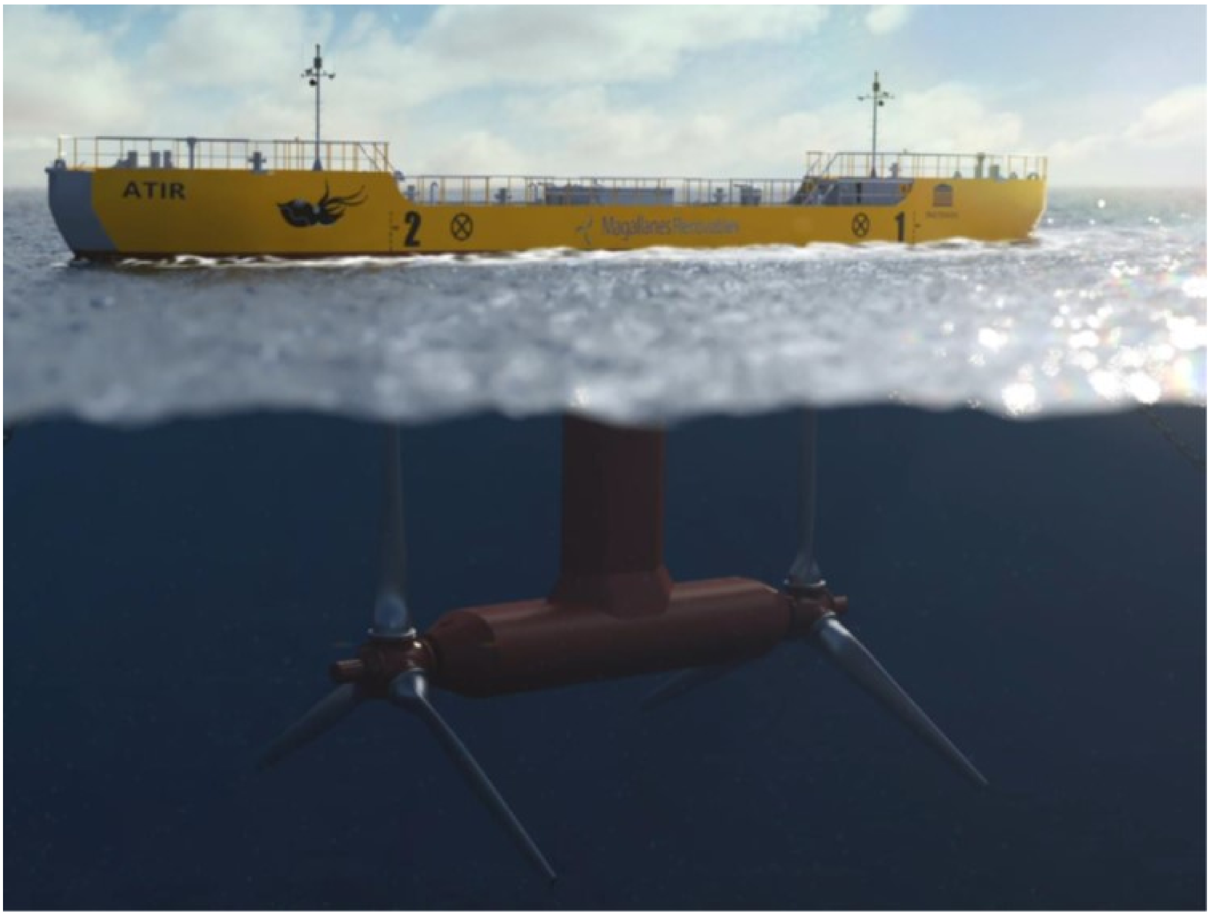
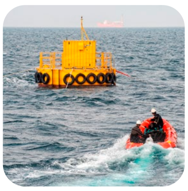
Magallanes Array

Project Information Summary

December 2023








Document History

Revision	Date	Description	Originated by	Reviewed by	Approved by
1.0	19/12/2023	First draft	JH (Mag)	AS/DL (EMEC)	

Disclaimer

Contents

List of Figures

List of Tables

1 Introduction

1.1 Company background

Magallanes Tidal Energy is a leading developer of tidal energy technology. We are the recently established UK branch of Magallanes Renovables and have been set up specifically to commercialise the Magallanes technology, leveraging the unparalleled expertise of the UK supply chain to do so. Magallanes Tidal Energy is registered in Scotland, established in 2020.

Founded in 2007 Magallanes Renovables was created with the sole purpose of developing and commercialising a cost-effective tidal technology, overcoming the hurdles that have historically held the sector back. Our philosophy is simplicity and cost-effectiveness, which has led us to develop breakthrough systems, solving the many challenges encountered with innovative and cost-effective solutions.

Our technology is centered around a simple and reliable surface floating platform that leverages existing technology from the mature wind and naval industries, minimising technology risk. Our platforms deliver high output with low installation and maintenance costs.

We are a highly experienced multidisciplinary team with innovation, sustainability and quality as our core values. We have deployed and tested a full-scale platform in the unforgiving environment of the Orkney Islands. Previously we developed and tested 2 scale models to inform the full-scale design.

Key team experience

Our multidisciplinary and highly skilled team has been the main driver of our success, each individual is in charge of one of the working areas for technology development. Important decisions are taken in quorum and teamwork is part of our open working structure.

In addition, Magallanes Renovables has collaborated very closely with skilled partners in different business and technology areas needed to develop a ground-breaking system in tidal energy generation.

Since its inception, the company has been involved in multiple R&D projects focused on developing floating tidal turbines.

Work completed:

- 2007 to 2011 – concept development and evaluation including partial systems tests at small scale – e.g., 1:30 turbine and rotor
- 2011 to 2012 - 1:10 scale model constructed to evaluate and validate the concept. Prototype tested in Bay of Vigo and Scotland with positive results.
- 2013 to 2015 – Design of full-scale platform and systems.
- 2016 to 2017 – Construction of full scale, 1.5MW platform in Spain
- 2018 to 2018 - Sea-trials of full-scale platform around Vigo.
- 2019 onwards - Platform installed and grid-connected at EMEC, Scotland in early 2019, where it operates currently.
- 2020 – upgrades to key systems on the full scale platform

The accumulated project experience in areas of structural design, marine operations, control systems, energy production, mooring systems, etc. has allowed us to achieve the goal of having a demonstrated and validated floating platform.

1.2 Technology background

Magallanes was established to investigate and develop new methods of extracting electrical power from tidal currents.

The first prototype of the platform was designed 2008 - 2009 with the aim of fulfilling the following requirements:

- floatability;
- simplicity;
- sturdiness;
- minimal moving parts
- facilitation of maintenance

Significant numbers of alternative designs were assessed during this stage of development, 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 to develop 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 were carried out in Spain and Scotland (EMEC).

With the data obtained from 1:10 scale model, the Company improved the platform design and upgraded the test programme, proving different components integrated into the platform.

All this enabled the further development of a full-scale prototype, whose design began in 2013 and assembly finalised in 2015. This was aimed at moving forward in the optimisation of the platform and, therefore, achieving a more efficient and effective device. This 45-meter floating platform had two 21-meter-high output rotors with a combined capacity of 1.5 MW. The launch of the 'ATIR' took place in April 2017, in Vigo, as it can be seen in the figure below.

Figure 1| Evolution of the Magallanes Tidal Energy Technology

During these first prototype tests, we proved and validated the technology, and currently we are focused on the design and development of a fully commercial product based on our existing platform, as well as the validation of our performance, Operations & Maintenance procedures and advancing our manufacturing readiness level.

The final achievement was obtaining high-performance output, with low CAPEX and OPEX costs to demonstrate the most reliable, robust, efficient, proven and competitive platform in the tidal energy market.

Figure 2| Launch of the Prototype ATIR platform

1.3 Project background

The first full scale prototype ATIR device has been deployed and operated at EMECs Fall of Warness tidal test site, which has enabled us to assess its performance in real sea conditions throughout the annual seasonality cycle. This testing has allowed us to progress the ATIR towards commercial viability.

This proposed project will see two additional platforms deployed for up to 25 years at the EMEC Fall of Warness site, beginning in 2029. These 2 new platforms will be installed alongside the single platform installed by Magallanes Tidal Energy in an earlier project in Berth 1.

The project aims are as follows:

- Verify and validate the commercial version of the technology with an independent electrical power performance assessment.
- Demonstrate the long term operational performance of a small array of the technology in a real, open sea environment.
- Develop a business and marketing strategy to assist identification of potential customers.
- Develop the supply chain for further, commercial projects.

Data obtained from this period of testing will be crucial for the future projects as it provides valuable information regarding long term operation, maintenance, together with electrical performance.

Existing funds have come from two separate funding sources: European Grants and the equity investment from the founder of Magallanes Renovables. These sources will secure the continuous development of Magallanes Renovables technology until its commercialisation, as well as the process of securing future projects.

2 Technology

2.1 Device description

The full scale floating tidal devices to be deployed at EMEC under this proposed project consist of a surface floating platform (upper block), with a nacelle and rotors directly below it (lower block) and a 'mast' (vertical block) connecting the two.

