Nova Innovation Ltd

Marine Scotland License Application

Shetland Tidal Array Extension – Schedule and Method Statement

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Revision Number	Date	Summary of Amendments	Purpose of Revision
1.0	09/10/2017		First release
1.1	03/11/2017	Further detail on offshore deposits and operational methodology	Request for further information from Marine Scotland dated 23/10/2017
1.2	09/02/2018	Corrected schedule for deployment	Updated to accompany renewed license application
1.3	21/02/2018	Minor corrections	Updated for publication

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1 Introduction

This Method Statement has been drafted to accompany the Marine License Application for the Shetland Tidal Array Extension. The purpose of the Method Statement is to describe the methods and techniques that will be employed to install, operate and decommission the extended array of Nova M100 tidal turbines in the Bluemull Sound near Cullivoe in Shetland. A schedule is included to indicate the planned timing of operations.

1.1 Project overview

The tidal array will consist of six 100 kW Nova M100 tidal turbines deployed in the Bluemull Sound, Shetland. A Marine License (04859/15/1) has been awarded permitting the deployment of five turbines at the site, of which three turbines have already been deployed. The present application represents an extension of one additional turbine, making six in total.

The location of the existing turbines and future turbines to be deployed are shown in the attached maps. Following deployment, three turbines (T4, T5, T6) will be relocated within the array area, with the aim of studying wake effects and turbine interactions within an in-sea tidal array – a world first.

The findings from this project will be of tremendous benefit to the wider tidal energy industry, and will inform the design of all future tidal arrays. For this reason, this project (titled EnFAIT) has received €15m funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 745862. The EnFAIT project is a collaboration between nine leading European organisations, led by Nova Innovation.

1.2 Nova M100 turbine

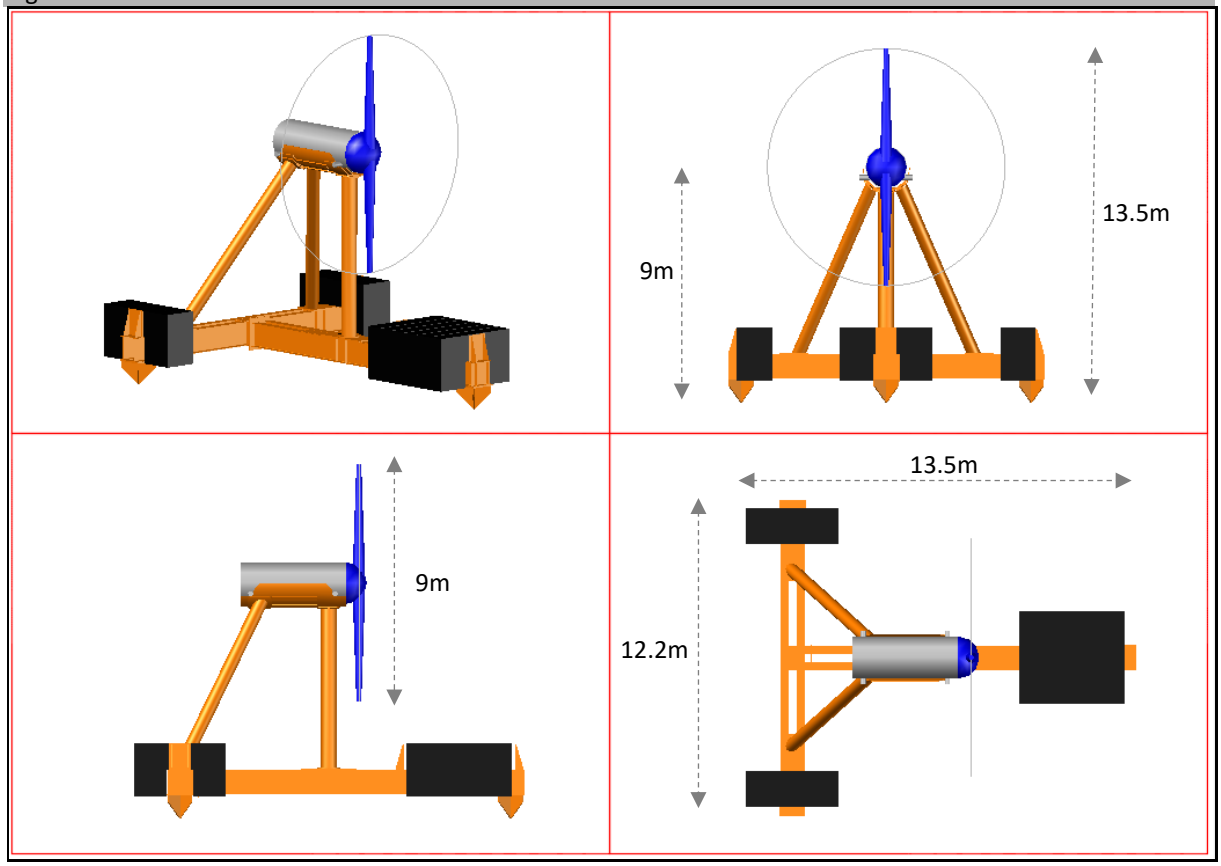
A representative image of the Nova Innovation 100 kW (Nova M100) device is shown in Figure 1.1.

