbishment is carried out by fully qualified teams that understand the materials, procedures and environments to which marine buoyancy is exposed.

Balmoral benefits from many years' design, manufacture and materials experience and has dedicated teams of repair personnel travelling the world on a regular basis.

# ROV / AUV BUOYANCY

**With advances in deepwater technology the need for remote intervention as part of field installation has seen a major increase in the number of deepwater remotely operated and autonomous underwater vehicles.**

As the complexity of these vehicles evolves the demand for lower density, high performance buoyancy systems has increased. The use of conventional cast composite buoyancy still has many commercial benefits for large vehicles, however, for deep dive work class ROVs, operating beyond 2000msw, the performance benefits of Balmoral's LDF series becomes significant.

Our low density, pure foam composite provides an opportunity to increase the uplift of the vehicle while

reducing the size of the buoyancy modules. Balmoral LDF buoyancy is available from stock for operations at depths to 7000msw.

We also supply ROV support equipment for use on the umbilical systems including floats and FlexLink®, a buoyant umbilical bend control system.

## Composite foam systems

A "composite" buoyancy foam system refers to a syntactic foam comprising glass microspheres and macrospheres held together within a polymer matrix. These are cast using dedicated moulds providing repeatable consistent production and are therefore ideally suited in applications such as work class ROVs – particularly on a multi-build requirement.

Each component within any given Balmoral syntactic foam is individually rated for specific operating depths resulting in a strong, lightweight composite formulation. There is an overlap in the operating depth ranges which is caused by macro efficiency changes in design operating depths. This means that more efficient, lower density composites may generate improved uplift for a given volume as the operating depth increases.

Composite buoyancy systems comprise an integrated skin to ensure maximum protection of the core material in the event of accidental impact and abrasion.



## Pure foam systems

Pure syntactic foams provide many advantages over macrosphere composite foam systems including robustness, ease of repair and modification in the event of damage or design changes while offering extremely low water ingress rates.

It should be noted, however, that this is a premium product and is therefore typically selected for more demanding service conditions such as extreme operating depths and/or service criticality such as manned service.

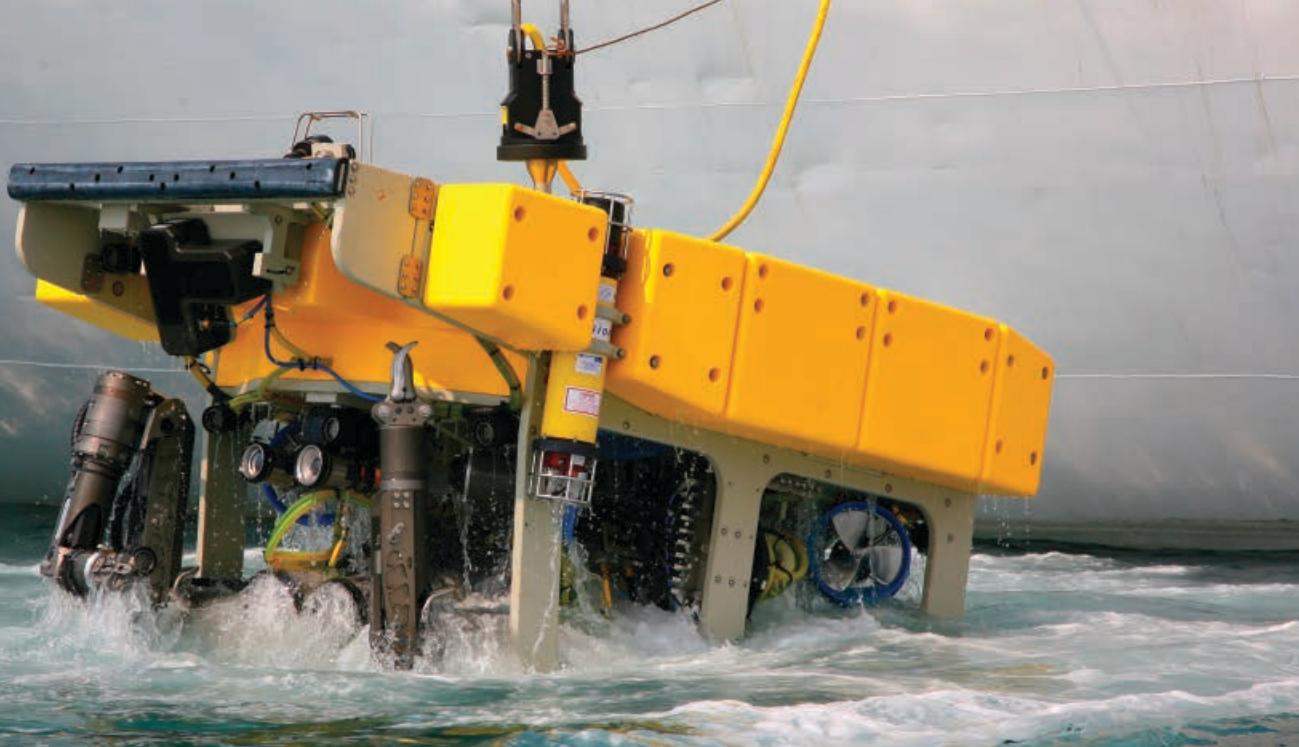
The ultra-low density range of pure syntactic foam is normally produced in pre-cast blocks. These blocks may be supplied for client assembly or can be factory assembled into finished buoyancy modules in our on-site machine shop and tested in the company's hydrostatic test centre giving us complete control over the entire manufacture, finishing and testing process.

