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# LIFTING YOUR SUBSEA SOLUTION

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Cost-efficient PVC foams for  
buoyancy and subsea applications



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# ALWAYS AT THE CORE OF YOUR SOLUTION

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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.



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# BEST SOLUTION FOR BUOYANCY APPLICATIONS DOWN TO 700 METERS

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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 choice for buoyancy units and sandwich structures.

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# SUSTAINABILITY IS AT OUR CORE

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We offer industry-leading competence and the broadest range of stronger, lighter, smarter sandwich cores and buoyancy materials. Since our start 75 years ago, we have developed, improved, and fine-tuned our products. Now, we are on an ambitious journey towards net zero emissions.

Today, sustainability is not an option. It is mandatory. And at Diab, we work hard to make a difference on the significant issues that matter to us all. We are firmly committed to making your solution more sustainable in every way. With our structural core materials, you can boost energy efficiency, reduce emissions, conserve natural resources, and create a longer life cycle for your product.

We have also made sustainability one of our top business priorities. For instance, we are the world's first composite materials company to set science-based targets approved by the SBTi (Science-Based Targets initiative), which have been renewed for a new five-year period. That means we have a documented plan for reducing the carbon footprint in line with what is defined in the Paris Agreement to keep the planet below 1.5 degrees overheating.

In addition, we have been awarded a silver medal by EcoVadis, one of the world's foremost sustainability rating standards. This prestigious recognition places us among the top 15% of companies evaluated globally by EcoVadis, highlighting our comprehensive commitment to sustainability across environmental, social, and governance dimensions.

## **FOSSIL-FREE PVC**

As proof of our commitment, we have started to use fossil-free plastics in the core foam. Our manufacturing site in Laholm, Sweden, has obtained ISCC PLUS certification, which means we can offer mass balanced PVC in our Advanced kits. Mass balanced material, with circular and/or biobased feedstock, resembles renewable energy. When you buy renewable energy, you can't ensure that, for example, a windmill or solar panel powers your specific outlet. Instead, you receive a certificate guaranteeing that the provider adds the same amount of renewable energy you procure to the grid. Similarly, by purchasing mass balanced material, you acquire a sustainability declaration from the supplier stating the amount of mass balanced feedstock produced in their processing unit to represent the amount in every specific supply you receive. The ISCC PLUS certification guarantees full traceability throughout the mass balanced material supply chain to the finished kit at our processing unit, including a sustainability declaration upon delivery.

# THE COST-EFFICIENT CHOICE FOR BUOYANCY UNITS AND SANDWICH STRUCTURES

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 PVC foams are appreciated for their high buoyancy per weight, low density, and high uplift. They are commonly used as floatation units in remotely operated under-water 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.

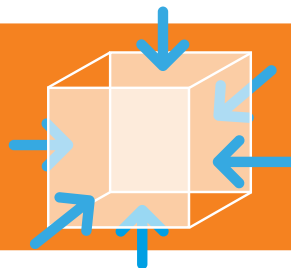
## Understanding buoyancy requirements

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 can lose 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





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# SELECTING THE RIGHT MATERIAL

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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.

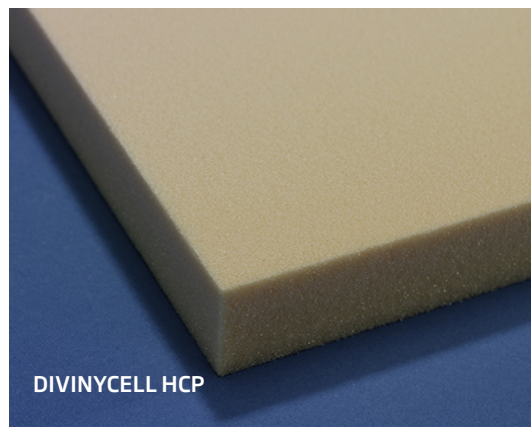
They allow for part consolidation, reducing manufacturing costs and time by avoiding riveting or joining smaller components.

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 choice 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.



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.