The Nova M100 is a bottom mounted, gravity anchored, non-yawing, horizontal axis tidal turbine. Each tidal turbine comprises a cylindrical nacelle unit, rotor and gravity base to secure it to the sea bed (no seabed drilling or additional site works are required). The negatively buoyant nacelle is connected to the base by means of a secure structural connection.

The turbine has a rotor diameter of 9 m, and a hub height of 9 m, making the total height 13.5 m from the bottom of the feet on the base to the tip of the blades. The footprint of the device is 13.5 x 12.2 m, and the weight in water is 80 tonnes. Each turbine is located at a depth that ensures all parts of the turbine are at least 15 m below lowest astronomical tide to allow ample draft clearance for shipping. The nacelle is securely fixed in position during operation; the nacelle does not yaw, and the only external moving parts are the two rotor blades. The turbine blades are bidirectional and operate in both directions of tidal flow.

The scale of the turbine is small in comparison to many of those being deployed in Scottish waters. The scale has been chosen because we believe this is likely to result in a more robust product with lower environmental, operational and financial risk.

Figure 1.1 Nova Innovation Nova M100 Tidal Turbine



Source: Copyright © Nova Innovation Ltd 2017

1.3 Site location

Bluemull Sound is situated between the Shetland Islands of Yell and Unst (Figure 1.2). The site for the array is east of the Ness of Cullivoe. The turbines will be located in water of 30-40m depth and will each have a dedicated sub-sea cable back to land at the Cullivoe pier (Figure 1.3).

Figure 1.2 Bluemull Sound location

Figure 1.3 Shetland Tidal Array location east of Cullivoe Pier (T1-3 turbine locations and cable routes shown)

The proposed location of the tidal array is shown in the maps that accompany this license application.

1.3.1 Project coordinates

T1, T2 and T3 are already deployed at the locations shown and coordinates given below. Proposed locations are also provided for T4, T5 and T6. Subsea cables will connect the array to a substation on Cullivoe Pier. Cables will be deployed within the array area and corridor shown in the attached plans. The points below refer to annotated points on the attached charts.