The buoyancy performance of Balmoral's ultra-low-density material is understood to be unique amongst ROV buoyancy foams in that the buoyancy does not progressively reduce due to hydrostatic compression as the ROV moves into deeper water. This is because the bulk modulus, ie, the compressibility under hydrostatic pressure of the foams, is marginally less than sea water.

### Pure foam ultra-low density range (LDF)

Operating depth (ft/msw)	Typical core density kg/m <sup>3</sup>
6500 / 2000	385
9850 / 3000	401
13100 / 4000	435
16500 / 5000	479
19685 / 6000	519
23000 / 7000	565





## External finishing

Selecting a coating for buoyancy modules of any type is a critical issue. These coatings provide impact and abrasion resistance while offering a high visibility smooth gloss finish.

The most frequently supplied ROV/AUV coating is a 3-5mm spray-applied elastomer which is applied to all upper and external surfaces to give a very effective finish, particularly for work class vehicles.

Standard finishes are provided in high gloss yellow, orange, red or white while other colours are available to suit project parameters. An extremely high quality smooth finish is available for specialised applications.

## ROV buoyancy CNC machining and milling

We operate an on-site ROV buoyancy block milling and CNC machining facility that allows us to create intricate ROV PFS and LDF buoyancy profiles with virtually no size limitations using a 5-axis CAD/CAM-controlled milling facilities.



## FlexLink® umbilical buoyancy

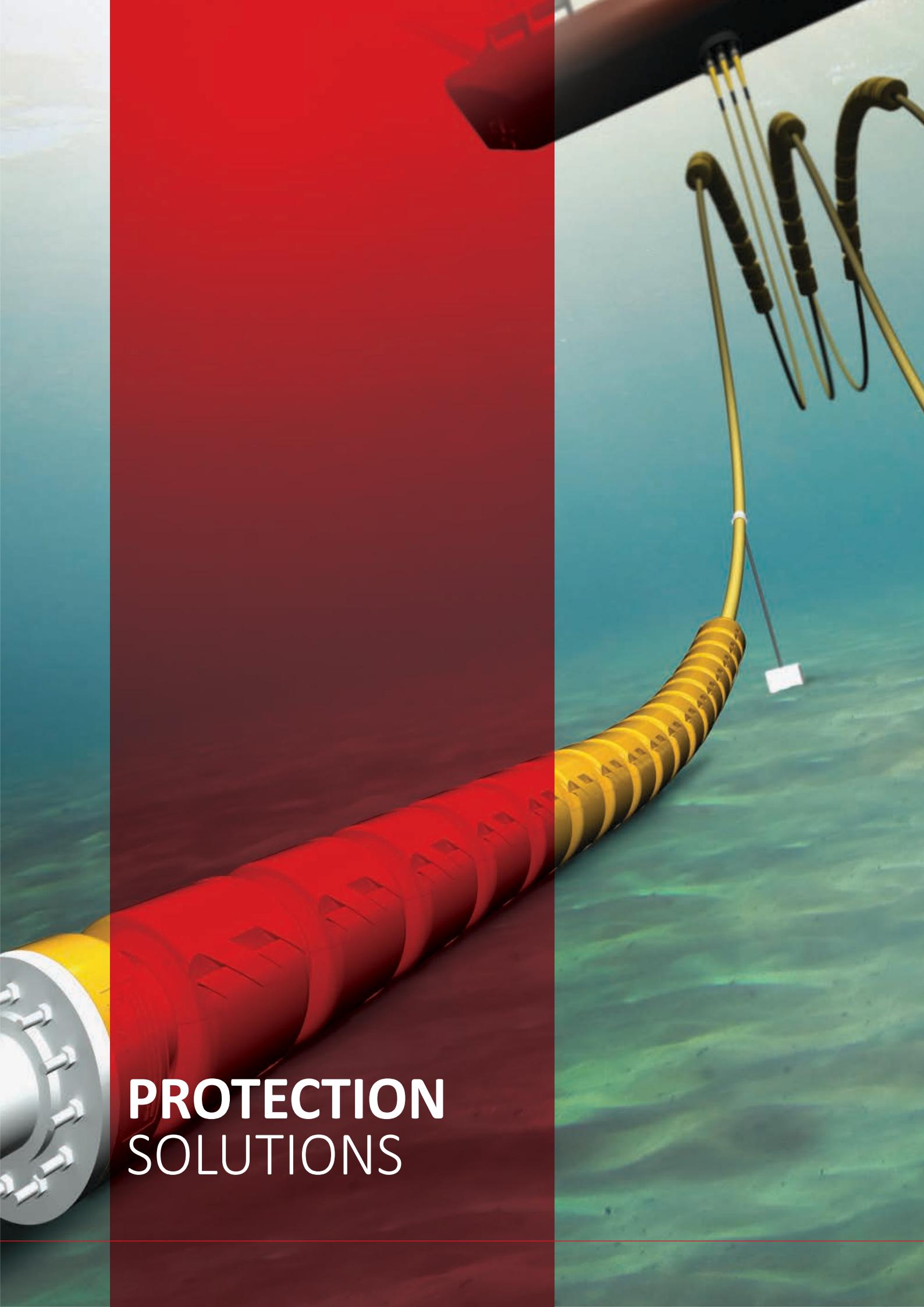
FlexLink was developed to meet the needs of large, tracked, trenching vehicles that operate on the sea bed.

