Nova Innovation Ltd

Bluemull Sound Tidal Array

Navigational Risk Assessment

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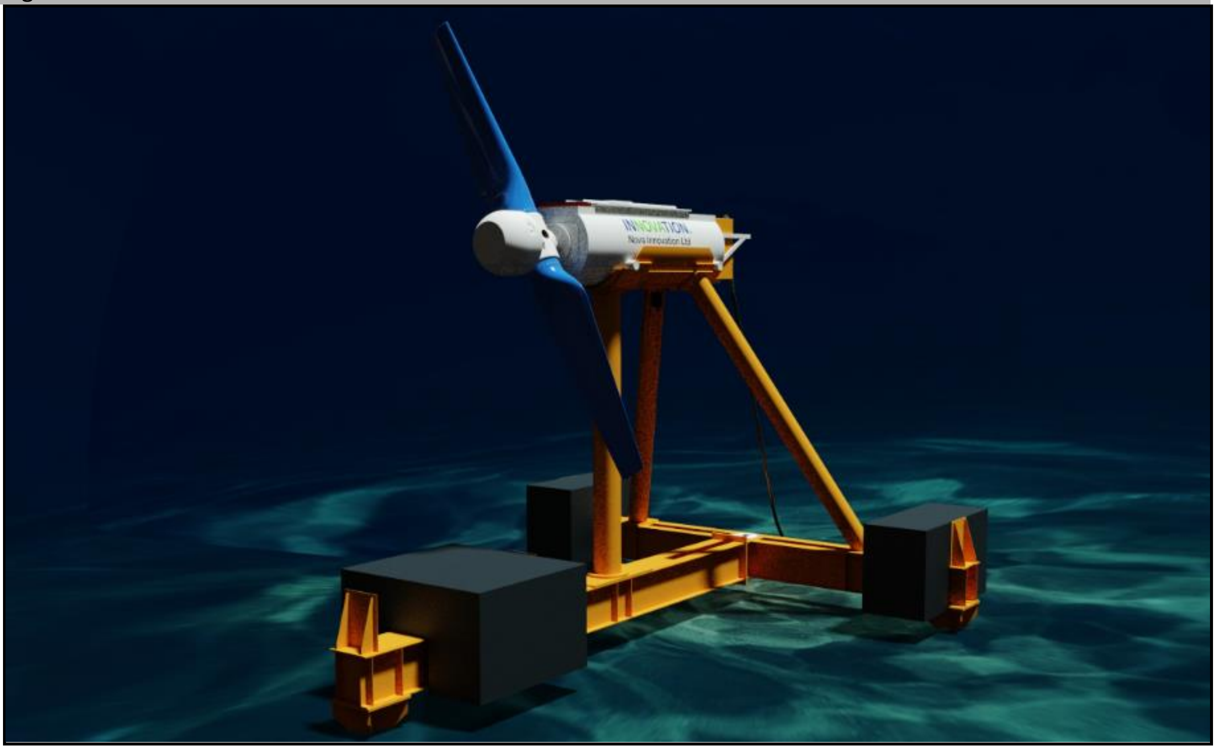
Abbreviations

ATBA	Area To Be Avoided
AIS	Automatic Identification System
ERCoP	Emergency Response Cooperation Plan
kW	kilowatt
MCA	Maritime and Coastguard Agency
MRCC	Maritime Rescue Coordination Centre
MWLS	Mean Low Water Spring
NRA	Navigational Risk Assessment
OREI	Offshore Renewable Energy Installation
SFA	The Shetland Fishermen's Association
SSMO	Shetland Shellfish Management Organisation

1 Introduction

Nova Innovation proposes to install an array of five tidal energy devices in the Bluemull Sound near Cullivoe in Shetland. The devices are bottom mounted, gravity anchored, non-yawing horizontal axis tidal turbines with 100 kW output capacity as illustrated in Figure 1.1.

Figure 1.1 Nova Innovation Nova M100 Tidal Turbine



Source: Nova Innovation 2015 ©

The scale of the turbine is small (100 kW) 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.

This Navigational Risk Assessment (NRA) has been drafted in accordance with the Maritime and Coastguard Agency (MCA) guidance note MGN 371[1]. The document structure is: an introduction; method statement; and then five sections corresponding to the five annexes of MGN 371, followed by an Appendix with the Hazard Log. While completing the NRA, attention was also paid to the report Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms[2].

This NRA forms part of the license application for a small-scale array of tidal devices. The MCA documents referred to above are written with much larger commercial installations in mind (indeed, the navigational safety risk assessment guidance document refers only to offshore windfarms). As such, many of the stipulations set out in the guidance notes may be impractical or unsuitable for a small-scale tidal array. We have taken a pragmatic approach to the NRA, guided by the MCA's principal objectives – navigational safety and Search and Rescue. We hope this meets with the approval of stakeholders and would welcome their comments.

[1] Maritime and Coastguard Agency, Marine Guidance Note MGN 371 (M+F) Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response Issues

[2] Guidance on the Assessment of the Impact of Offshore Wind Farms - Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms

2 Method Statement

The purpose of the Method Statement is to describe the methods and techniques that will be employed to install, operate and decommission the Nova Innovation tidal turbine array in the Bluemull Sound (the Shetland Tidal Array). All staff and personnel involved in the project will be fully trained and briefed, and will exercise good health and safety and environmental work practices.

2.1 The Nova M100 tidal turbine

As illustrated in Figure 1.1, 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 securely connected to the base by means of a latching system.

The turbine has a rotor diameter of 10 m, and a hub height of 9 m, making the total height 14 m from the bottom of feet to the tip of the blades. In the Buemull Array the devices will be installed in water depths greater than 30 m, so clearance will be more than 15 m below lowest astronomical tide (LAT). The footprint of the device is 13.5 x 12.2 m, and the weight in water is 80 tonnes.

The nacelle is securely fixed in position during operation: the only external moving parts are the rotor blades. The rotor rotates in the tidal stream and drives a gearbox and generator housed within the nacelle. The electricity produced by the generator is exported to shore by a sub-sea cable connected to the nacelle. Each turbine has its own dedicated export cable. All electrical power conditioning and control is based onshore at the grid connection point on Cullivoe pier.

2.2 Installation

The means by which the devices are to be installed on the site, including the timing of installation, the nature of the mooring and details of any vessels to be used for installation are outlined below.

Vessel to be used

The relatively small scale of the tidal devices in the array allows a Multicat vessel to be utilised for all installation, maintenance and recovery operations. An illustrative example of a Multicat is shown in Figure 2.1.

Figure 2.1 Representative turbine deployment / retrieval vessel

Source: Delta Marine

These vessels have previously proven more than capable of operating in the conditions commonly experienced in and around the Bluemull Sound, particularly during the successful deployment of our Nova 30 demonstrator tidal turbine. They have sufficient margin of additional operational safety capacity to be able to comfortably deal with the size and weight of equipment for this project.

Tidal device installation procedure

Each tidal turbine will be individually deployed in 3 stages:

1) The base is carried by the Multicat to the installation location, whence it is lowered to the correct position on the seabed. Guide chains connected to the base are attached to a temporary 'works' marker buoy.

2) The cable will be laid from the stern of the Multicat as a single length from the turbine location to the pier at Cullivoe. A marker buoy connected to cable will temporarily mark the location of the cable turbine end. The cable is not fixed to the seabed, but lies on top of the sea bed with cast-iron clam-shell cable protection utilised for stability and protection as required.

3) The Multicat returns to Cullivoe Pier and collects the turbine nacelle, which is brought to the installation location. The temporary marker buoy is recovered and guide chains and cable attached to the nacelle. Controlled by the guide chains, the nacelle is lowered from the vessel to the base to which it is mated by use of a secure latching system.

Timing and management of installation

All offshore operations will be conducted during slack tide at a time of optimum wave and weather conditions. The installation will be managed by Nova Innovation staff who will be resident in Shetland for the project. Following successful commissioning, monitoring of the devices will be undertaken remotely via a fibre optic cable. This will allow the devices to be monitored either from the shore or remotely via a secure internet connection.

2.3 Operation, Monitoring and Control

A fibre optic cable embedded in the power cable allows communication with the machine, either at Cullivoe Pier or remotely via a secure internet connection. It is therefore possible to control and monitor the turbine locally and remotely at any time by a responsible qualified person.