Nova Innovation has a lease with the Crown Estate Scotland for the 5 turbine array, and is negotiating a lease for the sixth turbine. The Coordinates of the lease area are (WGS84 datum):

- Point A: 60° 41.900' N 0° 59.150' W
- Point B: 60° 42.052' N 0° 59.150' W
- Point C: 60° 42.052' N 0° 58.847' W
- Point D: 60° 41.900' N 0° 58.847' W

Turbine coordinates:

- T1 60° 41.909' N 0° 59.016' W
- T2 60° 41.916' N 0° 58.978' W
- T3 60° 41.931' N 0° 59.045' W
- T4 60° 41.964' N 0° 59.039’ W
- T5 60° 41.964' N 0° 59.011' W
- T6 60° 41.961' N 0° 58.972' W

Coordinates of the cable corridor:

- C1 60° 41.805' N 0° 59.101' W
- C2 60° 41.781' N 0° 59.235' W
- C3 60° 41.769' N 0° 59.401' W
- C4 60° 41.770' N 0° 59.549' W

- C5 60° 41.776' N 0° 59.701' W
- C6 60° 41.781' N 0° 59.831' W
- C7 60° 41.789' N 0° 59.905' W
- C8 60° 41.808' N 0° 59.943' W
- C9 60° 41.836' N 0° 59.962' W
- C10 60° 41.849' N 0° 59.964' W
- C11 60° 41.848' N 0° 59.673' W
- C12 60° 41.849' N 0° 59.638' W
- C13 60° 41.849' N 0° 59.529' W
- C14 60° 41.849' N 0° 59.435' W
- C15 60° 41.866' N 0° 59.245' W
- C16 60° 41.900' N 0° 59.152' W
- C17 60° 41.900' N 0° 59.150' W
- C18 60° 41.900' N 0° 59.069' W
- C19 60° 41.900' N 0° 59.045' W
- C20 60° 41.900' N 0° 58.861' W
- C21 60° 41.880' N 0° 58.890' W
- C22 60° 41.838' N 0° 58.970' W

1.4 Electrical architecture

The electricity produced by the turbines is exported to the grid by subsea cables, which make landfall at Cullivoe Pier. The three existing turbines (T1, T2, T3) are each connected to shore by a dedicated subsea cable. The three additional turbines (T4, T5 and T6) will be connected by short array "jumper" cables to a subsea hub, with a single 1.2 km export cable running from the hub to shore. The precise length of each jumper cable will be determined during the detailed array design process, but the maximum length of each jumper cable will be 600m.

The total length of offshore cabling associated with the six-turbine array is a maximum of 6.6 km (4 x 1200m export cables, 3 x 600m jumper cables). This is a small increase on the existing five turbine licence, which incorporates 6 km of offshore cabling (5 x 1200m export cables).

1.5 Site marking / mooring buoys

Given the depth of the turbine and the advice of marine navigation stakeholders to keep the area clear of potential hazards, the site will not be marked with any buoys or markers during normal operation. Temporary marker buoys and mooring anchors required for maintenance work will be deployed in compliance with COLREGS and removed on completion of work.

2 Project schedule

The planned project schedule is outlined below.

Cable and subsea hub and cable deployment (Q3 2019)
Deploy a 1.2 km export cable from Cullivoe Pier to the project site. Deploy a subsea hub and jumper cables, used to connect the hub to turbines T4, T5 and T6.

T4 deployment (Q3 2019)
Deploy the fourth array turbine on the site and connect it to the subsea hub.

T5, T6 deployment (Q2 2020)
Deploy the fifth and sixth turbines on the site and connect them to the subsea hub.

Reconfigure array (Q1 2021)
Relocate turbines T4, T5 and T6 within the array area.

Array operation (2018 to 2038)

Offshore work during this period will involve scheduled and unscheduled service visits, where a multicat, small workboat or similar vessel removes offshore equipment to shore for inspection and maintenance, before redeployment. Offshore surveys and inspections using ROVs, current measurement devices, dropcams and divers will also be conducted during array operation.

Decommissioning (2038)

All elements of the array - the turbines (nacelle, base and gravity foundations), array/jumper cables, hub, export cables and all associated equipment will be removed from the site and transported to shore for disposal.