To prevent such vehicles damaging their control lines, FlexLink is installed at the tether point to provide a continuous, articulate buoyant section above the vehicle, thereby ensuring the umbilical remains out of the vehicle work zone at all times.

FlexLink is used as a permanent installation and is designed to pass through the sheave wheels of launch and recovery systems (LARS). It is supplied for installation onto umbilicals of 25-75mm OD while the buoyancy can be specified to suit project requirements.

Typical uplift ranges 6-12kg/m in design operating depths to 6000msw.





# PROTECTION SOLUTIONS

# BEND STIFFENERS

Bend stiffeners are used to support flexible pipe, umbilicals and cables when connected to rigid structures or a floating production system where there is a requirement to control the minimum bend radius of the pipe. They are usually attached at either the topside or seabed connection.

Our bend stiffeners are fully accredited by Bureau Veritas to API 17L standards and, using specifically formulated polyurethane materials, are designed to suit engineered operational parameters including fluid temperature variance, project specific flowline, umbilical or cable stiffness and minimum bend radius (MBR) requirements.

In dynamic applications bend stiffeners require to have sufficient fatigue resistance to control the in-service bend radii and sustain the cyclic loads to the end of the specified life whereas in static applications they protect against gross over-bending.

Stiffeners are typically conically shaped polyurethane mouldings with a cylindrical bore that slips over the pipe, umbilical or cable. The following options are available: dynamic, intermediate, static and split.



## Stiffener interface

Proprietary installation tools are supplied with our distributed buoyancy modules which dramatically reduce installation times. When properly deployed a pair of Balmoral DBMs can be fully installed in under six minutes. The benefits of faster installation times have a significant positive impact on overall total cost of ownership.



## Balmoral SolGuard® UV protection coating

The vast majority of offshore elastomer products are used subsea where UV degradation is not an issue.

However, a limited number of moulded products are deployed above the surface and by far the most critical in terms of performance and consequences of failure are bend stiffeners.

To overcome this issue, we developed our unique SolGuard UV protection system which effectively creates an overcoat layer preventing UV penetration to the stiffener.

# BEND RESTRICTORS

**Bend restrictors prevent over-bending at the interface between flexible flowlines/umbilicals/cables and rigid structures by mechanically locking up.**

They are normally used in static applications but, unlike bend stiffeners, only provide protection when the pipe has achieved the desired bend radius between the flexible line and rigid structures such as wellhead connections, J-tube exits, rigid pipe crossovers and PLET connections.



