Scotrenewables Tidal Power Ltd

SR250 Deployment

Fall of Warness

Environmental Statement

Volume I

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Scotrenewables® Tidal Power Ltd

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Non-Technical Summary

Introduction

Scotrenewables Tidal Power Ltd is seeking permission to install and operate a 250kW tidal turbine, the SR250, at the European Marine Energy Centre (EMEC) tidal test site in the Fall of Warness, Orkney. It is proposed that the SR250 prototype will be installed by March 2011 and be grid connected via the EMEC sub-station with a newly installed cable. Construction of the SR250 prototype is underway with installation planned at EMEC by March 2011. Between January and February 2011 the SR250 mooring system will be installed, and the new cable laid and connected via a duct into the EMEC sub-station facility. Scotrenewables plan to de-risk the testing of the SR250 by undertaking an incremental staged development plan resulting in controlled learning gains at each stage.

This Environmental Statement has been produced to support the licence application under the Food and Environment Protection Act 1985 (FEPA) and consent under the Coast Protection Act 1949 (CPA) for proposed deployment. A European Protected Species Licence will be applied for towards the end of the consent process detailed above. This section forms the Non-Technical Summary of the Environmental Statement.

Existing Environment

Physical Environment

The EMEC tidal test site is located in the Fall of Warness, to the east of the island of Eday in the Orkney Islands. The centre of the Scotrenewables test berth is at 59 08.581' North, 002 48.392' West (WGS84) at a depth 35m (LAT). At the SR250 test site the maximum sea surface current is 2.5m/s. A few metres above the seabed the currents will be weaker, a maximum of 1.5m/s at the test site (35m contour) decreasing along the cable route to 0.7m/s between the 30 and 20m contour lines, and then down to 0.3m/s at the 5m contour and approaching the shore.

Biological Environment

<u>Seabed</u>

The proposed cable route up to 20m depth is dominated by kelp forests that support a relatively diverse community of fauna. The seabed communities observed further offshore in deeper water (>20 m) are dominated by encrusting invertebrates. The seabed at the proposed test site is mainly hard and rocky with pebbles, cobbles and boulders interspersed with patches of coarse shelly sand. No particularly sensitive species or communities are present in the vicinity of the planned deployment areas or cable route.

Birds

There is a breeding colony of cormorants on Little Green Holm c2km from the proposed test site. They are protected under the general provisions of the Wildlife and Countryside Act, 1981, and are listed as a local priority species due to declining numbers.

Fish

Basking sharks have been observed using the Fall of Warness. Basking sharks have full protection from international capture or disturbance in British waters (up to 12miles off shore) under a 1998 listing on Schedule 5 of the Wildlife and Countryside Act (1981). They are also listed under CITES Appendix III in UK waters.

Marine Mammals

Otters

Otters will regularly use the inshore waters in the Fall of Warness for feeding, normally between dawn and dusk, out to a depth of 10m. The Eurasian otter (Lutra lutra) is listed on Appendix 1 of CITES, Appendix II of the Bern Convention and Annexes II and IV of the Habitats Directive. It is protected under schedule five of the Wildlife and Countryside Act (1981) and Schedule 2 of the Conservation Regulations (1994) (Regulation 38).

Seals

Both grey and harbour (common) seals are protected under European legislation and are listed in Annex II of the European Habitat Directive. They are also protected under the Conservation (Natural Habitats, etc.) Regulations (1994) and the Conservation of Seals Act 1970. The islands of Muckle Green Holm and Little Green Holm, and Faray and Holm of Faray are designated SSSI sites for grey seal. In addition, the inshore waters surrounding Faray and the Holm of Faray, have been designated as a marine Special Area of Conservation (SAC) for grey seal. To the east of Eday lies the island of Sanday where the inshore waters have been designated as a marine SAC for harbour seal. The

Potential Biological Removal (PBR) seal numbers in the Northern Isles metapopulation stands at 13 individuals for harbour seal and 885individuals for grey seal.

Cetaceans
It is known that the Fall of Warness is routinely used in the summer months by cetacean species. All species of dolphins, porpoises and whales are listed in Annex II of CITES, Appendix II of the Bern Convention Annex, and in Appendix IV of the European Habitats Directive as species of interest and in need of strict protection.

Human Environment

<u>Fisheries</u>

Approximately 12 creel fishing boats fish on the SW coast of Eday within the Fall of Warness out as far as the 30m contour.

<u>Other Vessel Traffic</u>

The Navigation Risk Assessment (NRA) was undertaken identified the nearest ship recorded in the area was an inter-island ferry which passed at 210m SSW of the site. The local North Isles ferries use alternative routes through the Fall of Warness in poor weather. The inherent nature of the channel makes it hazardous for small craft. The area is used by larger vessels, cruise ships and pelagic fishing vessels for passage.

Technical Description

The technical aspects of the proposed project comprise the armored sea cable, the mooring system and the SR250 device.

Armoured Subsea Cable

The armoured electro/optical 6.6kV subsea power & signal cable will be rated at a capacity of 250kW with a total length of approximately 3km. The cable will be 41mm in diameter with a two layer armour package consisting of galvanised high tensile steel wires. The cable will have additional protection through the surf zone between the end of the duct up to 5m water depth. If the cable needs additional stability where it crosses the EMEC cables 1 tonne steel clump anchors may be attached to the cable post installation.

Mooring System

This mooring system for the SR250 prototype will consist of a single-point mooring.. The SR250 will be anchored to the seabed via a four-riser catenary spread compliant mooring system with a centrally located quick-release disconnectable turret. The 3 tonne steel turret contains quick-release mechanical and electrical connections which allow remote connection and disconnection of the SR250. The prototype mooring lines consisting of synthetic line and ground chain will be in an "X" configuration taking up an area approximately 218m by 126m. Mooring lines will be anchored to the seabed using gravity anchors. Each of the 4 (one at each corner) gravity anchors consists of 4 reinforced concrete blocks each measuring 2.4m x 5m x 0.5m.

SR250

The full scale SR250 prototype comprises a 34m long horizontal, free-floating, cylindrical steel tube with a 2.325m diameter constrained at one end by a catenary mooring system. The other end of the tube supports two angled beams (rotor legs) that protrude down into the water. The rotors are each suspended from these separate hydraulically retractable rotor legs attached to the buoyancy tube, which raise and lower the rotors from transport to operation modes. The SR250 is rated to operate in 2.5m/s current where it can generate up to 250kW of power. The device will 'cut-out' at a current velocity of 2.8m/s or greater. In extreme storm conditions power generation will cease automatically and the rotor legs will retract up in to a transport/survivability mode. The dimensions of the SR250 and distances relative to sea surface and seabed are detailed below.

Tube length	34m
Tube diameter	2.325m
Distance of hull that's subsurface (draught)	1.63m (tube draught)
Distance of hull that's above surface (assuming calm conditions),	0.7m
Rotor diameter	8m
Rotor swept aera	50.3m2
Clearance above rotor sweep	4m (to sea surface)
Distance between bottom of rotor sweep and sea floor	23.2m (LAT) – 18.2m (HAT)
Seabed footprint	218m x 126m
Sea surface footprint	68m x 50m

Instrumentation & Control Systems

The operation of the whole system will be monitored and controlled remotely via a SCADA system which will run permanently on a dedicated PC located onshore. This SCADA application will be able, amongst other things, to show the instantaneous state of the system, acknowledge warnings and alarms from it, give the operator the option to record them or not and print reports when necessary.

Installation Activities

Mooring Installation

The installation of the mooring system will take up to one week and be carried out between January and February 2011 using a multi – cat work vessel. The synthetic and chain spread mooring lines will be attached to the each of the 4 gravity anchors and placed on the seabed using a GPS. Once all four anchors are in position a winch mechanism will be used to bring the chains/ropes together at a central point where the ends will be attached to the turret. The turret will be lowered to 10m below LAT and marked with a buoy to allow retrieval. The mooring system will remain in place for the duration of the testing period.

Cable Laying

The duration of the cable laying activities will be c2 days and be carried out sometime during January to February 2011. Approximately 3km of new cable will be laid by a multi-cat vessel. One end of the cable will be pulled through the EMEC installed duct to be connected to the onshore infrastructure. The vessel will now proceed towards the test site with the cable payed over side. A GPS system will be used to ensure the cable is laid in the right location. Once the vessel reaches the centre of the site, the cable will be terminated into the mooring turret which will be located at the centre of the mooring system. As the cable is laid chain 'sinkers' will be added every 50m for stability, and additional protection fitted through the surf zone, and underneath the turret.

SR250 Installation

Once the device is ready to be tested at the test site, the multi-cat will tow the SR250 to the Fall of Warness. The turret will be retrieved and the device attached.

