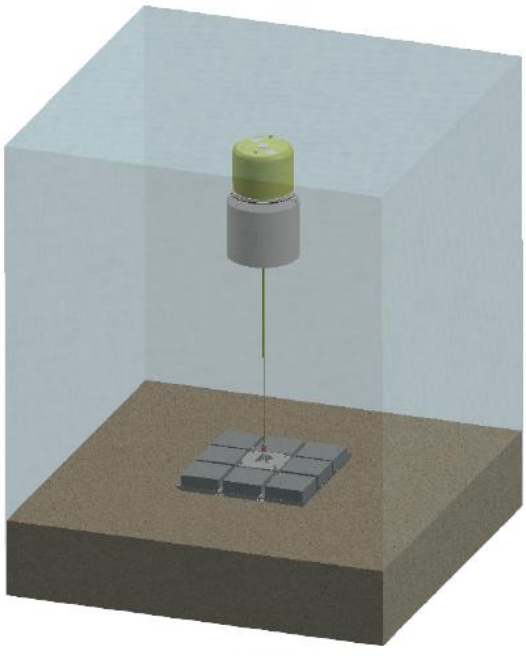
AWS OCEAN ENERGY LTD |PARTIAL SCALE WAVESWING DEMONSTRATOR

Project Information Summary

December 2020



25m WATER DEPTH

Purpose

This Project Information Summary gives a high-level view of the company, the device, and the proposed project. This document is the foreword to the project's Marine Licence application, and will feed into the rest of the application supporting documentation, including but not limited to the following documents:

- Project Environmental Monitoring Plan
- Navigational Risk Assessment Addendum
- Decommissioning Program
- Third Party Verification

Document History

Revision	Date	Description	Originated by	Reviewed by	Approved by
1	15/12/20	Originate	JM (AWS)	DL (EMEC)	

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1 Introduction

1.1 Company background

AWS Ocean Energy Ltd is a technology development company aiming to provide marine energy solutions to customers and partners worldwide. Established in 2004, AWS has developed a range of technologies and services to meet customer needs from isolated off-grid power supplies to utility scale offshore power production.

Our main focus is wave power generation technology, but we are also working on intelligent active mooring systems and sub-sea self-drilled piling equipment.

Our team has significant experience in marine engineering, technology development, business growth and fund-raising.

1.2 Technology background

The Archimedes Waveswing WEC was invented in Holland in 1996 and has undergone near continuous development since that time including the following key development steps:

- 1:20 scale proof of concept testing at university of Cork in 1998;
- Deployment of full-scale pilot test machine offshore Portugal in 2004;
- Development of commercial designs during 2004 – 2009;
- WES NWEC Stage 1 project investigating improvements in 2015 – 2016;
- WES NWEC Stage 2 project including 1:20 performance testing and 1:40 survival testing 2016 – 2018;
- WES NWEC Stage 3, including further specific performance and survival testing, 2019.

The current TRL of the technology is approx. TRL 4 to 5.

1.3 Project background

The project is being undertaken through the WES NWEC3 programme, providing a significant opportunity to advance the Waveswing technology and to achieve TRL7. The specific objectives of the project are:

- Develop the rolling seal and complete multi-cycle testing, both on dry-land and at-sea to qualify this key sub-system;
- Investigate the wider control of the device, particularly internal air pressure control and confirm stability;
- Demonstrate operation of tidal compensation system;
- Prove survival systems and survivability;
- Investigate environmental effects, biofouling, etc to inform full-scale design and gather operational data that will inform future device consenting;
- Collect load and motion data to inform and de-risk full-scale design;
- Prove the installation, removal and maintenance operations to confirm feasibility and inform full-scale design;
- Gather general experience of the device operation, what works and what doesn't work so well and identify areas for future improvement;

- Reduce uncertainties in future cost projections for both CAPEX and OPEX through experience and identify opportunities for cost reduction through improved manufacturability;
- Provide a demonstration of the technology to generate interest amongst stakeholders and potential future commercial partners and customers.
- To develop a Waveswing-specific PTO and prove this through deployment in the partial-scale device;
- Investigate and document PTO performance in a real-world operating environment;
- Replicate tank-scale power capture and control at large scale and in a real-world environment and provide data points to validate the full power matrix;

To achieve these aims, it is intended to design and build a (nominally) half-scale Waveswing (4.5m diameter, 1.5m stroke, 7.5m high and approx. mass 50ton ballasted, rated at 16kW electrical).