2.4 Tidal device maintenance

The nacelle is recovered to shore for maintenance and repair following the procedure outlined below.

Device maintenance procedure

Each tidal turbine will be individually removed in 4 stages:

1) A Multicat or similar vessel is deployed to the site. The turbine nacelle lifting line is released from the base by triggering a mechanism using the turbine control system (which can be operated from the vessel). In the event that the remote release mechanism fails the mechanism can be triggered by an ROV.

2) The negatively buoyant nacelle is recovered to the vessel, controlled by the lift gear and guide chain.

3) The nacelle removed by the Multicat or similar vessel from the array site to Cullivoe Pier, where it is lifted onshore for maintenance and repair.

4) When maintenance is complete, the nacelle is redeployed on the base following step 3 of the installation procedure.

Timing and management of maintenance

All offshore operations will be conducted during slack tide at a time of optimum wave and weather conditions. Device maintenance will be managed by Nova Innovation staff who will be resident in Shetland for the project. The frequency of maintenance is expected to be twice per year for each device during the initial two years of operation, and once every two years thereafter.

2.5 Contingency Plans for Loss of Device

Three levels of redundancy are employed in the latching mechanism to insure against accidental release. However, in the highly unlikely event that the nacelle should become detached from its base, an alarm is immediately sent to the operator on duty who will co-ordinate retrieval operations. As the nacelle is negatively buoyant there would be no risk to surface vessels.

2.6 Decommissioning

The expected operational life for the array is twenty years. Removal of the devices at any time is relatively straightforward due to their relatively small scale.

Device removal procedure

Each tidal turbine will be individually removed in 4 stages:

1) The nacelle is removed to shore following the procedure described for device maintenance above (steps 1-3).

2) The cable is recovered separately, and spooled onto a drum on the Multicat and taken to shore in the reverse of the cable installation operation. Cable protection is removed with the cable and also taken to shore.

3) A diver or ROV attaches lifting chains to the base, which is lifted by a Multicat and removed to shore.

4) Once onshore the device is recycled or disposed of in accordance with relevant recycling and waste disposal procedures.

All parts of the array will be removed from the seabed during decommissioning. The sea bed and surrounding locality should return to their natural state with no permanent impact from the devices.

2.7 Hazard Log

A Hazard Log is set out in Appendix A. The risk from this tidal array is considered to be "tolerable with monitoring"[3] given the controls outlined in this NRA and Hazard Log.

[3] Risk Tolerability definitions are taken from the publication – Guidance on the Assessment of the Impact of Offshore Wind Farms Table C.4.4 – see Appendix A

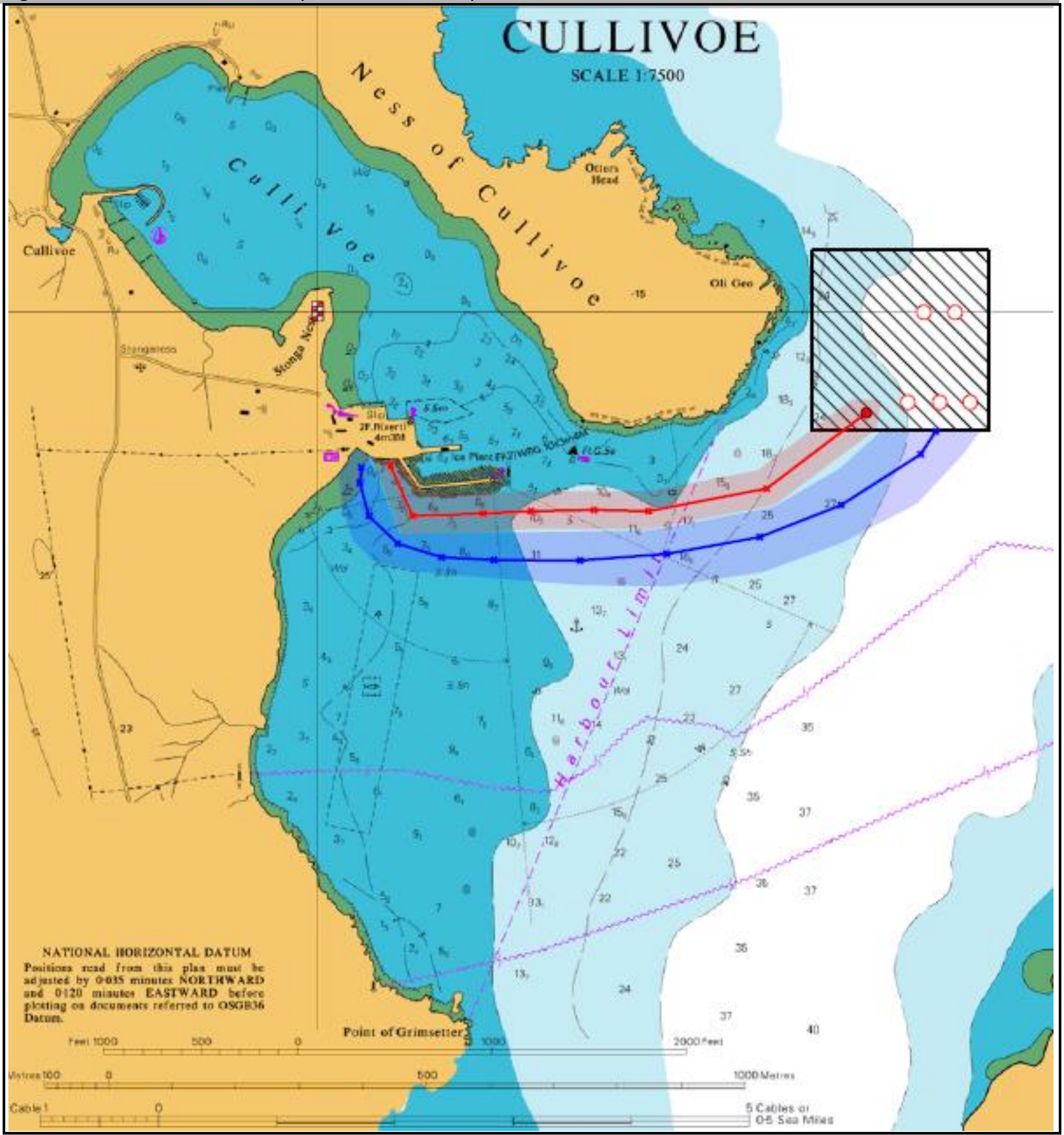
3 Consideration on site position, structures and safety zones

3.1 Site and Installation Co-ordinates

The Bluemull Sound is situated between the Shetland Islands of Yell and Unst. 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 3.1 shows the proposed position of the tidal array.

Figure 3.1 Location of tidal array, cable and surveyed area



Source: Nova Innovation 2015 ©, UKHO

- The cross-hatched rectangle shows the lease area.
- The existing Nova 30 demonstrator turbine is marked with a red dot. The red line shows the path of the cable from this turbine to shore; the red shaded area is the Crown Estate lease area for this cable.

- The location of the five proposed array turbines are marked with open circles. The exact location of each turbine will be communicated to UKHO following deployment to be marked on hydrographic charts. The five array cables will follow the track of the blue line to shore, and will lie within the blue shaded area.

The location of the turbines has been selected to minimise risk to shipping in the area. The minimum depth of the tip of the turbine blades is 15 m below mean lowest astronomical tide, giving a minimum 6 m static draught clearance for vessels with a 9 m draught.

The following bodies were consulted with in the preparation of this Navigational Risk Assessment:

- Shetland Ports and Harbours
- Lerwick Boating Club
- Shetland Shellfish Management Organisation (SSMO)
- Shetland Fishermans Association (SFA)

Nova Innovation will make available the co-ordinates of the site to any interested parties at all stages of the project, including application for consent, development, operation and decommissioning.

3.2 Traffic Survey

A traffic survey was conducted drawing on the following information sources:

1. An Automatic Identification System (AIS) receiver located on Cullivoe Pier

2. Fishing activity data from the NAFC Marine Centre (NAFC).

3. Consultation with the Shetland Fishermens Association and the Shetland Shellfish Management Organisation.

3.2.1 Shetland Isles Overview

Shipping passes around the islands and a number of ferry routes and regular dry cargo trades run from the mainland and between the individual Islands in the Shetlands. The oil terminal at Sullom Voe generates calls by tankers well in excess of 350 metre in length together with oil rig and other support services. Construction work at Sullom Voe and at surrounding oil fields and development projects also generate vessel traffic. Shallow water and restricted navigation means that larger vessels avoid the Bluemull Sound.