Operation and Maintenance

Upon completion of the device construction, the launch will be followed by towing trials prior to first installation at the EMEC site. The testing of the SR250 device will be undertaken in a controlled and staged manner starting in March 2011 with an initial 2 year testing programme. The device will then be installed onsite at EMEC for numerous short-term test periods gradually increasing to the point where a continuous three-month grid connected deployment is achieved during 2012. This represents a staged and risk minimised technical development plan led by the development of the technology. The device will be towed to Hatston to undertake all maintenance activities. The site and device will be marked and lit in accordance with Northern Lighthouse Board (NLB).

Decommissioning

As the device is a floating structure and non-piled gravity anchors are intended for use in the mooring system, the decommissioning process is expected to be relatively straightforward. A suitably sized multicat work vessel will be contracted to carry out the operational aspects of the decommissioning plan. It is anticipated that it will take approximately 7 working days to remove all traces of the mooring system from the seabed. An in-depth decommissioning plan will be submitted to DECC under the Energy Act (2004) prior to device deployment.

Impact Assessment

Consultation was undertaken with EMEC identified consultees. The key issues and related effects are detailed in the Environmental Statement and summarised next:

<u>Water Quality</u>

Both pollution of the water column from anti-foulants, hydraulic fluids and lubricants (from the device), and disturbance of substrate (installation and long-term presence of the mooring system) leading to increased sediment load in water could result in a reduction in water quality.

<u>Marine Wildlife</u>

The interactions of deployed tidal devices with marine wildlife are largely unknown.

Potential impacts that have been identified include the risk of disturbance or displacement as a result of noise generated by the device operation and associated activities. Direct interactions include the potential for entanglement, and also for collision (particularly with rotors) which has clear implications at a population level.

Navigation Risk

As a surface piercing device with a low freeboard the SR250 presents a navigation risk to surface vessels due to the strong tidal stream of the Fall of Warness and lack of vessel manoeuvrability in rough seas. In order to fully assess the risk a site specific Navigation Risk Assessment (NRA) was undertaken by Anatec Ltd.

Residual Environmental Impacts

A robust post installation monitoring strategy is to be established in consultation with Marine Scotland Licensing Operations Team (MS-LOT), Scottish Natural Heritage (SMH) and EMEC. This strategy along with measures taken during the design process will help mitigate and avoid environmental impact where possible. The six remaining residual impacts ranked Minor or greater are:

Impact of surface and sub-surface noise on marine wildlife

Although noise associated with installation, maintenance and decommissioning activities is considered likely to pose only a mild, very localised disturbance to marine mammals, given the importance of species known to use the Fall of Warness, and the unknowns surrounding the impact of operational noise the residual impact remains ranked as MAJOR.

Risk of displacement or disturbance to marine wildlife

The installation, maintenance and decommissioning activities are considered to pose only a mild, very localised disturbance to marine species. Although the scale of the development is relatively small and the device will not be deployed for a continuous period during the testing programme given the importance of species known to use the Fall of Warness, and the uncertainty that surrounds this issue the residual impact is ranked as MODERATE.

Risk of marine wildlife becoming entangled/entrapped in mooring system or umbilical

Although it is considered very unlikely that marine mammals, diving birds or basking shark could become entangled in either the cable or mooring system, as this is an untried technology at this scale the residual impact is ranked as MINOR.

Risk of marine wildlife colliding with operational device

Given the uncertainly that surrounds the risk of collision with the device and the importance of identified protected species both at individual and population level the residual impact remains ranked as MAJOR. The results of the monitoring activities will give a better understanding a=of how marine species interact with the device and this will inform future developments.

Navigation Risk

With the proposed mitigation in place it is considered that the risk posed to vessels operating in the area has been reduced to an acceptable level. However, given that this is an untried technology (at this scale) that will be operating in a challenging marine environment where other developers have failed the residual impact will have to remain ranked as MAJOR.

Cumulative Impacts

It is very difficult to make any kind of assessment of what the cumulative impact might be of multiple operators in the Fall of Warness when the impact of the individual devices remains unknown, particularly where many aspects of the developments at the site remain commercially sensitive. The four residual impacts ranked as MODERATE or MAJOR above have the *potential* in combination with the impacts of the other developers to have a significant impact at a cumulative level. So cautiously the residual impact of the cumulative impact remains ranked overall as MAJOR.

Careful site selection and appropriate mitigation measures have ensured that the impacts of the proposed development will be NEGLIGIBLE or non-existent on seabed habitats, water quality, cultural heritage and fishing interests.

Conclusions

While Scotrenewables have done all they can to ensure that the environmental impacts of the proposed development have been reduced to a tolerable level with robust mitigation and rigorous attention to design, they appreciate that this is an untried technology (at this scale) in a challenging marine environment where other developers have failed.

From the outset the Scotrenewables approach has been to de-risk the testing of the Scotrenewables tidal turbine by undertaking an incremental staged development plan in a safe and controlled manner. The information and experiences from the SR250 deployment will give Scotrenewables the knowledge and confidence to take the step to a 1MW full-scale prototype at a more exposed and energetic location, before moving onto a larger commercial development.

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1 Introduction

The applicant, Scotrenewables Tidal Power Ltd (Scotrenewables) is seeking permission to install and operate a 250kW tidal turbine, the SR250, at the European Marine Energy Centre (EMEC) tidal test site in the Fall of Warness, Orkney (see Figure 1.1). This Environmental Statement (ES), along with a Navigation Risk Assessment and Third Party Verification Certificate (to be available at the end of December 2010) by Det Norske Veritas (DNV), has been produced to support the consent applications associated with the proposed works (see Section 1.2). The ES will address the installation of a subsea cable, mooring system and device, and the operation and decommissioning of the SR250. The on-shore works are outwith the scope of this study.

Scotrenewables has developed an innovative, floating tidal energy converter. The Scotrenewables tidal turbine has undergone extensive scale model testing and hydrodynamic modelling since 2002. The concept has been trialled at 1/40th, 1/20th (rotor dynamics) and 1/7th scales in test-tank facilities and a 1/5th scale model has recently completed a comprehensive open-sea test programme at Burra Sound in Orkney. The results so far are encouraging and have thoroughly validated the design and concept. Construction of the company's first large-scale 250kW prototype – the SR250 - has begun. It is proposed that the SR250 prototype will be installed at EMEC by March 2011 and be grid connected via the EMEC sub-station with a newly installed cable.

The Scotrenewables approach is to de-risk the testing of the Scotrenewables tidal turbine by undertaking an incremental staged development plan resulting in controlled learning gains at each stage. The information and experiences from the SR250 will give Scotrenewables the knowledge and confidence to take the step to a 1MW full-scale prototype at a more exposed and energetic location.

Scotrenewables feel that the approach of not going straight from small-scale models in wave tanks to large scale prototypes on extreme sites is the ultimate way to successfully advance the device and the marine renewables industry in a safe and controlled manner.

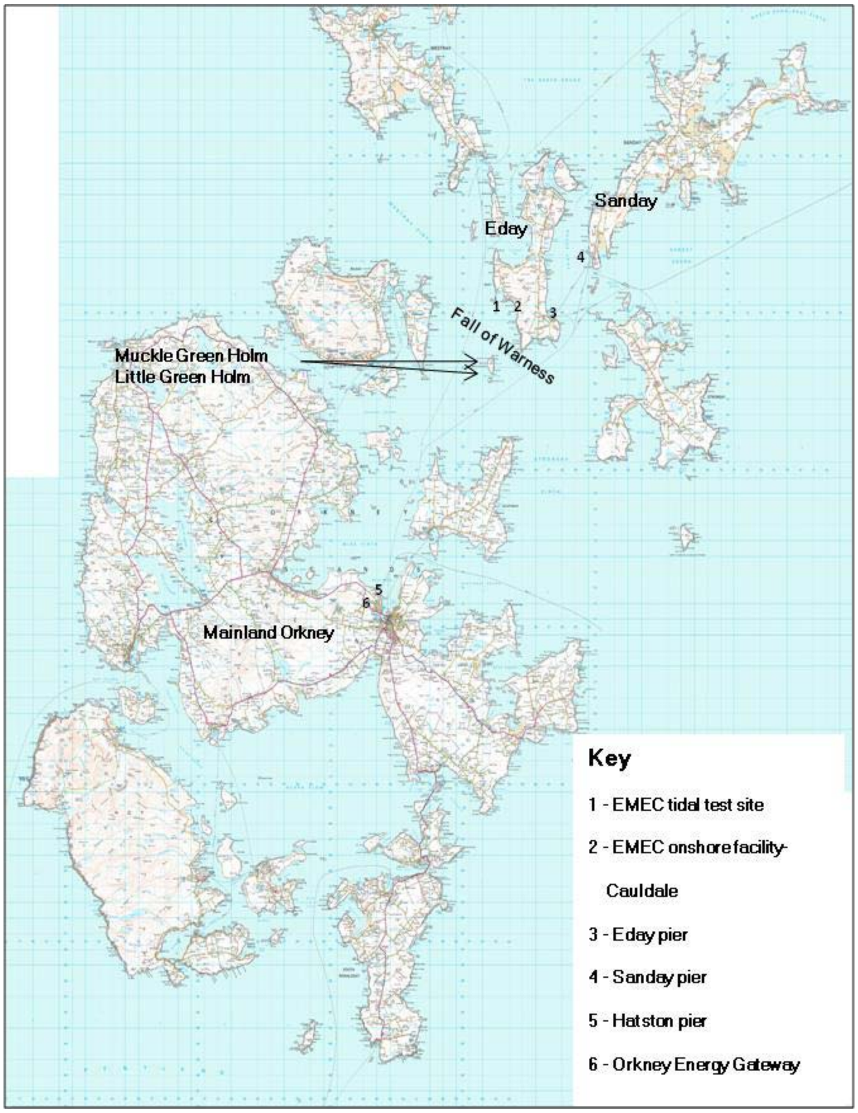


Figure 1.1 SR250 Test Site and Operations Locations

1.1 The Applicant

Orkney based Scotrenewables (Marine Power) Ltd was established in Scotland in 2002 by Barry Johnston solely to commercialise the Scotrenewables tidal turbine. Scotrenewables are the only truly established, indigenous and still majority locally owned tidal energy technology developer based and registered in Scotland.