3 Health, Safety and the Environment

The work will be conducted in compliance with Nova Innovation's HSE policy. All staff and personnel involved in the project will be fully briefed and trained and will exercise good health and safety and environmental work practices.

Environmental impact

An Environmental Assessment Report has been produced to accompany this application that assesses the effects of the proposed development on the environment. In addition, Nova Innovation will develop a Project Environmental Monitoring Programme (PEMP) for the array, setting out how the potential environmental impact of the project will be monitored and managed.

Pollution prevention measures

There are no hazardous substances contained in the turbines. All exposed steel surfaces are painted with standard marine-grade paint. A minimal amount of lubricant is used in each device; all lubricant is held within a sealed unit (e.g. the gearbox) within the watertight nacelle and is therefore doubly contained.

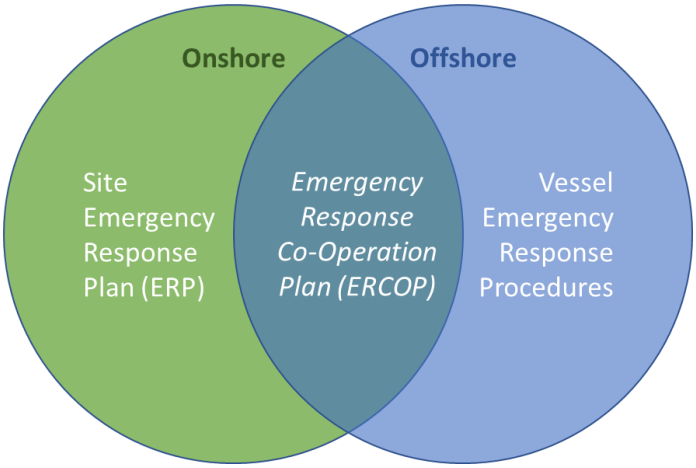
Measures to avoid the introduction of marine non-native species (NNS)

None of the additional equipment to be deployed in Bluemull Sound has previously been deployed subsea. Temporary moorings (e.g. chains) will either be sourced from Shetland or will be pressure washed or air dried prior to deployment in the Bluemull Sound. Attempts will be made to use locally based boats for offshore operations where it is practical to do so. Additional measures to avoid introduction of NNS during the project lifetime will be outlined in the PEMP, following recommendations in *A Biosecurity Plan for the Shetland Islands* (NAFC 2015).

Coordination of onshore and offshore activities

Nova Innovation use method statements, risk assessments and (when necessary) a permit to work system to ensure that onshore and offshore work is carried out safely and to ensure that everyone on site is aware of any work taking place that could affect them. HSE onshore is the responsibility of the Nova Onshore Manager. Offshore, the vessel captain has primary operational responsibility for HSE, supervised by the Nova Offshore Manager. In the event of any major incident requiring coordination between the offshore and onshore teams, the Nova Offshore Manager will be responsible.

Figure 3.1 Emergency Response Procedures



Notifications

Nova innovation will issue Notices to Mariners and operational updates via the UK Kingfisher Bulletins to ensure that other vessels in the area are aware of any operations.

4 Method statement

This chapter covers the offshore operations associated with the Shetland Tidal Array Extension. Some details of the method statement may change as the project develops; we will consult with Marine Scotland on any substantive changes.

4.1 Vessels to be used

The scale of the tidal devices allows small, readily available workboats, multicats and similar vessels to be utilised for all offshore operations. An example of a suitable vessel is shown in Figure 4.1.

Figure 4.1 Representative turbine deployment and retrieval vessel

Source: Leask Marine

These vessels have previously proven more than capable of operating in the conditions commonly experienced in and around the Bluemull Sound; for example, during the successful deployment and maintenance of the first three turbines in the array. Surveying operations will be conducted using small workboats.

