MAGALLANES RENOVABLES S.L. Floating energy generation platform – ATIR

Project Information Summary

May 2018

Document History

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1 Introduction

1.1 Project background

Tidal energy is one of the most interesting forms of renewable energy sources, since it is predictable. This makes tidal energy quite an attractive source of electricity for utilities to invest in. Furthermore, provided that water is about 1,000 times denser than air, it can capture an equivalent amount of energy using a much smaller machine than the one required for wind, thus reducing the comparable cost for materials. For that reason, Magallanes Renovables S.L. (the "Company") has decided to develop a high stability floating platform that will have a generating capacity up to 2 MW from tidal currents.

It is the Company's intention to test the platform at the European Marine Energy Centre (EMEC) Fall of Warness test site, Eday, Orkney Islands, Scotland. The testing period is expected to last at least twelve months, enabling the Company to assess the platform behaviour in a real open sea environment throughout the seasons of a complete annual cycle. In addition, the test campaign will be essential for going through with the precertification process before placing the platform with every guarantee on the market.

The project's key aims are the following:

- To demonstrate the operational performance of a grid connected full-scale prototype in a real open sea environment;
- To improve the prototype for cost competitive energy generation;
- To precertify the real-scale prototype, with an independent electrical power performance assessment;
- To develop a business strategy and marketing approach according to the project outputs and to identify potential customers during the project deployment.

The information obtained from tests will be crucial for the future of the project, since it will help to confirm whether the costs of installation, operation, maintenance and removal, together with the electricity generated, fit with what had been forecasted.

This document has been produced in support of a marine licence application for installation, testing and removal at EMEC's Fall of Warness test site. In addition, this document should confirm that the project falls within the project design envelope and thresholds of the EMEC held section 36 consent under the Electricity Act 1989. This consent was granted in 2016 by Scottish Ministers, to construct and operate the EMEC Fall of Warness test site with a generating capacity of up to 10 MW.

1.2 Company background

Magallanes Renovables S.L. is a limited company registered in Spain that started its business activity in 2007 and, since then, has focused its activity on the development of a floating platform and its different systems in order to harness the energy of tidal currents and to convert it into electrical energy. The Company aims to become a world leader in the production of floating platforms for the generation of electrical energy from tidal currents.

Magallanes Renovables S.L. is supported by its holding company Sagres S.L., national leader with international presence in the sector of integrated supply of specialized high-performance clothing.

The Company relies on a multidisciplinary group of experts specialized in different fields. This team has played a leading role in the success achieved so far, although collaboration has also been established with numerous companies focused on the naval sector, together with technological, engineering and composite materials companies. This has enabled the creation of synergies by adapting the knowledge of those sectors to each of the platform's systems.

1.3 Technology background

The origins of what is now referred to as "the platform" are dated 2007, which was when the Company was established to conduct research into a new way of obtaining electrical power from tidal currents.

During 2008 and 2009, the first prototype of the platform was designed, with the aim of fulfilling the following requirements: floatability, simplicity, sturdiness, minimal moving parts in the water and facilitating maintenance tasks. A significant number of design alternatives were assessed at that stage, as well as simulations aimed at optimising the platform's stability under different wave spectra, wind and tidal currents.

Throughout 2010, the knowledge acquired in the previous stages was put into practice for developing a 1:10 scale model of the platform. The scale model was constructed in 2011 and tested during 2012. Both dry dock and sea trials have been carried out. Dry dock tests were conducted in the town of Redondela (Spain), whereas sea trials were undertaken at different locations in the Vigo estuary (Spain) and in the estuary of Miño River, close to the town of A Guarda (Spain). The at sea test programme included, among others, navigability, stability and rotor behaviour tests, together with survival assays and the analysis of the anchoring system. The operation of the electrical and electronic systems, including energy conditioning and storage, was also tested. It is also worth mentioning that official testing of the 1:10 scale model at EMEC was successfully accomplished in 2015.

With the data obtained from 1:10 scale model assays the Company improved the platform design and upgraded the test programme, proving different components integrated into the platform. Due to the nature of the platform, minimal human intervention is required, allowing the platform to stay on site for long periods of time. This is facilitated by a remotely operated control system and a communication system.

All this enabled the further development of a full-scale prototype, whose design began in 2013 and assembly finalised in 2015. Nevertheless, aimed at moving forward in the optimisation of the platform and, therefore, achieving a more efficient and effective device, the Company is currently upgrading the full-scale prototype. The device launch took place in April 2017, in Vigo, as it can be seen in Figure 1 below.

Figure 1. Device launch in Vigo

After the tests to be performed in Vigo estuary and its surroundings, which will confirm that systems and subsystems work properly, this prototype will be the one deployed for the testing campaign under open water conditions at EMEC's full-scale tidal test site, Fall of Warness.

2 Device Description

The full-scale prototype to be tested (at EMEC) can be broken down in the following blocks: upper block, vertical block (or mast) and lower block (or nacelle).

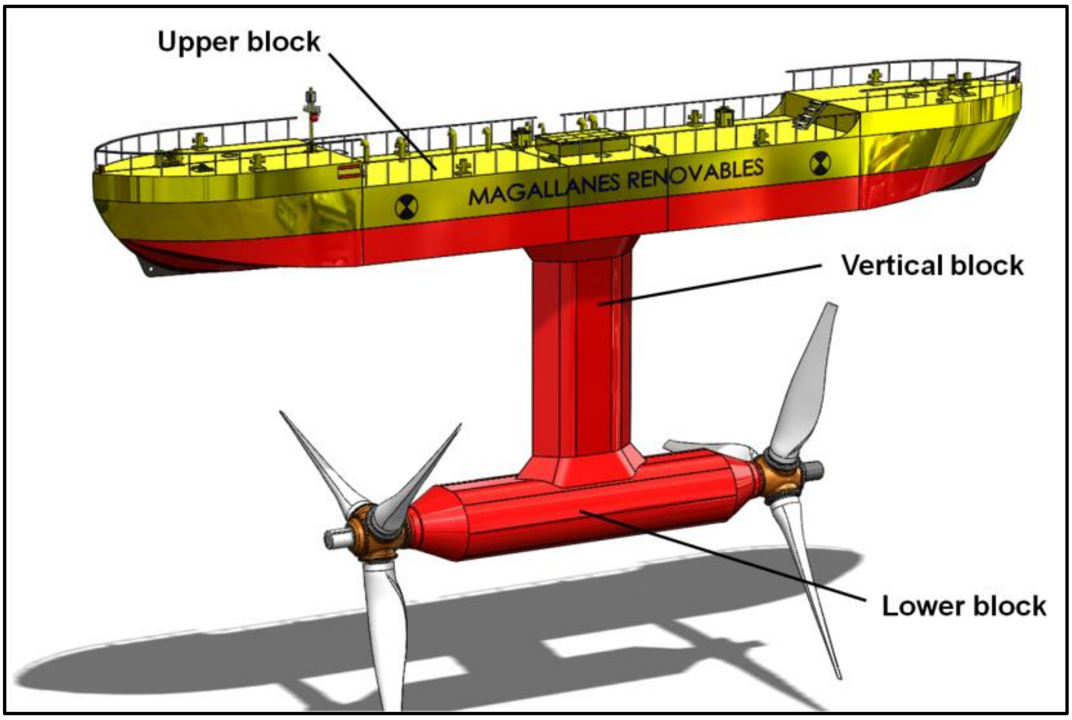

Figure 2. Scheme of blocks distribution

Upper block

It is the visible block of the platform, as around a half of it is above the waterline. It is the block through which the platform is accessible for maintenance. It is divided into three main rooms: one room is allocated to pumps and emergency power systems, whereas the other two rooms have been designed for accommodating the transformers, converters, switchgears and electrical panels, in addition to other parts of the electrical and electronic systems. Apart from these three main rooms, there are two inaccessible compartments at both ends of the block which are part of the ballast system which employs fresh water treated, as well as several tanks in the centre of the block for environmental acceptable lubricant supply and bilge water.

Vertical block (mast)

Fixes the lower block to the upper block. It is a hollow space through which the communication and low-voltage cables connect the equipment housed in the lower block with the parts of the systems within the upper block. Rigid pipes for environmental acceptable lubricant supply and draining, among others, are also installed in the vertical block.

Lower block (nacelle)

It is significantly smaller than the upper block and it is devoted to the mechanical system. The most relevant components placed in this block are the main shafts, ball bearings, gear boxes and generators. As it had been indicated before, the platform is fitted with two counter-rotating rotors. As a result, all components of the mechanical system shall be in duplicate (one for each rotor).

A scheme related to the mechanical system for one of the rotors is illustrated in Figure 3. The mechanical system for the other rotor is identical, but installed oppositely, in the other end of the lower block.