3.2.2 Cullivoe Pier

The Harbour at Cullivoe has an ice house used by the fishing industry. It is primarily used by fishing and service vessels although there is also some leisure traffic.

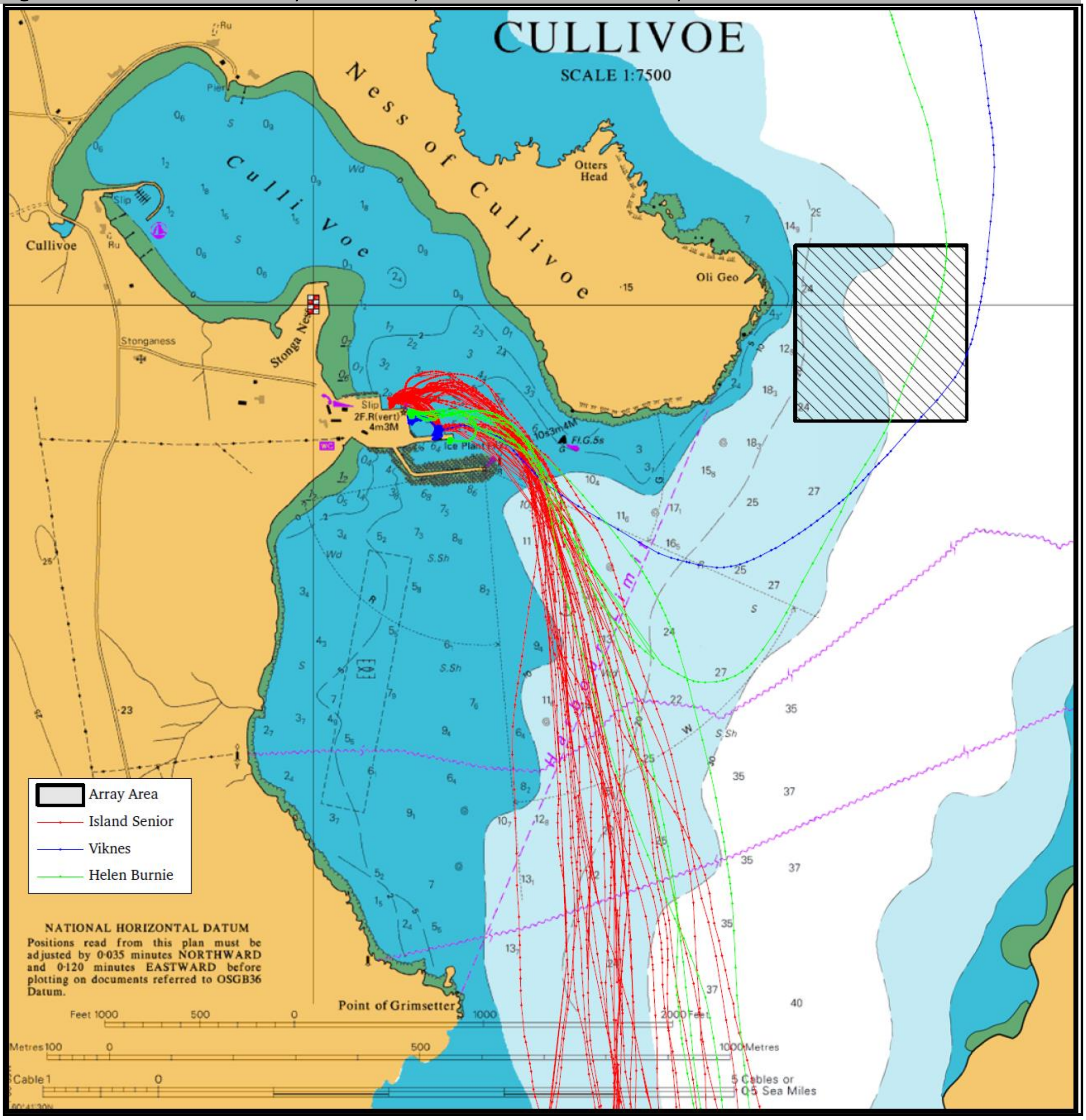
3.2.3 Ferry services

To the South of the Bluemull Sound, approximately 2 km from the array site, ferries run between Gutcher, Belmont and Hamars Ness. The ferry occasionally berths at Cullivoe Pier in poor weather or to refuel.

3.2.4 AIS traffic survey

AIS data was collected over two 2-week periods, one in Summer (2nd to 15th of July 2014) and one in Winter (1st to 14th of February 2015). The results are shown in Figure 3.2 and Figure 3.3.

Figure 3.2 Results of AIS survey of the array site conducted in February 2015



Source: Nova Innovation 2015 ©, UKHO

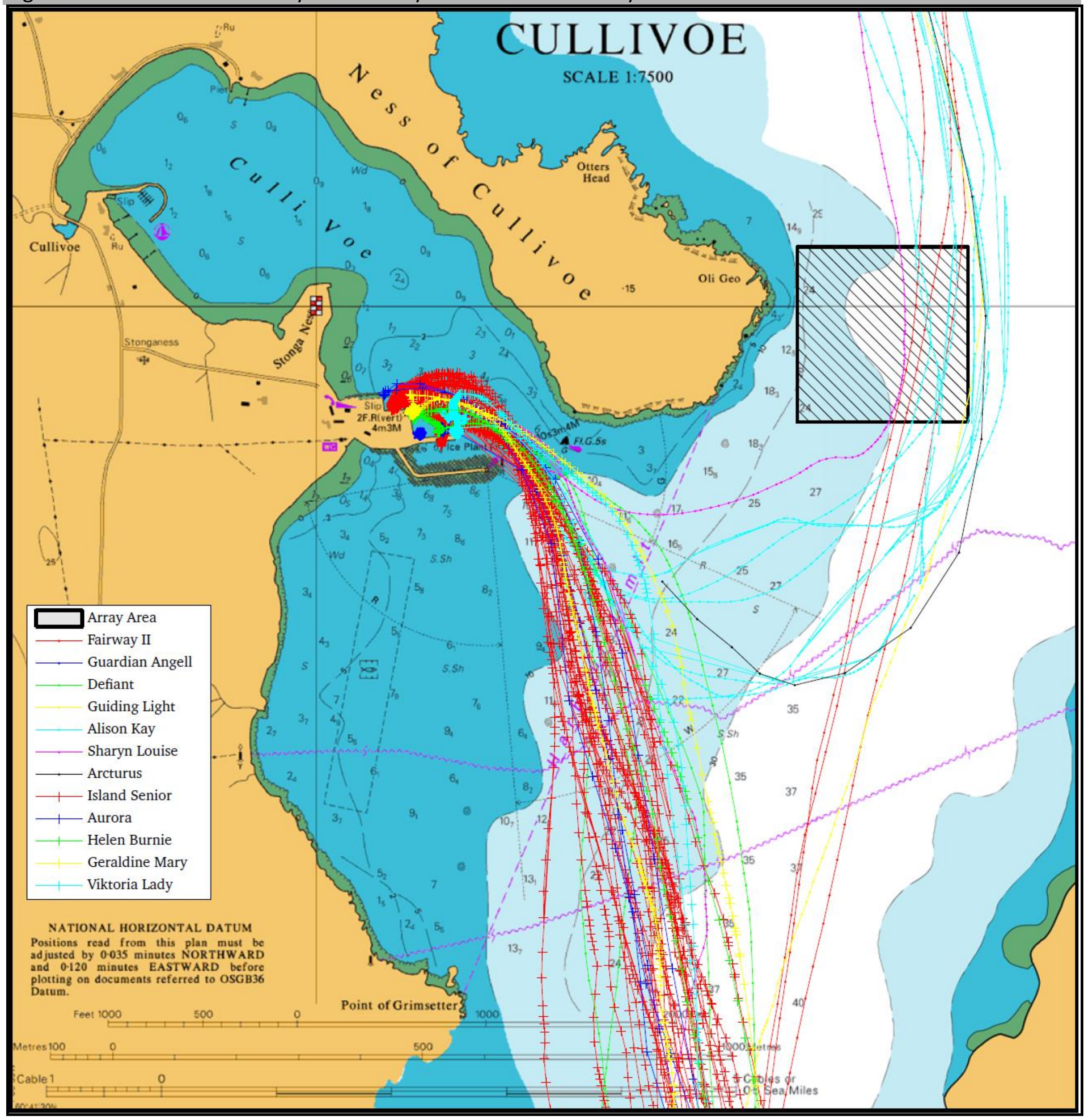
During the winter AIS survey only two vessels were observed passing over the array site (one traverse per week) – see Table 3.1. Both vessels were travelling to or from Cullivoe Pier, and crossed the deep water (30m+) area to the East of the array site.

