



LIFTING YOUR SUBSEA SOLUTION



Cost-efficient material for buoyancy
and subsea applications



ALWAYS AT THE CORE OF YOUR SOLUTION

Diab was founded in Sweden in 1950. Ever since the beginning, and throughout our steady development into a global company, we have been dedicated to constant innovation and promoting a widespread adoption of structural core materials.

Our products and solutions have been used in applications for marine, wind, aerospace, and industry for decades and are qualified according to relevant industry standards. With a complete range of high-performance core materials, numerous finishing options and kit operations in combination with engineering services and expertise, we present presumably the widest and most valuable offering in the sandwich composite industry.

BEST SOLUTION FOR BUOYANCY APPLICATIONS DOWN TO 700 METERS

The waters of our oceans are demanding, setting high standards on the materials used in applications for lower depth or subsea. Security and functionality are crucial to avoiding unwanted, costly disruptions and operational interruptions. Diab has provided material solutions for subsea applications for over 50 years. We know that strength, buoyancy, and insulation, with high quality and long service life, are essential product features for any application.

Our product range and know-how in this area enable us to provide total material and application solutions to our customers worldwide. Diab's Divinycell HCP is applicable in many types of applications, like ROVs, submarines, AUVs, subsea buoyancy units, diving bells and impact protection structures. It provides high performance concerning strength, buoyancy, and insulation. The low density with high uplift capacity, combined with its impact resistance and shaping possibilities, makes it a cost-efficient alternative to syntactic foam.

LET'S GET CIRCULAR

We offer industry-leading competence and the broadest range of stronger, lighter, smarter sandwich cores and buoyancy materials. Since our start over 70 years ago, we have developed, improved, and fine-tuned our products. Now, we are on an ambitious journey to fully embrace a circular economy, creating a whole new level of sustainability.

Diab is the only company in our industry reducing our carbon footprint in line with Science Based Targets. That means we have a documented plan to reduce the carbon footprint of our products approved by UN Global Compact Science Based Targets.

However, our effort to reduce our carbon footprint goes beyond managing Diab's sustainability performance. We also work with our supply chain (Scope 3) because supporting our suppliers in lowering their emissions benefits our products, which helps our customers' applications. It's a chain effect that works in both directions.

DIAB'S CIRCULAR BUSINESS MODEL

We make products with recycled raw materials, which lowers our carbon footprint in line with the Science Based Targets and, thereby, our customers' carbon footprint. We have high sustainability goals, use renewable energy in our plants and are researching bio-based raw material alternatives.



The customer can use a recycled product in their application, lowering their carbon footprint. The low weight also contributes to a lower footprint during the application's life cycle. Our materials also have an extreme life span, making them beneficial in the life cycle assessment.

Our products can easily be recycled or reused because Diab is transparent and provides clear information about the included materials. That makes it possible to reuse foam from one application at the end of life to produce new foam or use it in other products.

THE COST-EFFICIENT ALTERNATIVE TO SYNTACTIC FOAM

Diab has over 50 years of experience with buoyancy foam for defence and oil and gas operations. Still, composite materials are expanding into other subsea and offshore applications, where high-quality buoyancy, strength and long lifetime are essential.

Our closed-cell foams are appreciated for their high buoyancy per weight, low density, and high uplift. They are commonly used as floatation units in remotely operated underwater vehicles (ROVs) and autonomous underwater vehicles (AUVs), as well as in both larger and smaller submarines, diving bells and offshore renewable energy solutions, such as wave and tidal power generation.

Also, lower depth buoyancy, such as floatation units or moorings, benefits from our low-density foam. The light weight does not compromise the toughness of the product. PVC foam cores are chemical resistant, can handle high impact and offer long-term creep resistance, improved thermal/acoustic insulation and excellent transmittance. In addition, they are easy to machine, making shaping easier and more efficient.

Our high-performance buoyancy foams offer:

- Strength that can withstand sea-level water pressure down to 700 meters.

- Buoyancy that permits smooth and sustained operation of your equipment.
- High-quality that contributes to low equipment maintenance, long product service life, and optimal life cycle economy.
- Wide range of densities with highest uplift per volume, for cost efficient design.
- Good creep resistance.
- No water absorption.
- Good machinability.
- Good thermal and acoustic insulation.
- Good dielectric properties.
- Thermoformable.
- Compatible with most common paint and coating systems.