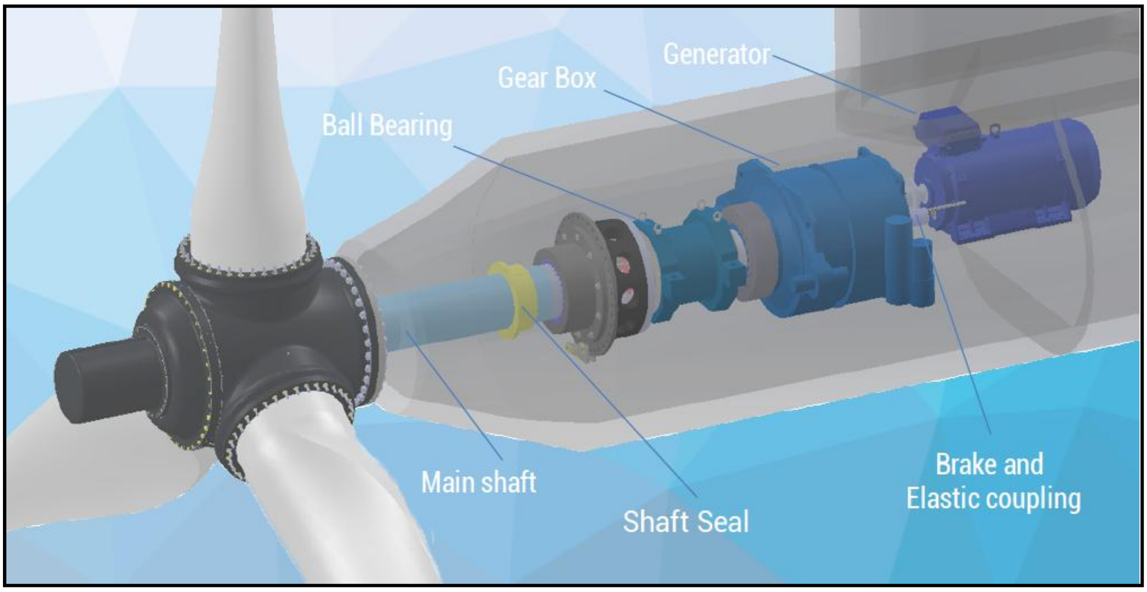

Figure 3. Main components of the mechanical system

Out of the lower block but aligned with the main shaft is the hub with the three blades, comprising the rotor.

The following figure, Figure 4, outlines the indicative overall dimensions of the platform, in meters.

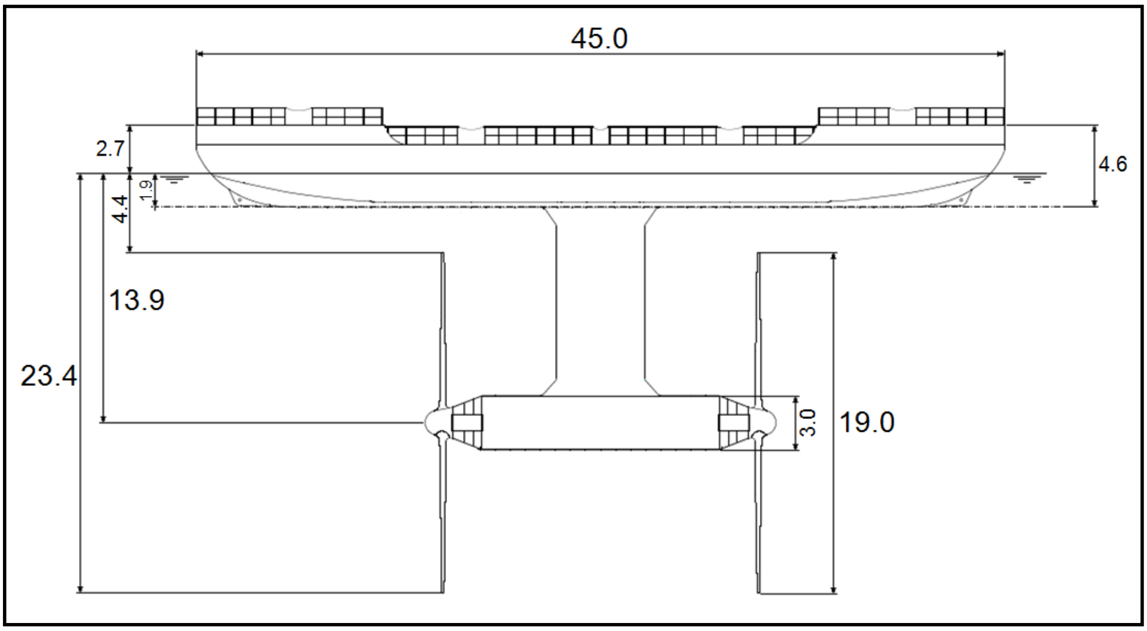

Figure 4. Indicative overall dimensions of the platform

Dimensions have been rounded to the first decimal place.

Table 1 summarises the main specifications of the platform.

Table 1. Main specifications of the platform

Item	Specification
Scale of the device	Full-scale
Overall length	45 m
Extreme moulded breadth	6 m
Operational draught	23.4 m
Maximum output power	Up to 2 MW
Number of rotors	2
Type of rotor	Open-bladed rotor
Rotor diameter	19 m
Rotor depth	More than 2.5 m clearance from sea surface (4.4 m approx.)
Blade/rotor design	Blades with counter-rotating mechanism
Mooring system	gravity-based anchors with four mooring lines attached (ca. 300 m, each)
Relative position of the device on the water's surface	Not more than 300 m from the berth cable end

2.1 How it works

The platform is fixed to the seabed with four anchor points, two located at the bow of the platform and the other two at the stern. Once moored, tidal currents turn the blades of the two counter-rotating rotors, which are operational at the same time. The movement of those blades produces the spinning of a shaft and, subsequently, by means of a generator, such mechanical energy is converted into electricity. A power transformer increases the voltage so as to reduce energy losses during power take off. Finally, the electricity generated by the platform is transmitted first through an umbilical cable and then through EMEC's subsea cables to EMEC's shore-based substation for onward transmission to the National Grid.

Concerning the umbilical cable, one of its ends will be inserted in the platform from the deck of the upper block (just above the electrical compartment). Then, the umbilical cable will be fixed along the deck until it leaves the platform from one of the ends of the upper block (bow or stern).

The diagram below, Figure 5, shows some of the components necessary for obtaining electrical power from tidal currents, whereas in Figure 6 the scheme of the umbilical cable entering the platform can be seen.

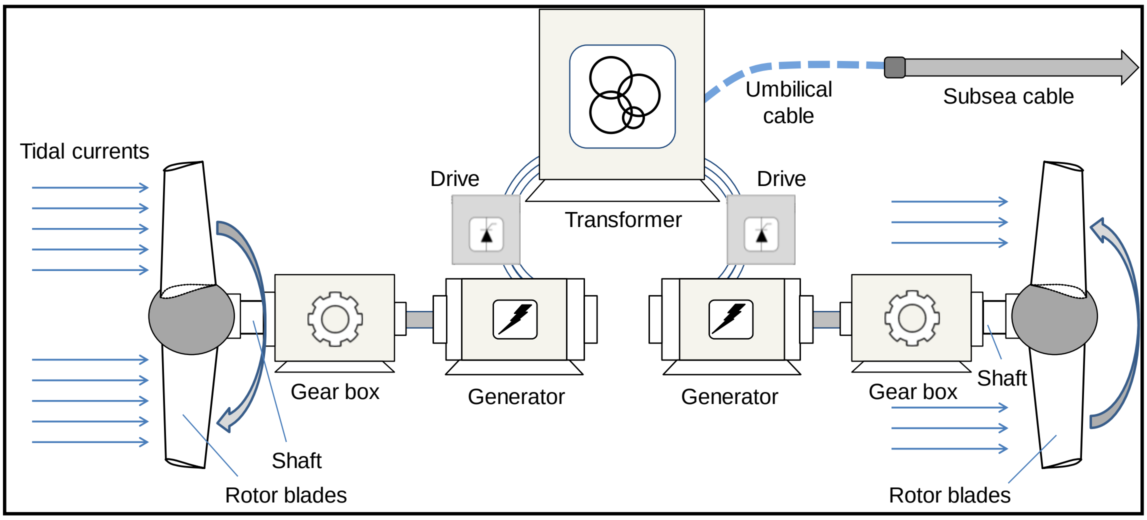

Figure 5. Diagram of electrical power generation from tidal currents

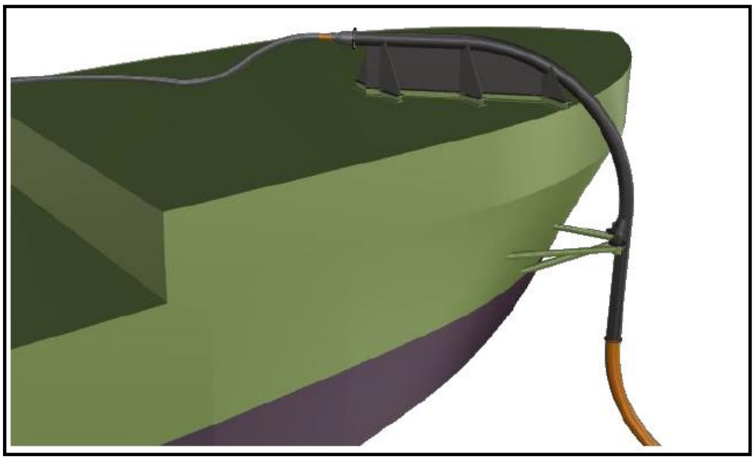

Figure 6. Scheme of umbilical cable entering the platform

2.2 Mooring system

As it has been mentioned above, the floating platform is moored by bow and stern, fixed to the seabed by means of four anchor points. Several anchor points, such as embedment anchors or gravity-based anchors have been assessed; in this sense, gravity-based anchor option is the one finally chosen at the Fall of Warness test site.