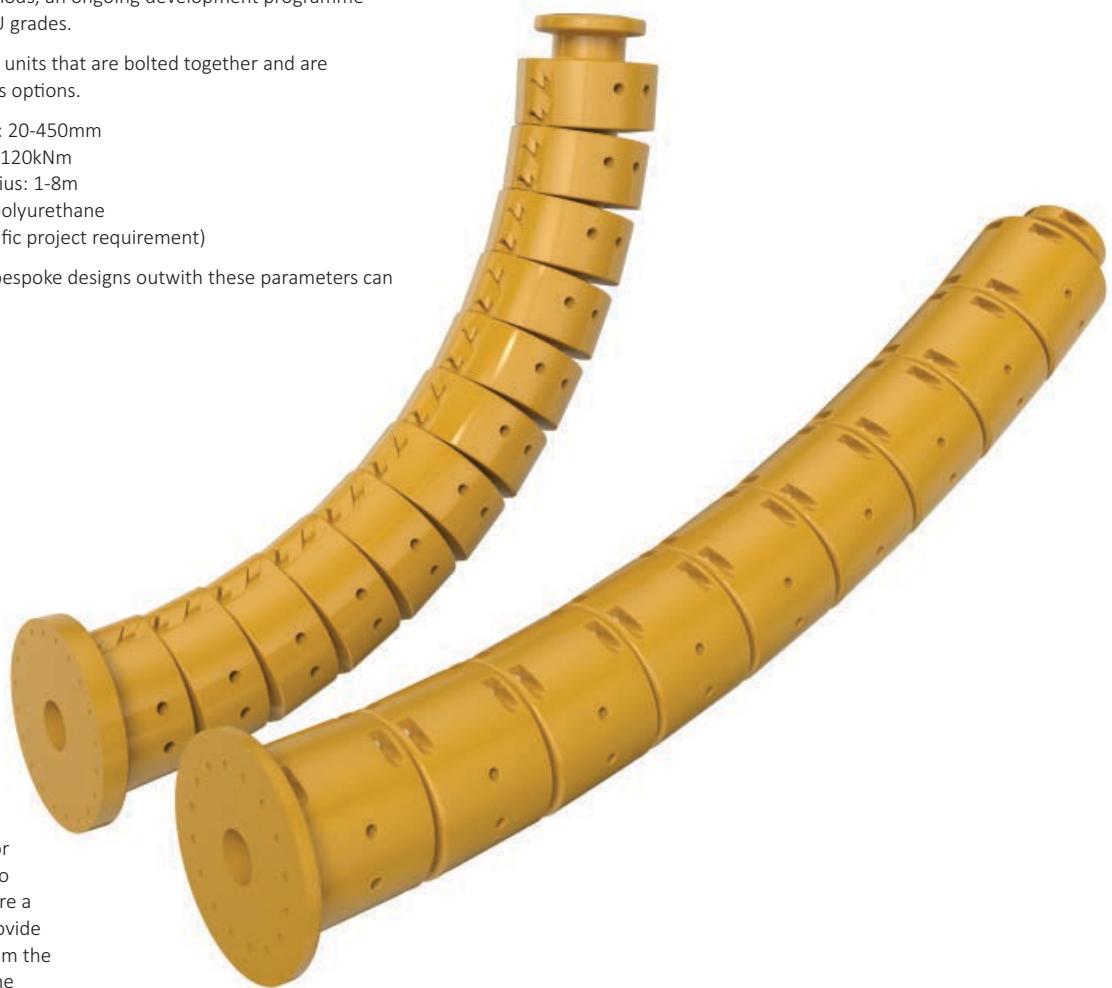
## Bend restrictor systems

Accredited by Bureau Veritas to API 17L standards and tailored to meet or exceed customer requirements across the oil & gas, renewable energy and defence industries, Balmoral bend restrictors provide cost effective solutions through optimised design methods, an ongoing development programme and the use of multiple rigid PU grades.

They are supplied as two-piece units that are bolted together and are available as standard or boltless options.

- Typical cable/pipe diameters: 20-450mm
- Typical bending moments: 2-120kNm
- Standard minimum bend radius: 1-8m
- Materials: Balmoral marine polyurethane
- Design life: 35 years (or specific project requirement)

These are indicative values as bespoke designs outwith these parameters can be achieved.



## End fittings

We offer a variety of options for bend restrictor end fittings, also known as reaction collars, where a robust design is required to provide the smooth transfer of load from the client interface to the end of the restrictor string ensuring protection is maintained at all times.



## CABLE PROTECTION

Balmoral Duraguard was developed to protect subsea umbilicals, cables, jumpers, flowlines and riser touchdown zones although many other applications have been identified spanning several industries.

It provides cost-effective localised impact and abrasion protection and is supplied as pairs of interlocking half shells secured around the core product using circumferential straps.

Duraguard is manufactured in a range of polyurethane elastomer grades, depending on specific operational conditions, and can be supplied in a wide range of diameters, thicknesses and lengths. Typical lengths are determined by the individual half shell weight and can vary from 500-2000mm.