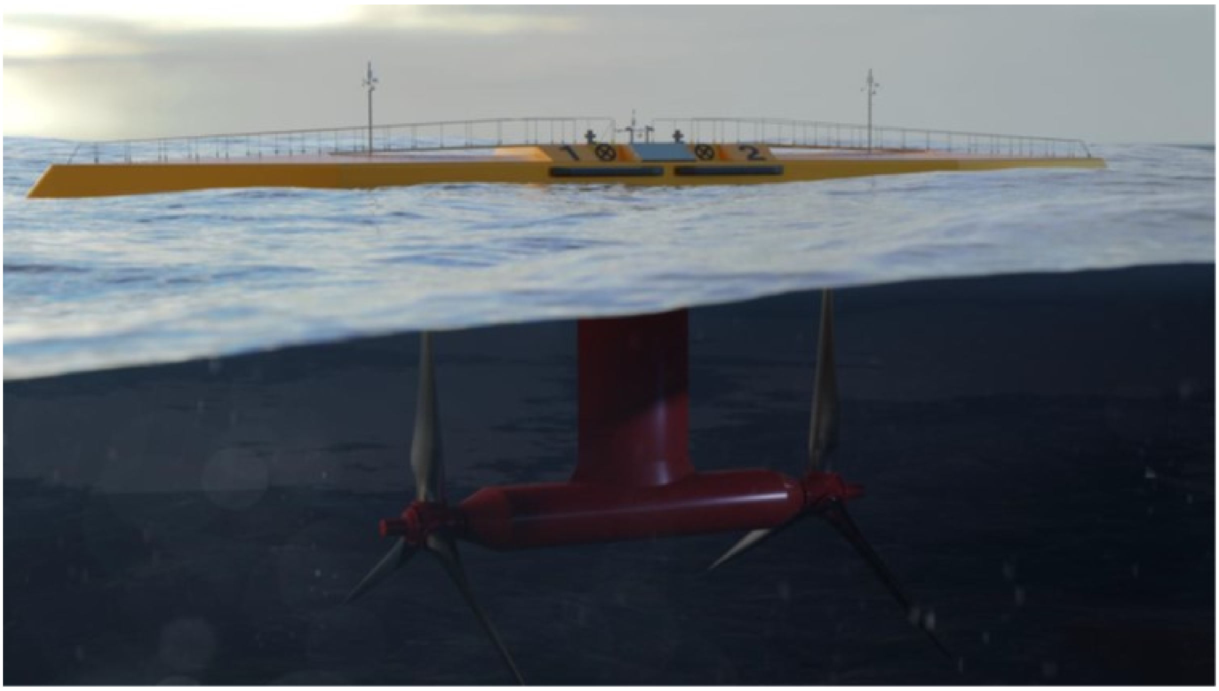


Figure 3| ATIR platform showing 'blocks'

This floating tidal energy converter has a total length of 55m, 6m of beam, a minimum draft of 18.5m without blades and 29m with blades. Its maximum weight with ballast is approximately 600tons.

Figure 4| ATIR from above

It has two counter-rotating horizontal axis turbines in series, one behind the other, so that it counteracts the efforts of one turbine with those of the other to avoid list and yaw. Each rotor consists of 3 blades with a rotor diameter of up to 24m.

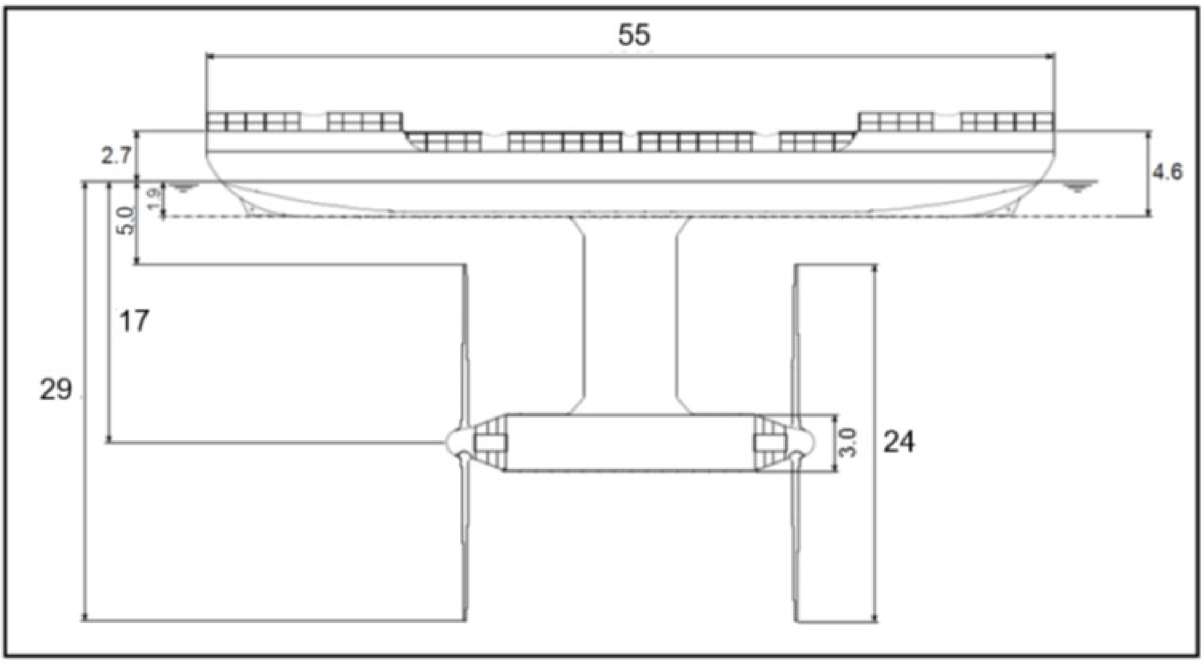


Figure 5| Indicative overall dimensions of the device

Each rotor is equipped with a generator of 850kW of nominal power, and an associated frequency converter; allowing for a peak power of up to 1.7MW; however, the nominal power is limited to 1.5MW. It's moored to the seabed through four mooring lines, two at each end. The device is able to orient itself to different directions of current in a passive way and to generate energy efficiently on both the ebb and flood currents.

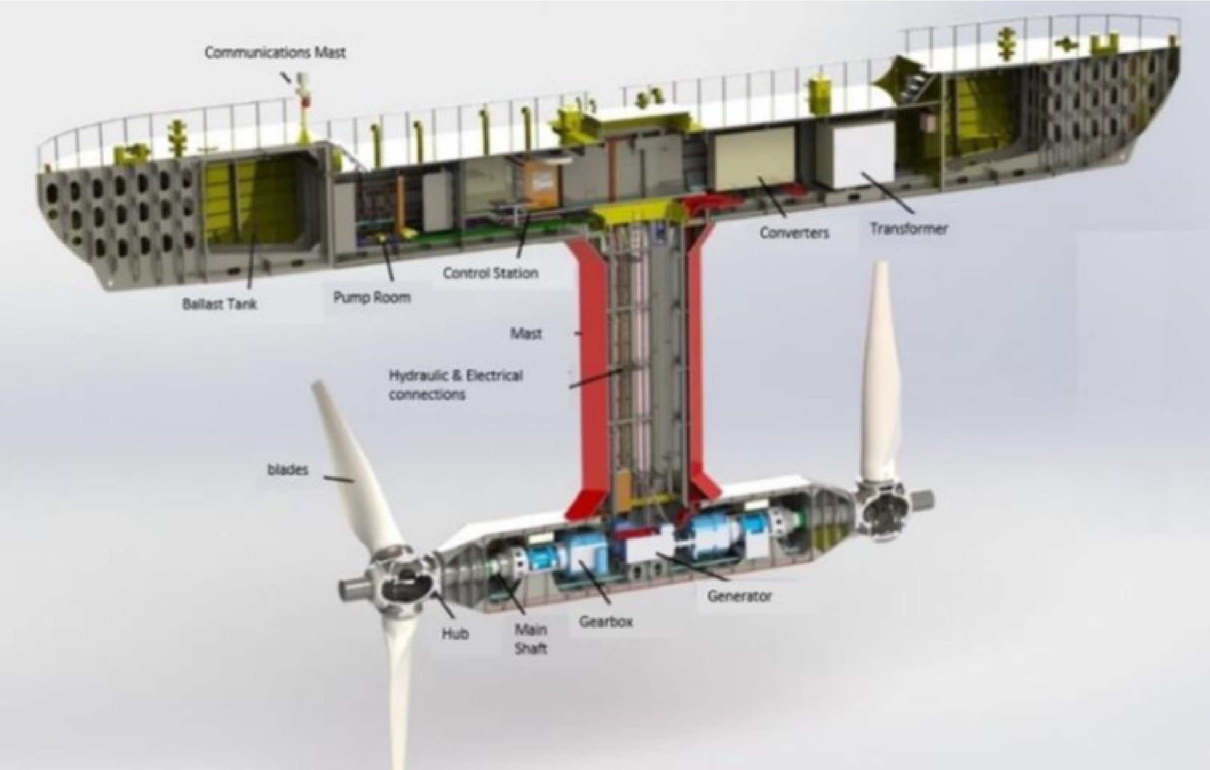


Figure 6| Main components of the ATIR platform

The floating platform (upper block) is the visible part of the device. It has an upper deck, where the entrance hatches are located. It also has 2 inaccessible compartments on both ends of the block, which are part of the variable ballast system. The accessible part of this block is composed of 3 main rooms, the first of them houses pumps and emergency systems, the other 2 have been designed to accommodate transformers, frequency converters, electric panels and other auxiliary electrical or electronic systems.