Over the years Scotrenewables has built a highly capable and motivated team of engineers who have actively made the decision to dedicate their careers and a substantial amount time out of hours to making tidal energy a commercial reality.

1.2 Legislative Background

The EMEC test site already has a Crown Estate lease, however the proposed works cannot commence until the necessary statutory consents are in place. The licence applications required under Section 34 of the Coast Protection Act 1949 (CPA) and the Food and Environment Protection Act 1985 (FEPA) (as amended) have been submitted along with this report to the Marine Scotland Licensing Operations Team. In addition, a European Protected Species (EPS) licence will be applied for towards the end of this application process. As the maximum power generated by the proposed testing will not exceed 250kW a Section 36 Agreement under the Electricity Act 1989 has not been applied for.

1.3 Data Gaps and Uncertainties

During the preparation of this report a number of data gaps were identified for which additional work was commissioned to inform the environmental statement and project decision-making progress. Specific investigations/studies undertaken for the project are:

- Seabed survey and assessment;
- Investigation into the noise output from work vessels; and
- Navigation Risk Assessment.

2 Scoping and Consultation

2.1 Consultation Undertaken

The EMEC tidal site was subject to a comprehensive consenting process during 2005 which included wide consultation with the full spectrum of statutory consultees and local stakeholder groups. One of EMEC's supporting roles is to liaise between developers and the statutory consultees, and also any local stakeholder groups whose activities it is considered may be affected by the device/site specific activities of the individual developer. As a consequence only the following have been consulted:

- Marine Scotland - Science
- Marine Scotland - Compliance
- Maritime and Coastguard Agency (MCA)
- Northern Lighthouse Board (NLB)
- Orkney Fishermans Association (OFA)
- Orkney Island Council – Marine Services
- Royal Society for the Protection of Birds (RSPB)
- Scottish Environment Protection Agency (SEPA)
- Scottish Natural Heritage (SNH)

These bodies were initially consulted in September 2009. However, following the decision to move the test berth to a more sheltered location and modify the size of the device (see Section 4.1.1) a revised scoping document was re-submitted for comment in April 2010. Responses were received from all of the above in September 2009 with the exception of OFA. When re-consulted in 2010, OFA did however respond on this occasion as did the rest of the consultees. The main issues raised are detailed in Table 2.1 below with the full responses to be found in Appendix 2. In addition, a comment received from the Royal Yachting Association as part of the Navigation Risk Assessment consultation process is also included.

Two consultation feedback meetings were held with SNH and OFA. On June 22nd 2010 representatives from Scotrenewables and EMEC met with SNH. Further to the issues already raised in the formal scoping response, clarification was supplied on the requirements for the seabed ROV survey and wildlife monitoring strategy, and it was requested that the testing programme be as detailed as possible.

Following an objection from OFA that the proposed site was situated within an area routinely used by scallop divers, a meeting was held to discuss this issue on August 25th 2010 at EMEC offices. Prior to this meeting Scotrenewables had consulted with OIC Marine Services and EMEC on the suitability of an alternative site further south in the Fall of Warness. With their agreement this site was proposed to OFA and they withdrew their objection.

Consultee	Issue	Mitigation
Marine Scotland (CPA)	NRA to address all issues raised in scoping document. Third Party Verification (TPV) certificate (covering both mooring system and device) to be provided.	Navigation Risk Assessment undertaken (see Section 7.2). TPV certificate to be available end December 2010.
Marine Scotland (FEPA)	Due to the design and speed of the SR250 device there may be a significant risk for marine mammals, large fish and diving birds. Issues: Potential for collision with device. Noise generation and potential impact on marine species Interaction between the mooring system and marine species Potential impact on EPS species Cumulative effects associated with construction, installation and operation of multiple devices at the tidal site. Mitigation- monitoring/need for additional surveys/studies outwith EMEC existing protocols to be addressed in the ES. Monitoring requirements to include the interactions between the mooring chains and the device whilst at the EMEC site Request for definitive installation timelines as soon as possible. Request for information on any findings from the deployment of 1/5th scale device in Burra Sound, particularly the forces placed on mooring lines from tidal effects.	EPS licence to be applied for (see Section 1.4.5). Assessment of collision risk with regard to cetaceans, seals and diving birds undertaken (see Section 7.1). Noise assessment undertaken (see Section 7.1) Post installation monitoring strategy and any additional studies required to be agreed with SNH and Marine Scotland (see Section 7.1 and 9.4). Installation timetable detailed in Section 4.2 and Table 4.1. More specific timetable to be supplied to regulator as soon as it becomes available. Cumulative effects discussed (see Section 7.3). Details provided of forces placed on the device and mooring lines in 5th scale testing (see Section 4.4.2).
Maritime and Coastguard Agency	Given the low freeboard of the device when floating on the surface the marking and lighting and radar reflecting issues will be of particular importance.	Formal recommendation for lighting and marking to be agreed with NLB. Navigation Risk Assessment undertaken (see Section 7.2 and Appendix 3). .
Northern Lighthouse Board	Appropriate device lighting and marking to be agreed. Navigation Risk Assessment to include warning procedures should any part of the device become detached.	Formal recommendation for lighting and marking to be given through the Coast Protection Act 1949 – Section 34 consultation process. Navigation Risk Assessment undertaken (see Section 7.2).

Consultee	Issue	Mitigation
	Inform the Hydrographic Office of the device location so the Admiralty Chart can be updated.	EMEC will ensure Hydrographic Office informed (see Section 9.4).
Orkney Fishermans Association	Area used routinely by scallop divers. Concerns over safety for divers from device operation and presence of mooring system. Also concerns mooring system will interfere with creeling activities. Site should be clearly marked at all times. Requested that site be moved further south and towards 40m contour.	Site relocated further south as requested to a position well away from creeling and scallop diving fishing areas. Formal recommendation for lighting and marking to be agreed with NLB. Navigation Risk Assessment undertaken (see Section 7.2).
Orkney Island Council - Marine Services	The new position is on the track for ferries deviating to avoid weather. When the SR250 is deployed what is the catenary going to be like of the mooring that has the most tension – ie what will be the footprint that ferries and other craft will have to avoid. Considerations about marking – both when the device is connected to the turret and when not.	Formal recommendation for lighting and marking to be agreed with NLB. Details of device footprint supplied (see Section 4.4.2 and Figure 4.5). Navigation Risk Assessment undertaken (see Section 7.2).
Royal Society for the Protection of Birds	RSPB Scotland would strongly urge EMEC and the developer to carry out as much underwater monitoring of wildlife interactions with the device as possible.	Post operational monitoring strategy to be agreed with SNH and Marine Scotland (see Section 7.1).
Royal Yachting Association	Procedures should be put in place to deal with vessels swept onto the site by adverse conditions, and the site should be clearly marked and lit.	Formal recommendation for lighting and marking to be agreed with NLB. Navigation Risk Assessment undertaken (see Section 7.2).
Scottish Environment Protection Agency	Device to be moored in such a way as to minimise the disturbance of the seabed. Extent of seabed potentially affected by proposed activity to be identified.	Very limited/ localised seabed disturbance anticipated (see Section 4.4.2, Table 6.2 and Figure 4.11). No protected habitats or species in area (see Section 5.2.2).