Table 3.1 Vessels observed traversing the array area, AIS survey, February 2015

Name	Vessel type	Dimensions	Draught
Viknes	Fish carrier	36 x 8 m	5 m
Helen Burnie	Work vessel	25 x 10 m	3 m

Source: Nova Innovation 2015 ©

Figure 3.3 Results of AIS survey of the array site conducted in July 2014



Source: Nova Innovation 2015 ©, UKHO

During the Summer AIS survey the vessels listed in Table 3.2 were observed passing over or near the array site. There was an increase in traffic compared to the winter survey: the site was traversed eight times by four different vessels during the survey period (approximately one traverse every two days): four times by vessels travelling to/from Cullivoe Pier; four times by vessels passing through the Sound. The observed seasonal variation in activity was confirmed in consultation with the relevant stakeholders.

Table 3.2 Vessels observed traversing the array area, AIS survey, July 2014

Name	Vessel type	Dimensions	Draught
Sharyn Louise	Fishing vessel	19 x 7 m	4 m
Fairway II	Fishing vessel	24 x 7 m	4 m
Alison Kay	Trawler	24 x 8 m	5 m
Guiding Light	Trawler	23 x 7 m	3 m
Arcturus	Fishing vessel	26 x 8 m	5 m

Source: Nova Innovation 2015 ©

3.2.5 Non AIS Traffic

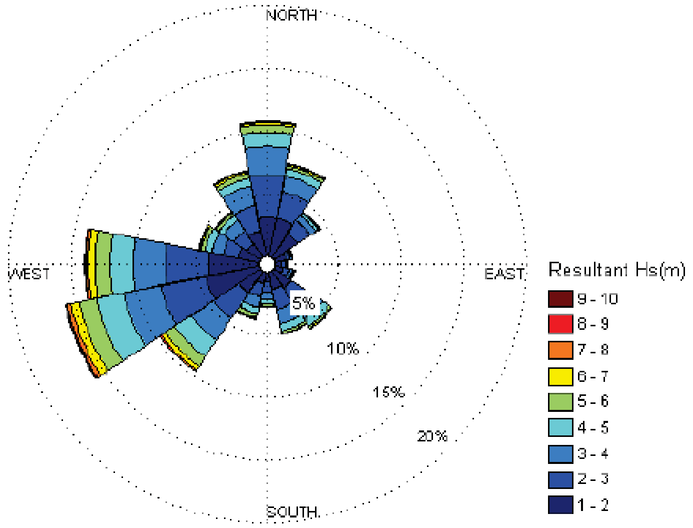
Much of the traffic using the Bluemull Sound consists of smaller vessels which will not necessarily be fitted with AIS (mandatory for ships over 300 gross tonnes). This will include fishing vessels, service boats and leisure boats. Many of these vessels use Bluemull Sound as a transit route. The local harbour at Cullivoe also attracts vessels to the area along with a small marina for leisure boats.

To better understand the local traffic and site specific issues, the position and size of the deployment area was discussed and agreed in consultation with Ports and Harbours and the Shetland Fishermen's Association and MMSO. The position of the devices was selected to avoid any area used for safe anchorage and to minimise any risk to shipping in the area. It was agreed that 15 metres would be adequate draft clearance for the deployment area selected. It was also agreed that the site would not be permanently marked by a buoy (or similar device) as this could create a hazard to shipping.

3.2.6 Under-keel clearance

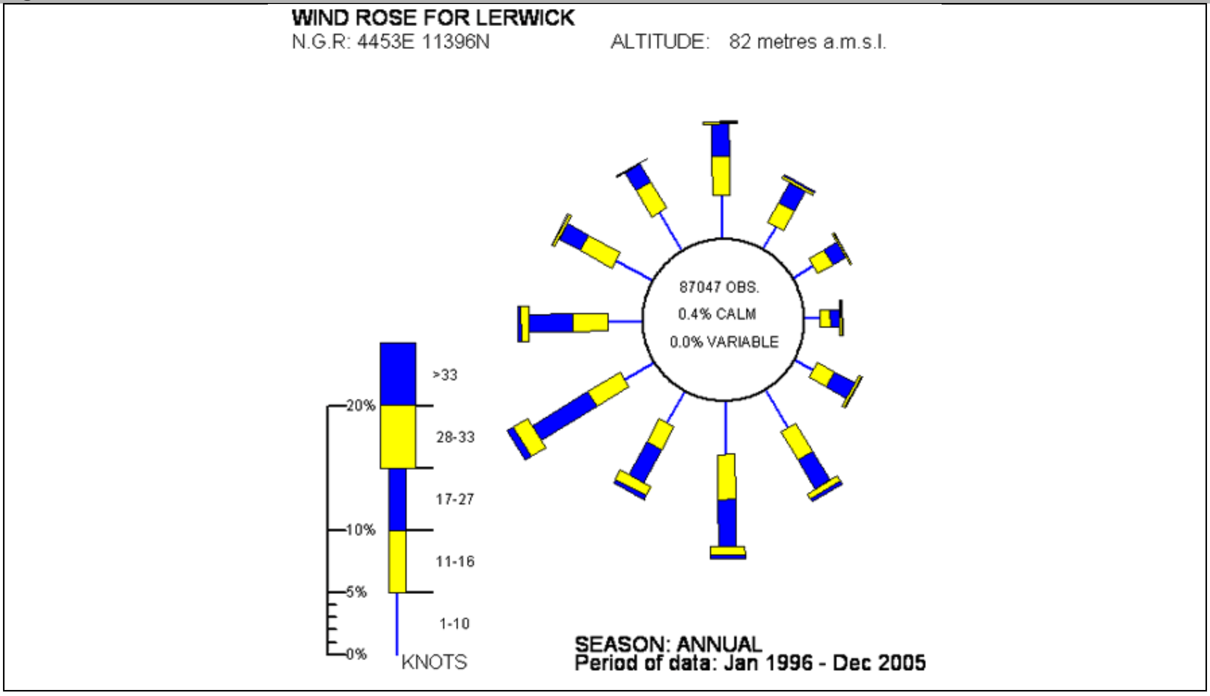
After discussions with Ports and Harbours, SFA and SSMO it was agreed that 15 metres would be adequate draft clearance for the deployment area selected. In order to validate this clearance, a worst case scenario was considered for a deep draft vessel passing directly over the turbine at low tide in a rough sea state. Wave and wind data for Shetland are shown in Figure 3.4 and Figure 3.5.

Figure 3.4 Wave rose, West of Shetland (offshore)



Source: Shetland Island Council, Shetland Marine Resource Study 2011

Figure 3.5 Wind rose for Lerwick



Source: Met office

Sea state at the turbine location was estimated with reference to the Shetland Tidal Resource Study[4]. This found that the wave regime to the west of Shetland was relatively stable throughout the year, with waves incident predominantly from the West, a mean wave height 2-4 m, a period of 7-8 seconds, and an extreme annual significant wave height[5] of 8 m.

In contrast, because the Bluemull Sound is a narrow channel sheltered from the prevailing winds, the mean wave height in the Sound was found to be less than 0.6 m. Assuming the ratio of maximum to mean wave height is the same in the Sound as offshore, the maximum significant wave height experienced in one year would be less than 2 m. This is confirmed by the classification of the Bluemull Sound by the MCA[6] as Category D, meaning "Tidal rivers and estuaries where the significant wave height could not be expected to exceed 2.0 metres at any time".