### Duraguard™ cable/pipeline protection systems

We offer four systems:

#### Duraguard Standard

#### DuraguardPlus™

As Duraguard standard but supplied as one-piece hinged modules with integrated banding system.

#### Duraballast™

High density ballast system

#### Duramat®



#### Duramat

Moulded in marine grade polyurethane elastomer, Duramat provides dropped object impact and abrasion protection to seabed umbilicals, flowlines and pipelines.

During manufacture, the PU is filled with barites that provide ballast and prevent tidal movement while the grooved element design allows flexing and separation of the protected lines.

Duramat is ROV and diver installable and is generally supplied with through holes for rope handling. Typically provided in 3000x3000x40mm sections, the mats can be custom sized to meet project specifications.

### Installation

Duraguard can be fitted during unreeling/laying or prior to reeling and is installed by placing the two modules around the flexible and banding them into place. Alloy 625 or titanium bands are normally set 300mm apart. Adjacent segments with integrated overlapping ends are added to provide a continuous protected length.

The bands can be installed using manual or pneumatic tools for rapid installation while alternative strapping systems can be provided depending on application and performance requirements.



#### J-tube seals

J-tube seals are used to provide sealing and corrosion protection between flexible umbilicals, cables or pipes and the so-called J- or I-tubes found on offshore installations in the oil & gas and renewable energy sectors.

Balmoral provides diverless and diver-installed seals that are available in a range of sizes for pre- or retrofitting; all manufactured in accordance to API 17L standards.

Additionally, centralisers can be specified to maintain the cable position within a J-tube while bend restrictors or stiffeners can assist with positioning and stability.

# RISER PROTECTION



## Riser impact protection

The Balmoral riser impact protection system allows the bare joint to be stored in the same stack as buoyant riser joints and minimises the chance of operational damage during deployment and recovery.

When running a bare riser string, ie, without buoyancy modules, several problems can be encountered on the drill platform including:

- Storage difficulties because of the differences and irregularities in profile
- Impact damage while being passed through the rotary table

To minimise damage during operations Balmoral provides a selection of riser impact protection systems:

- Rotationally moulded polyethylene modules for standard protection
- A combination of polyethylene and polyurethane elastomer modules for heavy duty protection and maximum stacking

These products are engineered to provide maximum impact and abrasion protection whilst at the same time being lightweight and easy to handle.

Balmoral riser protection modules are fitted around the riser with moulded apertures accommodating auxiliary lines and riser clamps.



## Riser stacking shims

In addition to riser impact protection modules Balmoral manufactures polyurethane elastomer stacking shims which provide intermediate protection along the riser length and are suitable for protecting standard slick joints, pup and telescopic joints.





## Pin and box end protection

When transporting and storing drill riser joints, pin and box end connectors are always subject to potential damage.

To prevent unnecessary and expensive repair work to these critical areas, Balmoral provides a range of lightweight, high impact and abrasion resistant elastomer protectors.

With growing numbers of drilling contractors recognising the latest in high performing PU pin and box end protection, Balmoral can help achieve easier handling, fitting, transportation and storage by providing these highly cost effective products.

## Riser clamps

Polymer riser clamps are now recognised as an industry standard solution whilst offering significant weight reduction in deep and ultra-deepwater environments.

A conventional drill riser comprises of a 21" diameter main line with choke, kill, booster and hydraulic lines surrounding it. These service lines require to be connected to the main body by means of clamps to prevent buckling when the riser is operational.

Historically, steel clamps have been used – quite often “burn outs” from thick steel sheet – which are heavy and cumbersome when attaching to the riser. However, as drilling depths become greater the requirement for weight saving on riser strings has increased.

One area where this has been possible is through the evolution of polymer riser clamps. Initially the steel clamp evolved to a combination of a steel strap with polymer elements and thereafter to a full polymer product.

Maintaining its policy of product innovation and continuous improvement, Balmoral optimised its riser clamp design in terms of functionality, handling and ease of attachment to the riser string.

The design optimisation process resulted in a clamp that is:

- Extremely robust
- Highly impact resistant
- Offers a significant weight saving when compared to steel
- Vastly reduced assembly time
- Custom designed to suit specific riser requirements



## Balmoral elastomer protectors

- Typically 25kg or less per unit
- Exceptional abrasion resistance
- Non-corrosive PU-based materials
- Meets H&S criteria for single-man lift
- Quick and simple installation, no tools required
- Can be re-used over many projects
- Corporate graphics can be moulded into the product

## Traditional steel protectors

- Very heavy, 50kg+ each
- Low abrasion resistance
- Prone to corrosion
- Heavy two-man handling
- Unwieldy installation
- Generally one-off use due to irreparable damage
- Difficult to identify



# MARINE ANTIFOULING

**Marine biofouling is an issue which must be seriously considered when installing any structure or launching any vehicle into an aquatic environment. Accumulation of fouling organisms leads to increases in submerged weight but, far more importantly, such fouling significantly affects the hydrodynamic performance of subsea structures and equipment.**

At Group HQ in Aberdeen, Balmoral operates what is believed to be the industry's only purpose built marine antifouling coating line. The semi-automated facility enables the company to apply a range of coatings to its surface and subsurface products.