Consultee	Issue	Mitigation
Scottish Natural Heritage	*Key areas to be addressed are:* Sanday Special Area of Conservation (SAC) and Faray and Holm of Faray SAC – need for Competent Authority to carry out an appropriate assessment of the implication of the proposal for the sites qualifying interests. European Protected Species (EPS), namely cetaceans. Other protected species, namely harbour seals and basking shark. Cumulative impacts on protected species caused by collision risk. *In addition:* Collision risk for diving birds. Noise disturbance to marine birds and mammals. Post installation monitoring strategy to be established. Accidental release of potential pollutants. Benthic impacts from mooring installation activities. Full details of the decommissioning process to be supplied.	Information supplied to inform Appropriate Assessment (see Appendix 6 & 7) EPS licence to be applied for (see Section 1.2). Assessment of collision risk with regard to marine mammals and diving birds undertaken (see Section 7.1). Noise assessment undertaken (see Section 7.1) Pre and post installation monitoring strategy and any additional studies required to be agreed with SNH and Marine Scotland (see Section 7.1 and 9.4). Marine standard 'foul release' paints, biodegradable lubricants and aluminium anodes to be used. Measures in place to minimise any risk of polluting marine environment (see Sections 4.1 & 4.4.7, 9.2.2 and Appendix 4). Very limited/ localised seabed disturbance anticipated (see Section 4.4.2, Table 6.2 and Figure 4.11). Decommissioning plan to be subject of separate consultation prior to submission to DECC (see Section 4.7).

Table 2.1 Consultation Responses

3 Site Selection

As an Orkney based Company the intention from the outset of the project has been to test the SR250 at The European Marine Energy Centre (EMEC).

Originally Scotrenewables were contracted with EMEC to occupy berth 5. However, it has been decided to develop a more sheltered site within the Fall of Warness (see Section 4.1.1).

4 Project Description

4.1 Alternatives Considered

4.1.1 Site Location

The original plan was to test a 1MW Scotrenewables Tidal Turbine at berth 5 of the EMEC tidal site at the Fall of Warness. However it was decided that it was potentially too big a leap from the 2 tonne 1/5 scale testing at a relatively calm site to the 265 tonne 1 MW full scale prototype testing in a high energy environment where others have failed. It was considered that at berth 5 the current strength (see Figure 4.1) would be too great as would wave exposure (see Figure 4.2). Accordingly a more sheltered site was sought within the EMEC lease area. Following an objection from OFA (see Section 2) at the scoping stage an alternative site with the same water depth and similar degree of exposure was selected (see Figure 4.3). The decision was also taken to develop a device with a reduced physical size (see Figure 4.4), reduced power rating of 250kW, and reduced weight of 100 tonnes. An additional benefit is that this new site is located away from the main deep channel shipping lanes.

4.1.2 SR250 Design Consideration

Beyond the design considerations which have focussed on maximising performance and reducing/eliminating risk of failure, the following decisions have also been made:

- To reduce the power rating from 1MW to 250kW (see Section 4.1.1);
- To reduce the overall physical scale of the device (see Figure 4.4);
- To reduce the draft from 5m to 3.9m to optimise opportunities for harbour maintenance activities; and
- To change the colour from blue to yellow to increase visibility for marine safety reasons.