During adverse weather conditions there will be a spectrum of wave heights around the significant wave height. Assuming that the distribution of the individual wave heights follows a Rayleigh distribution, approximately 1 in 2000 waves will be at least twice the significant wave height[7]. We therefore make the conservative assumption that the extreme maximum wave height likely to be experienced at the site is 4 m.

The static draft of a vessel depends on the vessel design and loading. The dynamic draft refers to the change in vessel draft with speed, and incorporates squat (a change in the vessel's fore to aft angle) and settlement (a lowering of the local water level around the ship due to displacement). The draft of a vessel can also change as it pitches and rolls with waves, and depends in a complex manner on the sea state and the loading and design of the vessel in question.

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[4] Shetland Islands Wave and Tidal Resource, Shetland Island Council 2011.

[5] Significant wave height is defined as the mean height (trough to crest) of the highest third of waves.

[6] Merchant shipping note MSN 1837 (M), Categorisation of Waters

[7] For example see MCA Research Project 509, HSC – Evaluation of Existing Criteria (Deakin 2005)

In order to illustrate a worst-case scenario for the proposed site, we consider the under-keel clearance in rough seas at lowest astronomical tide (LAT) of one of the largest fishing vessels known to frequent the sound: the Altaire[8]. The maximum recorded static draft of the vessel is 9.2 m. We assume that the dynamic draft increases to 10 m when the vessel moves at full speed. If the vessel is moving parallel with the trough of a 4 m extreme wave[9] then the bottom of the boat will lie 12 m below LAT.

The water depth at the chosen site is a minimum of 30 m (measured from lowest astronomical tide), and the maximum height of the tip of the Nova-100 turbine blade from the sea bed is 14 m. The minimum distance between the turbine blade and LAT is therefore 16 m (NB this is below the minimum depth of 15 m agreed in consultation with stakeholders), and the under-keel clearance for the vessel in the worst-case scenario is therefore 4 m. Considering the conservative nature of the assumptions used, this shows that it is highly unlikely that the array will interfere with marine traffic.

3.2.7 Proximity of Site to Existing Structures

The deployment site was selected to avoid any disturbance or interference with existing structures in the area. Most notably are the archaeological wreck to the northwest and the subsea power cables approximately 1 km and 2 km to the south. All lie well outside the area of influence of the array or any works related to it.

3.2.8 Fishing activity

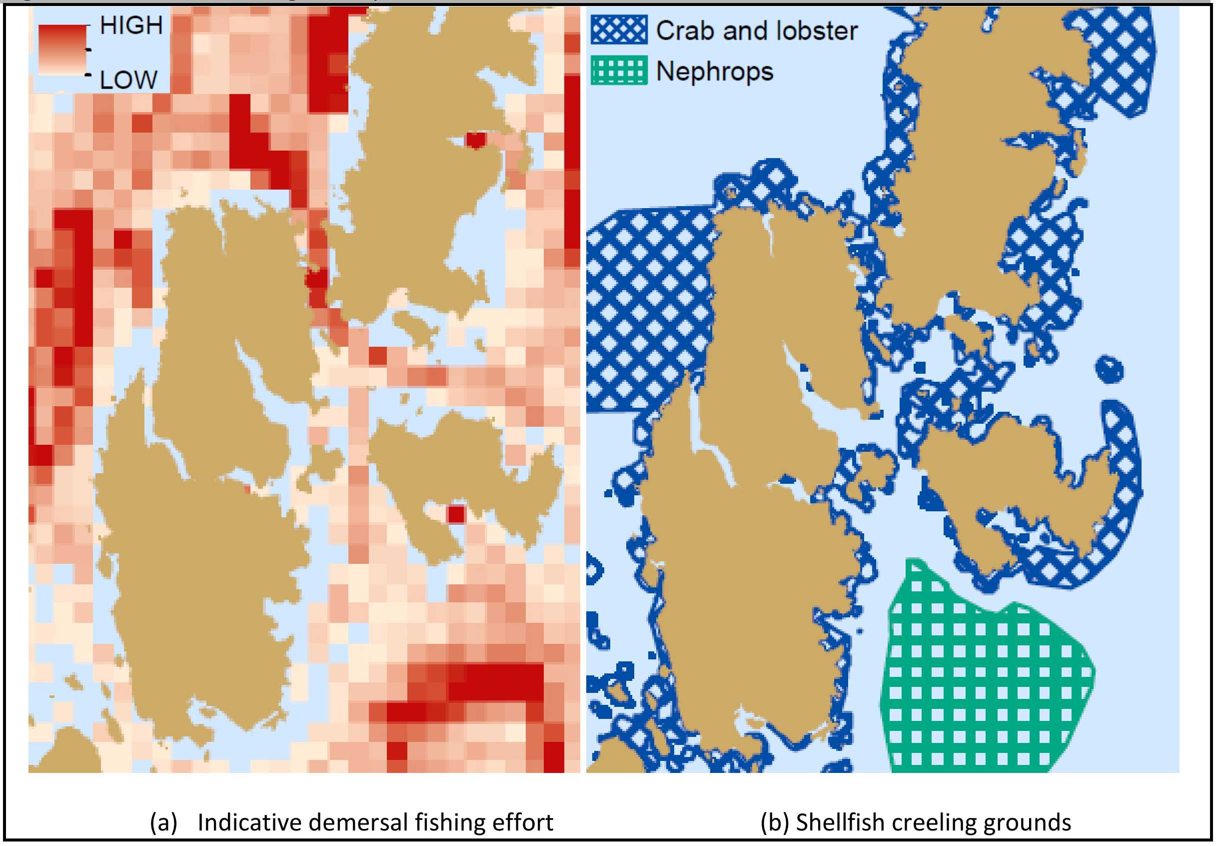
Data on fishing grounds around the Shetland coast was sourced from the NAFC. Two charts from the Shetland Marine Spatial Plan are provided in Figure 3.6, showing (a) indicative demersal fishing activity derived from VMS data, and (b) shellfish creeling grounds, based on NAFC modelling and consultations with shellfish fishermen.

Regarding the demersal fishing activity data, NAFC caution that “VMS data for larger vessels tends to overestimate fishing effort in this area as the strong tidal flow means that boats travel more slowly, and this gives the false appearance of fishing effort”. This is because “fishing effort” is derived from VMS data by assuming that slow vessel speeds are associated with fishing activity; vessels arriving at Cullivoe Pier will also be incorrectly flagged as “fishing” using this data source. Consultation with the SFA and Shetland Shellfish Management Organisation indicates that, whilst creeling does take place around in the Bluemull Sound, the high flow speeds encountered at the array site and its proximity to the main passage North from Cullivoe Harbour mean that the selected site is not an active fishing or creeling area.

[8] http://www.marinetraffic.com/ais/shipdetails.aspx?MMSI=235838000

[9] An extremelyly unlikely scenario, since it would involve the vessel moving at maximum speed across the Sound, parallel to waves, outside the main shipping channel during very rough weather.

Figure 3.6 Indicative fishing activity in and around the Bluemull Sound



(a) Indicative demersal fishing effort (b) Shellfish creeling grounds

Source: NAFC 2013

3.2.9 Traffic Survey Conclusion

Large vessel traffic intensity around the site is low. In consultation with local Ports and Harbours Authority SFA and SSMO, direction has been taken on the optimum position for the turbine to minimise risk and hazard to shipping. The position chosen has been deemed acceptable by the relevant parties consulted during this NRA.

3.3 Offshore Renewable Energy Installation (OREI) Structure

All parts of the array will be located below the sea surface at a depth of at least 15 metres below lowest astronomical tide. Consequently, the OREI structures are deemed not to pose a danger to shipping or the emergency services. Should an emergency shut down be required, this can be done remotely or at Cullivoe Pier by means of enabling an electrical brake. These brakes are fail-safe and are enabled in the event of loss of power. Greater detail can be found in Section 7.

3.4 Assessment of Access to and Navigation Within, or Close to, an OREI

The Nova Innovation tidal turbine is a subsea device and has been designed to allow navigation by all vessels that use the Bluemull Sound. The draft clearance and position of the turbines has been chosen such that vessels can pass directly above the array without coming into contact or interfering with it. Vessels large enough to have a draft sufficient to come into contact with a device are unlikely to navigate through the area because of the depth of the water, strong tides and other navigation hazards present in the Bluemull Sound.