In summary, the mooring system consists of 4 chain catenary legs, two north and two south, attached to one hull attachment points at the bow and stern. The mooring system holds the ATIR platform in line with the current flow. The design is shown in Figure 7 below.

- Two legs are positioned along the centre-line, principally in line with the flow (approximately 10 degrees off).
- Two legs are offset from the centre-line by 45 degrees to the west. These lines assist in reducing device yaw and easterly excursion.

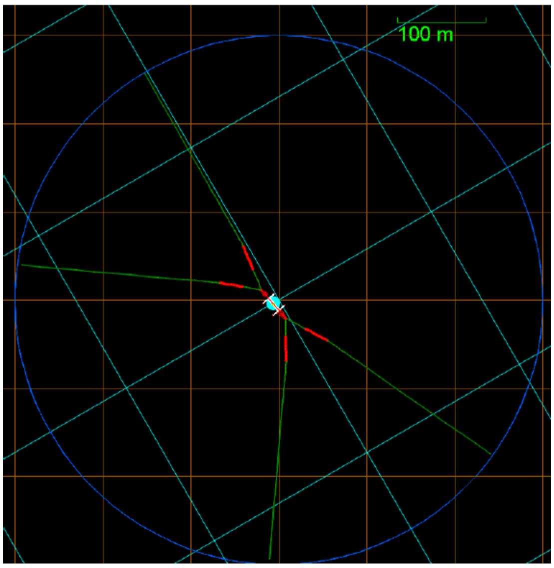

Figure 7. Proposed mooring system

Each mooring leg is identical, but only up to the gravity anchors themselves. The anchor sizes vary due to the statistically derived environmental loading and the larger environmental forces from the North. The elements comprising the mooring system together with their approximate size are indicated below:

- Hull Attachment
  - A single padeye at the bow and stern, in which a single shackle is connected and from which two mooring lines are attached.
- Upper catenary chain
  - 5m of 76mm chain (x8)
  - 40m of 80mm Bridon Superline Polyester (x4)
  - 125t WLL Bow Safety Shackle with spacers (x8)
  - 250t WLL Bow Safety Shackle with spacers (x6)
- Catenary link
  - 7.5m of 38mm chain (x2)
  - 13.5Te Bow Safety Shackle (x4)
  - 38Te Masterlink (x4)
- Excursion Limiter
  - 76-111mm chain or similar arranged in 4 lengths of 30m connected at each end by a triplate (x16)
  - Pins – as appropriate (x 40)
  - Triplate (x8)
- Ground Chain/Lower Catenary
  - 227.5m of 76mm chain (x3) and 225m of 76mm chain (x1)
  - 85t SWL Bow Shackle and spacers (x8)
- Chain Clump Anchor (dry-weights)
  - The device is connected to the seabed using four chain clump weights with a total capacity (wet weight) as follows:
    - NW – 90 Te
    - NE – 161 Te
    - SE – 163 Te
    - SW – 137 Te

For transporting and lowering chains and chain clump anchors, support vessels and vessels with deck crane may be used. Gravity-based anchors together with the mooring lines ensure that the position of the platform within the berth is maintained, and the survivability of the device during its operation is guaranteed in rough wind conditions and waves.

A basic scheme of the mooring system to be used is illustrated in Figure 8 below.

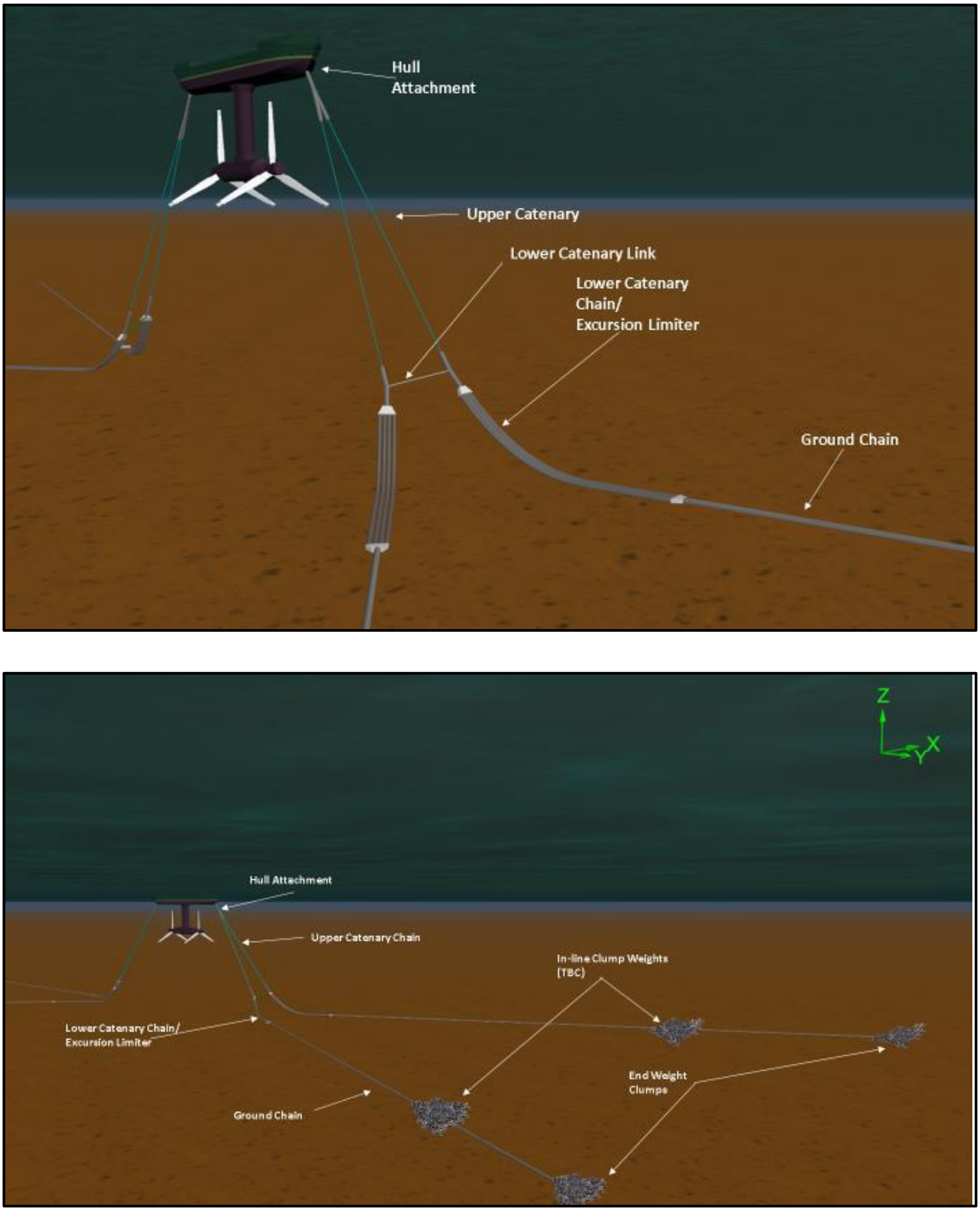

Figure 8. Scheme of mooring system

Anchor points will be settled in such a way that the platform will always stay within the limits of the berth, i.e. within approx. 300 m radius (included contingency) from the berth cable end. Nevertheless, once deployed the platform, exact coordinates of the anchor points will be provided.

2.3 Materials used

Materials used in the construction of the device, together with the mooring system, are listed in Table 2 below. Please note that around a 20% contingency has been added to the following deposit quantities, and it is expected that the final amounts will be less than those indicated in Table 2. If a licence is granted, a FEP5 form will be completed after installation to confirm the quantities installed.