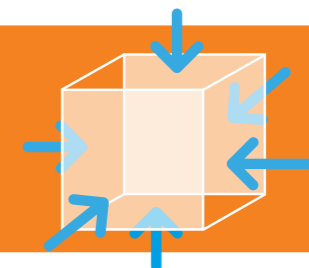
Understanding buoyancy requirements

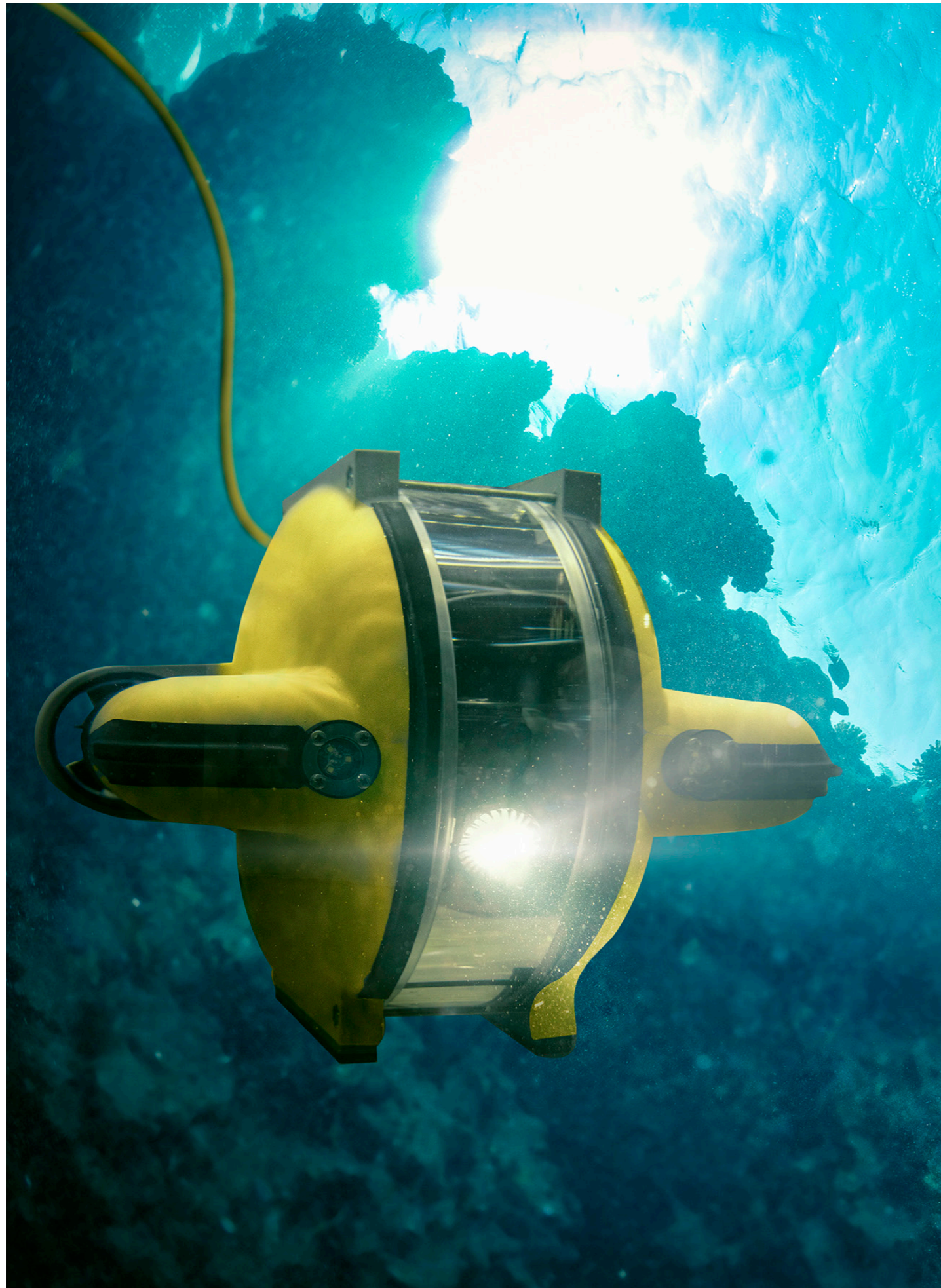
Pressure is applied from all directions in a subsea environment. The buoyancy loss mechanism for a closed cellular foam differs from that of a syntactic foam. A syntactic foam loose buoyancy over time due to water absorption into the material through micro cracks in the matrix material. A closed cellular foam will not absorb any water to any relevant degree, the buoyancy loss is a result of the hydrostatic creep acting over time resulting in a small volumetric loss.