The location and depth of the array is such that there should be no navigational, safety or routing problems for vessels operating in the area. As such, we do not consider it necessary to prohibit any specific vessel types that typically use the area. However, we do strongly advise that no subsea activity be carried out within the vicinity of the array, e.g. fishing, diving or anchorage. It should be noted that the area was chosen specifically because no such activities are undertaken at the location.

4 Navigation, collision avoidance and communications

4.1 The Effect of Tides and Tidal Streams

i. The array will not affect the current traffic flows and operations in the general area either at high or low water conditions.

ii. The tidal stream at the site is severe and has a significant effect on vessels in the area. The array will not exacerbate or make worse the effect of the tide for shipping.

iii. The set of the tidal flow has no effect on navigational risk because the facility is fully submerged at a depth that will not interfere with shipping.

iv. The set of the tidal flow has no effect on navigational risk because the facility is fully submerged at a depth that will not interfere with shipping.

v. Engine failure in the area would cause any vessel in the area to be in danger since the tidal stream is powerful and fast. Adequate safety measure and backup will be required for vessels involved in installation, maintenance and decommissioning.

vi. The small size of the array means that any changes to the set and rate of the tidal stream will be minimal, predominantly a minimal change to downstream turbulence.

vii. There will be no scouring or sediment deposition as a result of the array; the local seabed consists of small boulders and shattered rock.

4.2 Weather

i. The array will not pose any additional difficulties for vessels or craft that could be present during adverse weather conditions. The devices have been designed to operate at a depth that will not interfere with navigation. For this reason, no permanent buoy or marker will be used at the site.

ii. Since there are no parts of the array above the surface it will not create any problems in the area for vessels under sail, such as wind masking, turbulence or sheer.

iii. Engine failure or other circumstances will not be exacerbated by the installation of the array because it is installed subsea at a clearance depth greater than 15 m.

4.3 Visual Navigation and Collision Avoidance

i. The array and associated structures will not block or hinder the view of vessels underway in any route or direction.

ii. The array and associated structures will not block or hinder the view of the coastline or any other navigational feature such as aids to navigation, landmarks, promontories, etc.

4.4 Communications, Radar and Positioning Systems

i. Because all parts of the array and associated structures are below the sea surface, no radio interference with respect to any frequencies used for maritime positioning, navigation or communication (including AIS) will be produced.

ii. Because all parts of the array and associated structures are below the sea surface there will be no negative impacts on radar.

iii. The OREI will comply with all current recommendations concerning electromagnetic interference.

iv. No part of the array will produce sonar interference that could affect fishing, industrial or military systems used in the area.

v. The facility is fully submerged, and so will produce no acoustic noise which could mask prescribed sound signals.

vi. The generators and seabed cabling are electrically shielded and submerged in at least 20m of seawater, and will generate no magnetic fields that could interfere with compasses or other navigation systems. Onshore works are also shielded to prevent stray electro-magnetic fields.

4.4.1 Potential Noise Sources and Pathways

The array is located subsea, with a minimum depth of 15m. There will therefore be no potential to mask prescribed sound signals.

The turbines are mechanical devices with power electronics located onshore behind a high frequency filter. The acoustic output will therefore be mainly low frequency broadband and unlikely to interfere with high or mid-frequency, narrowband navigational and depth finder sonars.

4.4.2 Noise Monitoring and Mitigation

The background (ambient) acoustic noise at the site will be monitored by means of an underwater hydrophone to produce a baseline.

The acoustic noise emitted by a turbine in isolation will be determined by taking acoustic measurements during device testing, the results of which will be used to predict the various noise generation mechanisms likely from a full-scale device.

Use of the pre-installation baseline noise monitoring, and an operational noise monitoring strategy utilising the same hydrophones will validate that the predicted levels are produced.

Should any noise level be outside of those acceptable within the curtilage of the device or be evidenced as negatively impacting fishing, industrial or military systems used in the area, removal or reduction of the noise to suitable levels will immediately be undertaken.

Because of the device size and electrical shielding, neither the turbines, the cables nor the onshore works will be capable of producing an electro-magnetic field that could affect compasses or other navigation systems.

4.5 Marine Navigational Marking

The proposed array is located below the sea surface with all parts at a depth greater than 15 m. Following consultation with the SFA, SSMO and Ports and Harbours it was agreed the site would not be permanently marked by a buoy (or similar surface device) as this could create a hazard to shipping.

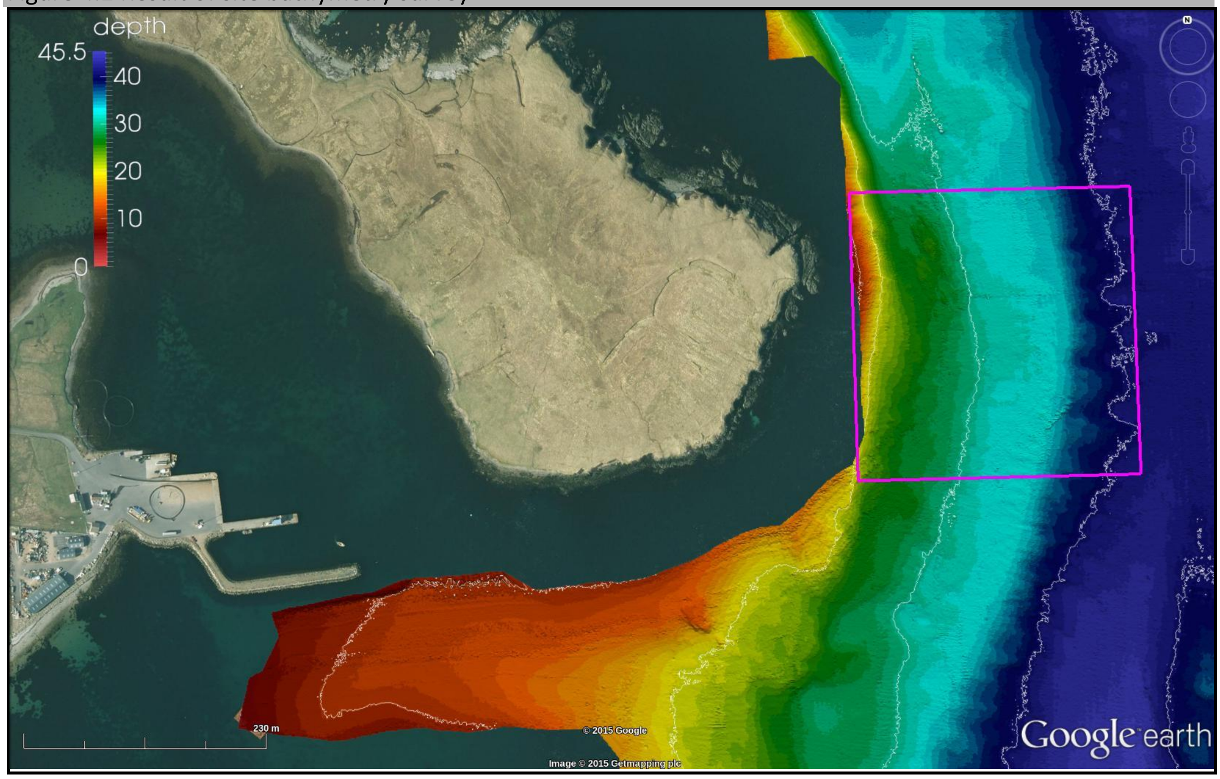
4.6 Hydrography

An initial site survey has been undertaken using underwater cameras to establish that the seabed in the area is free from hazards. The sea bottom at the site consists of relatively flat shattered rock and small boulders that forms a stable seabed. An additional detailed survey of the sea bed in the designated area will be carried before any works begin.