2 Technology

2.1 Device Description

The Archimedes Waveswing is a submerged point absorber that changes volume in response to pressure variations caused by ocean waves. Nominal rating for a full-scale device is 195kW although this is capable of being scaled up as the technology becomes further developed.

In simple form the device is a submerged telescopic structure with a lower part tethered to the seabed and the upper part free to move vertically. The device comprises two large concentric cylinders. The moving upper cylinder or Floater has a closed upper end which provides the wave absorbing surface whilst the lower, fixed part or Silo contains the PTO and other equipment. The Silo is held on station by means of a tension tether connected to a suitable anchor, the design of which is dependent upon sea-bed conditions. The relative motion between the two parts drives a power take-off unit (PTO).

The device proposed for Stage 3 open-water testing will be a half-scale machine which will contain all the major subsystems, including a fully functioning PTO and control system and representative versions of other sub-systems. The device drawings are presented in 18-002-1047

Overall, the partial-scale WEC will measure 4.5m diameter and have an approximate height of 7.5m. The PTO will have a continuous rating of 16kW. The device will be designed for full onshore commissioning and extended dry testing ahead of deployment from sea-transport at the test site.

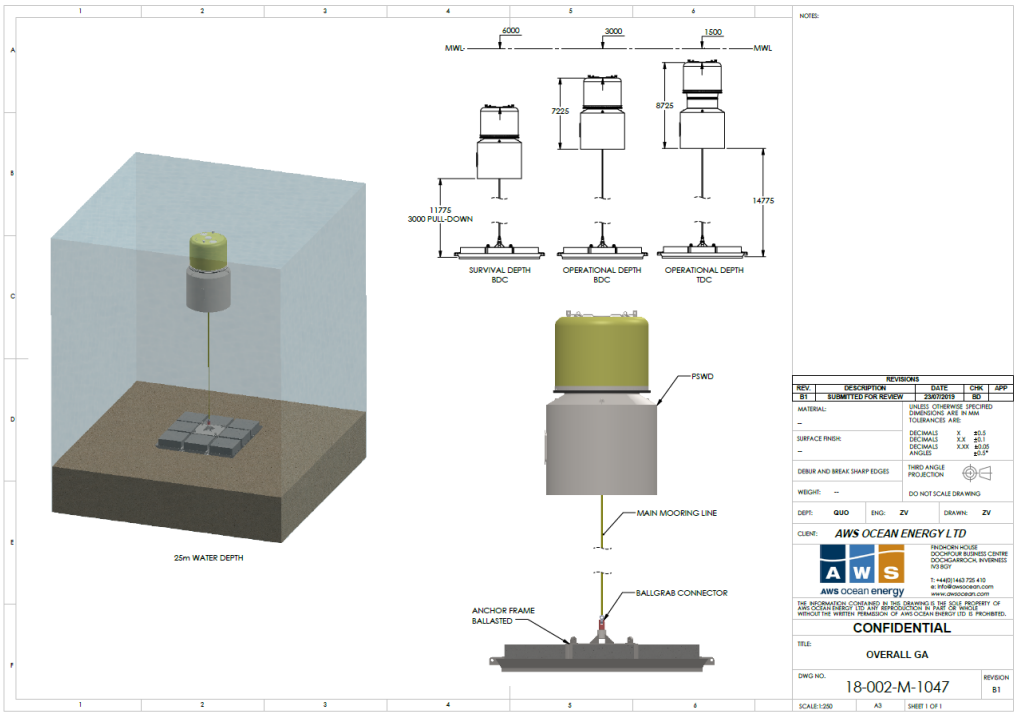

Figure 1- GA of Device (drawing 18-002-1047)

2.2 Mooring system

The device uses a single-point tension tether mooring attached to a tidal compensation winch mounted within the WEC. The tether is attached by means of a quick release 'Rocksteady' connector to a gravity-base anchor comprised of a fabricated steel frame and concrete ballast blocks. The WEC is submerged and the tidal compensation system ensures that the minimum submergence from the floater crown to the mean water level is 1.5m.