The mast (vertical block) fixes the nacelle (lower block) to the platform (upper block). It is a hollow space through which the communication and low-voltage cables connect the equipment housed in the nacelle with the parts of the electrical systems within the upper block. Rigid pipes for environmental acceptable lubricant supply and draining, among others, are also installed in the mast. It also allows access to the lower block for inspection and maintenance.

The nacelle (lower block) is significantly smaller than the upper block and is dedicated to the mechanical PTO systems. This block is where the main shafts, gearboxes and generators are located. As the platform is equipped with two counter-rotating rotors, all the components for the PTO system are duplicated (one for each rotor).

Each device has electronic power converters onboard the platform that adapts the energy output to the frequency and phase of the network, in addition, they will also have a step-up transformer that will establish the output voltage of each platform at 11kV - the connection voltage).

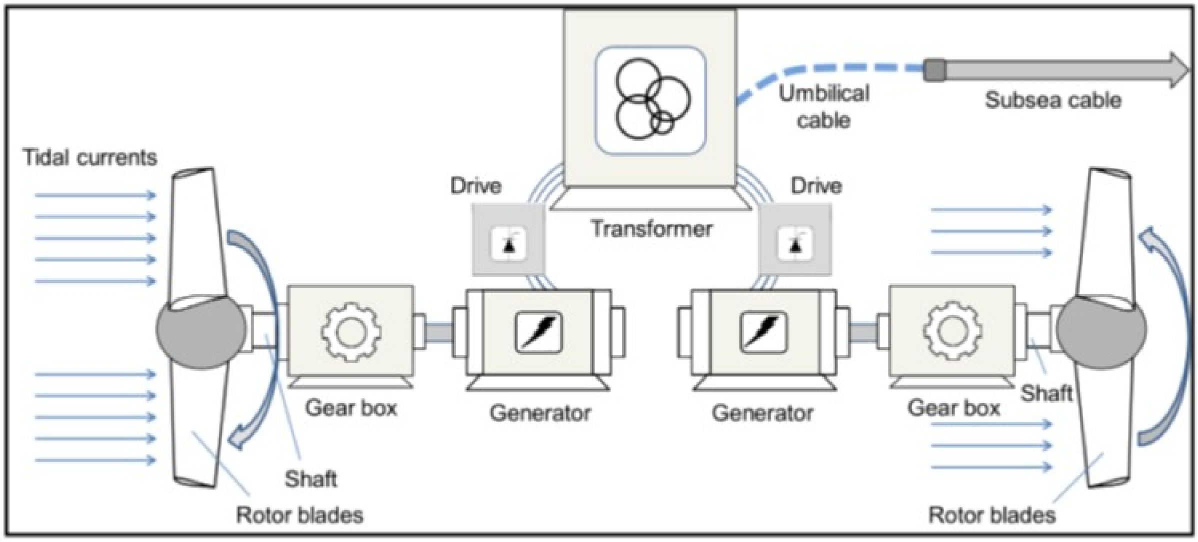


Figure 7| Diagram of electrical power generation from tidal currents

Two options are currently under consideration to connect the platforms to the export cable.

Op1: Ring Connection: the 3 platforms daisy-chained together in a ring, with a single export cable as shown in Figure 8 below. The two ends of the 'ring' will be joined together by a passive subsea hub (/busbar) to ensure that output is not lost for multiple platforms in the event of a cable fault anywhere along the ring. All device interconnection cables will be dynamic cables.

Op2: Star Connection: multiple cable legs connecting the platforms to a single passive subsea hub and export cable, as shown in Figure 9 below. A hybrid version may also be created where the ends of each leg are joined up to make multiple 'rings'. All device interconnection cables will be dynamic cables.

Further optimization modelling will be required to determine the optimum layout for the site.

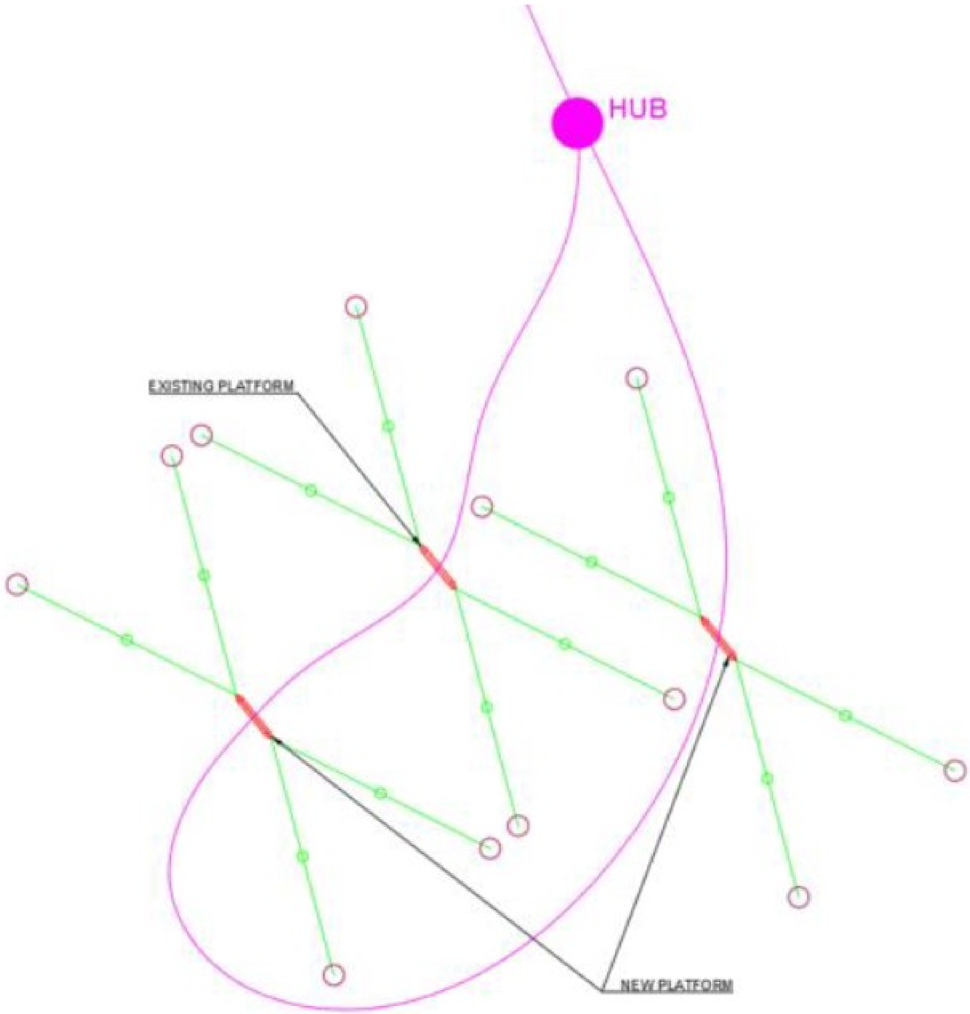


Figure 8| Ring cable concept

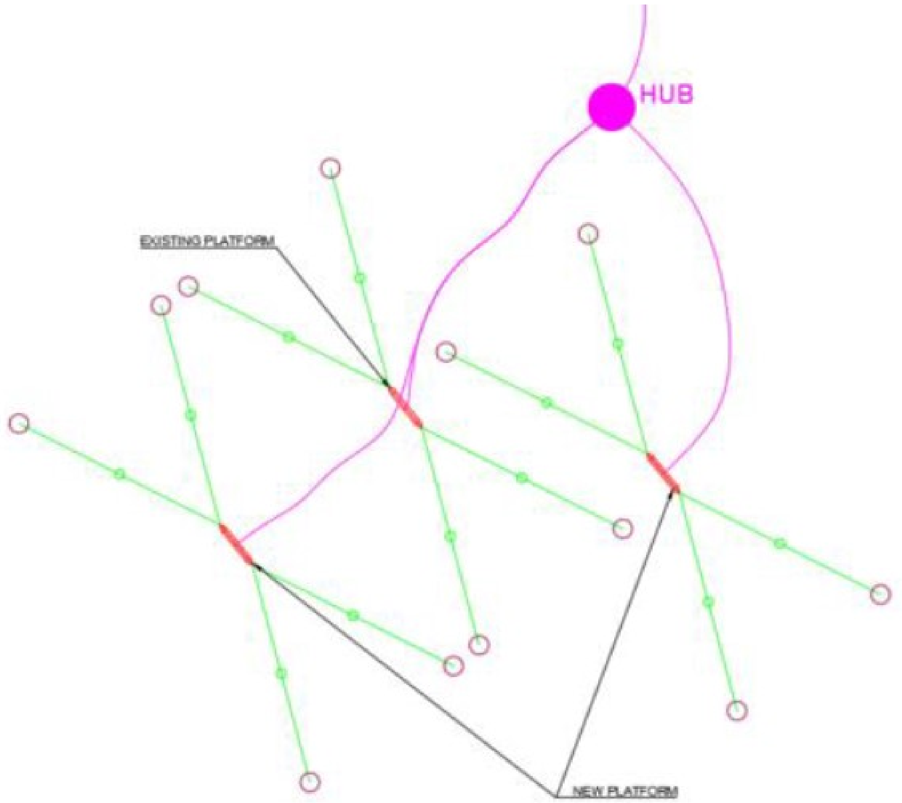


Figure 9| Star cable concept

The export and umbilical cables will be secured / stabilised with the use of up to 30 rock bags (consisting of graded rock in a mesh 'bag') or mattresses (a 'flexible' matrix of linked concrete blocks) up to 8 tonnes each.