Table 2. Materials used in testing the device at EMEC

Fall of Warness		
Type of Deposit	**Nature of Deposit (P = Permanent, T = Temporary)**	**Deposit Quantity (tonnes, m^3, etc.)**
Steel/Iron	P	≈ 2500 tonnes
Timber	-	-
Plastic/Synthetic	-	-
Composite	P	≈ 10 tonnes
GRP	-	-
Concrete	-	-
Silt	-	-
Sand	-	-
Stone/Rock/Gravel	-	-
Concrete bags/mattresses	-	-
Cable	P	≈ 420 m
Other (please detail below):		
Steel/Iron	T	≈ 150 tonnes
Environmental acceptable lubricant (Biovesta-46, or similar), fulfilling ISO 15380 requirements	P	≈ 12 tonnes
Diesel oil (for emergency power generator only)	P	≈ 1 tonne
Shapinsay Sound		
Type of Deposit	**Nature of Deposit (P = Permanent, T = Temporary)**	**Deposit Quantity (tonnes, m^3, etc.)**
Steel/Iron	T	≈ 600 tonnes
Timber	-	-
Plastic/Synthetic	T	≈ 30 m^3
Composite	T	≈ 10 tonnes
GRP	-	-
Concrete	-	≈ 400 tonnes
Silt	-	-
Sand	-	-
Stone/Rock/Gravel	-	-

Concrete bags/mattresses	-	-
Cable	-	-
Other (please detail below):		
Environmental acceptable lubricant (Biovesta-46, or similar), fulfilling ISO 15380 requirements	T	≈ 12 tonnes
Diesel oil (for emergency power generator only)	T	≈ 1 tonne

Please note that all deposits (steel/iron, composite, etc.) referred to as “Temporary” are due to the fact that the platform is going to be temporarily moored at the Shapinsay Sound scale test site, before it is finally towed and deployed at Fall of Warness test site.

3 Project Description

3.1 Location

The platform is intended to be deployed at the EMEC Fall of Warness test site, off the island of Eday, Orkney, in the allocated berth. Nevertheless, in certain moments, the platform will make use of EMEC's Shapinsay Sound test site, east of Kirkwall just off the Orkney mainland. The more benign conditions found there will facilitate the assembly and disassembly of the rotor blades, as well as the undertaking of maintenance tasks, if needed.

Figure 9 to Figure 12 illustrate the area of EMEC test site at Fall of Warness, together with the position of berth, the mooring system footprint as well as detailed schematic encompassing other berths. The selected berth is test berth 1.