The footprint of the anchor is 8m by 8m, resulting in a total coverage of 64m^2.

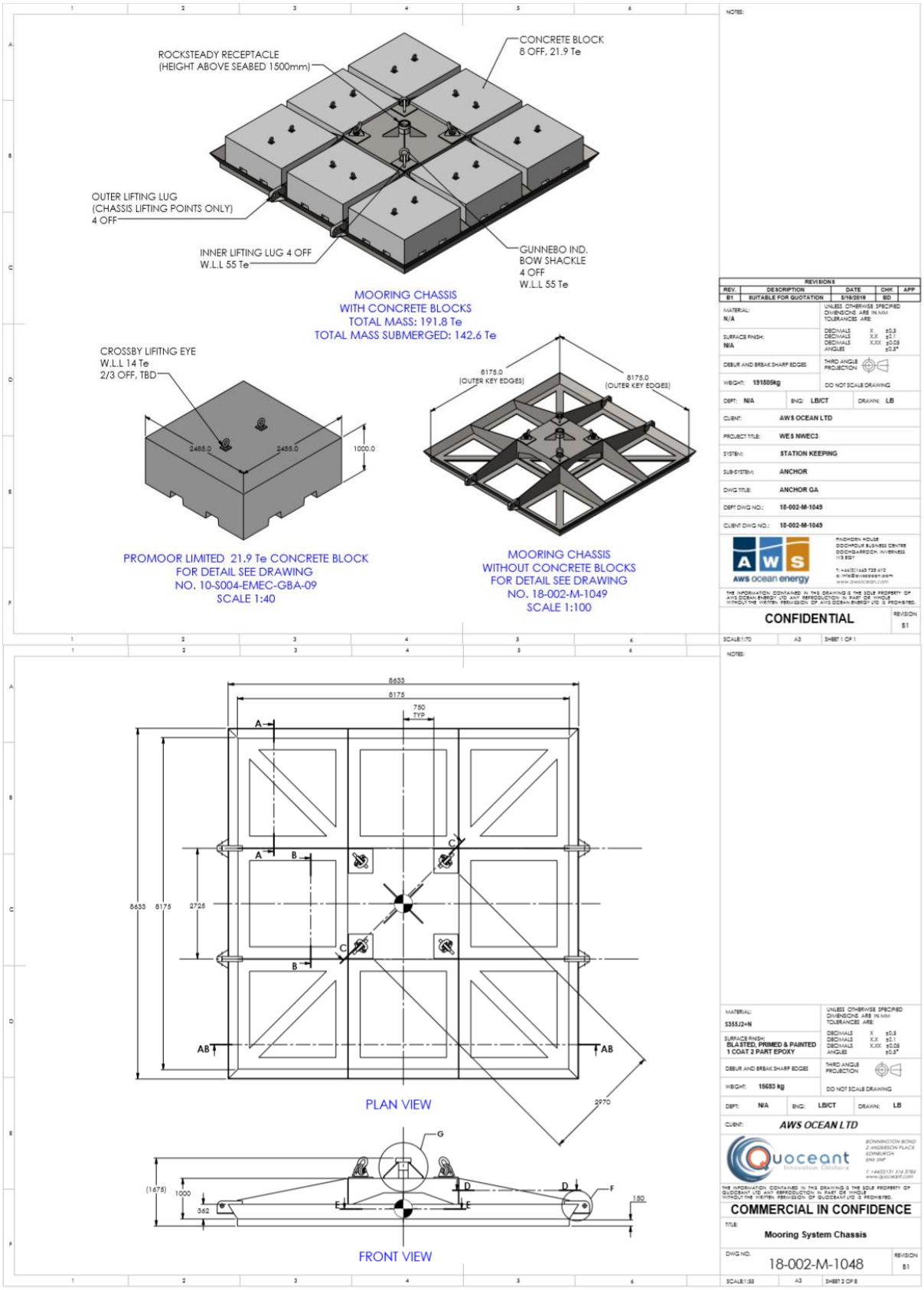

Figure 2. Anchor General Arrangement (GA)