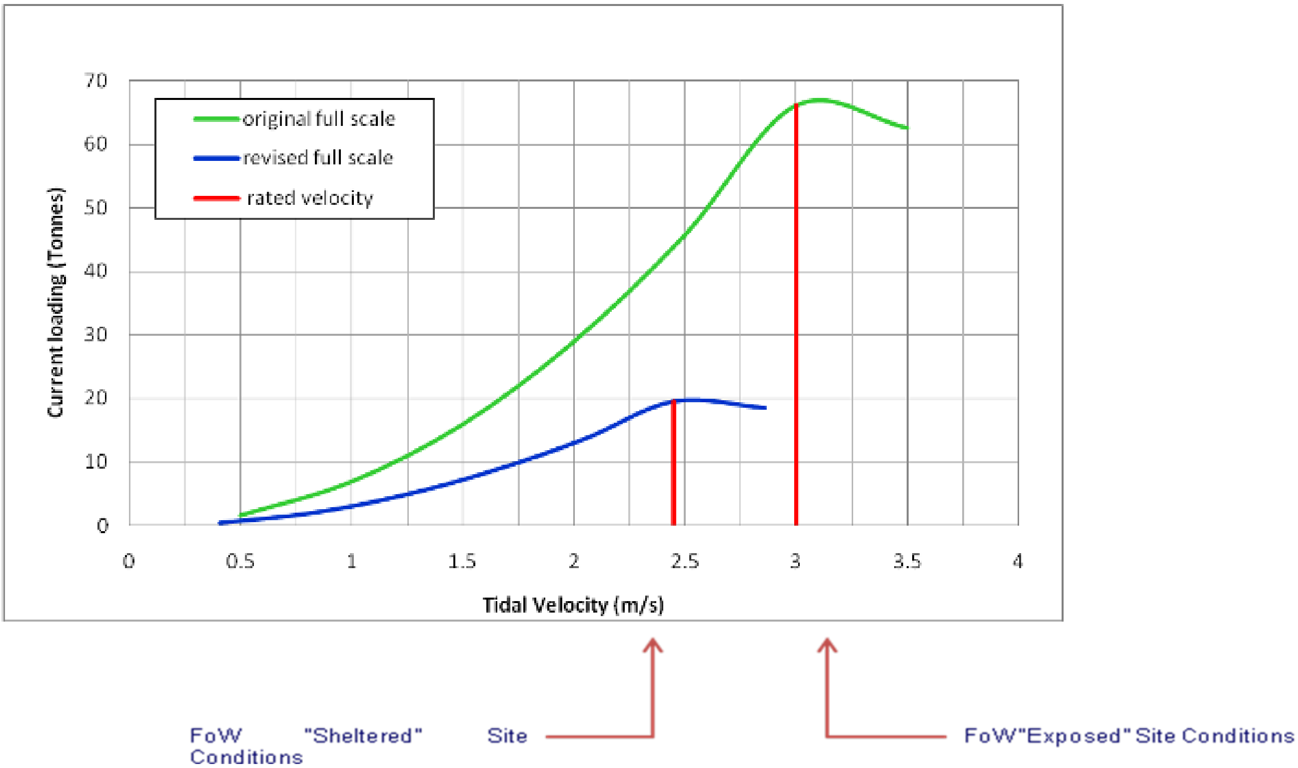


Figure 4.1 SR250 Current Loading

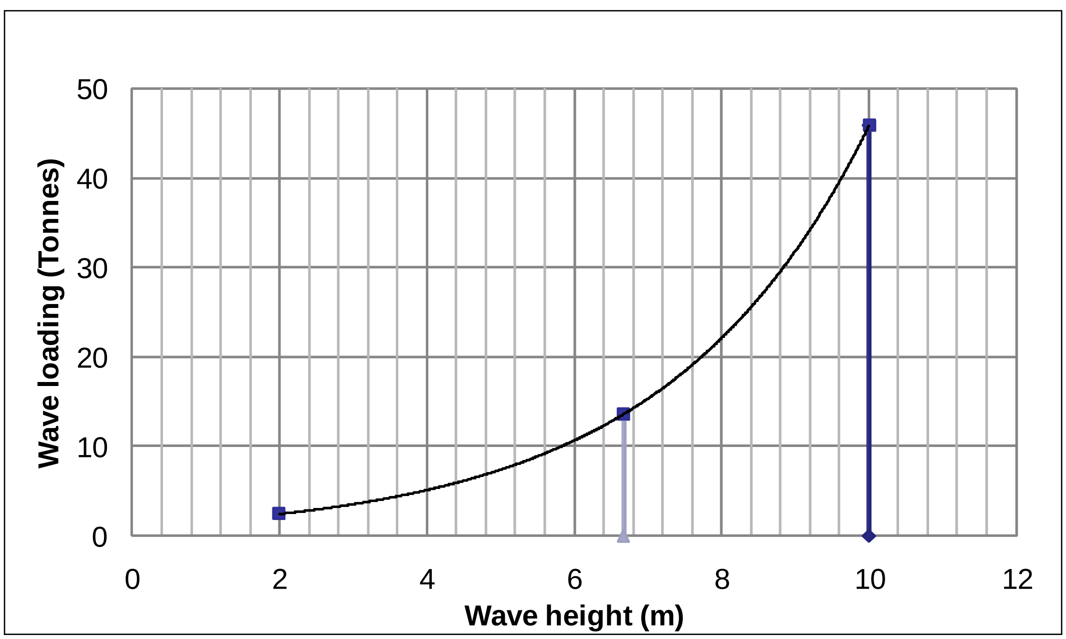


Figure 4.2 SR250 Wave Loading

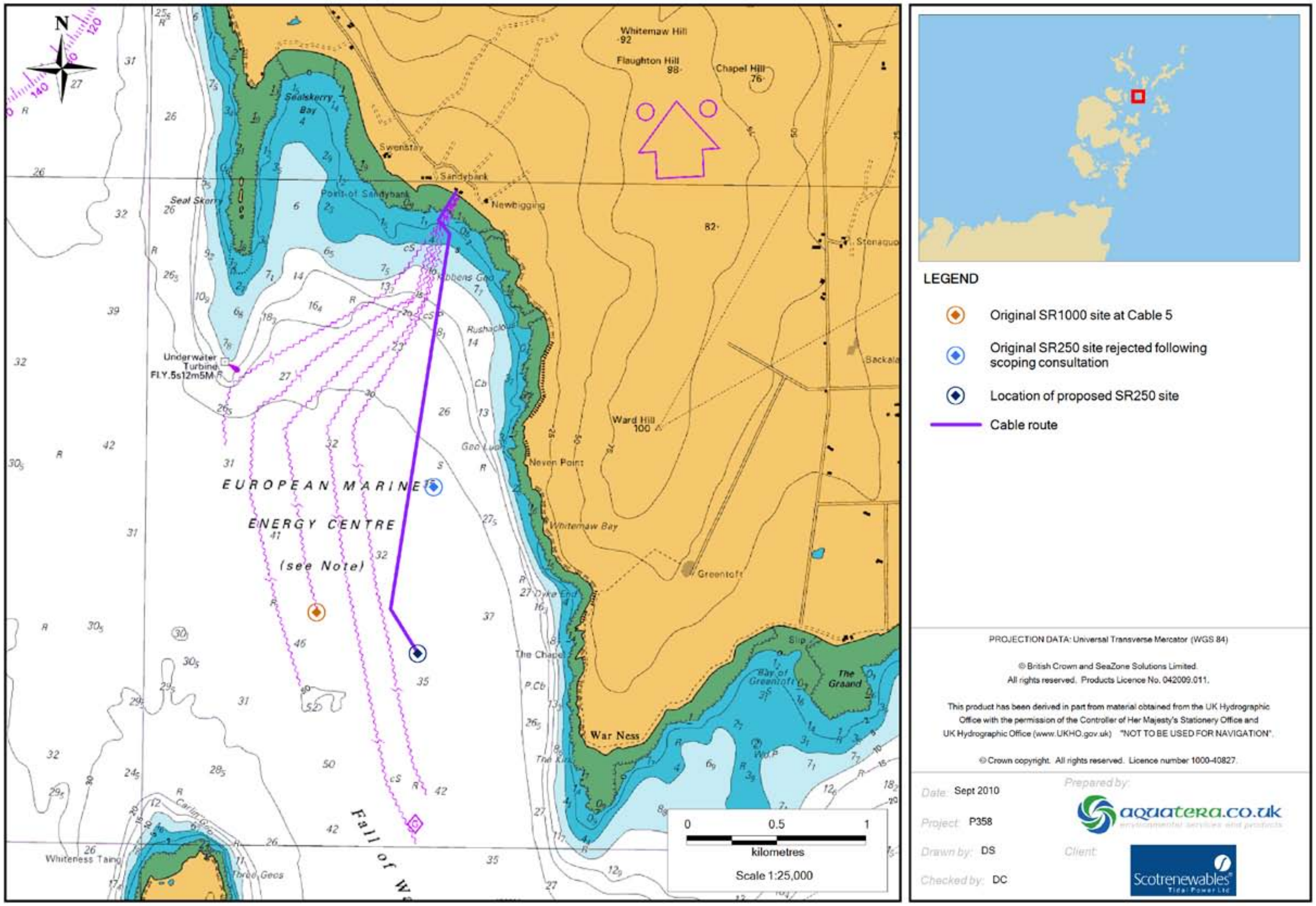


Figure 4.3 Alternative Sites Considered

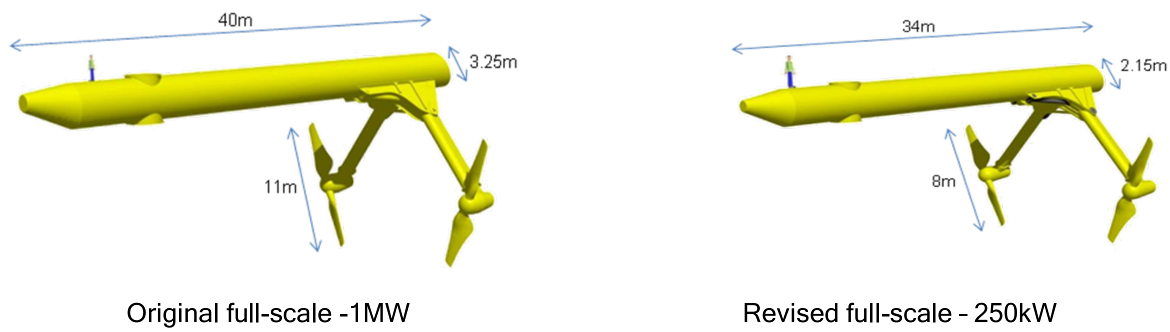


Figure 4.4 Comparison Between Dimensions of SR1000 and SR250 Full Scale Prototypes

4.1.3 Anti-fouling System

Fouling is the attachment and growth of marine organisms on immersed surfaces. Marine organisms stick to a ship's hull by secreting an adhesive that is either hydrophobic or hydrophilic in nature. Typically fouling on marine vessels has been controlled by the use of environmentally damaging biocides. Initially Scotrenewables had considered using a less environmentally damaging non-copper based anti-fouling paint to coat the SR250. However, during the consultation process SNH proposed the use of ultra-smooth surfaces and regular out-of-sea maintenance for marine renewable devices in preference to the use of anti-fouling paints (see Section 2.2).

Scotrenewables investigated this, and is now intending to use the new anti-fouling "Foul Release" technology. This method of fouling control relies on the prevention of secure attachment of the fouling organisms, allowing them to be removed by hydrodynamic shear forces rather than their eradication once the organisms have settled on the hull.

The final external paint will be the International Intersleek 900, a patented fluoropolymer foul release coating, which presents the organisms with an amphiphilic surface, combining hydrophilic and hydrophobic properties in order to minimise the chemical and electrostatic adhesion between the surface and the fouling organism, whether the adhesive is hydrophobic or hydrophilic.

4.1.4 Cathodic Protection

Whilst zinc alloy anodes are still commonly used in the marine environment, the SR250 will be protected using aluminium alloy anodes for the following reasons:

- As the capacity of aluminium is almost 3.5 times higher than zinc the total amount of required anode material is less resulting in a cheaper cathodic protection system to that given by zinc with an equal level of protection;
- As the total weight of anode material for a system using aluminium is less compared to a system using zinc anodes the installation costs for a system using aluminium anodes will also be less; and
- Compared to aluminium alloys, zinc alloys contain more elements which are detrimental to the environment.

4.1.5 Use of Hydrocarbons

Although there are cost implications, Scotrenewables is committed to reducing any risk of polluting the marine environment, so only biodegradable oils will be used in the operation of the SR250 (see Table 4.5).

4.1.6 Cable Route/Position of Anchor Blocks

The final cable route and positioning of the gravity mooring system was decided taking the following factors into account:

- The cable laying and mooring installation activities, long term presence of the cable and mooring system, device operation, and decommissioning activities should not adversely affect sensitive/protected seabed habitats;
- The existing EMEC subsea cables lie between the cable duct supplied by EMEC for the Scotrenewables cable and the proposed site, so the method and location of the Scotrenewables cable crossing point would need to be agreed with EMEC;
- The presence of the new cable should not interfere with or compromise existing tidal site infrastructure or other developers activities;
- Ideally the seabed would be relatively uniform with no large boulders to avoid cable spanning and to ensure the anchor blocks are laid accurately;
- The route the cable takes into the site centre where it will connect with the turret should allow for the maximum separation distance between the mooring lines and

the cable; and

- The cable should be laid entirely within the EMEC lease area.

Following discussions with EMEC it was identified that the ideal cable crossing point should be in the vicinity of the 3m contour. Once this had been agreed a dive survey on the cable route out to the 20m contour was undertaken in July (see Section 5.2.1). The ROV survey of the remaining route and site was delayed until August until the final site location was confirmed (see Section 4.1.1). At the time when the tidal conditions were suitable to undertake the survey a final decision had not been made on which site would be selected so both sheltered sites were surveyed. The results of this survey (see Section 5.2.2 and Appendix 8) indicated that there were no sensitive habitats to avoid and an absence of boulders both on the cable route and site locations. This meant that the cable route could follow the most direct route from the substation to the Scotrenewables site - with all sections of the cable lying within the EMEC lease area. Enough width was left either side of where the cables cross (cable section B-C on Figure 4.5) to allow for a simple gravity anchor to add additional stability to the cable if necessary (see Section 4.5.3).

As can be seen in Figure 4.5 (cable section D), there is a 'dogleg' in the cable route 300m from the site centre. This allows the cable to follow the principal axis of the mooring system so there is the maximum separation distance between the mooring lines and the cable. In addition, the location of the 'dogleg' has been positioned to be over 50m from the nearest EMEC cable. The anchor blocks have also been positioned such that the nearest block is over 50m from the nearest EMEC cable. The orientation of the site was dictated such that the mooring system captures the wave and current direction to avoid uneven loading on each of the mooring lines.

