REEF ENHANCEMENT FOR SCOUR PROTECTION PROJECT

World-First Full-Scale Ecological Scour Deployment at UK Wind Farm

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2023 - 2025



ARC marine®
ACCELERATING REEF CREATION

RWE

arcmarine.co.uk

MANAGEMENT SYSTEM CERTIFICATION DNV ISO 9001 • ISO 14001 ISO 45001

Certified B Corporation

ARC'S SCOUR PROTECTION STORY

Integrating Nature-Inclusive Design (NID) into offshore energy is a pioneering way to restore ocean health. Biodiversity-enhancing scour protection has been at the core of ARC marine's work since 2017.

It reflects our mission to regenerate the world's marine ecosystems through eco-engineering, ensuring infrastructure delivers ecological benefits alongside robust asset protection.

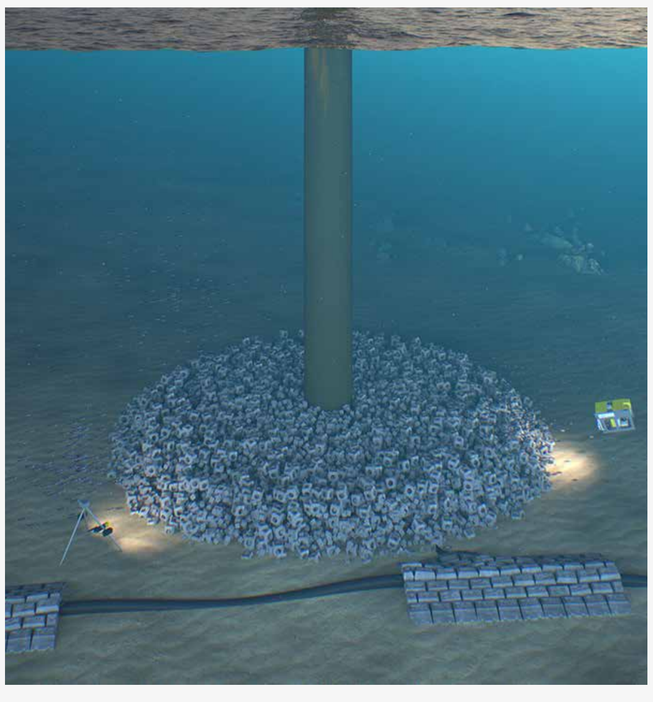
From hydrodynamic stability testing at HR Wallingford to advanced CFD modelling, we've spent years refining solutions that combine engineering excellence with habitat creation. Our Reef cubes® are low-carbon, plastic-free and designed with internal chambers to shelter marine life while shielding turbine foundations. We're proving that nature-inclusive scour protection can protect assets and enhance biodiversity for future generations.

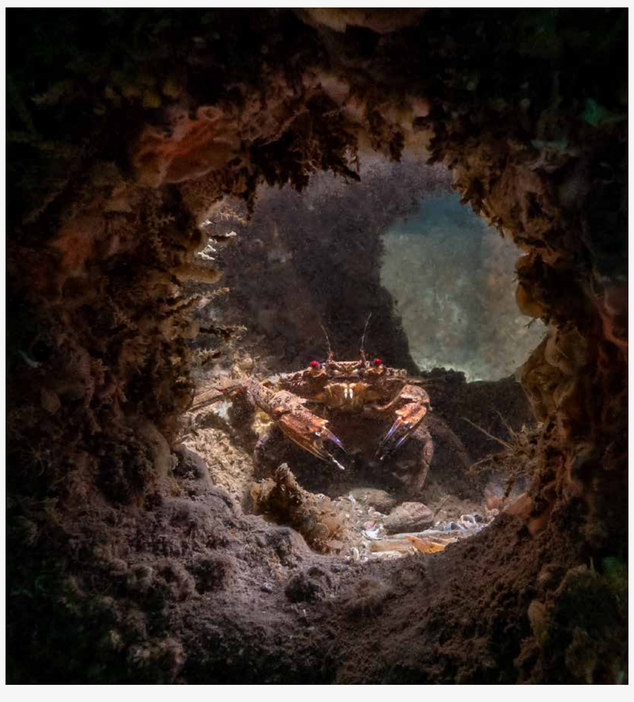
REEF ENHANCEMENT FOR SCOUR PROTECTION (RESP)

Launched in 2023 with Innovate UK funding, the Reef Enhancement for Scour Protection (RESP) project aimed to research, develop and test ARC marine's ecologically-enhanced scour protection, culminating in a live pilot installation around an offshore monopile.