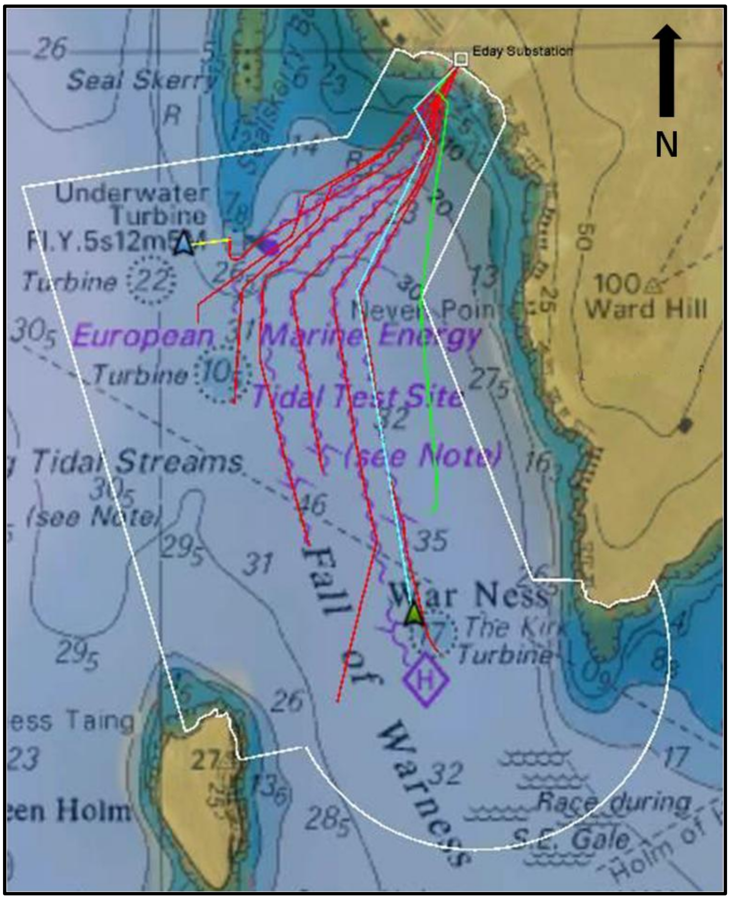

Figure 9. Chart showing the area of EMEC Fall of Warness test site

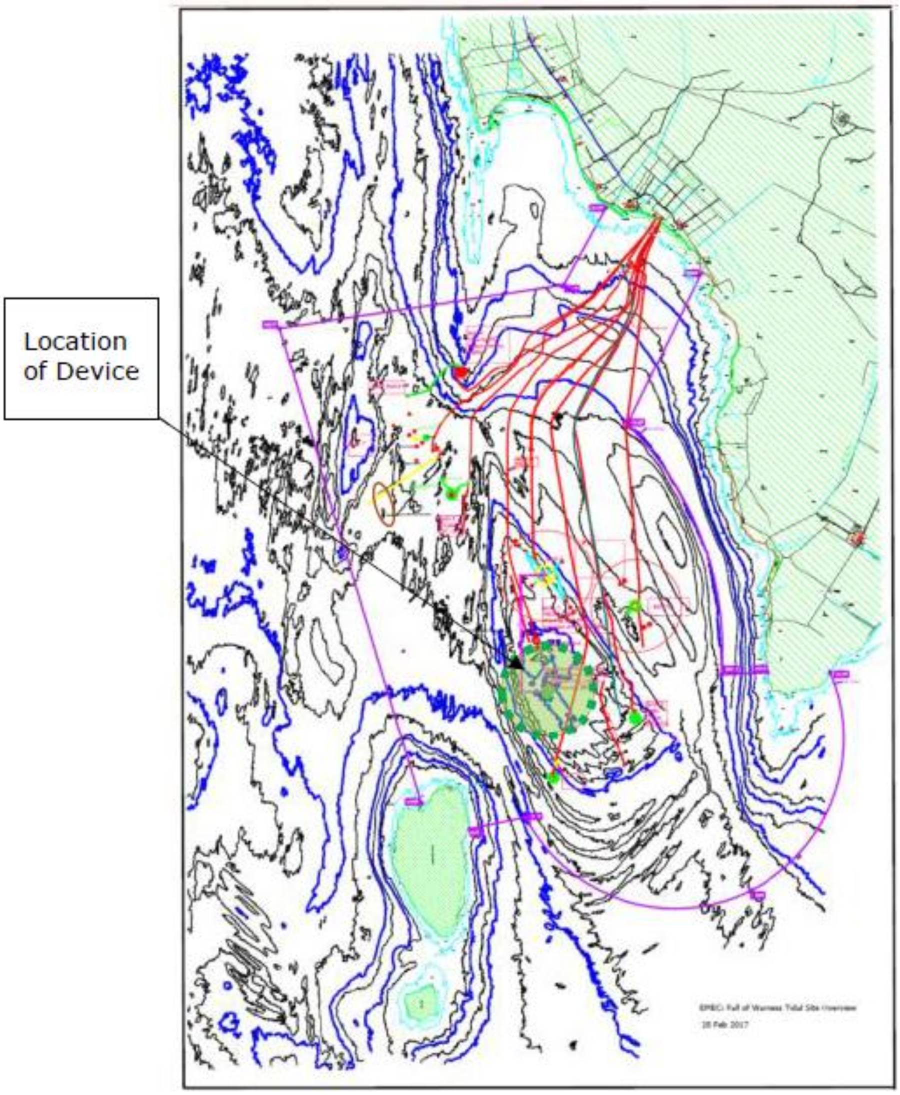

Figure 10. Location of device

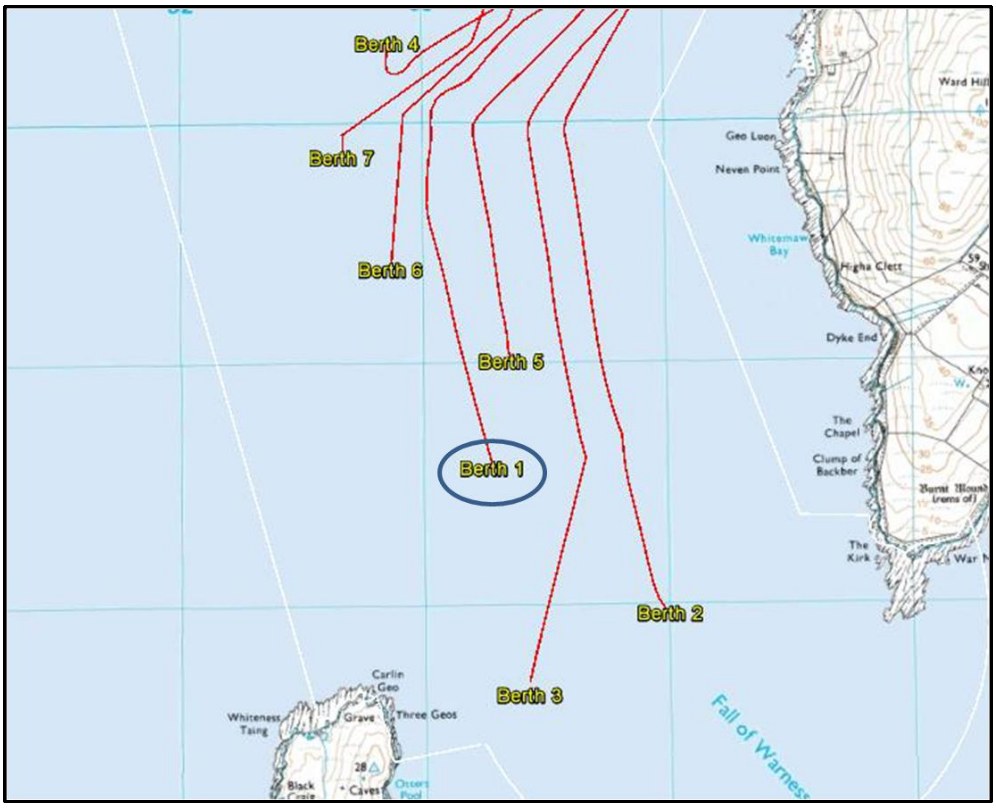

Figure 11. Test berth for deploying the platform

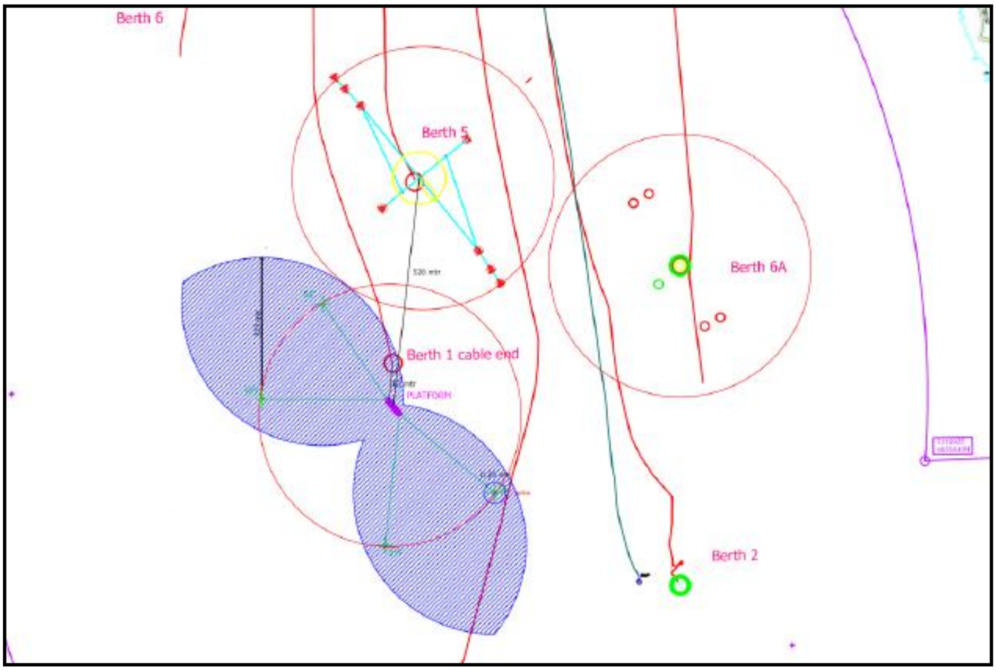

Figure 12. Detailed schematic encompassing other berths, with the maximum academic excursion following any single failure event of the mooring legs

The deployment will take place in the vicinity of the berth location and within the boundary coordinates provided in Table 3 and shown in Figure 13 below.

Table 3. Deployment location at EMEC's Fall of Warness test site

Test berth	Latitude (WGS84)	Longitude (WGS84)
Berth 1	59° 08.484'N	02° 49.037'W
Points along platform deployment boundary	59° 08.441'N 59° 08.593'N 59° 08.337'N 59° 08.195'N	02° 49.477'W 02° 49.185'W 02° 48.692'W 02° 49.054'W

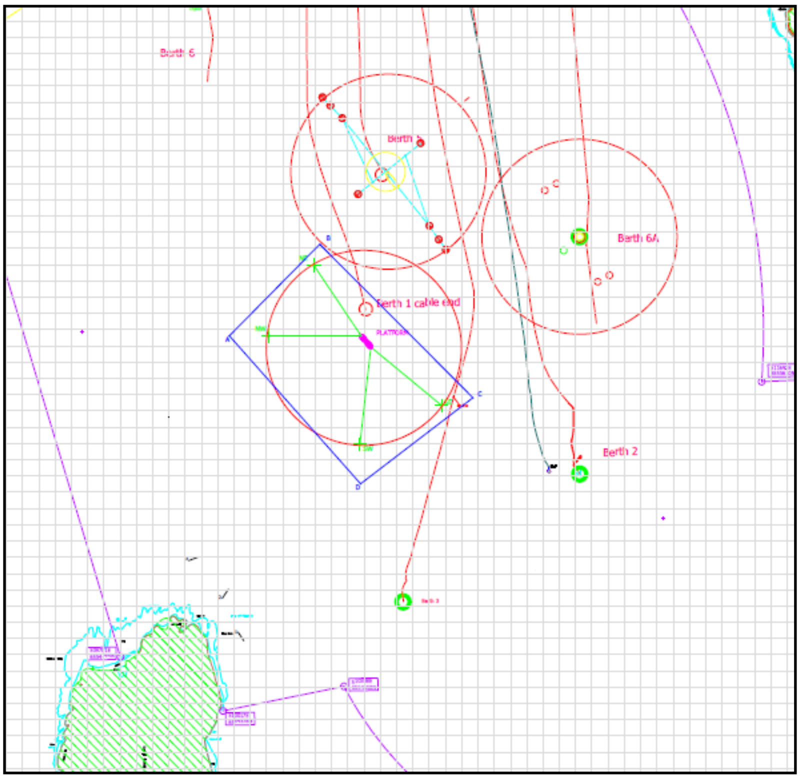

Figure 13. Platform deployment boundaries, Fall of Warness

3.2 Installation method

The platform, without the blades, will be towed by a tug vessel from Vigo estuary (Spain) to EMEC's scale tidal test site, Shapinsay Sound. Shapinsay Sound is located east of Kirkwall just off the Orkney mainland, see Figure 14. At present, the details of the tug which will be employed are not known, but it is expected such a vessel will have a length no greater than 31 m and a draught up to 5 m.