4.2 Project Overview

Construction of the SR250 prototype is underway and contracted to be completed early in January 2011 with installation at EMEC by March 2011. The installation of the SR250 will be undertaken in a number of phases as detailed in Table 4.1. The mooring installation (see Section 4.5.1) will be undertaken between January 2011 and February 2011 when there is an appropriate weather window and suitable tidal conditions. The decision to proceed with installation which will be based on operator's experience. The new cable will be laid (see Section 4.5.3) and be connected via a duct into the EMEC sub-station facility (see Section 4.5.2) between January and February 2011.

Phase	Activity	Duration	Proposed timescale
I	Mooring installation	7 days	January 2011 – February 2011
II	Cable laying	2 days	January- February 2011
III	Turret connection	<1 day	January - February 2011
IV	SR250 connection	< day	February 2011

NB time actually taken to complete each phase may be longer should bad weather prevent the work vessels from going to sea

Table 4.1 SR250 Installation Programme

The 1/5 scale testing programme has involved small incremental development stages over a period of 12 months which has resulted in a safe and successful approach to the work. This has resulted in a fully functioning 1/5 scale prototype that has verified the concept and provided vital information on loading and performance which have inputted in to the design of the SR250 prototype. In addition to this, the practical experience gained working and operating in tidal conditions has been invaluable and will potentially avoid very costly and damaging problems and failures at a larger scale in the future.

Following this precedent Scotrenewables plan to de-risk the testing of the SR250 by undertaking an incremental staged development plan (see Table 4.2 and Section 4.6.1) resulting in controlled learning gains at each stage.

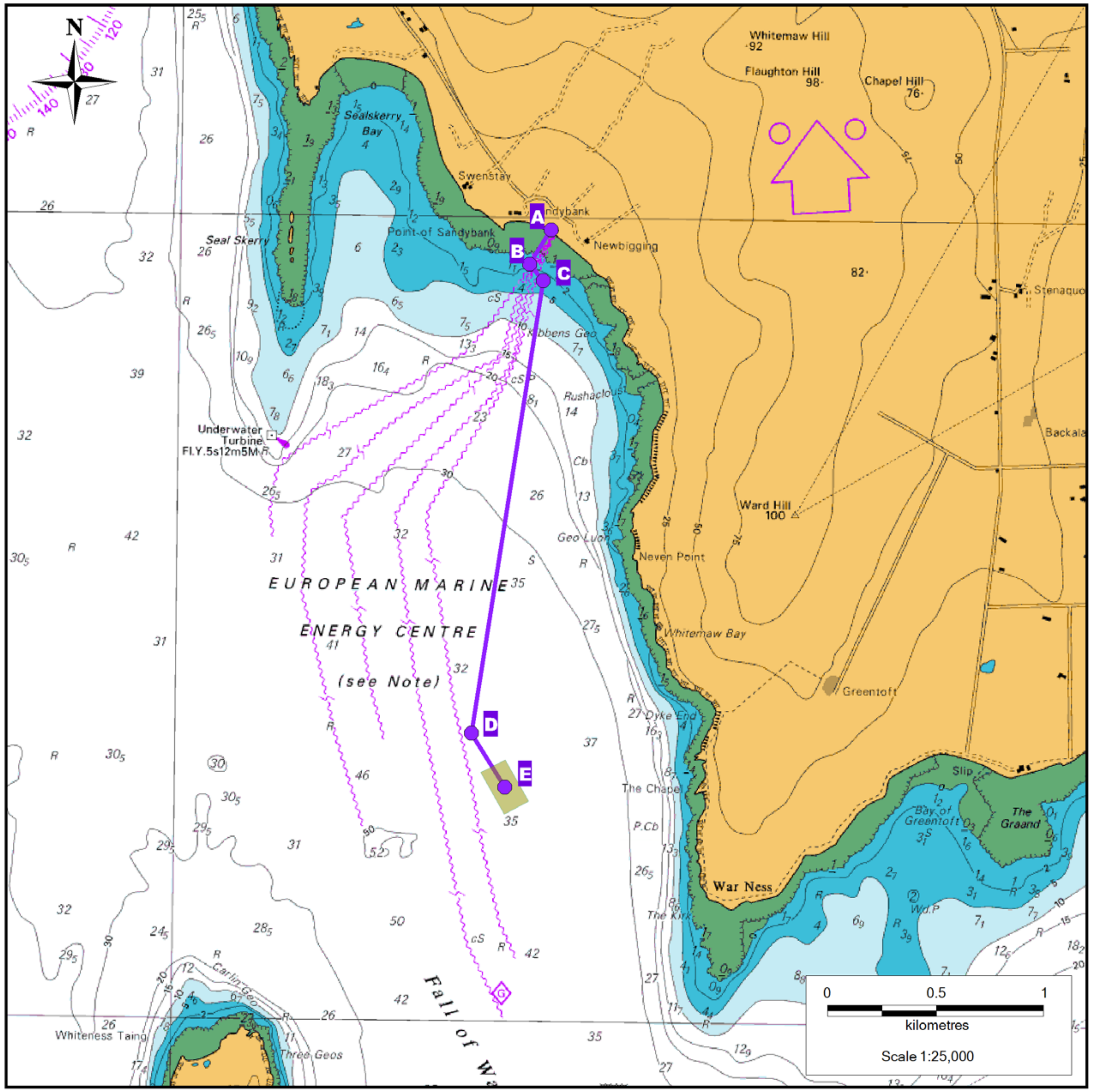
The SR250 is rated to operate in 2.5m/s current where it can generate up to 250kW of power. The device will 'cut-out' at a current velocity of 2.8m/s or greater. The cut-in velocity is approximately 0.5m/s. In extreme storm conditions power generation will cease automatically and the rotor legs will retract up in to a transport/survivability mode.

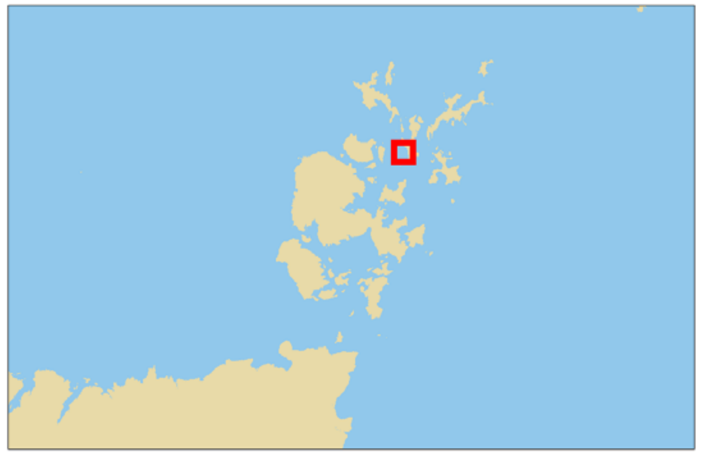
	2011				2012			
SR250 Testing	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4
Test Phase 1								
Data Analysis								
Hydrodynamic Model Verification								
Design Optimisation Programme								
SR250 Model Modifications								
Test Phase 2								
Continuous 3 Month Testing Period								

Table 4.2 SR250 Testing Programme

4.3 Site Location and Layout

The proposed test site is located within the consented EMEC tidal test site in the Fall of Warness, to the east of the island of Eday in the Orkney Islands as detailed in Figure 4.5. The centre of the Scotrenewables berth is at coordinates 59 08.581’ North, 002 48.392’ West (WGS84). The average berth sea depth is 35m.





LEGEND

- Cable points
- Cable route
- Anchor area

Cable Point	Latitude	Longitude	Cable Leg Distance
A (cable duct end)	59° 9.969'N	2° 48.200'W	
			180m
B	59° 9.883'N	2° 48.302'W	
			100m
C	59° 9.842'N	2° 48.235'W	
			2,100m
D	59° 8.714'N	2° 48.556'W	
			293m
E	59° 8.581'N	2° 48.392'W	

Anchor	Latitude	Longitude
NW	59° 8.615'N	2° 48.510'W
NE	59° 8.649'N	2° 48.392'W
SE	59° 8.547'N	2° 48.274'W
SW	59° 8.513'N	2° 48.392'W
Centre	59° 8.581'N	2° 48.392'W

Seabed Footprint	Sea Surface Footprint
27468m^2 (218m x 126m)	3365m^2 (67.3m x 50m)

Note: The level of Mean High Water Springs is 3.1m above chart data

PROJECTION DATA: Universal Transverse Mercator (WGS 84)

Date: Sept 2010
Project: P358
Drawn by: DS
Checked by: DC
Prepared by: aquatera.co.uk environmental services and products
Client: Scotrenewables Tidal Power Ltd

Figure 4.5 SR250 Site Location and Cable Route

4.4 Technical Specification

The technical aspects of the proposed project comprise the armored sea cable, the mooring system and the SR250 device.

4.4.1 Armoured Subsea Cable

The 3 x 10mm^2 armoured electro/optical 6.6kV subsea power & signal cable detailed below will be supplied by MacArtney Underwater Technology.