Co-funded by RWE, Innovate UK and ARC marine, RESP carries a budget of €3.4M and is led by ARC marine. In partnership with RWE, the pilot will see more than 75,000 RESP cubes deployed at turbine J04 of the Rampion Offshore Wind Farm off the Sussex coast. Following the award of a marine licence in March 2025, installation is scheduled for October 2025.

Beyond Rampion, RESP has a wider ambition: to accelerate biodiversity-enhancing scour protection as a proven technology, enabling its practical integration into offshore wind developments both during and after construction.





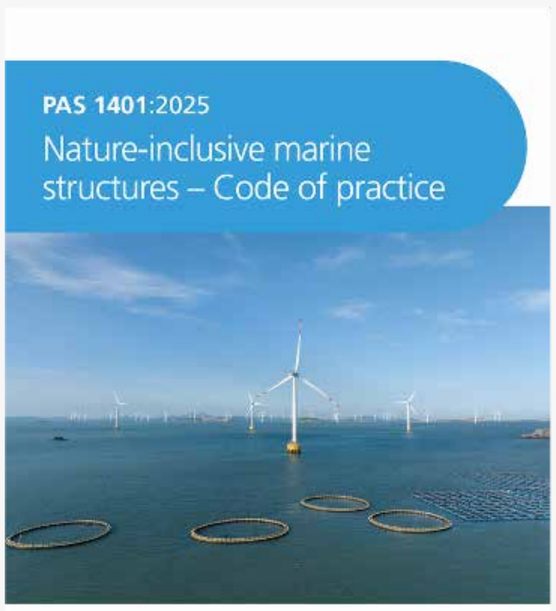
PAS 1401 NATURE-INCLUSIVE MARINE STRUCTURES

As part of the RESP project, ARC marine worked with the British Standards Institution (BSI) to develop Publicly Available Specification (PAS) 1401:2025 Nature-Inclusive Marine Structures. This landmark guidance sets out how to design, install and manage nature-inclusive marine infrastructure, giving engineers, developers and policymakers a clear framework for achieving the ecological goals of marine projects.

The PAS was shaped by a diverse steering group including APEM Group, the Environment Agency, Blue Marine Foundation, Natural England, bp, JBA Consulting, Bournemouth University, DEFRA, GoBe, Material Evolution, CIEEM, RWE and WSP.

PAS 1401 defines nature-inclusive design as **“design targeted at the integration of ecosystems, or specific habitats and species, with man-made architecture and infrastructure, via the intentional incorporation of habitat features, and backed by scientific evidence.”** It also sets out a flexible design procedure that is globally applicable.

The RESP project will mark the first systematic use of this procedure in practice, a milestone in bringing standardised, evidence-led NID into the offshore energy industry.



NATURE-INCLUSIVE DESIGN REEF CUBES®

For the RESP project, Reef cubes® are being deployed in two sizes: the RC350 (35 cm Reef cube® with a central spherical chamber and passageways) and the RC150 (15 cm solid cube). Both are engineered with Nature-Inclusive Design (NID) principles to create habitat while delivering effective scour protection.

The cubes feature a complex honeycomb surface texture, that is high in rugosity and designed to encourage settlement by fish and epibiota. Internal passages and chamber spaces provide additional refuge to support marine life.

By increasing surface complexity and refuge space, the Reef cubes® aim to enhance colonisation, promote biodiversity, and accelerate the regeneration of marine ecosystems around offshore infrastructure.

These design features have been digitally modelled and tested to optimise texture depth and habitat value, to achieve optimal performance for both ecological and engineering.