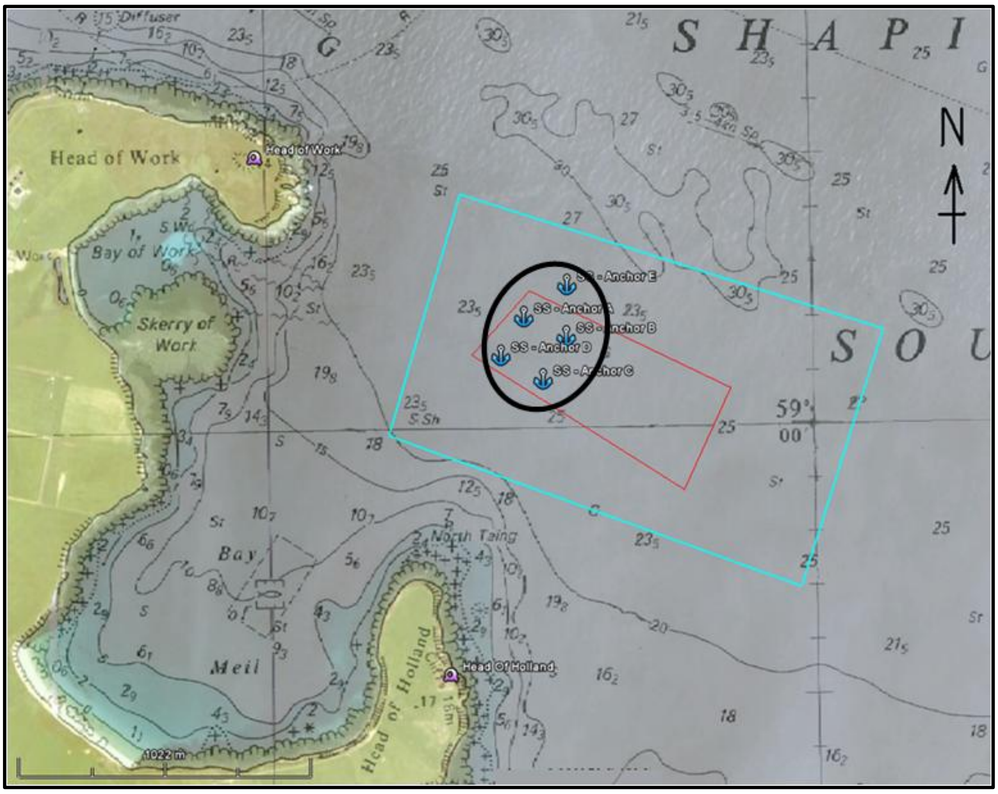

Figure 14. Map showing area of EMEC's scale tidal test site, Shapinsay Sound

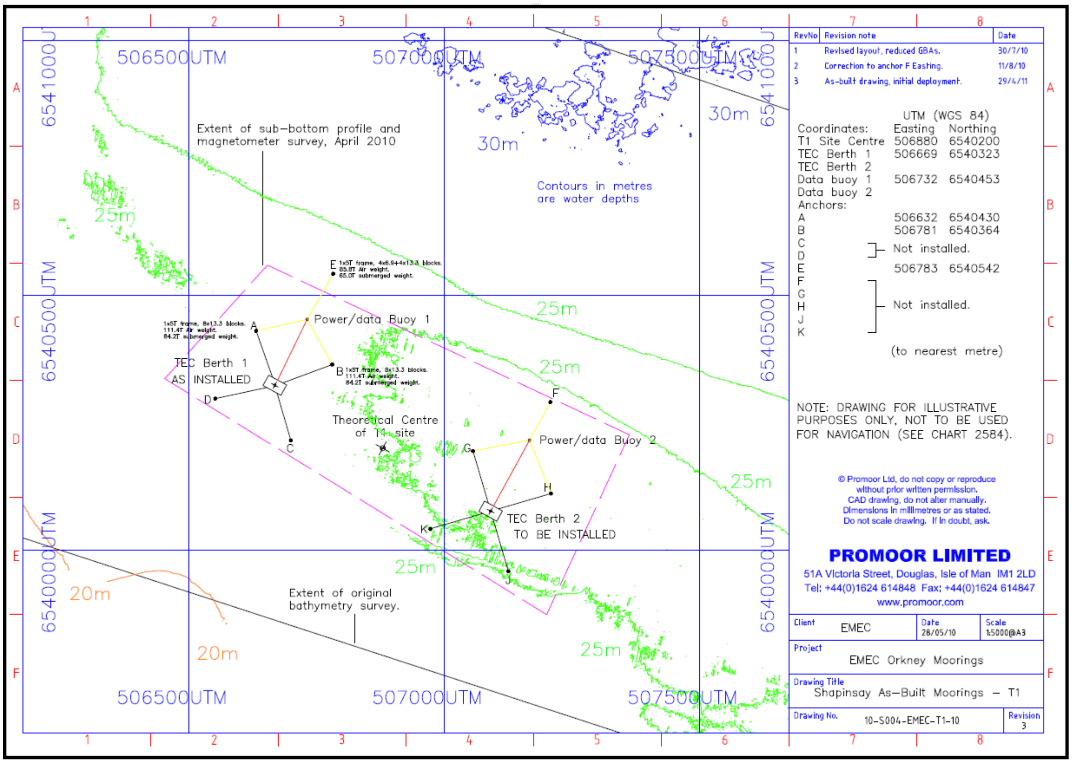

Figure 15. Shapinsay Sound as-built moorings

At Shapinsay Sound, where the conditions are more benign than those found at Fall of Warness, the platform will be temporary moored –expected time, less than two weeks, dependent on weather and tidal conditions– at Berth 1 (see Figure 14, above, in black colour, as well as Figure 15) made available by EMEC, which has already gravity based anchors and attachment points, whose coordinates are provided in table below.

Table 4. Attachment points at EMEC's Shapinsay Sound test site

Attachment point	Latitude (WGS84)	Longitude (WGS84)
Anchor A	59° 00.201'N	02° 53.073'W
Anchor B	59° 00.165'N	02° 52.918'W
Anchor E	59° 00.261'N	02° 52.915'W

The temporary mooring at Shapinsay Sound will take place within the boundary coordinates provided in Table 5 and shown in Figure 16 below.

Table 5. Deployment location at EMEC's Shapinsay Sound test site

Test berth	Latitude (WGS84)	Longitude (WGS84)
Points along platform deployment boundary	59° 00.191'N 59° 00.308'N 59° 00.231'N 59° 00.109'N	02° 53.201'W 02° 52.999'W 02° 52.756'W 02° 52.956'W

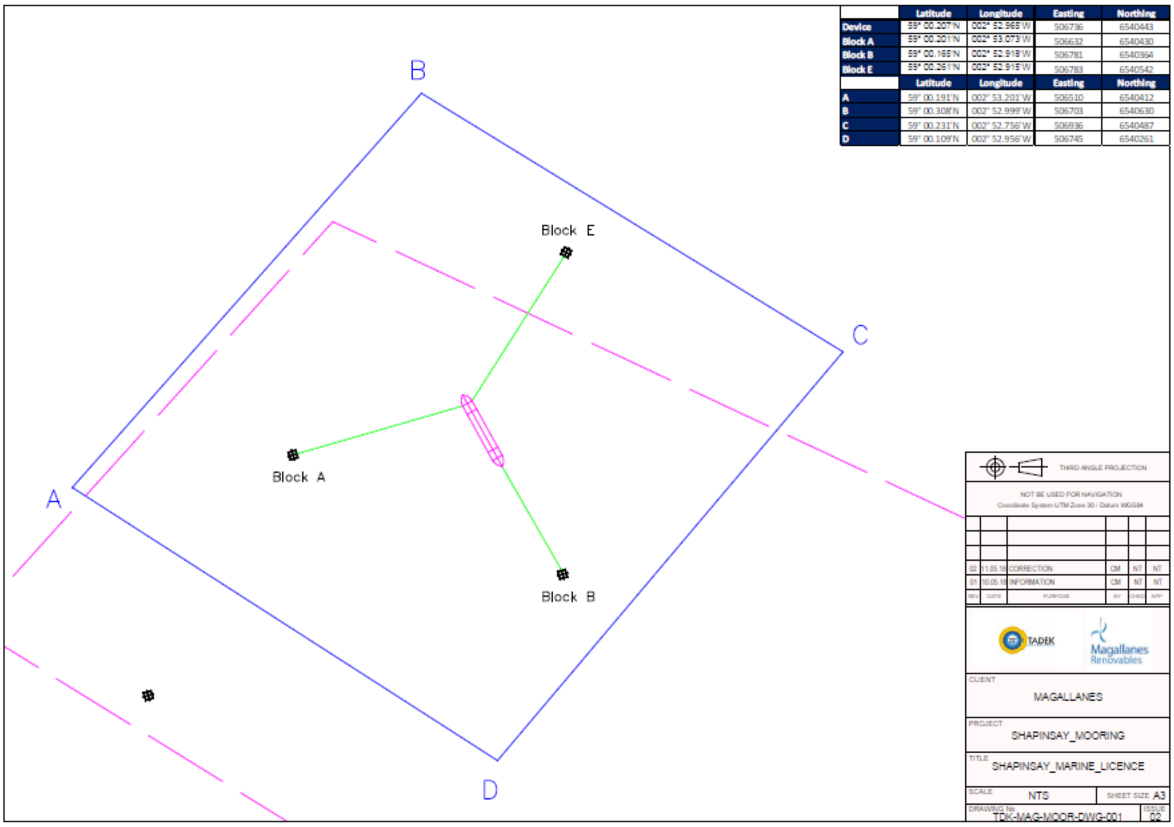

Figure 16. Platform deployment boundaries, Shapinsay Sound

The mooring design is a 3-point mooring arrangement with a spread of 95m, approx.. An overview of the mooring system is presented in the following figure.

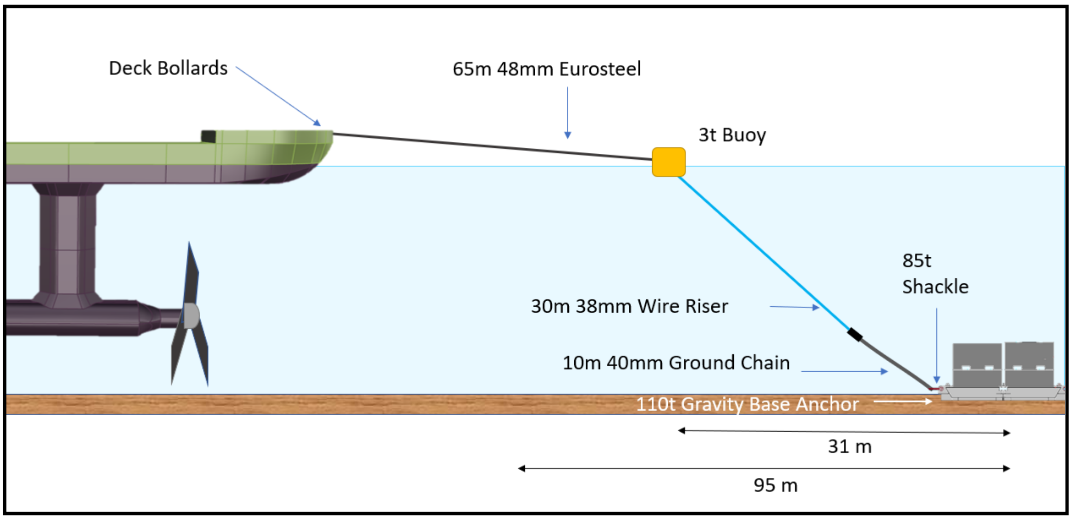

Figure 17. Schematic of the mooring system

By means of three steel mooring chains of around 105 m each, the platform will be moored to the already existing mooring blocks. A dive team will be in charge of connecting the mooring lines to the mooring blocks, whereas with the help of a multicat workboat, the other end of the mooring line will be lifted and attached to the platform.