Cable specification

Unlike the other EMEC cables which have a 5MW rated capacity and a diameter of 98mm, the new cable will be rated at a capacity of 250kW and will be considerably smaller with a diameter of 41mm (see Figure 4.6). The total length of the seabed cable will be approximately 3km.

Mechanical characteristics

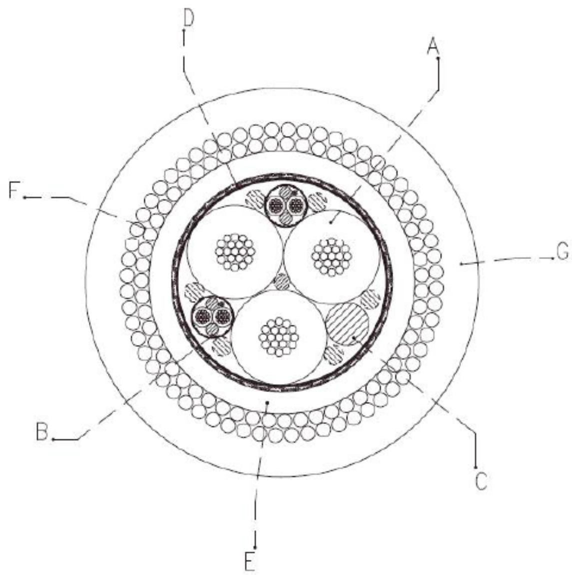
Finished diameter	41.0mm
Weight in air	3,150kg/km
Weight in sea-water	1,800kg/km (assumed sea-water density 1,026kg/m^3)
Minimum bend radius (static)	375mm
Minimum bend radius (dynamic)	490mm
Minimum breaking load	260kN
Armour coating no damage load	145kN

Umbilical armour package

The strength of the umbilical is provided by a two layer armour package consisting of galvanised high tensile steel wires. The armour package provides protection on the seabed, ballast and support during cable deployment.

Cable components

The cable components (see Figure 4.6) have been designed to offer a robust format for dynamic use. The individual components are cabled into a twisted helix around the central member. The helix limits tensional and compressional strains and improves cable flexibility during bending.



Ø 41mm

Key:

A 3 of EPDM insulated 10.0 mm^2 plain copper power conductors

B 2 of individually screened 1.43mm^2 twisted signal pairs.

C Fibre and/or extruded filler elements.

D Collective screen comprising 9.0mm^2 tinned copper wire braid and over-lapped copper/polyester laminate tape.

E Polyurethane inner sheath (2.5mm nominal thickness)

F Two contra-helical layers of high tensile galvanised steel wire armour

G Low density polyethylene outer sheath (3.6mm nominal thickness)

Figure 4.6 Subsea Power & Signal Cable - X-Section and Construction Characteristics

<u>Cable end</u>

A dummy protective end flange housing will be fitted to the cable end prior to connection to the turret (see Section 4.5.3).

Suitability for use in marine environment

Polyethylene has been used as a jacketing material for underwater cables for over 50 years and has a proven life expectancy of greater than 25 years in the subsea environment. The material is resistant to microbiological attack, and provides flexibility and abrasion resistance combined with resistance to long term immersion in seawater. In the shallow stretches and at the connection point with the turret additional protection will be required (see Section 4.5.3).

4.4.2 Mooring System

The mooring system for the SR250 prototype will consist of a single-point mooring (see Figure 4.7). The SR250 will be anchored to the seabed via a four-riser catenary spread compliant mooring system with a centrally located quick-release disconnectable turret which will remain a minimum of 10m below LAT when the SR250 is off site (see Figure 4.8). The 3 tonne steel turret contains quick-release mechanical and electrical connections which allow remote connection and disconnection of the SR250 in a quick single action without the requirement for vessels alongside or personnel on board the SR250. The turret also has an electrical swivel (which will remain with the SR250) that allows the device to passively yaw around the mooring system to capture the tidal flow in any direction. The turret is approximately 3.0m high and 1.5m in diameter (see Figure 4.9). The turret is designed to have an inherent excess buoyancy of 6kN which keeps tension in the top part of the mooring lines and prevents the electrical umbilical from exceeding its minimum bend radius of 400mm. The turret is kept at the minimum 10m below LAT by the balance of the excess buoyancy and the weight of the mooring lines lifted off from the seabed. In addition clump weights (302kg submerged weight) will be added at the join between the ground chain and synthetic line (see Figure 4.7) to ensure the turret remains at the optimum depth. The combination of clump weights and inherent buoyancy of the turret will ensure mooring lines remain taut. Figure 4.11 depicts the degree of excursion of the mooring system. Experience from the 5th scale testing and modelling undertaken for the SR250 has shown that there will be little movement of the mooring system ensuring minimal scouring of the seabed.

The prototype mooring lines will be in an “X” configuration with a half angle of 30 degrees, taking up an area approximately 218m by 126m (see Figure 4.10). The mooring system allows excursions of the device up to a maximum of 8 metres under steady and unsteady forces. The first prototype will have a stand-alone mooring system but future devices are expected to use an integrated mooring system. Mooring lines will be anchored to the seabed using gravity anchors. Each of the 4 (one at each corner) gravity anchors consists of 4 reinforced concrete blocks each measuring 2.4m x 5m x 0.5m as shown in Figure 4.10. The combined holding force of the blocks will be greater than 350kN (35 tonnes).

One of the tests undertaken with the 5th scale device was to prove the methodology devised to predict drag forces on the tidal turbine and mooring system. It was found that at rated current speed for the case of having the legs down and rotors not turning the drag forces on the model were of the order of 3kN (≈10kN at SR250 scale). This agrees with predictions within 6% thus proving the methodology. Each component of the mooring system (synthetic lines, chains, shackles, connections to anchor points etc.) have been over designed by a safety factor of between 2 and 4. It is interesting to note that marine growth on the synthetic line was greater than expected (particularly during summer) and this will need to be closely monitored at full-scale.

Marine growth on 5^{th} scale mooring lines, Summer 2010

Mooring line failure will be detected by reading of the mooring line fairlead tension and global positioning of the turret (see Section 7.2). The mooring design will be covered by the Independent Structural Verification which will be available at the end of December 2010.