38%

increase in surface rugosity compared to rock

RC150

0.118m² surface area

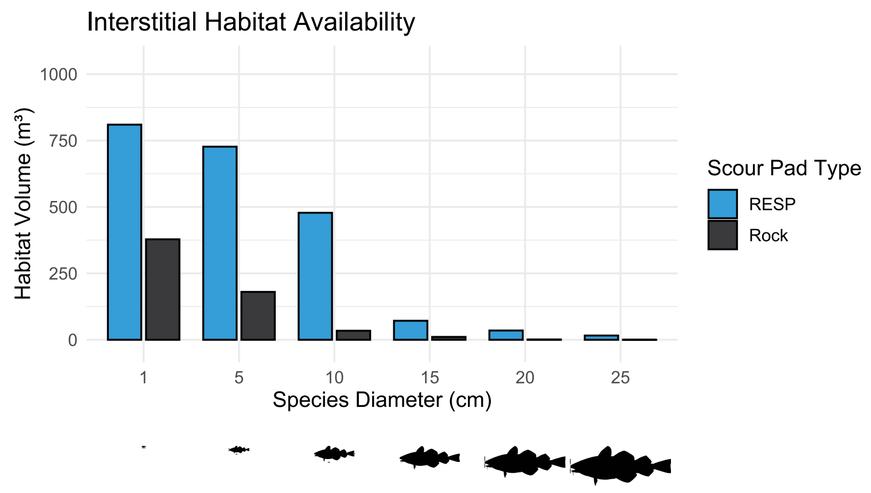
RC350

0.971m² surface area

NATURE-INCLUSIVE DESIGN THE RESP PAD

The RESP scour pad is constructed from approximately 75,000 individual Reef cubes® - around 60,000 RC150s and 19,000 RC350s. Designed to measure 32 metres across and two metres high, the pad combines robust engineering with ecological function.

Thanks to the modular design of the cubes, the way they interlock within the pad naturally creates accessible spaces and structural complexity, improving habitat metrics and providing valuable refuge for marine life.



A greater volume of space is accessible especially below 15 cm body depth (e.g. juvenile cod life stages)

791m²

HABITAT FOOTPRINT AREA

Up to 14 times more accessible space, especially for juvenile life forms.

112%

INCREASE IN INTERSTITIAL VOLUME

18,839

RC350 [Reef cubes®]

59,908

RC150 [Solid cubes]

ENGINEERING DESIGN

The RESP Reef cubes® underwent rigorous engineering assessment to ensure optimum protection of the J04 monopile foundations. Bespoke engineering calculations were developed for Reef Cubes® as a form of scour protection, informed by site-specific parameters such as depth, wave height and current speed.