## Balmoral CuNiClad™

Balmoral developed CuNiClad to provide exceptional marine fouling resistance when applied to flexible substrates or structures. The main advantage of CuNiClad is that it can be cold-spray applied as a two stage process onto complex geometries and is ideally suited to coating polyurethane.

The entire product surface is coated with discrete CuNi granules so that there are no gaps in the protection onto which fouling can accumulate. As each granule is supported on, and in, a polyurethane matrix, despite the nobility of copper metal there is no possibility of galvanic corrosion of underlying steelwork and, additionally, no electrical continuity across the coated surface which, if applied to a CP-protected substrate, could otherwise interfere with the anti-fouling properties of the copper alloy.

Balmoral CuNiClad is based upon 90:10 copper-nickel alloy held within a polyurethane matrix and so, after application, the anti-fouling system demonstrates the matt-brown colour of the CuNi granules. The colour will progressively turn green within weeks of immersion and may darken to near-black depending on localised marine conditions.

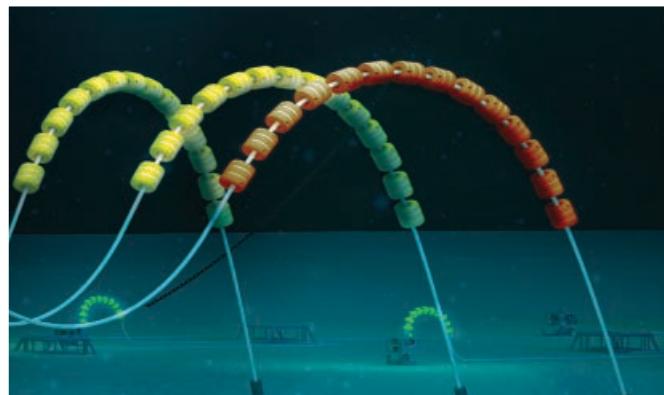
Balmoral has been granted approval from the UK Health and Safety Executive for CuNiClad in exercise of the powers conferred by regulation 5(1), 2(b) and (4) of the Control of Pesticides Regulations (1986) and the Control of Pesticides Regulations (Northern Ireland) 1987. This grants the sale, supply, storage use and advertisement of CuNiClad in accordance with current UK legislation.

## Balmoral CopperClad™

Balmoral worked with a market-leading marine antifouling paint supplier to develop Balmoral CopperClad™ which is a complete coating and application system designed to achieve outstanding bonding performance between polyethylene or polyurethane substrates and a slow biocide release antifouling coating system.

Balmoral CopperClad is based upon a silyl-acrylate binder that exhibits continuous slow solution and hydrolysis in seawater. This gradually releases biocide components into the surface/water interface to ensure continuous protection of the coated structure.

Full technical details of these systems can be obtained by contacting Balmoral.



# BALMORAL CASING GUARD

## Annular Pressure Build-up (APB) mitigation system

**As a subsea well is drilled, successively smaller casings are introduced creating several fluid-filled annular spaces and only the inner-most annulus can bleed off through the subsea tree. The outer annuli may be open to fluid movement through open shoes but, in practice, these annuli frequently get plugged off during cementing by formation collapse or solids settlement.**

Due to the combination of extreme water depths and hole depth in many modern wells, HP/HT reservoir fluids can reach temperatures as high as 350°F while flowing. When a well is brought on-line these hot fluids rise-up the casing string, elevating the temperature of the casings and annular fluids.

If natural thermal expansion of the annular fluids is restricted by plugging, a major pressure increase, known as annular pressure build up (APB), occurs. Pressure increases of 80-150psi/F are typical, meaning that even a relatively modest temperature increase of 100°F can result in pressures approaching 15,000psi.

It is not generally cost effective and, in many cases, impractical to design the casing string to tolerate the potentially massive APB's in modern wells. Engineered APB mitigation systems are therefore required to accommodate such expansion.

APB is known to have caused the rupture of intermediate and production casings on several wells. The financial impact and recovery implications of such failures are enormous.

### Balmoral Casing Guard

Balmoral is acknowledged as an innovative and proactive developer in the fields of advanced syntactic foam systems for subsea buoyancy and insulation and has developed a family of unique syntactic foam systems that provide protection against excessive APB in casings during the start-up of subsea wells.