Figure 4.1 Still picture from ROV footage on the array site

Source: Nova Innovation 2015 ©

Figure 4.2 Result of site bathymetry survey

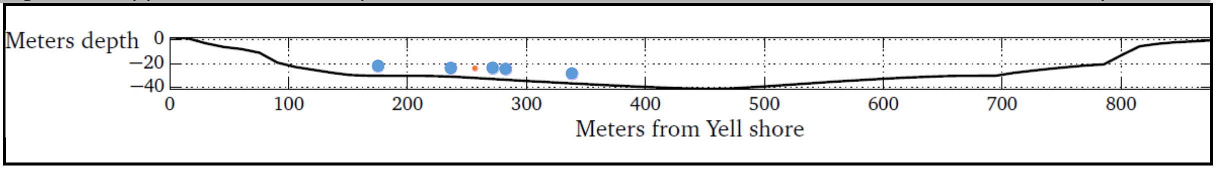


Source: Nova Innovation 2015 ©, Google earth

Figure 4.2 shows the results of the bathymetry survey, which indicates that the depth in the array area varies relatively smoothly from 10m depth at the west of the site to 40m depth at the east. The bathymetry survey was conducted to IHO Standard 1a.

The scale of the proposed array is such that it presents a very small blockage or proportion of the cross-sectional area of Bluemull Sound. Figure 4.3 is a scaled diagram showing the approximate proportion of the sound taken up by the array. This illustrates that the chances of a totally random collision of any floating or swimming body – even with absolutely no avoidance capability – is extremely low. The proportion of the cross-sectional area of the channel occupied by the turbines is less than 2%. Since the turbines will only be operational when the tidal flow is in excess of 1m/s (65% of the time) the probability of collision reduces further.

Figure 4.3 Approximate scaled representation of Bluemull Sound X-section with Nova Innovation array



Source: Nova Innovation 2015 ©. Array devices in blue, existing demonstrator turbine in orange

5 Safety and mitigation measures recommended for OREI during construction, operation and decommissioning

5.1 Promulgation of Navigation Warnings

Promulgation of Navigational Warnings will take place ahead of all phases of the project including planning, construction, operation and decommissioning. All information regarding navigational impact will be promulgated in ample time to all relevant mariners, organisations and authorities, locally and nationally. Notice of works will be promulgated through Notices to Mariners (NMs), and through the UKHO Maritime Safety Information system (NavWarns), if applicable. Direct notification will also take place to the following organisations:

- Maritime and Coastguard Agency
- Ports and Harbours
- Northern Lighthouse Board
- Fisheries Research Services (Marine Laboratory) – FEPA
- SFA
- SSMO
- RYA
- RNLI
- Shetland MRCC
- Search and Rescue Organisations
- Hydrographic Office
- Shetland Islands Council
- Recreational Angling Associations
- The Crown Estate

5.2 Vessel safety measures

All vessels involved in the installation, maintenance and decommissioning of the device will comply with all aspects of the International Regulations for Preventing Collisions at Sea (COLREGS)[10]. All vessels used will carry all equipment as required under the vessels' registration, e.g. the Code of practice for the safety of small workboats and pilot boats[11].

5.3 Safety zones and re-routing

No safety zones will be set up for the project, during the installation, maintenance and de-commissioning of the device. Navigational Warnings will be issued and any temporary buoys will comply with all aspects of COLREGS.

No re-routing measures are envisaged during normal operation of the device. During installation, maintenance and commissioning, some re-routing will be required, and will be addressed by the measures described in the previous paragraph.

We do not foresee a need for the area to be designated an Area To Be Avoided (ATBA).

5.4 Array monitoring

Monitoring and communications to the turbines is via the fibre optic cable embedded in the power cable. The output can be monitored at the pierside in Cullivoe or remotely, via a secure internet connection. It is therefore possible to control and monitor the turbine locally and remotely. A range of sensors including a device mounted underwater camera (CCTV), impact sensors and operational performance sensors will be monitored for any

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

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

adverse events. In addition, in the highly unlikely event that the device should become lost from its mooring, an alarm is immediately sent to the operator on duty who will co-ordinate retrieval operations.

5.5 Consultations

A range of organisations have been consulted with both as part of the consent and licensing process and in direct consultations by Nova Innovation in order to ensure that project safety procedures have input from all appropriate stakeholders. These organisations include:

- Maritime and Coastguard Agency
- Ports and Harbours
- Northern Lighthouse Board
- Fisheries Research Services (Marine Laboratory) - FEPA
- Shetland Fishermen's Association
- SSMO
- RYA
- RNLI
- Shetland Marine Rescue Co-ordination Centre
- Search and Rescue Organisations
- Hydrographic Office
- Shetland Islands Council
- Recreational Angling Associations
- Lerwick Boating Organisation
- The Crown Estate

5.6 Emergency response

As part of the planning stage and before installation commences, Nova Innovation will consult with the MCA Maritime Operations Branch to develop an Emergency Response Cooperation Plan (ERCoP) for the project. This plan will include a familiarisation programme to train project staff on the MRCC plan and MRCC staff on the array. This will build upon the procedures already established for the existing Nova tidal turbine deployed at the same site.

6 Standard and procedures for generator shutdown and other operational requirements in the event of a search and rescue, counter pollution or salvage incident in or around an OREI

Much of the MCA guidance on ERCoP[12] is written with surface structures and wind turbines in mind, but is evolving as new OREI technologies evolve. Nova Innovation will follow the latest guidance and work with MCA to develop an ERCoP before installation commences.

6.1 Design Requirements

The Nova Innovation array is situated on the seabed, well below the surface (with at least 15 m draft clearance). It is a small device and will not require divers or manual operation; it will not require markings or lighting for aviation purposes; there will be no on-site working (access hatches or ladders); it is not possible to use the turbine as a place of refuge.

The device will be equipped with three different levels of emergency shutdown providing a failsafe shutdown configuration. The procedures and points of contact will be set out as part of the ERCoP to be formulated with the MCA.

1) Remote control shutdown from either the local control point (electrical breakers) in Shetland or remotely via the internet.

2) Automatic shutdown should there be a loss of communication, power failure or loss of the distribution network connection.

3) “Dead man lever” – if the power supply fails then a ‘fail-safe’ mechanical brake is automatically applied to shut the device down and disconnect from the distribution network.

Appropriate assessments, points of contact and methods for safe shutdown will be established and agreed with the MCA as part of the ERCoP process. This will be completed before any installation work is initiated.

Braking configurations and device positioning will be agreed with the MCA as part of the ERCoP. A single point of contact operator, available 24 hours a day, will be able to position the blades of the device and control the energisation of offshore cables as agreed with the MCA.

6.2 Operational Requirements

The array will be monitored and controlled via the fibre optic cable embedded in the power cable, which can be accessed either pierside in Cullivoe or remotely via a secure internet connection. It is therefore possible to control and monitor the array locally and remotely.

The array will be monitored 24 hours a day. A single contact point will be designated by mutual agreement with Shetland MRCC. The contact will have a chart indicating the GPS position of the devices in the array. The Shetland MRCC will be advised of the contact telephone number of the single contact point (and vice versa). The Shetland MRCC will be supplied with an accurate chart of the array and GPS positions.

6.3 Operational Procedures

The following procedures will be included in the ERCoP to be produced in consultation with the MCA.

i. Upon receiving a distress call or other emergency alert from a vessel which is concerned about an unforeseen interaction with the device or is already close to the device, or when the MRCC receives a

[12] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/371636/Offshore_Renewable_Energy_Installations_4_11_14.pdf

report that persons are in actual or possible danger in or near the array and search and rescue aircraft and/or rescue boats or craft are required to operate over or nearby, the MRCC will establish the position of the vessel and the array. This information will be passed immediately to the single contact point, by the MRCC.

ii. The single contact point will immediately initiate the shut-down procedure for relevant devices in the array as requested by the MRCC, and maintain the devices in the appropriate shut-down position, as requested by the MRCC until receiving notification from the MRCC that it is safe to restart them.

iii. The appropriate procedure to be followed in respect of the device designs and configurations will be determined by the Maritime and Coastguard Agency branches, in consultation with appropriate stakeholders before any works commence.

iv. The communication procedures will be tested satisfactorily at least twice a year.

Shutdown and other procedures will be tested as and when mutually agreed with MCA.

6.4 SAR Helicopter Procedures/Requirements

Not applicable for a subsea array.