Figure 10| Examples of rock bags and concrete mattresses

2.2 Mooring system

The mooring system consists of 4 mooring lines, 2 at each end fixed to the platform, the mooring lines are redundantly dimensioned so that even if a line breaks, the other line on that side is capable of holding the platform on station.

The following parameters are currently estimated for the site, based on preliminary engineering analysis and modelling undertaken:

- Hull Attachment - A single padeye at the bow and stern, to which a single shackle is connected and from which two mooring lines are attached.

- The chain length from mooring attachment point to anchor: approximately 192.5m (76 and 11mm chain).
- The total length of chain per leg (including excursion limiters): approximately 372.5m.
- Mooring footprint diameter = approximately 500m (250m radius).

See diagram below.

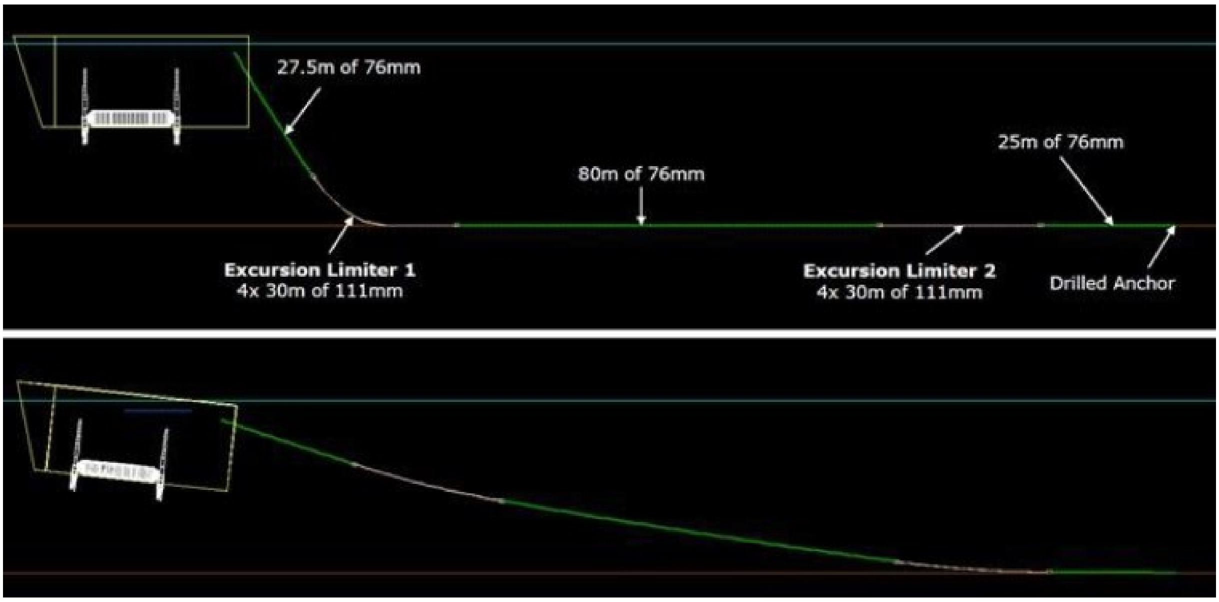


Figure 11| Indicative scheme for the mooring system

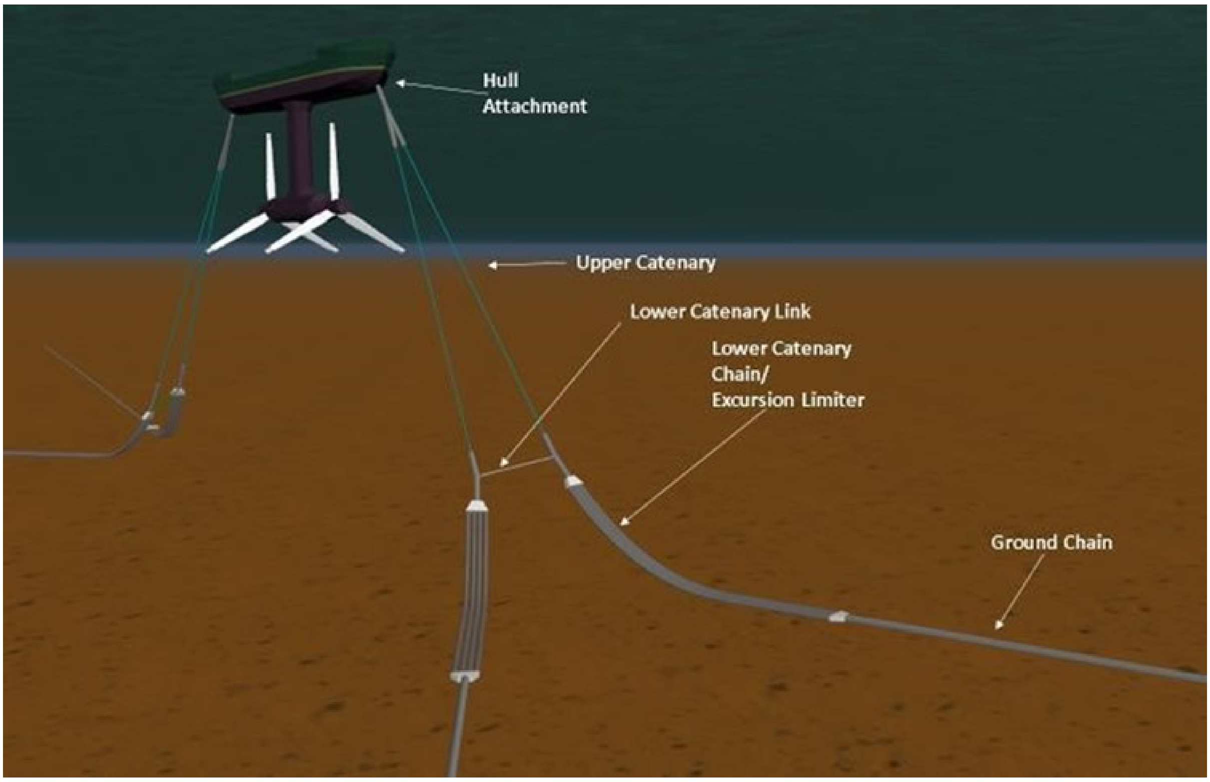
Anchor systems will be determined through geotechnical surveys. The preferred solution is drilled pile anchors (see below). These are anticipated to be up to 800mm in diameter, 10m long.

The location so the anchors and their exact size has not been determined yet and will be informed by the geotechnical survey.

However, gravity anchors (as detailed lower down) may be used if conditions do not prove suitable for drilled anchors. Magallanes and partner companies have experience with both types of anchor solutions. A basic scheme of the mooring system to be used is illustrated in Figure 13 below.

Figure 12| Strataloc anchor (left). Tricone (centre) and core (right) anchor piles that will be considered for use at the site (developed by Leask Marine)

If gravity anchors are used, these are anticipated to be chain clump weights with a total capacity (wet weight) varying between 90 and 165Te. Anchor sizes will vary due to the statistically derived environmental loading and the larger environmental forces from the North.