After being moored at Shapinsay Sound, the platform will be prepared for its later operation at Fall of Warness site. This includes, among other tasks, fitting the blades by a dive team supported by a multicat workboat with a deck crane, as well as the integration of all subsystems that comprise the platform. The reason for choosing Shapinsay Sound rather than one of the port facilities around Orkney is the draught requirements: when assembling the blades it is necessary to have a minimum draught of around 25 m. Such draught is difficult to be achieved in port facilities.

3.2.1 Blades installation methodology

Once the platform is moored at Shapinsay Sound, a multicat workboat with a deck crane will load the blades from a port facility around Orkney and transport them to Shapinsay Sound. Depending on the free deck area, one or more blades may be transported at once.

After the vessel lies alongside the platform, by means of several slings and the deck crane, one blade is lifted and taken down until it is located below the water surface, below the upper block of the platform. Once there, with the help of a cable/sling guidance system, the blade is attached to the underside of the upper block hull. The guidance system also ensures the blade is positioned vertically (with the tip of the blade upwards and the root, downwards), just above the nacelle hub.

Provided that the blade is vertical and above the nacelle hub, the blade is then lowered using tackles or similar equipment, until the blade root fits in the nacelle hub. Afterwards, by means of nuts and bolts the blade is fitted to the nacelle hub. Finally, the guidance system is disengaged from the blade installed, so that it can be used for the assembly of another blade.

Once installed the first blade, the methodology for assembling the remaining five blades (each rotor consists of three blades) would be similar.

3.2.2 Fall of Warness mooring works

In parallel, the mooring system at the selected berth at Fall of Warness will be prepared, as described in section 2.2 above. Aimed at knowing the conditions of the seabed prior to the deployment of the platform, a pre-installation seabed survey will be undertaken. This information will be useful for assessing, after the decommissioning of the platform, whether the site has been left in the same condition as it was before the installation.

Once all components and subsystems are fully assembled and the mooring system installed, the platform will be towed by a tug vessel from Shapinsay Sound test site to Fall of Warness. During the towing, the blades will be blocked in order to avoid their rotation. By means of four chain catenary legs, two by bow and two by stern, the platform will be attached to the anchor points, as it had been indicated in section 2.2 above, in order to be held in place.

Finally, the platform will be connected to EMEC’s subsea cable, connecting the test berth to the shore-based substation. For that purpose, firstly, EMEC’s subsea cable end will be lifted by a deck crane from the berth seabed to the deck of one of the vessels participating in the installation of the platform. Afterwards, EMEC’s cable will be spliced to an umbilical cable, expected to be of less than 400 m length, connected to the switchgear housed in the platform, and it will be laid back to the seabed.

The Company will work closely with local companies experienced in marine operations, with knowledge of the test site and available equipment and vessels to develop detailed procedures for the various activities related to the installation of the platform. It is not known yet the vessels which will be involved in the installation of the platform at the test site but, due to the characteristics and dimensions of the device, typical workboats or multicat workboats such as *MV C-Odyssey*, *MV C-Salvor*, *MV C-Chariot*, or similar, (with lengths no greater than 28 m and draught up to 4m) rather than large installation or heavy lift vessels will be used. In addition, it may be necessary to utilise support vessels (such as *MV Ocean Explorer*, or similar) for some tasks during the installation of the platform.

3.3 Operations and Maintenance Works

Due to the nature of the platform, minimal human intervention may be required, allowing the platform to stay on site for long periods of time. This is facilitated by the remotely operated control system and the communication system.

However, during the period of time the platform will be deployed, there will be surveillance and maintenance on site. Visits will take place at regular intervals, at least one per month, although during the first month of platform operation, visits may be more frequent.

The platform has been designed in such a way that there is enough inner space for having an accessible machine room, both in the upper block and the lower block. In addition, the lower block is accessible from the upper block through the vertical block. As a result, repairs can be done offshore with no need to take the platform to a shipyard for maintenance. It should be possible to carry out *in situ* all maintenance activities –dependent on weather and tidal conditions–.

In general, the vessels to be used during maintenance works are support vessels (such as *MV Ocean Explorer*, or similar), although it is not discarded the use of typical workboats or multicat workboats in the event of maintenance tasks which require more extensive equipment (for dive support, for example, or major corrective actions). In this sense, it may be necessary that those workboats will be assisted by support vessels, too.

3.4 Decommissioning / removal method

The decommissioning method will be quite similar to the installation method, but conducted conversely.

As a first step, the platform will be disconnected from the EMEC subsea cable. In order to undertake such disconnection, EMEC's subsea cable end will be lifted by a deck crane from the seabed to the deck of one of the vessels, umbilical cable will be then disconnected from the EMEC cable and, finally, the EMEC cable will be laid back to the seabed in the condition in which it was first taken over.

Afterwards, the platform will be detached from the mooring lines with the help of a multicat workboat and towed by a tug vessel from Fall of Warness test site to Shapinsay Sound, where it will be temporary moored –expected time, less than two weeks–. Installation method for the temporary mooring will be similar to that described in section 3.2 above. At Shapinsay Sound the blades will be disassembled from the platform by a dive team supported by a multicat workboat with a deck crane. The methodology for detaching the blades from the nacelle hub will be similar to that described in section 3.2 above, but undertaken in reverse.

If required, a dive team may help in the recovery of the mooring system by the crane of one of the vessels participating in the decommissioning of the platform. All remaining components which constitute the platform mooring system at the berth might be dismantled, on the condition that such removal doesn't entail further disturbance or impact on the environment.

Local companies with experience in marine operations (most probable the company that would have been involved in the installation of the platform) will participate in the platform decommissioning. In this sense, it is expected that conventional vessels similar to those employed during platform installation (workboat, multicat workboat, support vessel) will be used for the decommissioning.

A Decommissioning Programme will be produced in support of the marine licence application, which will outline the decommissioning procedure and associated schedules.

3.5 Anticipated vessel traffic to site

Due to the installation, surveillance/maintenance and decommission of the platform, vessel traffic is expected at Fall of Warness site and its surroundings. Vessels expected to be used are workboats, multicat workboats and support vessels. Listed below are the most significant activities together with the anticipated frequency of vessel movements.

Table 6. Operational activities and anticipated frequency of vessel movements

Activity	Anticipated frequency of vessel movements
<u>Platform installation</u>	
Preparation and installation of moorings at Shapinsay Sound	5-10 day trips
Preparation and installation of moorings at Fall of Warness	5-10 day trips
Assembly of blades at Shapinsay Sound	8-10 day trips
Towing the platform from Shapinsay Sound to Fall	1 day preparation

of Warness	1 day towing operation (2 x vessels)
Installation of the platform (including attachment to the mooring and subsea cable connection)	8-10 day trips (possibly over 2 x neap periods)
Surveillance/maintenance	
Surveillance on site	Visits at regular intervals. 2 trips per month (1 day trip). During the first month of platform operation, visits might be more frequent.
Maintenance on site	Visits at regular intervals. 1 trip per month (1 day trip). During the first month of platform operation, visits might be more frequent.
Towing the platform for maintenance in calmer waters	2-3 day trips
Redeployment of platform at Fall of Warness after maintenance in calmer waters	4-6 day trips
Platform decommissioning	
Decommissioning of the platform (including unmooring and subsea cable disconnection)	8-10 day trips (possibly over 2 x neap periods)
Preparation and installation of moorings at Shapinsay Sound	5-10 day trips
Towing the platform from Fall of Warness to Shapinsay Sound	1 day trip
Disassembly of blades	6-8 day trips
Decommissioning of moorings at Fall of Warness	5-10 day trips
Decommissioning of moorings at Shapinsay Sound	5-10 day trips

It has to be considered that all schedules might vary since, among other factors, they are subject to suitable environmental and tidal conditions and, therefore, adverse weather may increase the forecasted duration of activities. Furthermore, it should also be remarked that due to unplanned maintenance because of exceptional circumstances, additional trips might be required. Notice to Mariners will be issued prior to undertaking works onsite, specifying the type of works to be carried out and its duration, as well as the vessel(s) involved.