4.1.1 Vessel Management Plan

The vessels to be used for offshore operations will be determined in advance of the operation depending on availability. The size and operational capability of vessels will be as follows:

1) Surveying: small workboat.
2) Deployment and retrieval: Small workboat, multicat or equivalent vessel (see Figure 4.1)

The Cullivoe Harbour Master, Shetland Ports and Harbours and Shetland CGOC will be advised in advance of all operations. All work will be undertaken in compliance with the direction of the harbour master.

All vessels involved in the installation, maintenance and decommissioning of the device will comply with all relevant aspects of the International Regulations for Preventing Collisions at Sea (COLREGS)[1]. All vessels used will carry equipment as required under the vessels' registration, e.g. the Code of practice for the safety of small workboats and pilot boats[2].

Notices to Mariners will be used to inform stakeholders of offshore operations. During all offshore operations, Nova Innovation will adhere to the good practice guidelines associated with the Scottish Marine Wildlife Watching Code.

4.2 Offshore cabling installation

Three offshore cables have already been installed, connecting T1, T2, and T3 to shore. Additional cabling required for the extension consists of:

- a subsea electrical hub, connected to shore via a 1.2 km export cable;
- three jumper cables a maximum of 600m in length, connecting turbines T4, T5 and T6 to the hub.

Cable stability

The cables are stabilised on the seabed using their own weight; no additional deposits are used to secure the cables along the cable corridor. This decision is informed by experience with similar cables deployed in the existing array and previous Nova 30 demonstrator project. In over 3 years of offshore operations, the subsea cables have proven to be stable on the seabed without the need for additional deposits.

Deployment methodology

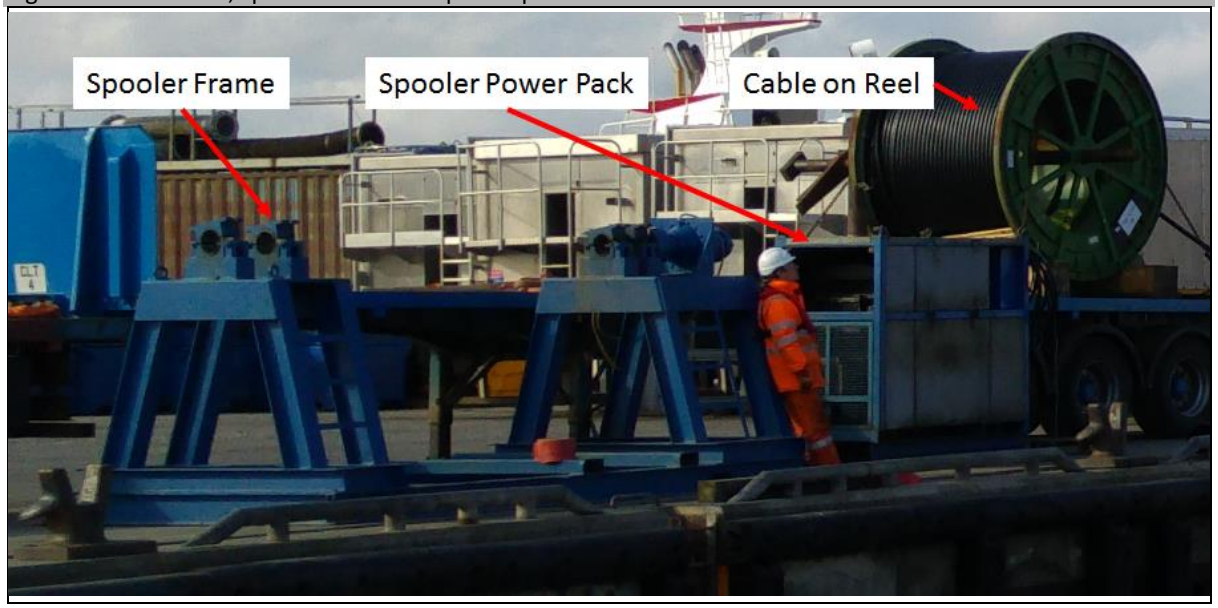
The export cable, hub and jumper cables will be deployed using a Multicat vessel or similar. A dropcam will be used to provide visibility of the subsea operations throughout.