Our technical experts will help you choose the material that best suits your needs, depending on your application and operational conditions.

What impacts buoyancy?

- Specific density & volume
- Exposure time
- Water density
- Safety factors chosen
- Service depth
- Water temperature
- Cycling or static use
- Surface treatment





SELECTING THE RIGHT MATERIAL

When selecting a suitable buoyancy foam, you must consider several factors impacting the choice to achieve the best result. These include what purpose your application has, how deep it must be able to descend, for how long it will be underwater, the level of safety required and, of course, the cost of the material. Depending on your needs, our technical experts will guide you in choosing the most suitable buoyancy foam.

Composite materials have numerous advantages in lower depth applications. They withstand the harsh marine environment, offering superior strength to weight and weight-to-stiffness ratios through flexible fibre and resin combinations. Composites excel at crafting complex shapes, enhancing hydrodynamics and stealth capabilities while adapting to round surfaces effortlessly.

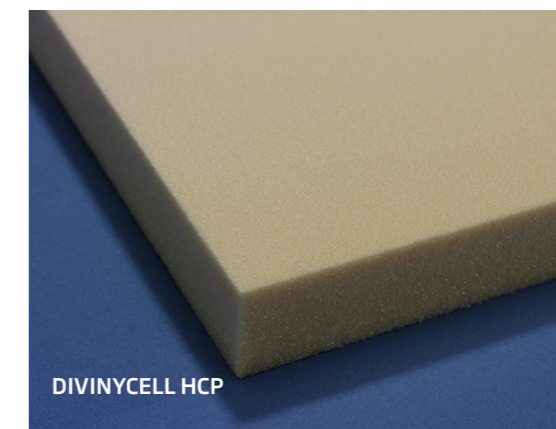
They allow for part consolidation, reducing manufacturing costs and time by avoiding riveting or joining smaller components.

Moreover, composites, being non corrosive contribute to minimum maintenance cost, provide excellent fatigue resistance, reduced maintenance costs, and improved thermal and insulating performance, making them a favourable choice over traditional metals in subsea construction.

DIVINYCELL HCP

Divinycell HCP is developed to meet the demands for high performance in subsea applications. It's a low-density cross-linked PVC foam with closed cells, providing high strength and buoyancy performance due to its unique material formulation. As a result of its excellent hydraulic compressive properties and closed cell structure, it has very low buoyancy loss and water absorption under long-term loading conditions. The low density with high uplift capacity makes it an ideal and cost-efficient alternative to syntactic foam in subsea applications.

Moreover, due to its material composition, HCP can be easily machined into almost any shape, enabling designers a high level of design freedom. HCP has an excellent track record and has been used in subsea applications for over 50 years as buoyancy or high-performance FRP Sandwich core.



DIVINYCELL HCP

Each block is pressure tested and qualified for HCP rating, and each delivery is accompanied by a batch and test certificate.

With its excellent hydraulic compressive strength and high buoyancy to weight properties, it is used widely, for example, in ROVs, larger and smaller submarines, AUVs, flotation units, diving bells and marine impact-protection structures at depths down to 700 meters. Diab provides Divinycell HCP in blocks or ready-shaped parts.

DIVINYCELL H

Divinycell H is an all-purpose grade with an excellent strength-to-weight ratio. It's widely used in multiple on shore industries and in lower depth environment. It has a proven track record in virtually every application area where sandwich composites or lower depth buoyancy are used.

Its excellent strength-to-weight ratio enables solutions with very low environmental impact, and it is compatible with almost all commonly used resin and manufacturing systems.

Divinycell H is a closed-cell PVC foam with low resin and water absorption that provides a wide range of mechanical performance,

enabling optimised structural designs.

Diab provides Divinycell H in blocks or ready-shaped parts. Typically used in renewable energy solutions such as wave and tidal power generation.

SUPPLY CAPABILITIES

The full range of Diab's materials can be delivered with various grades of customization. All materials can be provided in standard blocks. Our CNC machining capacity enables parts build to print production like full ROV buoyancy units. We can also provide ready painted parts.