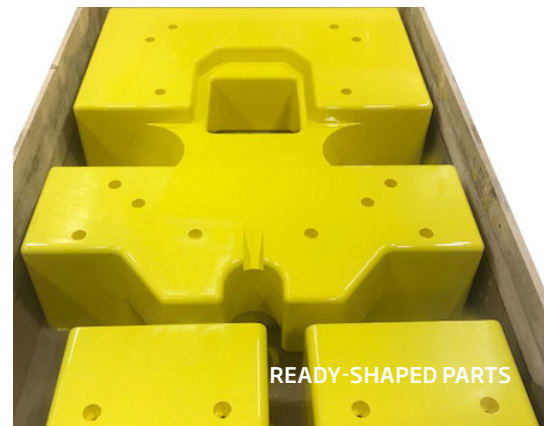
Diab provides Divinycell H in blocks or ready-shaped parts. Typically used in renewable energy solutions such as wave and tidal power generation.

### **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.





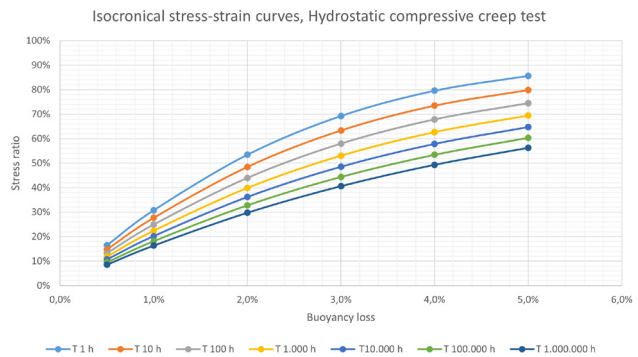
## MAKE THE MOST OF YOUR APPLICATION WITH OUR EXPERTISE

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.

## DEEP SEA SOLUTIONS

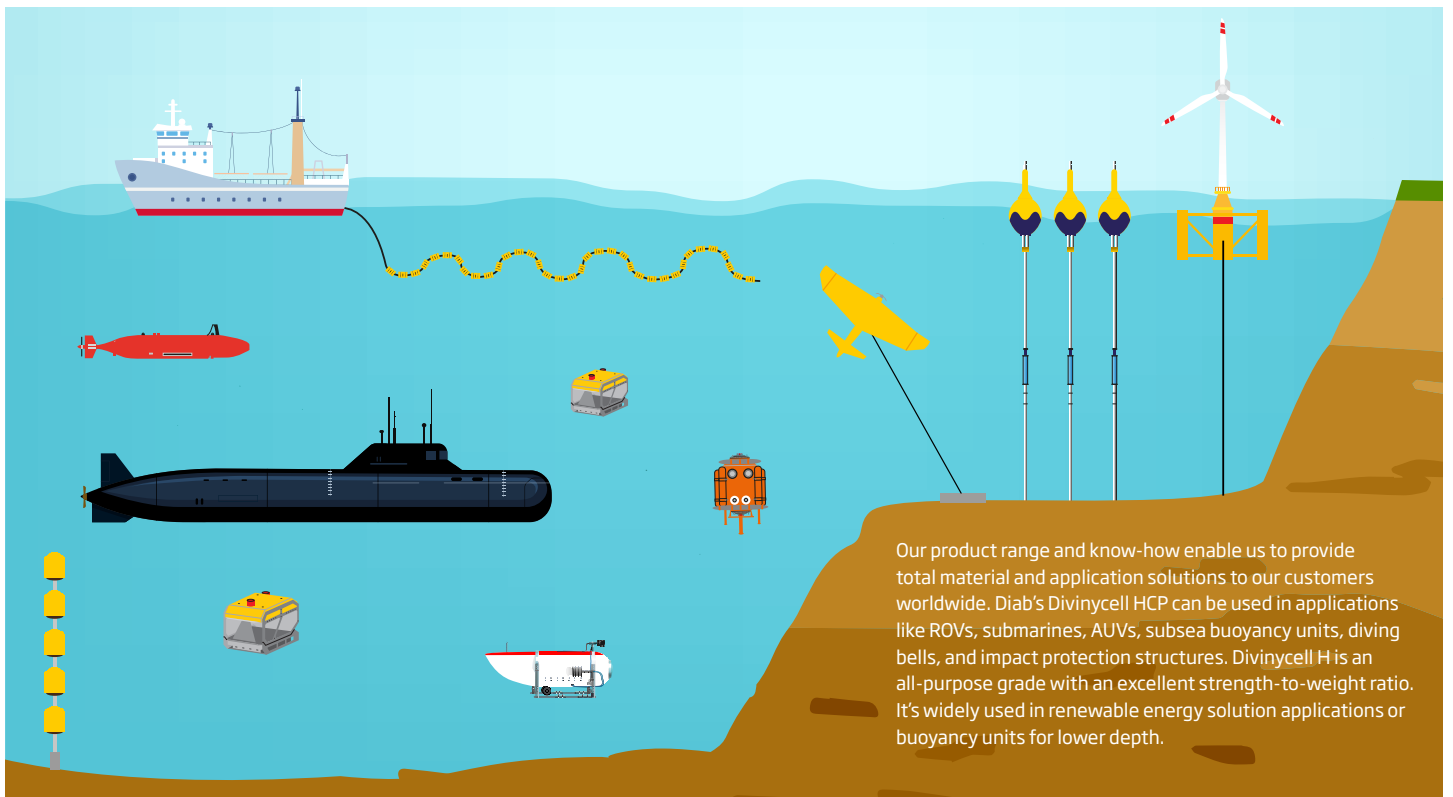
For depths below 700 meters all the way down to seabed we can provide built to print buoyancy solutions in Syntactic Foam. This through Subsea Composite Solutions, a part of Diab. Find out more at [www.scsolutions.no](http://www.scsolutions.no).