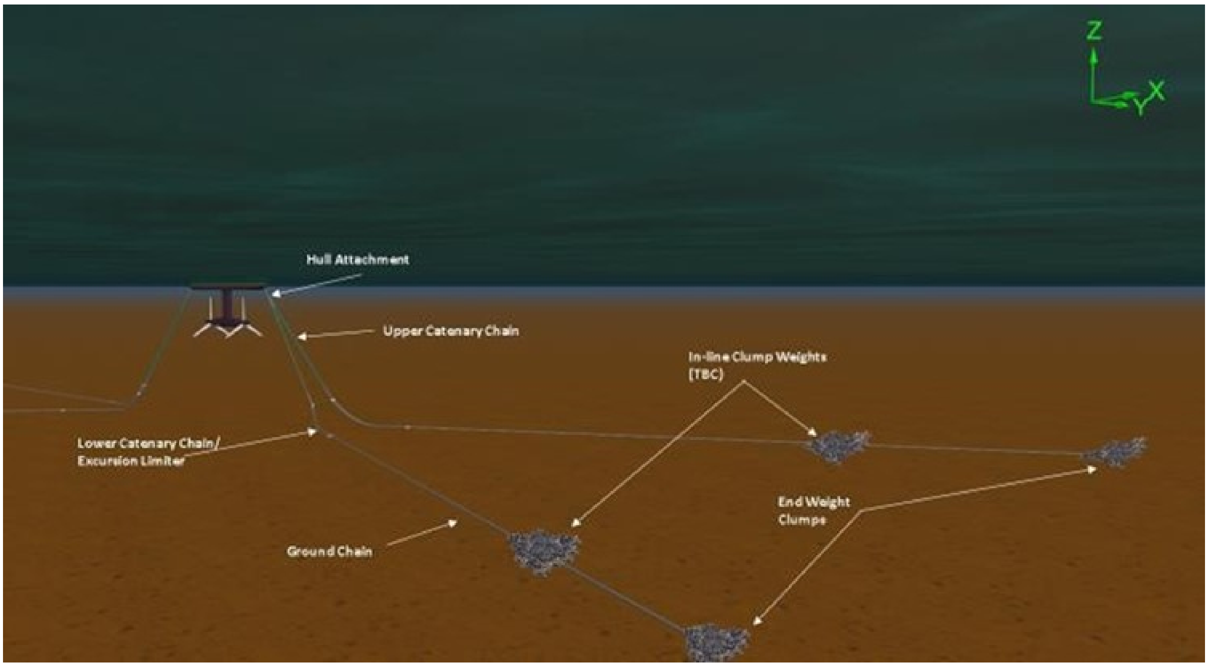


Figure 13| Scheme of mooring system

2.3 Temporary mooring system

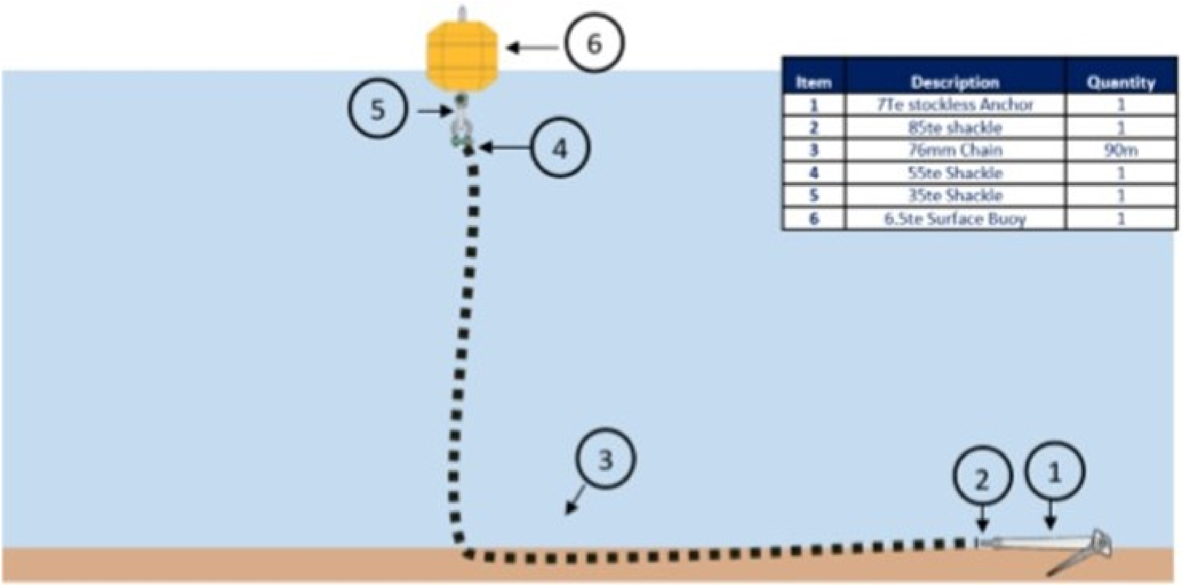
A temporary mooring site, either Deerness anchorage, Scapa Bay anchorage or Shapinsay Sound test site, will be used for installing and removing the blades before device installation and after removal from the Fall of Warness site respectively. It is most likely that the Deerness anchorage site, or Scapa Bay anchorage site will be the most favourable due to water depth requirements and limited tidal flow.

A multicat vessel will be used to tow the device from site to site as and when required. Moorings used at the temporary sites will only be installed for the duration of blade removal works and will be removed shortly after the device has been towed back to Fall or Warness or southwards for maintenance. The temporary mooring locations were chosen due to the relatively benign conditions required for removing the blades which then allows the transportation of the device by towing to the chosen docks for maintenance. As the current speeds are still quite considerable at the temporary mooring locations, significant maintenance activities are unable to be performed, hence transportation to a dry dock elsewhere.

Details of Deerness anchorage, Scapa Bay anchorage and Shapinsay Sound sites can be found in section 3.5.

The temporary mooring will use a single point mooring system as shown below in Figure 14, due to the less extreme environmental conditions.

A Notice to Mariners will be issued before any works that require the removal of the device from its moorings and transportation to another site.



Item	Description	Quantity
1	7Te stockless Anchor	1
2	85te shackle	1
3	76mm Chain	90m
4	55te Shackle	1
5	35te Shackle	1
6	6.5te Surface Buoy	1

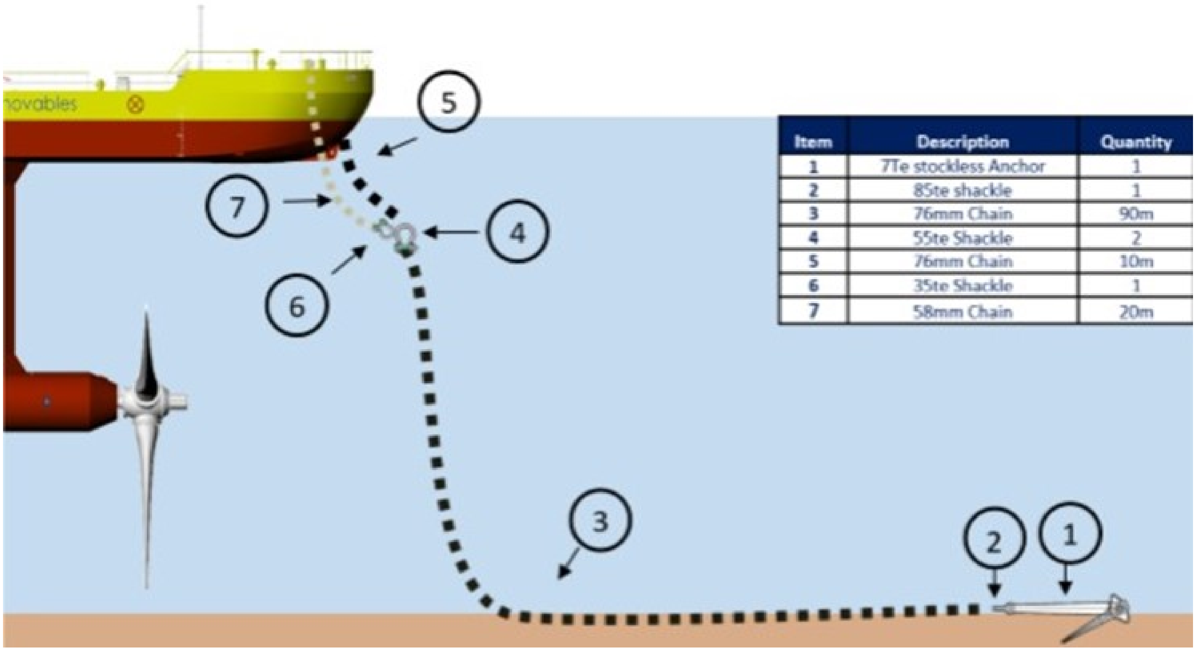


Figure 14| Single point mooring system schematic prior to device installation (Above), and during deployment (Below)

2.4 Materials used

Materials used in the construction of the device, together with the mooring system, are listed in the table 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 the table below. If a licence is granted, a FEP5 form will be completed after installation to confirm the quantities installed.

Fall of Warness Components	Type of deposit*	Nature of deposit (P=Permanent, T= Temporary)	Deposit quantity (tones, m^3 etc.)	Contingency allowance
Platform Structures	Steel	P	1,400 tonnes	20%
Turbine drivetrains	Steel	P	160 tonnes	20%
Rotor blades	Composite	P	40 tonnes	20%
Electrical & control cabinets	Various, largely copper, steel and plastics	P	30 tonnes	20%
Anchors and Mooring lines	Steel	P	5,000 tonnes	20%
Cable	Copper & plastics	P	1,700m	20%
Cable stability	Concrete Bags / mattresses	P	1,600 tonnes	20%
Lubricants	Environmental acceptable lubricant, fulfilling ISO 15380 requirements	P	48 tonnes	20%

Diesel (for emergency power generator)	Diesel	P	4 tonnes	20%
Deerness Anchorage / Shapinsay Sound / Scapa bay				
Components	**Type of Deposit***	**Nature of Deposit (P = Permanent, T = Temporary)**	**Deposit Quantity (tonnes, m3, etc.)**	**Contingency Allowance**
Anchors and moorings lines	Steel	T	470 tonnes	20%

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

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, Scapa Bay anchorage or Deerness anchorage, before it is finally towed and deployed at Fall of Warness test site.