TESTING CAPABILITIES

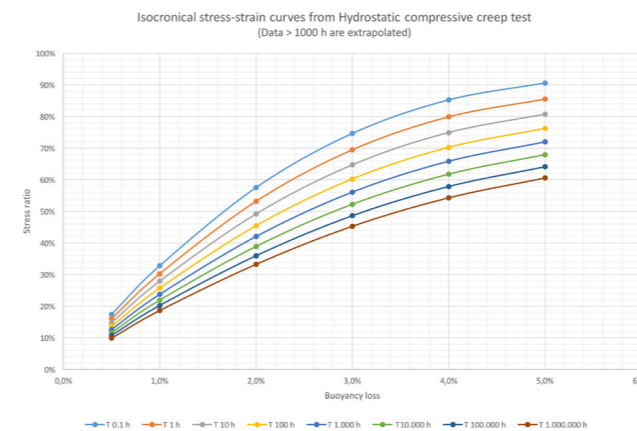
Comprehensive testing is the only way to ensure product reliability and long-term performance at subsea operations down to 700 meters. To ensure material performance, all materials are readily tested according to certified standard procedures. Every Divinycell HCP block is individually pressure tested, and a certificate follows each delivery.

MAKE THE MOST OF YOUR APPLICATION WITH OUR EXPERTISE

Diab Application Center is our powerful team of engineers, product specialists and process specialists, ready to team up with you to realise the total value of composites and buoyancy applications. We are here to support you with selecting the suitable

material for your application and essential guidance on different manufacturing processes.

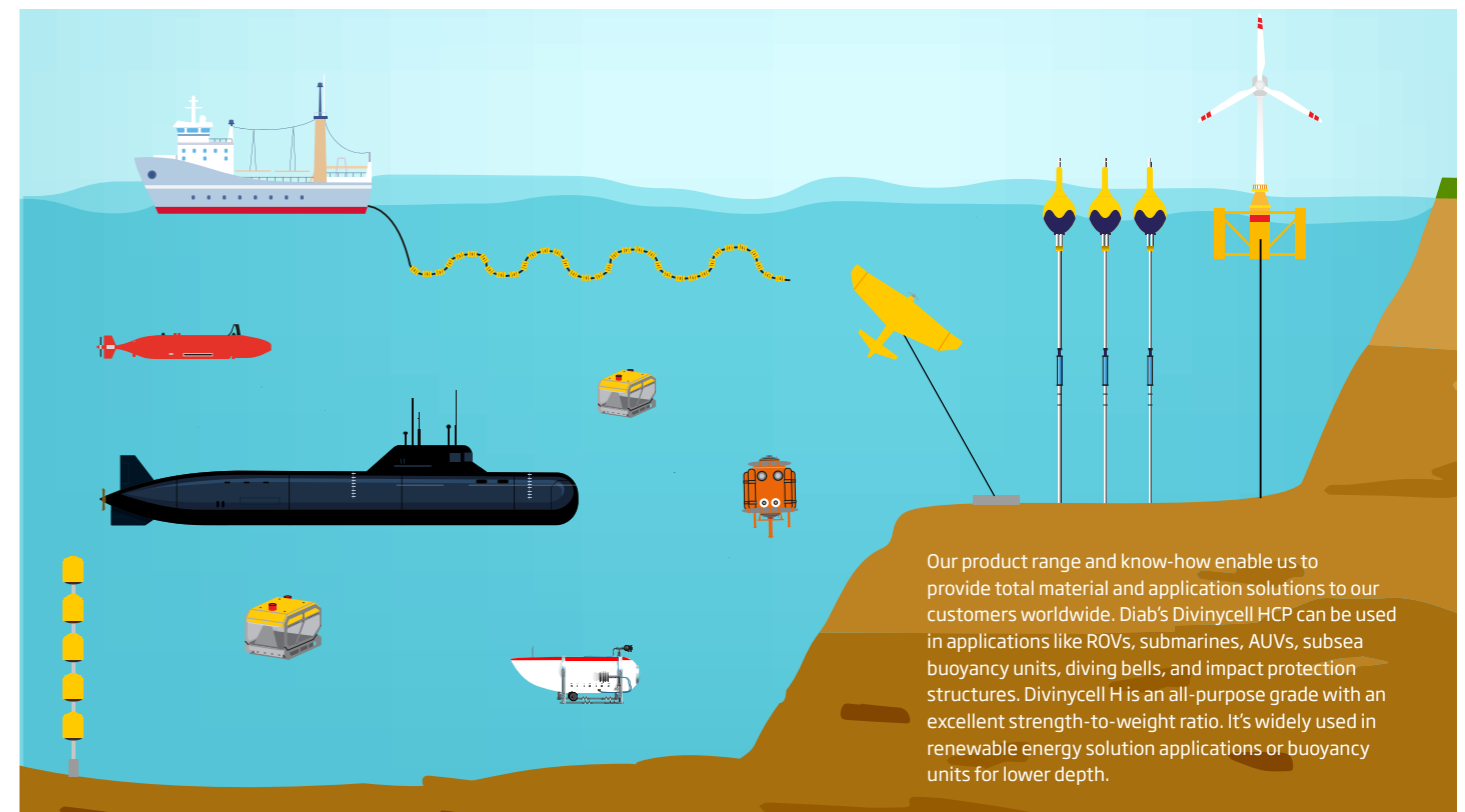
Composite Consulting Group (CCG) provides specialised composite technology and engineering services to improve your product further.