3.6 Device monitoring systems

The platform together with its subsystems is going to be monitored continuously in order to ensure that they operate properly and in order to be able to respond rapidly in case of an emergency situation. The most relevant device monitoring systems are outlined below, see Table 7.

Table 7. Platform monitoring systems

System	Description
General monitoring systems	
General position system (GPS)	It records time and date continuously, provides the exact position of the platform at all times and transmits the information to shore. The platform is expected to move on the sea surface

	within an area previously assigned (based on ebb and flow, depth, length of mooring lines, etc.). In the event that the platform is not held in place, but out of the pre-established range, this may mean that there has been a failure in one of the mooring lines. In such case, GPS will warn without delay about the abnormal position of the platform. This will help to provide a rapid response (with vessels, dive team, etc.) so as to return the platform to a safe and agreed location.
Inertial measurement unit (IMU)	Used for monitoring platform stability in terms of pitch, roll and yaw degrees.
Weather station	It records outside temperature, atmospheric pressure, wind speed and wind direction, among others. It helps to anticipate rough weather conditions that may impact on platform behaviour.
Insulation monitoring device	Employed in order to monitor the insulation resistance of unearthed main circuits and to detect early deterioration in the insulation.
Current meter	Instrument for providing with relative water velocity data and measurement of local flow conditions in real time.
Specific monitoring systems	
Variable pitch system	It allows the blades configuration and pitch to change according to the current.
Shaft positioning system	It assures the proper orientation of the rotor blade shaft, so that loads are balanced. It is also intended for facilitating blade assembly and disassembly.
Emergency response systems	
Fire detection system	Set of devices aimed at detecting fire or smoke in the platform and raising the alarm so as to respond as soon as possible and minimise the damages caused.
Bilge pumping system	Provided that unwanted water is present in the platform, and in order to prevent flooding of it, the system is arranged to drain any watertight compartment.
Uninterruptible power supply system (UPS)	In the event of failure in the main power source, this system will provide with emergency power to electrical devices so that they can keep running temporarily.
Emergency braking system	If an important fault takes place and such fault entails a risk for the integrity of the platform, emergency braking system comes into operation in order to stop mechanical system and, as a result, block rotor blade rotation.

Apart from the aforementioned monitoring and response systems, other variables such as temperature, humidity, pressure, voltage, power, etc. will be monitored within the platform, too. Furthermore, the main components such as generators, converters and gear boxes, among others, will also be monitored in order to ensure they work suitably. Two cameras might also be installed at the deck of the platform, one at the bow and one at the deck, for surveillance purposes, too.

Owing to the nature of the platform, which is conceived for minimising required human intervention, a remotely operated control system is developed in order to display and store within the platform the most relevant parameters. Communication with the platform is established through the umbilical cable and EMEC's subsea cable. Nevertheless, in the event of loss of communication, a satellite or radio communication system, which will behave as a redundant system until required, can be utilised. Both communication systems allow the transmission and operation of the control system variables remotely.

3.7 Third Party Verification (TPV)

With the aim of undertaking the Third Party Verification it is proposed to engage the services of Orcades Marine Maritime Consultants Ltd, which provides Marine Project Management, Specialist Marine Risk Management, Innovative and Practical Consultancy Advice, Third Party Verification and Marine Warranty Survey, Independent Auditing and Assessment to the Shipping and Port Industry, the Marine Renewable Energy Sector, and the Offshore Oil and Gas Industry, accredited to ISO 9001 and OHSAS 18001 for the provision of those services to the industry.

Orcades Marine Maritime Consultants has a wide experience in third party verification and marine warranty in the marine renewable sector. Among others, they have been involved in the following works: TPV for a tidal floating system for marine licensing purposes for the installation in Orkney, independent opinion as to the suitability of a grounding berth for securing a vessel safely alongside, or Marine and safety advisors for the installation of a tidal turbine in Singapore. Some of their clients in the past have been Tocardo, Sustainable Marine Energy, Aquatera or Andritz Hammerfest.

For all the above, the Company believes that Orcades Marine Maritime Consultants is appropriate to conduct the verification of the platform and its moorings. Such verification will certify the integrity of the structural design of the platform and its moorings for the conditions expected at test berth 1, Fall of Warness, and Shapinsay Sound.

4 Environmental and Navigational Risk Considerations

EMEC's Fall of Warness test site has been widely assessed both from an environmental and navigational point of view.

With regard to environmental considerations, various assessments have already been undertaken of the site and documentation produced. The test site has been well documented including an in-depth description of the receptors at the site and their sensitivities in the *EMEC Tidal Test Facility Fall of Warness Environmental Statement (AURORA 2005)*, *Environmental Description for the EMEC Tidal Test Site Fall of Warness (EMEC 2009) and Fall of Warness Environmental Sensitivity Table (EMEC 2010).*Recently an environmental appraisal of the site has been conducted based on a project envelope, in which it is believed this project fits within. The appraisal identifies the potential receptors and sources of risk to the environment, together with mitigation measures for minimising impacts. The *EMEC Fall of Warness Test Site Environmental Appraisal (EMEC 2014)* should be referred to when assessing the marine licence application for this project.

The materials used for construction of the platform and connections have been chosen for their suitability for use at sea, both in terms of durability and their impact on the environment. Except for the diesel oil[1] (small quantity, around 1 m^3, and only for emergency purposes), the materials are all non-toxic as can be seen from Table 2. Environmental acceptable lubricants will be used and all hydraulic fluids used within the platform will be certified as suitable for use in the marine environment. During installation and decommissioning of the platform, there is the possibility of disturbance to marine species due to vessel traffic. For that reason, special effort will be made so that those operational activities will be accomplished in the shortest time possible. In addition, all vessel activities onsite and to and from site will be conducted as far as possible in line with the Scottish Marine Wildlife Watching Code (SMWWC).

From the navigational point of view, the platform in question is a surface floating structure which could present a potential risk to navigation. Nevertheless, it should also be outlined that the Fall of Warness test site has been established since 2006 and its boundaries defined on navigational charts. It is therefore expected that vessel navigating the area should be aware of the test site and the presence of test devices. This allows vessels to plan their passage taking into account the test site. In addition, following the International Regulations for Preventing Collisions at Sea (COLREGS), the platform will be marked with a 3 mile yellow light flashing, and painted yellow above the waterline, so as to be more visible. Notice to Mariners with full details of the nature, location, start-date and duration of work will be issued prior to any works commencing.

There is a potential risk that the platform will become detached from its moorings during testing. The system has been designed specifically to minimise the chances of this occurring; however, to minimise the likelihood of any serious issues in the unlikely event that it does, measures have been taken to provide early warning of such an event. Systems, such as GPS or current meter will be installed and, in the event they provide with unexpected or abnormal data, it may suggest the platform to become detached from its mooring, so early alerts will be triggered.

[1]In the event of failure in the main power source, a diesel generator will provide with emergency power to electrical devices so that they can keep running temporarily.

Concerning potential navigational issues, there is already documentation available which analyses vessel activity at the Fall of Warness test site, navigation risk associated with cabled test berths, as well as risk of collision with submerged tidal devices. Notable among these documents are *Navigation Risk Assessment of the Proposed Tidal Test Facility at the European Marine Energy Centre (ABBOTT 2005)*, *Addendum to Navigation Risk Assessment of the Proposed Tidal Test Facility at the European Marine Energy Centre (ABBOTT 2005)* and *Navigation Risk Assessment Update – Fall of Warness (ANATEC 2010)*.

Apart from the aforementioned documentation already available relating to environmental and navigational risk considerations, in order to support the marine licence application, a Project-specific Environmental Monitoring Programme (PEMP) and Project-specific Navigation Risk Assessment will be submitted.

5 Proposed Timescales

The high-level Gantt chart below details key project dates (in months), considering as the reference month the one in which moorings at Fall of Warness test site are installed. It might be expected that those moorings would be installed no later than August 2018. It would be expected that installation and decommissioning would take around one month each.

At this stage, it is intended to operate and test the platform for at least an annual cycle (12 months), however, a contingency 3 months have been included to ensure that a valid marine licence would be held in case of unplanned maintenance, unexpected unavailability of the platform and any delays in the early stages of the project schedule.

Table 8. High-level Gantt chart

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17
Platform 1:1 testing and validation at EMEC test site																	
Preparation and installation of moorings at Fall of Warness																	
Temporary mooring of the platform at Shapinsay Sound																	
Installation of the platform at Fall of Warness																	
Commissioning of the platform																	
Test and demonstration for performance assessment (including contingency months)																	
Decommissioning of the platform																	
Temporary mooring of the platform at Shapinsay Sound																	
Decommissioning of moorings																	