Known as Balmoral Casing Guard, in-house technologists developed the materials by applying behaviour patterns for syntactic foams, originally established for more traditional buoyancy and insulation systems, to the unique requirements of APB mitigation.

### Application and operation

Balmoral Casing Guard is supplied as an easy-to-install kit for site application. It is typically supplied as foam segments, usually 0.5–1.5m in length. These segmented cylinders are bonded to the outside diameter of the pipe to create a continuous cylindrical foam section or, where a complete cylinder could later result in restricted fluid flow, in two or three sections around the casing outside diameter. The effective outside diameter of the installed quadrants is restricted to minimise damage to the foam during casing deployment.

The complete BCG kit comprises the foam segments, adhesive system, powered adhesive dispensing equipment, banding and full HSE and installation documentation.

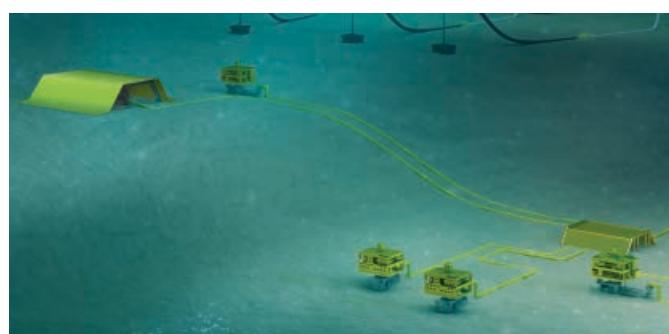
Once installed and the coated casing run, Balmoral Casing Guard has no detectable effect upon normal well operations and remains passive. When the design collapse conditions are reached, BCG responds immediately to provide the degree of APB mitigation specified by the engineering design team.



# COMPOSITES SOLUTIONS

**With 40+ years of GRP and advanced composites manufacturing history behind us we offer a range of products to the offshore oil and gas and renewable industries.**

Benefiting from in-depth technical, engineering, manufacturing and testing expertise we offer standard or bespoke products in these highly adaptable materials.





# INSULATION SOLUTIONS

# SUBSEA INSULATION

**Specialising in factory moulded half-shell, housing, clamp and retrofit options using a variety of material technologies, Balmoral has extensive experience of producing half-shell insulation shrouds in excess of 4m long and up to 650 litres in volume.**

Unlike linepipe or cast-in-place insulation, which is designed for hot-dry service, half-shell shrouds, housing, clamp and retro-fit insulation products endure hot-wet service as the cavity between the structure and insulation is flooded with seawater. Balmoral's Elastotherm® systems can provide suitable hot-wet performance over a design life of up to 30 years.

Our insulation shrouds can be designed to accommodate minimal fluid transfer rates over their service life which is particularly important where a long cool-down rate or target U-value is required.

For products requiring extremely tight geometric tolerances, our in-house machine shop, with an extensive range of CNC, vertical borers and milling machines can be used. Keeping the design, project management, moulding, finishing and testing processes in-house, gives full control over the workscope.



## Design and testing

Balmoral draws on its extensive engineering experience and comprehensive R&D programmes to offer FEA or CFD analysis of project design parameters to ultimately provide the most cost effective coating solutions. Early dialogue with clients means that optimum fit for purpose, through life solutions can be identified and implemented.

New, state-of-the-art, technical and subsea test centre facilities offer extensive laboratory and test capabilities to ensure all materials meet stringent industry requirements.

## Insulation covers/doghouses

Subsea pipelines, flowlines, risers and associated equipment carrying high temperature hydrocarbons must be insulated to prevent cooling and solidifying during the flow process.

However, the connections between the lines and subsea equipment can form cold regions unless properly protected. Balmoral has developed a range of insulation products to help maintain the overall flow assurance.

Using static or transient finite element analysis, Balmoral designs insulation covers tailored to match either a project's required overall heat transfer coefficient or design 'cool down' time and incorporate radial and longitudinal seals to ensure thermal integrity.

Our field-proven sealant system helps prevent excessive water movement either from within the insulation covers or into the assembly.

The covers can be designed to be mounted onboard the offshore construction vessel or installed subsea by either a diver or remotely operated vehicle.

## Balmoral Elastotherm®

This material is ideally suited to factory-moulding, producing components such as half-shell shrouds, housing, clamp and retrofit insulation products and we offer systems suitable for a wide range of applications, including:

### Excessive depth/hydrostatic pressure

None of our insulation systems contain polymeric or hollow glass microspheres and are therefore suited to depths to 7000msw.