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

Typical values and service depth for each PVC buoyancy foams, not to be considered as specification. Every application and operating condition is unique. Material selection and calculation should be performed per individual condition.



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.

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# PROOF OF OUR EXPERIENCES

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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**

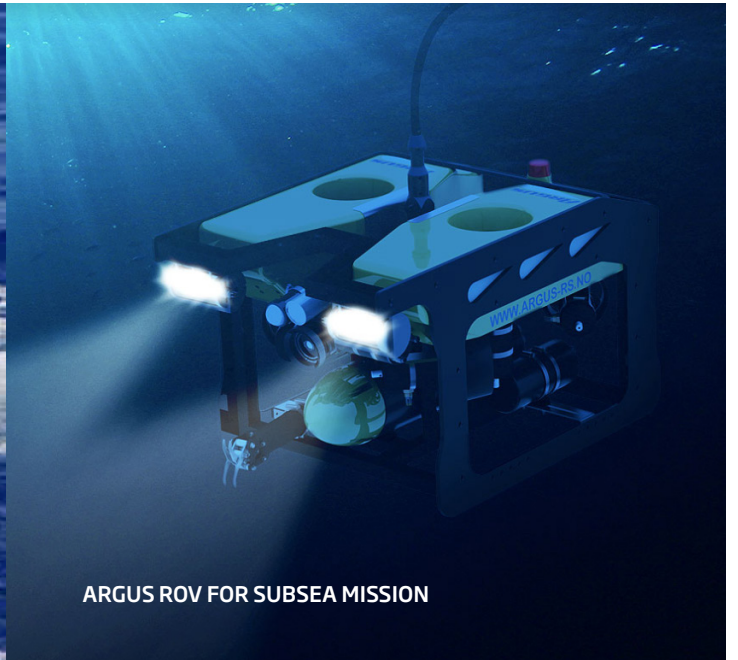
The Double Eagle ROV family is well-proven and used by global navies. Diab's well-proven PVC foam Divinycell HCP provides buoyancy to the MKII and MKIII ROVs with a 500-meter depth rating. Each foam block is tested for hydrostatic pressure to ensure safe and reliable MCM operations. Divinycell HCP family 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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