2.3 Materials used

Components	Type of Deposit*	Nature of Deposit (P = Permanent, T = Temporary)	Deposit Quantity (tonnes, m^3, etc.)	Contingency Allowance
WEC	Steel	T	60t	10t (included)
Anchor	Steel	T	30t	10t (included)
Anchor	Concrete	T	250t	50t (included)
Umbilical Cable	Umbilical Cable	T	170m	20m (included)

Table 1. Proposed list of materials to be used

Types of deposits to consider: Steel/Iron; Timber; Plastic/Synthetic; Composite; GRP; Concrete; Silt; Sand; Stone/Rock/Gravel; Concrete Bags/Mattresses; and, Cable.

2.4 Third Party Verification (TPV)

TPV will be carried out by Orcades Marine Management Consultants.

Orcades have extensive experience of marine energy operations in Orkney waters and have provided TPV for several other devices deployed at EMEC.

3 Project Description

The Partial Scale Waveswing Demonstrator (PSWD) shall be deployed at the EMEC nursery test site at St Mary's for a period of approximately 6 months during the period April – November 2021. Prior to deployment, anchors shall be installed and checked to allow the device to be connected and disconnected on site.

Initial testing shall demonstrate marine operations such as towing, device installation and removal as well as control system functions such as "survival modes". Following demonstration of these operations, the device shall be submerged and operated sub surface.

Although the test plan is yet to be fully developed, it is anticipated that prior to normal operation, the device will be activated underwater by the control system and PTO-demonstrating the full range of motion expected. Following successful completion of the initial tests, the device will be operated in normal mode and allowed to respond to the waves experienced.

3.1 Onshore Assets

N/a

3.2 Offshore Location

The test location is situated within Berth 1 of the Scapa Flow EMEC test site as shown below:

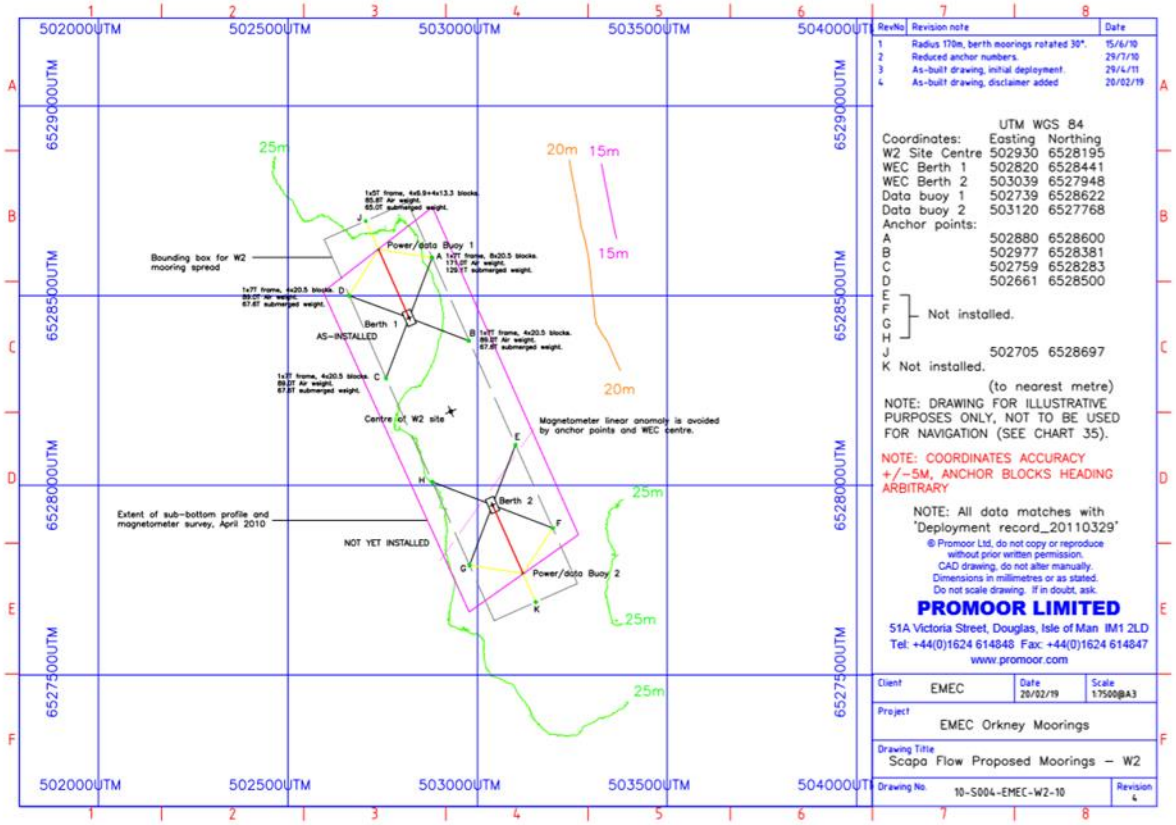

Figure 3. Test location

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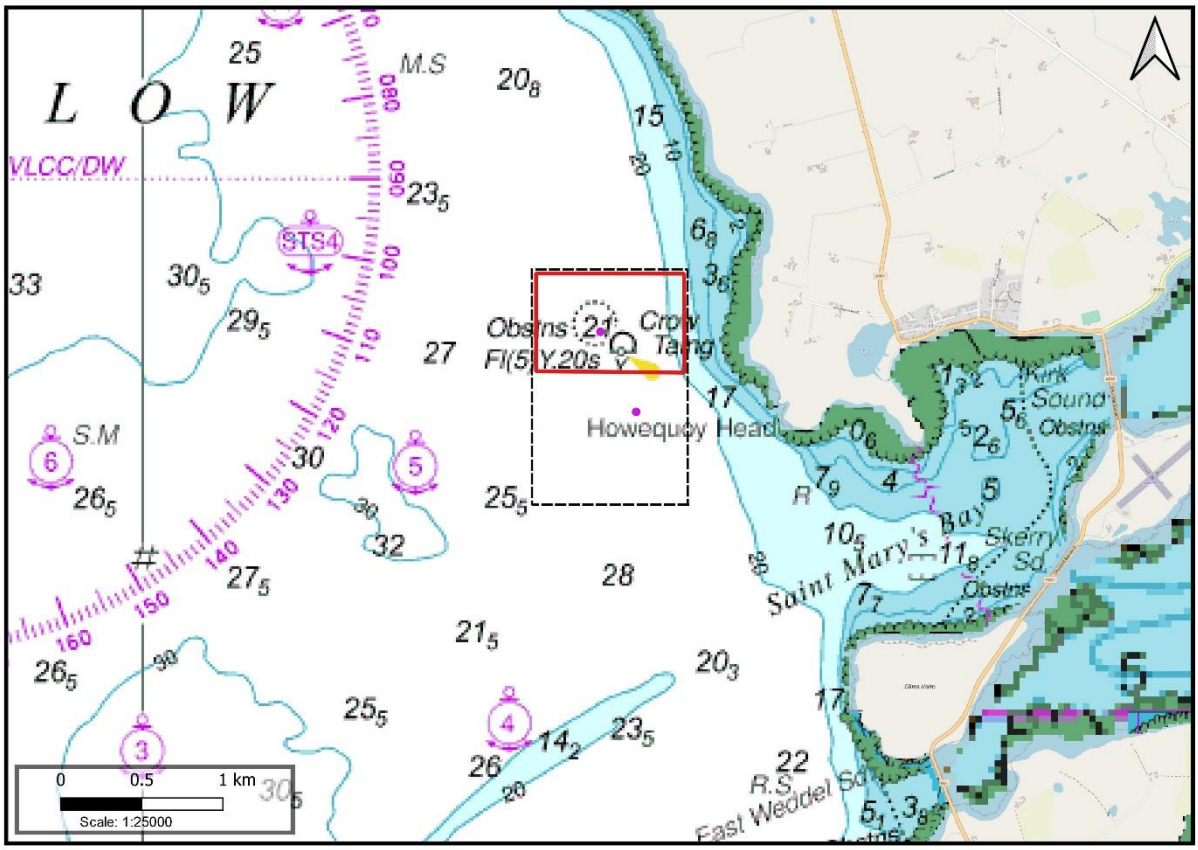