2.5 Third Party Verification (TPV)

With the aim of undertaking the Third Party Verification (TPV) it is proposed to engage the services of Orcades Marine 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. The Company is 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. Some examples of relevant previous experience include the following works:

- TPV for a tidal floating system for marine licensing purposes for installation in Orkney
- Independent opinion as to the suitability of a grounding berth for securing a vessel safely alongside
- 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, Magallanes Tidal Energy believes that Orcades Marine Consultants is appropriate to conduct the verification of the platforms and their moorings. Such verification will certify the integrity of the structural design of the platforms and their moorings for the conditions expected at the Fall of Warness site, and associated works.

3 Project Description

3.1 Location

The array will be deployed at Berth 1 at the EMEC Fall of Warness test site, off the island of Eday, Orkney. This is shown in Figure 15 below. During installation and removal operations, platforms will make temporary use of EMEC's Shapinsay Sound test site, Deerness anchorage or Scapa Bay. The more benign conditions found in these temporary locations will facilitate the assembly and disassembly of the rotor blades, as well as the undertaking of other maintenance works, if needed.

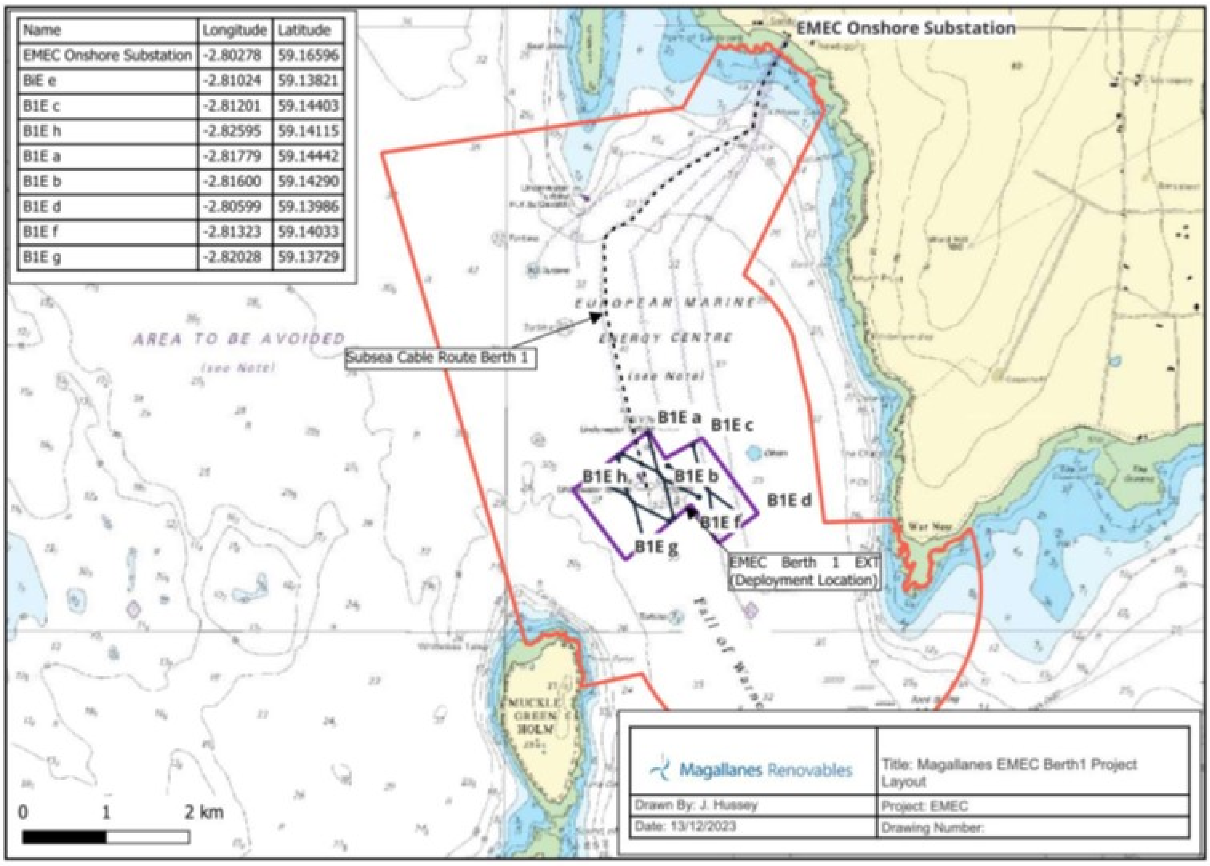


Figure 15| Chart showing EMEC's Fall of Warness test site and the Magallanes deployment area

The space between the devices will require optimising based on detailed array system modelling for the site. An idea spacing would be approximately 275m across the stream as shown below.

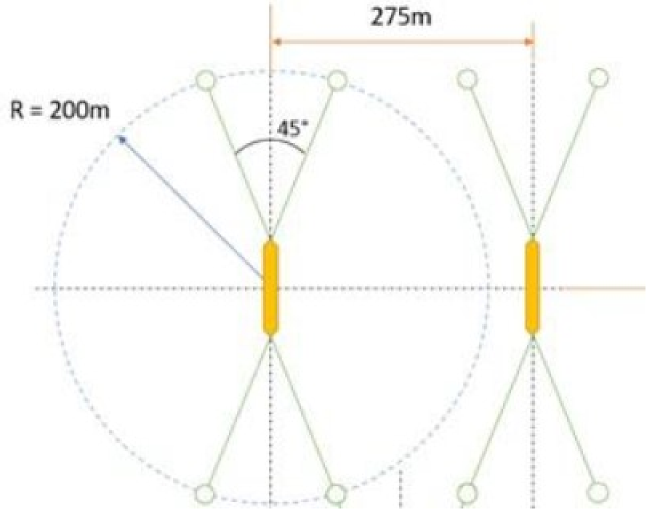


Figure 16| Mooring spread

Location Description	Latitude (WGS84)	Longitude (WGS84)
Deployment site centre point	59° 09’ 57” N	02° 48’ 10” W
Test site boundary points	59°08′40″ N 59°08′34″ N 59°08′39″ N 59°08′23″ N 59°08′25″ N 59°08′14″ N 59°08′28″ N 59°08′18″ N	002°49′04″ W 002°48′58″ W 002°48′43″ W 002°48′22″ W 002°48′48″ W 002°49′13″ W 002°49′33″ W 002°48′37″ W

Table 1| Location of Magallanes array

3.2 Installation method

The installation method is summarised below. A Construction Method Statement will be provided to MD-LOT closer to deployment.

3.3 Fall of Warness mooring works

The mooring systems in the deployment area at the Fall of Warness are described in Section 2.2 above. A pre-installation seabed survey will be undertaken initially to gain a better understanding of the seabed conditions, to determine if drilled anchors (the preferred solution) is feasible and to size the anchors correctly. The survey will consist of ROV or drop camera footage, grab sampling of the seabed and / or core sampling. This proposed activity may require a separate marine licence or exemption to be obtained from the Licensing Authority prior to undertaking the proposed activity closer to the time. This information will also be useful for assessing, after the decommissioning of the platforms, whether the site has been left in the same condition as it was before the installation.

The installation vessel will use a 4-point mooring spread for the duration of all installation activities on site. Installation operations are anticipated to last for a period of no more than 7

days per platform, after which the installation vessel shall recover its moorings and return to shore.
During the installation and subsequent offshore commissioning period, there will also be a daily requirement for a small workboat or RIB for return journeys between the site and Kirkwall Harbour, for transfer of personnel and equipment.

If drilled anchors are used, they will be installed using a submersible drilling rig deployed from a conventional multi-cat type vessel.

- The drill rig will be transported to the deployment site on the deck of a multi-cat.
- Once on site, the vessel will set up on its anchors and the drill rig will be lowered onto the seabed using the vessel crane and levelled using the four independent hydraulic legs.
- Drilling of the anchor to the required depth can then begin.
- If grouted anchors are used, the anchor will be grouted after the drilling is complete (see Section 2.2 for description of different anchor types.

Figure 17| Images showing drill rig loadout, deployment to seabed and drilling

If gravity anchors (consisting of multiple chain clump weights) are used, these will be deployed from a multicat vessel with sufficient crane capacity to handle the individual clump weights.

- Installation operations for the mooring systems and platforms are as described below:
- The multi-cat installation vessel will arrive on site, deploy its mooring spread and set up on the moorings.
- Lengths of ground chain will be deployed and connected (by divers) to each anchor.
- Each chain will then be laid on the seabed as shown in Section 2.2; and then connected to its recovery system (rope and buoy), ready for connection to the platforms.