The diagram shows the buoyancy loss at different loading scenarios and time of operation. With our extensive testing data and long experience we will evaluate each specific case of use for selecting the right buoyancy grade.

Material	Density Kg/m ³	Buoyancy Kg/m ³	Typical service depth (msw)															
			30	40	55	70	100	190	230	300	390	450	540	550	650	>700		
H60	60	965	Full															
H80	80	945	Full	Partial														
H100	100	925	Full	Full	Partial													
H130	130	895	Full	Full	Full	Partial												
HCP30	200	825					Partial											
HCP50	250	775						Partial										
HCP70	310	715							Partial									
HCP90	380	645								Partial								
HCP100	410	615									Partial							

Typical service depth for each buoyancy foam. A more comprehensive calculation is needed to determine the type of material and depth recommended depending on time of operation (full orange color longer operation time).



Our product range and know-how enable us to provide total material and application solutions to our customers worldwide. Diab's Divinycell HCP can be used in applications like ROVs, submarines, AUVs, subsea buoyancy units, diving bells, and impact protection structures. Divinycell H is an all-purpose grade with an excellent strength-to-weight ratio. It's widely used in renewable energy solution applications or buoyancy units for lower depth.

PROOF OF OUR EXPERIENCES

We are privileged to have participated in partnership with some of the world's leading companies in the marine industry. Their advances in using sandwich composites and our buoyancy solutions are fascinating.

DWTEK FLAGSHIP ROV "THE INVESTIGATOR"

DWTEK is Taiwan's first marine inspection equipment manufacturer and supplier. To develop their flagship ROV, "the Investigator", they needed technical expertise, support, and suitable materials. Diab supplied both knowledge and Divinycell HCP buoyancy units for the construction. The vessel has outstanding payload capacity and works according to all requirements.

ARGUS ROV FOR SUBSEA MISSIONS

Argus designs and manufactures its range of ROVs for subsea missions like surveys, repairs, maintenance, laying cables and pollution control. Divinycell HCP offers high buoyancy uplift per weight under long-term loading conditions, to ensure a sustained operation.

THE HDW CLASS 214 SUBMARINE BY THYSSENKRUPP MARINE SYSTEMS

ThyssenKrupp Marine Systems has, from the proven design of previous submarines in the family, developed the HDW Class 214 submarine. The new sub is well-equipped to perform various missions, ranging from operations in coastal waters to ocean-going patrols. This submarine is a cost-effective weapon system thanks to its modular design and high degree of automation. It is tough to detect and, thus, the unbeatable solution for future-orientated navies.