Figure 4. Marine licence boundary (red line), site boundary (black dashed line), and berths (purple dots)

Table 2. Coordinates of berth and test site boundary

Location Description	Latitude and longitude (WGS 84)				UTM (Eastings and Northings)			
Berth 1	58°53.07'N, 002°57.02'W				502820E, 6528441N			
Test site boundary points	Corner A	Corner B	Corner C	Corner D	Corner A	Corner B	Corner C	Corner D
	58° 53.950' N	58° 53.170' N	58° 53.170' N	58° 53.950' N	652882 6E	652737 8E	652737 7E	652882 6E
	002° 56.500' W	002° 56.500' W	002° 57.500' W	002° 56.500' W	503361 N	503362 N	502402 N	503361 N
Marine Licence Boundary	Corner A	Corner B	Corner C	Corner D	Corner A	Corner B	Corner C	Corner D
	58° 53.94'N	58° 53.61' N	58° 53.61'N	58° 53.94'N	652880 6E	652819 4E	652819 5E	652880 7E
	002° 57.47' W	002° 57.4'W	002° 56.52' W	002° 56.52' W	502430 N	502497 N	503343 N	503342 N

3.3 Installation method

In summary, the process envisages the device being transported from the fabrication yard to Stromness in a horizonal tow configuration using a multicat as the towing vessel.

A wet tow to the deployment site follows using a multicat to tow the WEC to the berth. The anchor will have been pre-installed, again using the multicat, or potentially the mutilcat and GM700 crane barge. The WEC mooring tether is connected to the anchor using a messenger line to guide a rocksteady connector into its receptacle. The power and controls umbilical is connected to the Test Support Buoy using a deck-mate connector allowing control of the on-board mooring line winch. The final installation stage is to winch the device down to the intended operational depth using the on-board pull-down system.

3.4 Removal method

Prior to decommissioning, a method statement will be provided.

Removal of the WEC from the Scapa Flow scale test site will involve the use of similar vessels to the installation process. The device will be winched up and disconnected from moorings, and power and controls umbilical. The device will then be wet towed to the appropriate harbour by a multicat vessel before being lifted onto a flat barge or other suitable transport vessel using a land-based crane or the Green Marine GM700 (or another similar vessel). The device will then be transported to a suitable holding location.

3.5 Anticipated vessel traffic to site

The vessels likely to be used are Green Marine's Multicat Green Isle, RIB Apollo and GM700 Gantry barge. Further Marine Operations planning is currently underway.

Table 3. Project phase and anticipated vessel traffic to site

Activity	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
Installation of anchor (**multicat & rib/workboat**)						
Installation of WEC (**multicat & rib/workboat**)						
Recovery of WEC for inspection (**multicat & rib/workboat**)						
Re-deploy WEC (**multicat and rib/workboat**)						

Recovery of WEC (**multicat & rib/workboat**)						
Recovery of anchor (**multicat & rib/workboat**)						

3.6 Device monitoring systems

The device will be monitored via a SCADA system. Communications to the device will be via an umbilical cable between the device and EMEC's test support buoy.