3.4 Fall of Warness electrical works

The array will be connected to the existing Berth 1 export cable, owned by EMEC. A connection management system (passive hub) is expected to be used to connect the individual platform dynamic cable tails to the EMEC export cable in either a star or ring connection as described in Section 2.1.

The hub, with cable tails attached will be loaded on a multi-cat vessel. The vessel will sail to the offshore site just off Eday and set up on anchors.

Once at the offshore site, the connector system / hub will be connected to the EMEC export cable and a marker buoy attached to each tail, then lowered onto the seabed for retrieval later.

The hub and cable tails will be secured / stabilised with the use of rock bags or concrete mattresses, as described in Section 2.2.

3.5 Blade installation methodology

A platform, without the blades, will be towed by a tug vessel from a safe harbour where final assembly will have taken place, to Shapinsay sound tidal test site, Deerness anchorage or Scapa bay. It is expected the tug vessel will have a length no greater than 31m and draught up to 5m.

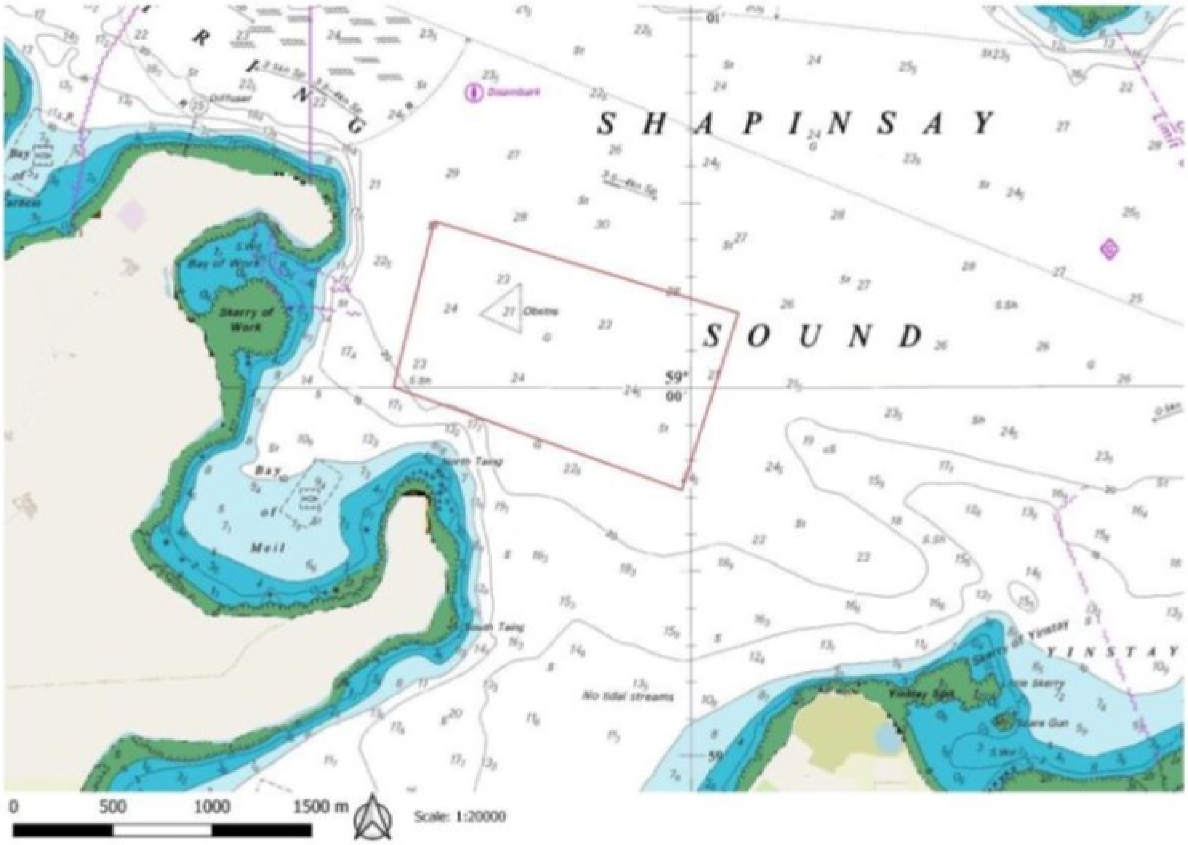


Figure 18| Map showing area of EMEC's scale tidal test site, Shapinsay Sound

Attachment point	Latitude (WGS84)	Longitude (WGS84)
Anchor A	59º 00.200'N	02º 53.073'W
Anchor B	59º 00.165'N	02º 52.918'W

Table 2| Attachment points at EMEC's Shapinsay Sound test site

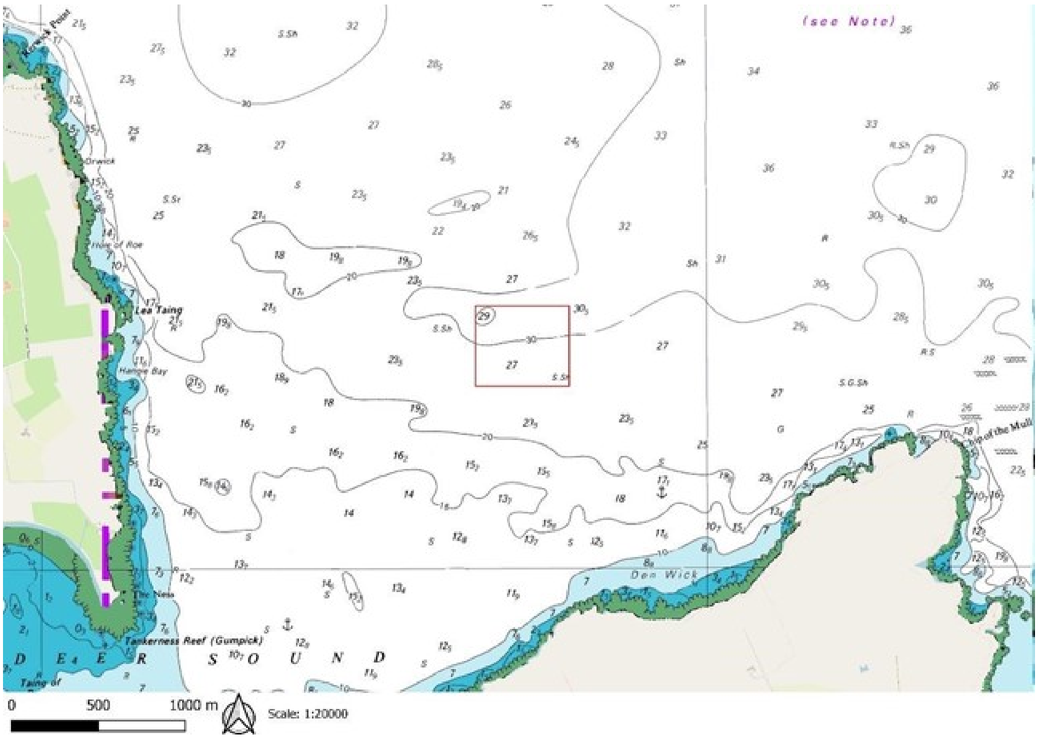


Figure 19| Map showing area of device temporary deployment at Deerness Sound

Anchorage	Latitude (WGS84)	Longitude (WGS84)
Proposed temporary deployment boundary	58º 58.813’N	02º 45.388’W
	58º 58.564’N	02º 45.388’W
	58º 58.564’N	02º 44.829’W
	58º 58.813’N	02º 44.829’W