The export cable will be laid from the turbine site towards shore. The export cable will be paid out from a spool on the vessel, an example of which is shown in Figure 4.2.

[1] Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) (as amended)

[2] https://www.gov.uk/government/publications/small-craft-codes

Figure 4.2 Cable reel, spooler frame and power pack



Source: Nova Innovation

The key steps to deploy the export cable, hub and jumper cables are as follows:

1) The hub will be lowered into the correct position offshore with the export cable attached (using a 4-point mooring if necessary).

2) The vessel will move slowly along the corridor defined in 1.3.1, paying out cable as she does so.

3) Close to shore, a line will be connected to the cable end and the cable drawn towards shore.

4) Onshore, the cable is placed in a cable conduit and terminated to the electrical substation.

5) Each jumper cable will be deployed separately by the installation vessel and connected to the subsea hub before routed to the connection point on the turbine base.

This is a standard operation which Nova have already carried out multiple times on this site with the Nova 30 and Nova M100 cables and their associated connectors.

4.3 Nova M100 turbine installation

Each of the new turbines will be installed in two phases:

1) Substructure installation: the base and ballast will be transported using a small workboat from a local harbour to the installation location, where they are lowered into position on the seabed and remain stable under their own weight.

2) Turbine installation: the nacelle will be transported from a local harbour to the installation location, where it will be lowered onto the base. Each nacelle is electrically connected to the jumper cable at the turbine base.

4.4 Site characterisation

Nova Innovation will occasionally deploy survey equipment (such as ADCPs) on-site during operation – for example, to determine the nature and size of turbine wakes. These will be deployed on frames (approx. dimensions 2 x 2 x 1m) and recovered from the seabed by a small workboat. Buoys on a ground weight attached

by a line to the frame may be deployed to allow visual retrieval of the sensor frames; these buoys will sit less than 1m off the seabed.

4.5 Post-deployment site surveys

A survey of the deployed turbine and cable route will be conducted using survey equipment deployed from a small workboat. The position of the deployed devices and cables will be communicated to UKHO to be marked on hydrographic charts.

4.6 Timing and management of installation

Offshore operations will be targeted for slack water times in suitable wave and weather conditions. The installation will be undertaken by a vessel contractor and managed by Nova Innovation staff, who will be located in Shetland for the duration of operations. Following successful commissioning, monitoring of the devices will be undertaken from the shoreside control panel and remotely via a secure internet connection.

4.7 Normal operation, monitoring and control

The turbine blades rotate in the tidal stream, driving a generator housed within the nacelle. The electricity produced by the generator is exported to the grid by subsea cables to the shore (via the subsea hub for turbines T4, T5 and T6).

Communication to the machines is via a fibre optic cable embedded in the power cable, which can be accessed by a secure ISDN/broadband communications link, allowing each individual turbine to be controlled and monitored locally in Shetland and remotely.

4.8 Environmental management and monitoring

Each device will be monitored automatically and manually for a period following deployment. Manual monitoring involves a Nova engineer maintaining direct oversight of the turbine during operation, including monitoring of data and video feeds. If no adverse events are observed, then the device will continue to be monitored automatically during its operating lifetime. Details of the monitoring plan will be set out in the PEMP.

If any significant environmental harm is observed, then the offending device or if appropriate the entire array, will be shut down. This can be done remotely via the secure internet connection or manually on-site. Details of the shutdown protocol will be provided in the PEMP.

4.9 Array maintenance

Each turbine nacelle will be periodically removed from its base and taken back to Cullivoe Pier for servicing on land, following which it will be returned to its base. The stages involved in this process are set out below:

1) **Retrieval**: The nacelle is released from the base and lifted to the surface, secured to the vessel and removed to shore for servicing. If necessary, equipment such as guide chains or cable ends left on the seabed temporarily may be fitted with temporary surface buoys or subsea pop-up buoys.