### Hot/wet conditions

We have a wide range of Elastotherm® thermal insulation materials offering hot-wet temperature resistance up to 140°C.

### Where constant insulation properties are required

Service life of up to 30 years is typical.

### Where high strains are anticipated during installation or service

A wide range of Elastotherm® insulation materials is available, each having its own specific mechanical properties. Flexible or rigid materials can be selected based on the required application and temperature resistance.

### Advantages of Balmoral Elastotherm® systems include:

- Machinable grades available allowing intricate geometries and tolerances to be achieved
- Standardised seal design
- Integrated lifting points for ease of handling
- Straightforward handling and installation procedures

Material specifications available at [balmoraloffshore.com/solutions/insulation](http://balmoraloffshore.com/solutions/insulation)





# OFFSHORE WIND SOLUTIONS

# OFFSHORE WIND

We provide a range of product package solutions for both fixed and floating offshore wind projects. Our dedicated renewable energy team, from tendering to technical, manufacturing and testing personnel, is highly experienced and offers fully integrated services.

## Fixed wind turbine solutions

Balmoral offers a range of cable protection systems (CPS) for inter array and export cables for fixed offshore wind installations.

We provide solutions for varying aperture entry holes on monopile installations, as well as J-tube and I-tube options, for jacket structures which include quayside pre-installation which can minimise offshore vessel time and cost.

Our unique and patented CPS solutions comprise standard dynamic units (SDU's) that are highly suited for working in dynamic situations typically created by scour development. This technology not only offers a wide installation window but also displays excellent free-span performance when such scour development occurs.

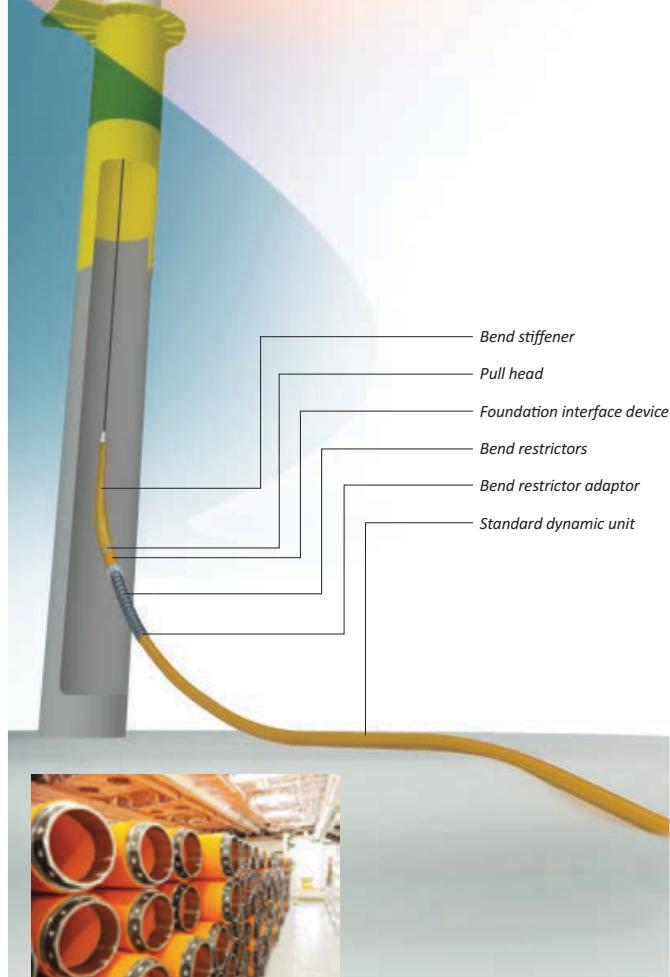


## Floating wind turbine solutions

Balmoral has, for four decades, provided engineered buoyancy, protection and insulation product solutions for the harshest subsea environments in the world.

The experience gained in consistently delivering the highest quality products has been transferred to the offshore wind market where our patented technologies that protect dynamic cables and aid efficient installation are exceptionally well suited to floating offshore wind installations.

These products, which form the core of our business, are tried, tested and supported by an extensive evidence-based track record.





# TAKE THE NEXT STEP

To find out how Balmoral can help you solve your current technical challenges, provide improved value for money and drive absolute **surety** in buoyancy, protection and insulation product development and delivery, please contact us at [surety@balmoral.co.uk](mailto:surety@balmoral.co.uk)

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Balmoral Park, Loirston  
Aberdeen AB12 3GY, Scotland

+44(0)1224 859000  
[surety@balmoral.co.uk](mailto:surety@balmoral.co.uk)  
[www.balmoraloffshore.com](http://www.balmoraloffshore.com)