Table 3| Boundary of lease area for temporary mooring at Deerness anchorage

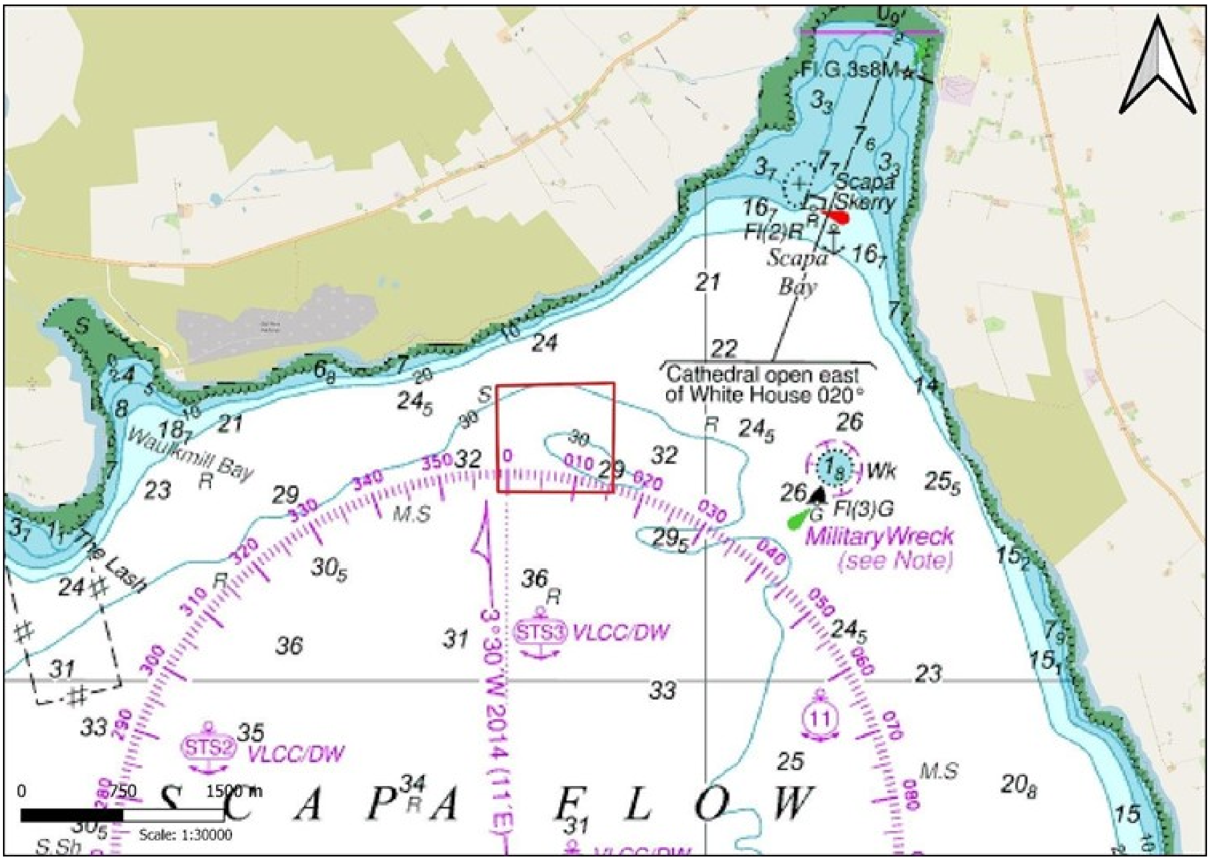


Figure 20| Map showing area of device temporary deployment at Scapa Bay anchorage

Anchorage	Latitude (WGS84)	Longitude (WGS84)
Proposed temporary deployment boundary	58º 56.17'N 58º 56.17'N 58º 55.74'N 58º 55.74'N	03º 01.61'W 03º 00.70'W 03º 00.70'W 03º 01.61'W

Table 4| Boundary of lease area for temporary mooring at Scapa Bay anchorage

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

The vessel will be brought alongside the platform, by means of several slings and the deck crane, one blade will be lifted and lowered into the water until it is located below the upper block of the platform. Once there, with the help of a cable/sling guidance system, the blade will be attached to the underside of the upper block hull. The guidance system also ensures the blade is positioned vertically (with the top of the blade upwards and the root, downwards), just above the nacelle hub. Once the blade is vertical and above the nacelle hub, it will then be lowered using tackles or similar equipment, until the blade root fits in the nacelle hub. The blade will then be bolted to the nacelle hub. Finally, the guidance system will be disengaged from the installed blade, so that it can be used for the assembly of another blade.

Once the first blade is installed, the methodology for assembling the remaining five blades (three blades per rotor) would be the same.

Platform installation

Once the mooring systems for all platforms has been installed and all components and subsystems are fully assembled onto the first platform; that platform will be towed by a tug vessel from Shapinsay Sound test site, Deerness anchorage or Scapa Bay to the Fall of Warness. During the towing, the blades will be locked in order to prevent rotation.

The platform will be attached to the 4 anchor points by means of four chain catenary legs, two at the bow and two at the stern, as described in section 2.2 above.

- The installation multi-cat will set up on its mooring spread.
- The multi-cat, assisted by a workboat will recover the surface buoy of one chain leg and winch in the ground chain, then connect that leg to the padeye on one end of the platform.
- A second chain will then be connected to the same end of the platform in a similar way
- The remaining 2 moorings legs will then be connected to the other end of the platform in a similar manner to that described above.
- Finally, the platform will be connected to its relevant cable tail. The cable tail will be lifted by deck crane from the seabed to the deck of the installation vessel. The cable tail will then be winched onto the platform and connected to the onboard switchgear.

The other platforms will be connected in a similar manner, except that it is likely that subsequent umbilicals will be daisy-chained from one platform to the next.

Magallanes Tidal Energy will work closely with local companies experienced in marine operations, with knowledge of the 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 for the installation of the platform, 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 28m 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 platforms.

3.6 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 the platform will be delayed, there will be surveillance and maintenance on site. Visits will take place at regular intervals, at least once 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, dependant 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.

3.7 Decommissioning / removal method

The removal method will essentially be the reverse of installation using the same multicat type vessels, supported by smaller workboats and a tugboat.

The platform to be removed will be disconnected from its umbilical cable(s) within the platform. The cable end(s) will be capped, buoyed off and lowered onto the seabed. The platform will then be detached from the mooring lines using a multicat workboat and towed by a tug vessel from Fall of Warness test site to one of the temporary sites, where it will be temporarily moored for no more than two weeks.

At the temporary mooring, 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 3.5 above but in reverse.

For end of life decommissioning, the mooring systems will also be removed, using the crane of one of the vessels participating in the decommissioning operations. If required, a dive team may also help in the recovery of the mooring system. All remaining components which constitute the platform mooring system will be dismantled, on the condition that such removal doesn't entail further disturbance or impact on the environment. The cable end will be lifted by deck crane from the seabed to the deck of the vessel, and the cable reeled back onto the deck of the vessel.

A decommissioning programme will be produced in support of the marine license application, which will outline the decommissioning procedure and associated schedules.

Local companies with experience in marine operations (most probable the company that would have been involved with the installation of the platforms) will participate in removal and decommissioning.

3.8 Anticipated vessel traffic to site

Due to the installation, surveillance/maintenance and decommissioning 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.

Activity	Anticipated movements frequency of vessel
Platform installation	
Preparation and installation of moorings at Fall of Warness	20-40 day trips
Assembly of blades at temporary anchorage	30-40 day trips

Towing the platform from temporary anchorage to Fall of Warness	4 day preparation 4 day towing operation (2 x vessels)
Installation of the platform (including attachment to the mooring and subsea cable connection)	30-40 day trips (possibly over 2 x neap periods)
Operation and maintenance	
Operations and maintenance 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 operation, and in the event of any major repairs required, visits might be more frequent.
Towing the platform for maintenance in calmer waters	2-3 single day trips per year
Redeployment of platform at Fall of Warness after maintenance in calmer waters	4-6 single day trips per year
Platform decommissioning	
Decommissioning of the platform (including unmooring and subsea cable disconnection)	30-40 day trips (possibly over 2 x neap periods)
Towing the platform from Fall of Warness to temporary anchorage	4 single day trips
Disassembly of blades	6-8 day trips
Decommissioning of moorings at Fall of Warness	20-40 single day trips

Table 5| Operational activities and anticipated frequency of vessel movements

It should be noted that all schedules might vary since operations are subject to suitable weather and tidal conditions and, therefore, adverse weather may increase the forecasted duration of activities. Furthermore, it should also be noted that additional trips might be required due to unplanned maintenance. Notices 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.

3.9 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. The most relevant device monitoring systems are outlined below.

System	Description
General monitoring systems	

General position system (GPS)	Records time and date continuously, provides the exact position of the platform at all times and transmits the information to shore. Each platform will move on the sea surface within an area constrained by its compliant mooring system (based on ebb and flow, depth, length of mooring lines, etc.). In the event that a platform moves outside of its pre-established range, this may mean that there has been a failure in one of the mooring lines. In such case, GPS system will warn immediately about the abnormal position of a 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 (pitch, roll and yaw degrees).
Weather station	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 water velocity data and measurement of local flow conditions in real time.
Specific monitoring systems	
Variable pitch system	Allows the blades' configuration and pitch to change according to the current.
Shaft positioning system	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 for detecting fire or smoke in the platforms and raising the alarm so as to respond as soon as possible and minimise any damage caused.
Bilge pumping system	If unwanted water is present in a platform, the system is design to drain any watertight compartment, in order to prevent flooding and minimise risk of damage due to the presence of internal water.
Uninterruptible power supply system (UPS)	In the event of failure of the grid, this system will provide emergency power to electrical devices so that they can keep running temporarily.

Emergency braking system	If a critical fault takes place and such fault presents a risk to the integrity of a platform, the emergency braking system comes into operation in order to stop the mechanical system and, as a result, stop rotor blade rotation.

Table 6| Platform monitoring systems

Apart from the aforementioned monitoring and response systems, other variables such as temperature, humidity, pressure, voltage, power, etc. will be monitored within the platform. 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.

Owing to the nature of the platform, which is conceived for minimising required human intervention, a remotely operated system is developed in order to display and store within the platform the most relevant parameters. Communication with the platform is established thought he umbilical cable at EMEC's subsea cable. Nevertheless, in the event of loss 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.

4 Project Schedule

Key project dates are as follows:

- Site surveys: Q2 2027 – Q1 2028
- Installation: Q2 – Q3 2028
- Commissioning Q3 -Q4 2028
- Operations: 2028 - 2053
- Decommissioning: 2053

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