2) **Redeployment**: On completion of servicing, the nacelle is transported back to the installation site before being lowered onto the base and connected for operation.

If required, the base, turbine nacelle, hub and cables can be recovered to shore for maintenance or any other reason, by reversing the installation procedures.

4.10 Contingency plans for loss or damage of device

In the highly unlikely event that any of the devices should become detached or damaged, an alarm is immediately sent to the operator on duty who will co-ordinate retrieval operations. The device is negatively buoyant, so will remain on the seabed in the event of failure. The amount of lubricant is minimal, and all lubricants are housed within sealed units inside a watertight nacelle i.e. they are doubly contained.

4.11 Array reconfiguration

As part of the EnFAIT project, turbines T4, T5 and T6 will be moved within the array site following an initial period of operation. The purpose of this is to explore wake effects between rows of turbine for the first time on a real tidal array. The precise location of the devices after relocation will depend on the research carried out during the EnFAIT project.

The methodology will be as follows:

1) **Planning**: Determine the new location to which the turbines will be moved. The locations will be selected in consideration of the following factors:

    a. *Safety*: consider how the devices can be safely moved from their initial deployment location to the new locations, minimising risks to equipment, personnel and other users of the sea.

    b. *Knowledge exchange*: adjust the turbine locations based on detailed site measurements and hydrodynamic modelling of wake interaction effects, to optimise performance and maximise learning of wider use to the marine energy industry.

2) **Communication**: keep stakeholders informed of planned changes. The communication strategy is outlined below.

3) **Nacelle retrieval**: The nacelle will be retrieved to shore following the same procedure as for nacelle maintenance.

4) **Cable relocation**: The jumper cable will be moved to a suitable location on the seabed, close to the new deployment location but clear of operations.

5) **Base relocation**: Lifting lines will be attached to the base by a subsea grab, divers or ROVs. A Multicat vessel or similar will lift the base from the seabed and deposit it at the new location. The jumper cable will then be brought to this location and made ready for the nacelle deployment.

6) **Nacelle redeployment**: The nacelle will be redeployed following the original deployment procedure.

7) **Site survey**: The site will be surveyed to confirm the location of equipment. Confirmation of changes will be communicated to UKHO for marking on nautical charts.

4.12 Communication strategy

Significant changes to the array configuration will require two steps of communication:

1) **Pre-operation communication**: stakeholders will be informed in advance of all planned changes to the array configuration.

2) **Post-operation communication**: stakeholders will be informed following offshore operations of any significant changes to turbine and cable locations.

The following stakeholders will be included in this Communication Strategy:

- Marine Scotland
- Shetland Islands Council
- Shetland Ports and Harbours
- Maritime and Coastguard Agency
- Scottish National Heritage
- Northern Lighthouse Board
- Shetland Fishermen's Association
- Shetland Shellfish Management Organisation

- Shetland Coastguard Operations Centre
- Hydrographic Office
- Recreational vessel operators

Notices to Mariners and any significant changes in the array will be communicated to Marine Scotland, along with accompanying shapefile data.

4.13 Decommissioning

Removal of the devices at any time is relatively straightforward due to their size and the fact that all components are secured by their own weight. Means for the removal from site of the major subcomponents are listed below:

1) **Turbine nacelle** removal follows the maintenance procedure described above. The nacelle will be dismantled onshore for re-use or recycling.

2) **Turbine base** is lifted from the sea bed to the surface by a service vessel. The base is secured to the vessel and taken to shore, where it can be re-used or dismantled for recycling.

3) The **cables** are retrieved by spooling them back onto a reel aboard a work boat (see Figure 4.2), reversing the deployment process.

Once the devices and associated structures are removed, surveys will be conducted to ensure that the site has been cleared. The seabed and surrounding area will return to their natural state with no permanent impact from the project.