MINESTO TIDAL STREAM & OCEAN CURRENT ENERGY

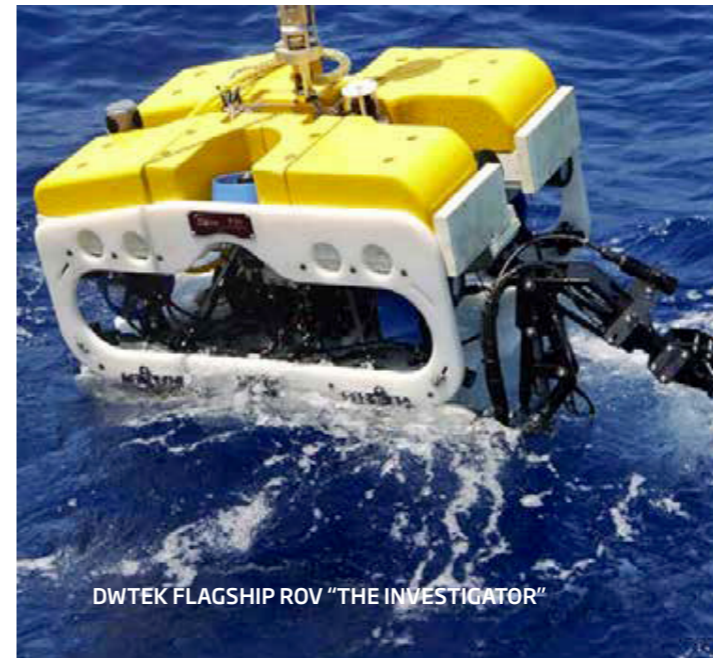
Minesto's Deep Green technology generates electricity from low-flow predictable tidal streams and ocean currents by a unique and patented principle similar to a stunt kite flying in the wind. The wing uses the hydrodynamic lift force the underwater current creates to move the kite. A light and strong FRP structure with a CNC-kitted Divinycell foam core withstands the forces generated when the kite circulates underwater at high speed.

SAAB DOUBLE EAGLE ROV

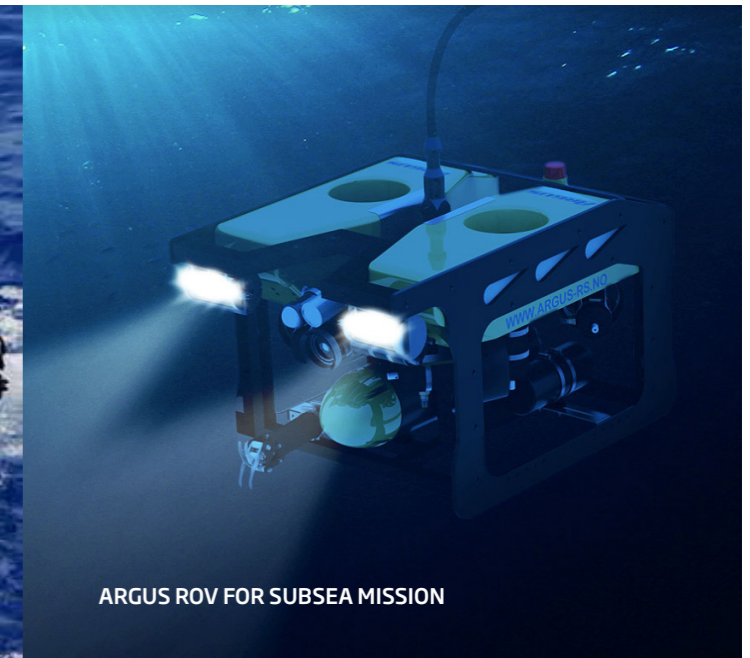
The Double Eagle ROV family is well-proven and used by global navies. Diab's well-proven PVC foam Divinycell HCP provides buoyancy to the MKII and MKIII ROVs with a 500-meter depth rating. Each foam block is tested for hydrostatic pressure to ensure safe and reliable MCM operations. Divinycell HCP family is capable of designs down to 700 meters. The buoyancy foam is supplied in machined and ready-painted modules to be installed on the vehicle.

CORPOWER OCEAN WAVE ENERGY CONVERTER

CorPower Ocean and Diab has constructed its first commercial-scale Wave Energy Converter (WEC). Using sustainable materials is particularly important in this application, as the WEC will be exposed to significant fatigue, slamming, and impact loads. The hull's sandwich structure involves Diab's unique Divinycell H-grade material, providing many benefits, including high strength, durability, impact resistance, and lightweight and buoyancy performance. Diab provided structural engineering support to ensure the correct selection of core materials and laminates.



DWTEK FLAGSHIP ROV "THE INVESTIGATOR"



ARGUS ROV FOR SUBSEA MISSION



THE HDW CLASS 214 SUBMARINE BY THYSSENKRUPP MARINE SYSTEMS



MINESTO TIDAL STREAM & OCEAN CURRENT ENERGY



SAAB DOUBLE EAGLE ROV



CORPOWER OCEAN WAVE ENERGY CONVERTER



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Diab is a world leader in sandwich composite solutions that make customers' products stronger, lighter and smarter. Diab provides a range of core materials, cost-effective kits and finishings, along with in-depth knowledge on composites. Diab also provides engineering services for composite technology through Composites Consulting Group (CCG). Diab is a participant in the UN Global Compact.