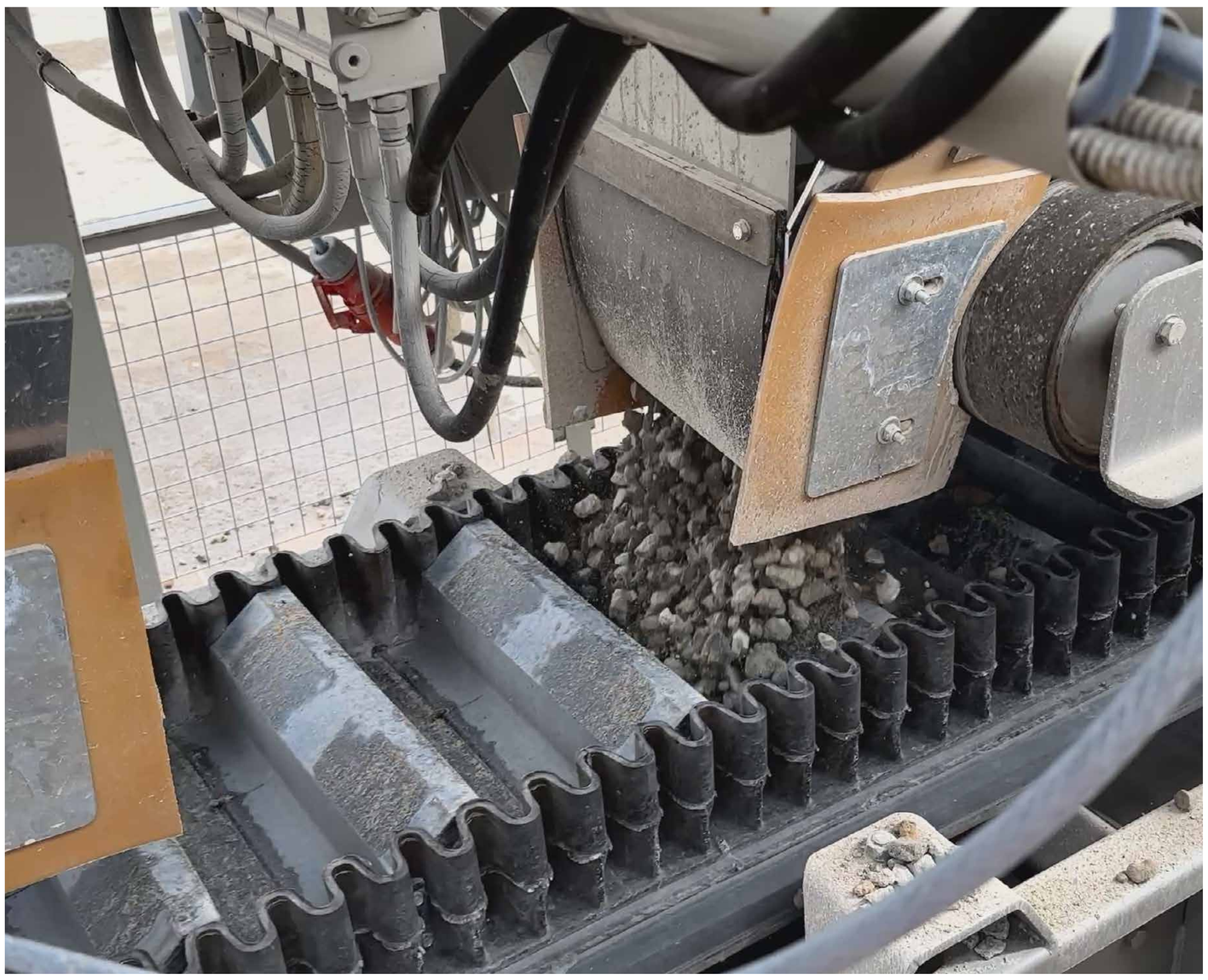
To prepare for deployment, the Reef cube® scour pad design was validated through hydrodynamic stability testing at HR Wallingford's physical modelling facilities, using real site metocean data.

Alongside the engineering programme, ecological baseline surveys were completed to establish a reference point for biodiversity monitoring, and a marine licence was successfully secured for full-scale installation at Rampion Offshore Wind Farm. Together, these steps ensure RESP is ready for safe, effective deployment offshore.

MANUFACTURING AND CONSTRUCTION

Manufacturing of the RESP Reef cubes® has now been completed, with more than 1,800 tonnes produced for installation at Rampion Offshore Wind Farm. A specialist deployment contractor has been appointed, with offshore works scheduled for October 2025.

The cubes will be installed using a fall-pipe vessel, following procedures similar to conventional rock placement, demonstrating how nature-inclusive scour protection can be delivered at scale using established offshore construction methods.



"We're proud to partner with ARC marine to advance their innovative solutions, which offer a practical and scalable approach to sustainable offshore development. ARC marine's approach - integrating eco-engineering into marine construction - is both timely and closely aligned with the growing emphasis on environmental stewardship across the industry."

- Helen Elphick, Technical Innovation Partner - Sustainability & Biodiversity, RWE

RWE

PLEASE GET IN TOUCH WITH US TO DISCUSS YOUR REQUIREMENTS AT **HELLO@ARCMARINE.CO.UK.**

REEF CUBE® SPECIFICATION

Quantity deployed:
75,000 units

Sizes:
RC150, RC350

Strength:
20-60 MPa

Nature-Inclusive Design Features:
Complex surface texture
Reef cube® chamber and passage

Emissions:
Low-carbon mix design

Materials:
98% Recycled
Meets EU leachate testing standards
Durable in harsh marine environments

TRUSTED BY

REEF CUBES® RESTORE MARINE ECOSYSTEMS AND BIODIVERSITY BY PROVIDING A SUSTAINABLE, MAN-MADE SOLUTION TO HUMAN IMPACT. ABLE TO SUPPORT THE OIL & GAS AND WIND INDUSTRIES IN REDUCING CO_2 THROUGH ECO-FRIENDLY DESIGN. PIONEERING ORGANIC MARINE GROWTH AND SUBSEA SUPPORT.

PARTNERS

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