Appendix A Hazard Log

A.1 Risk Criticality Matrix used in the Risk Log

Risk Criticality	Condition	Explanation
Broadly Acceptable	None	Technical review is required to confirm the risk assessment is reasonable. No further action is required
Broadly Acceptable	None	Technical review is required to confirm the risk assessment is reasonable. No further action is required
Tolerable with monitoring	With a commitment to risk monitoring and reduction during operation	Risk must be mitigated with engineering and/or administrative controls. Must verify that procedures and controls cited are in place and periodically checked
Tolerable with Additional Controls	With a commitment to further risk reduction before operation	Risk should be mitigated with design modification, engineering and/or administrative control to a Risk Class of 4 or below before construction
Tolerable with Modifications	With a commitment to further risk reduction before construction	Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent
Unacceptable	None	Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent
Unacceptable	None	Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent

A.2 Risk Tolerability Matrix used in the Risk Log

Hazard Identification Risk Assessment (HIRA)					
HIRA Risk Matrix					
	Consequence	**Insignificant**	**Minor**	**Major**	**Catastrophic**
Frequency	**Definition**	No significant harm to people	Injury to vessel crew Injury to OREI installation crew Injury on the shore	Loss of vessel crew members (1-3) Loss of OREI installation or maintenance crew members (1-3) Fatalities on shore (1-3)	Total loss of vessel crew Total loss of OREI installation or maintenance crew Multiple fatalities onshore
Frequent	Likely to happen annually or more frequently	Tolerable with Additional Controls	Tolerable with Modifications	Unacceptable	Unacceptable
Reasonably Probable	Likely to happen duting the license period of an OREI (nominally 20 years)	Tolerable with monitoring	Tolerable with Additional Controls	Tolerable with Modifications	Unacceptable
Remote	Unlikely (but not exceptional) to happen during the licence period	Broadly Acceptable	Tolerable with monitoring	Tolerable with Additional Controls	Tolerable with Modifications
Extremely Remote	Only likely to happen in exceptional circumstances	Broadly Acceptable	Broadly Acceptable	Tolerable with monitoring	Tolerable with Additional Controls

A.3 Hazard Log - Summary of Safety Issues and Mitigation Measures

The table below summarises the hazards during construction, operation and decommissioning along with mitigation measures that can be taken.

Element	Phase	Hazard	Consequence	Initial Risk			Control / Mitigation	Residual Risk		
				Frequency	Consequence	Risk		Frequency	Consequence	Risk
Device, mooring and cable	Installation	Vessel Not Under Command (NUC)	Collision between NUC vessel and installation vessel(s) leading to vessel damage/injury/loss of life	Remote	Major	Tolerable with additional controls	Notice to Mariners/ Navigation Warnings/ Vessel Lighting and Markings Compliance with COLREGs	Extremely Remote	Major	Tolerable with Monitoring
		Vessel enters array area and collides with installation vessel	Collision between vessels leading to damage to vessel/ injury/ loss of life	Remote	Major	Tolerable with additional controls	Notice to Mariners/ Navigation Warnings/ Vessel Lighting and Markings/ Compliance with COLREGs	Extremely Remote	Major	Tolerable with Monitoring
		Use of incorrect IMM VHF channel	Interference with IMM VHF ship/shore and ship/ship communications	Reasonably probable	Minor	Tolerable with additional controls	Installation vessel(s) to agree working channel with Ports and Harbours	Extremely Remote	Minor	Broadly Acceptable
		Nacelle breaks free from foundation	Unmarked obstruction on the seabed	Remote	Minor	Tolerable with Monitoring	Retrieval procedure in place	Remote	Minor	Tolerable with Monitoring

Element	Phase	Hazard	Consequence	Initial Risk			Control / Mitigation	Residual Risk		
				Frequency	Consequence	Risk		Frequency	Consequence	Risk
Device, mooring and cable	Operation & maintenance	Vessel Not Under Command (NUC)	Collision between NUC vessel and device or maintenance vessel leading to vessel or device damage/injury/loss of life	Extremely Remote	Major	Tolerable with monitoring	Notice to Mariners/ Navigation Warnings/ Vessel Lighting and Markings/ Device on-board monitoring for impacts/ CCTV	Extremely Remote	Major	Tolerable with Monitoring
		Vessel enters array area and collides with maintenance/ inspection vessel	Collision between vessels leading to damage to vessel/ injury/ loss of life	Remote	Major	Tolerable with additional controls	Notice to Mariners/ Navigation Warnings/ Vessel Lighting and Markings/ Compliance with COLREGs	Extremely Remote	Major	Tolerable with Monitoring
		Cable Snagged by object, e.g. anchor, tackle	Cable damaged or vessel unable to free anchor. Damage to vessel or cable.	Reasonably Probable	Minor	Tolerable with additional controls	Update Admiralty charts with cable route. Mechanical protection on cable near Cullivoe Pier.	Remote	Minor	Tolerable with Monitoring
		EMI Interference with navigational equipment	Potential for navigational error due to effects on navigation equipment, e.g. magnetic compass	Extremely Remote	Insignificant	Broadly Acceptable	Device compliance with all EMI regulations. No evidence of EMI from cables, e.g. SSE much higher power & voltage cable to the south	Extremely Remote	Insignificant	Broadly Acceptable
		Interference with military/civil SONAR	Potential for navigational error due to inaccurate depth readings due to effects on SONAR	Extremely Remote	Minor	Broadly Acceptable	Acoustic output mainly low frequency. All predicted calculations within limits.	Extremely Remote	Minor	Broadly Acceptable
		Loss of device or significant components	Surface vessel collision with floating objects; vessel damage/ injury/ loss of life	Remote	Major	Tolerable with additional controls	Device provides failure signal. Emergency response invoked (ERCoP)	Extremely Remote	Major	Tolerable with monitoring

Element	Phase	Hazard	Consequence	Initial Risk			Control / Mitigation	Residual Risk		
				Frequency	Impact	Risk		Frequency	Impact	Risk
Device, mooring and cable	Decommissioning	Vessel Not Under Command	Collision between NUC vessel and installation vessel(s) leading to vessel damage/injury/loss of life	Remote	Major	Tolerable with additional controls	Notice to Mariners/ Navigation Warnings/ Vessel Lighting and Markings Compliance with COLREGs	Extremely Remote	Major	Tolerable with Monitoring
		Vessel enters test area and collides with de-commissioning vessel	Collision between vessels leading to damage to vessel/ injury/ loss of life	Remote	Major	Tolerable with additional controls	Notice to Mariners/ Navigation Warnings/ Vessel Lighting and Markings/ Compliance with COLREGs	Extremely Remote	Major	Tolerable with Monitoring
		Use of incorrect IMM VHF channel	Interference with IMM VHF ship/shore and ship/ship communications	Reasonably probable	Minor	Tolerable with additional controls	Installation vessel(s) to agree working channel with Ports and Harbours	Remote	Minor	Tolerable with monitoring
		Nacelle breaks free from foundation	Unmarked obstruction on the seabed	Remote	Minor	Tolerable with Monitoring	Retrieval procedure in place	Remote	Minor	Tolerable with Monitoring

Element	Phase	Hazard	Consequence	Initial Risk			Control / Mitigation	Residual Risk		
				Frequency	Impact	Risk		Frequency	Impact	Risk
Subsea Cable	Decommissioning	Cable Snagged by object, e.g. anchor	Cable damaged or Vessel unable to free anchor.	Reasonably Probable	Minor	Tolerable with monitoring	Update Admiralty charts with cable route. Trench in possible anchorage areas. Mechanical protection on cable.	Remote	Insignificant	Broadly Acceptable
		Vessel Not Under Command	Collision between NUC vessel and installation vessel(s) leading to vessel damage/injury/loss of life	Remote	Major	Tolerable with additional controls	Notice to Mariners/ Navigation Warnings/ Vessel Lighting and Markings Compliance with COLREGs	Extremely Remote	Major	Tolerable with Monitoring
		Vessel enters test area and collides with de-commissioning vessel	Collision between vessels leading to damage to vessel/ injury/ loss of life	Remote	Major	Tolerable with additional controls	Notice to Mariners/ Navigation Warnings/ Vessel Lighting and Markings/ Compliance with COLREGs	Extremely Remote	Major	Tolerable with Monitoring
		Cable snags	Vessel becomes unstable leading to possible damage/ injury/ loss of life	Remote	Major	Tolerable with additional controls	Have quick release mechanism to detach vessel lifting gear from cable	Remote	Minor	Tolerable with Monitoring