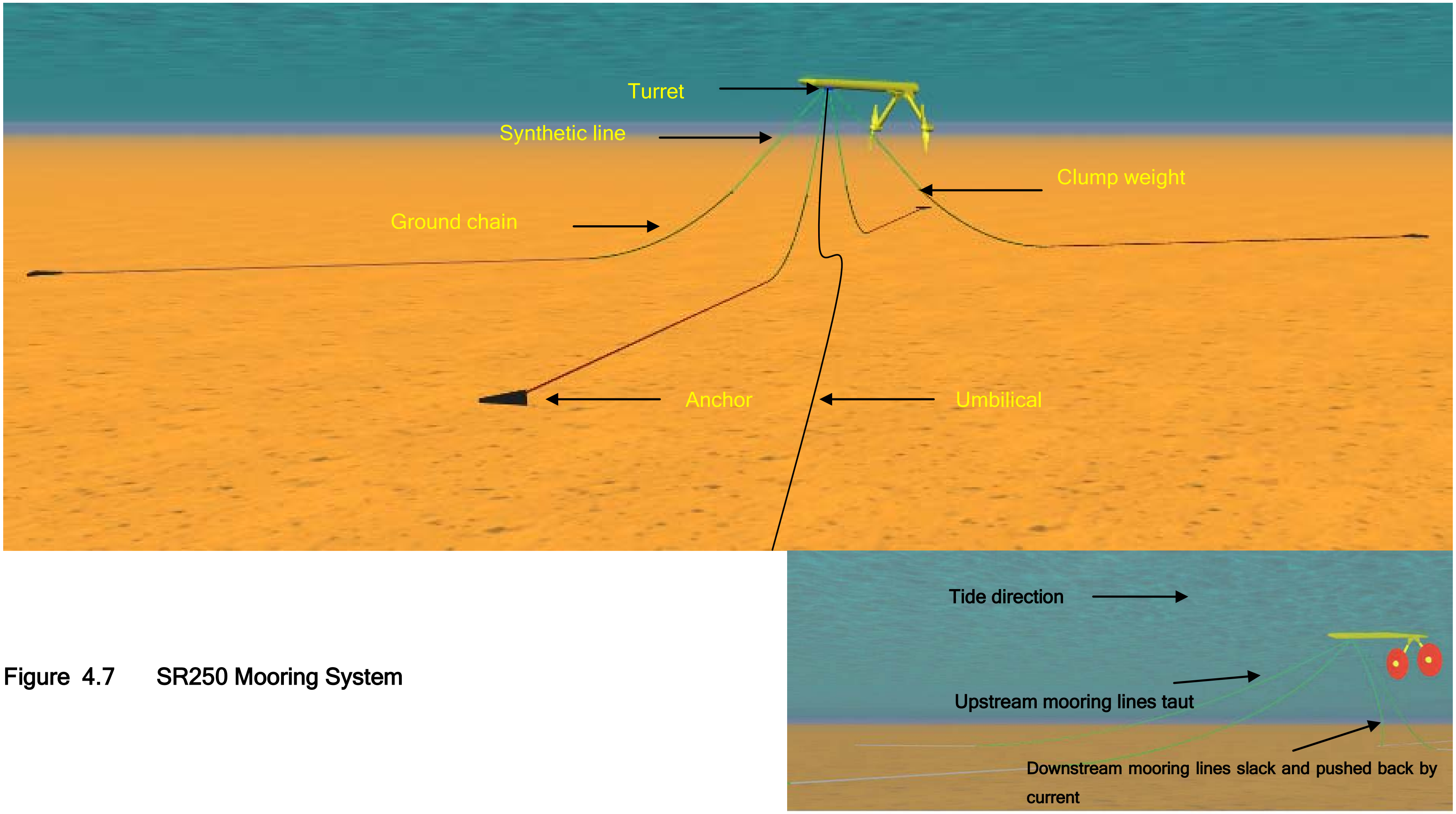


Figure 4.7 SR250 Mooring System

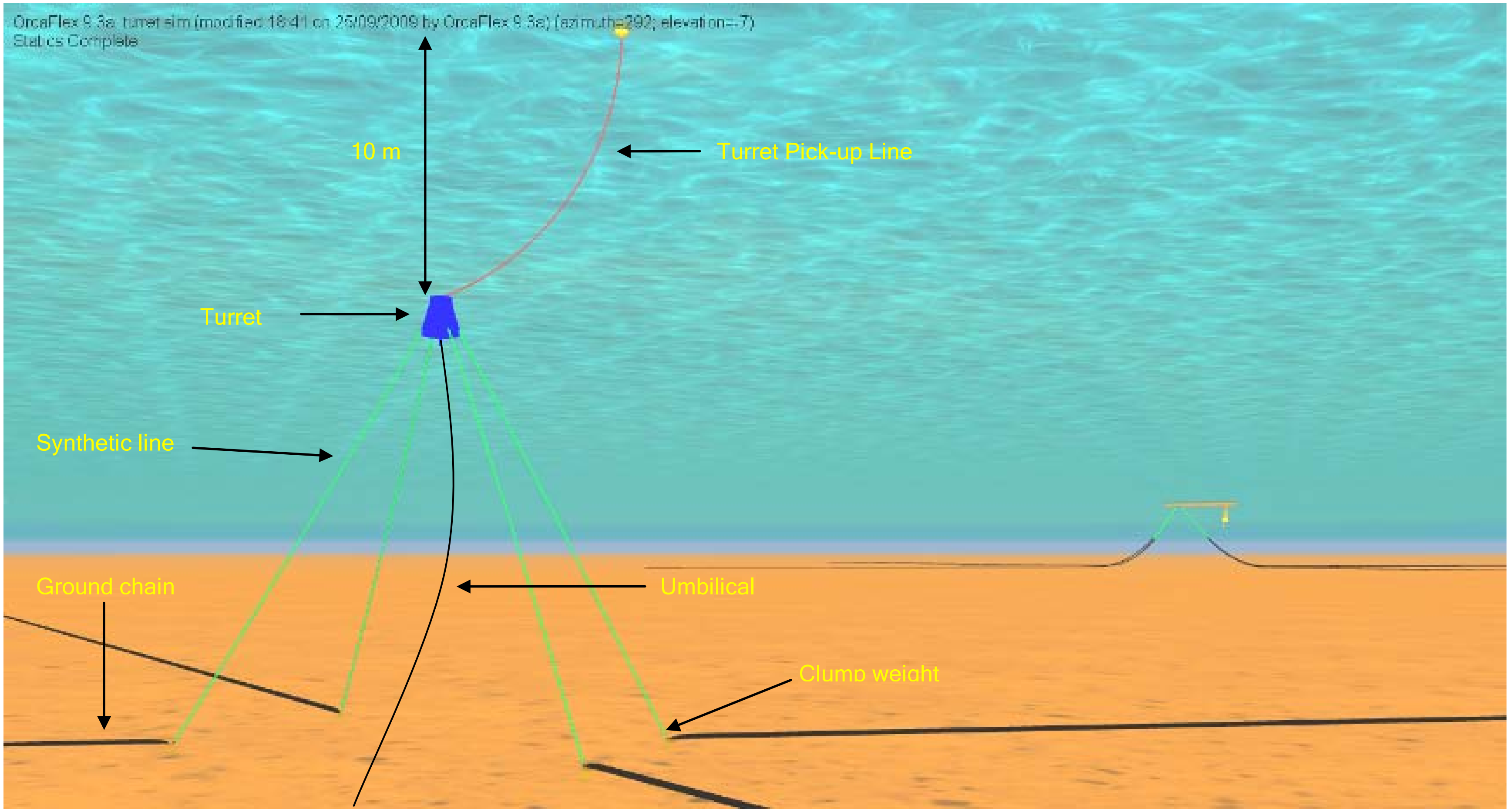


Figure 4.8 SR250 Disconnected Turret

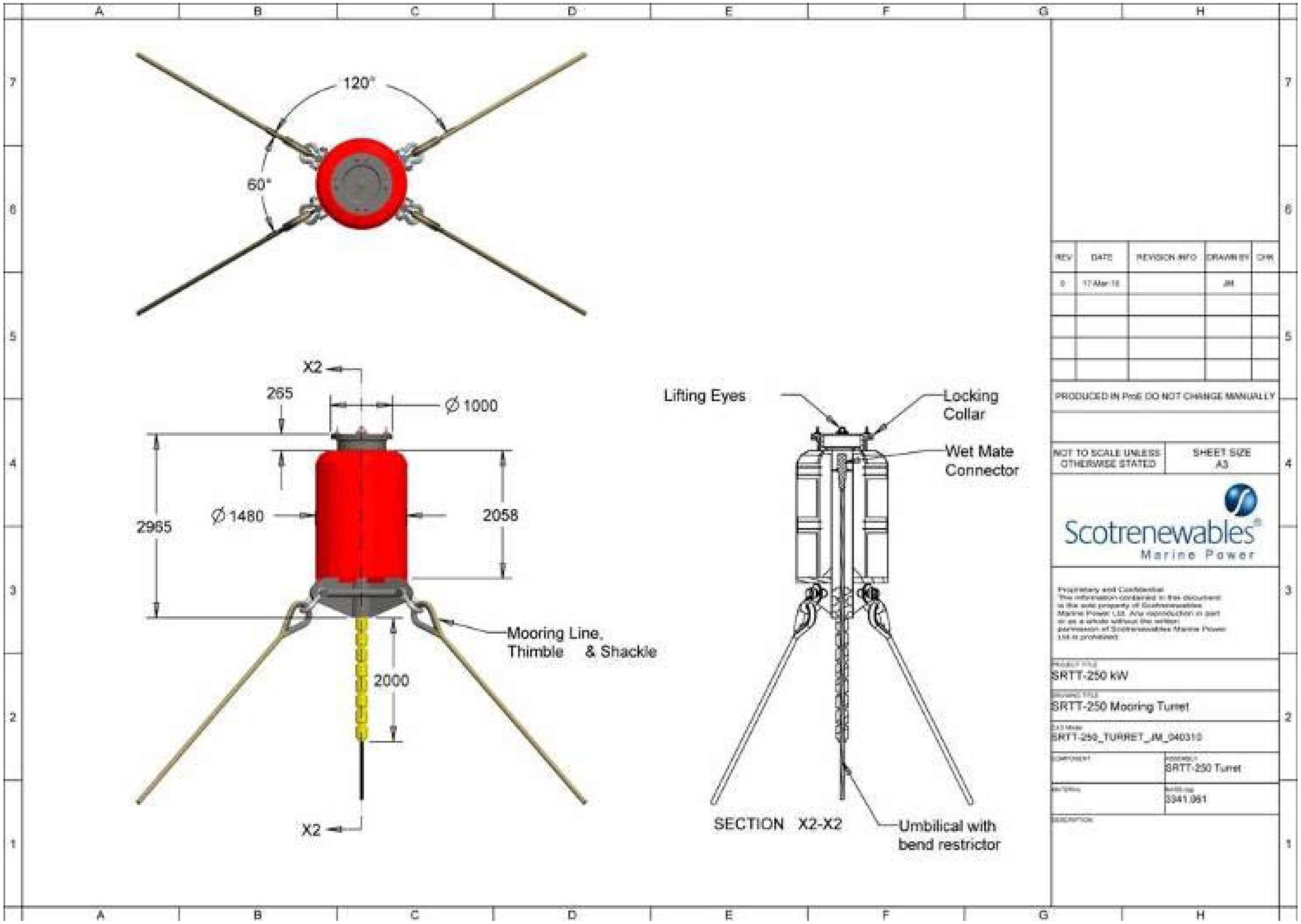
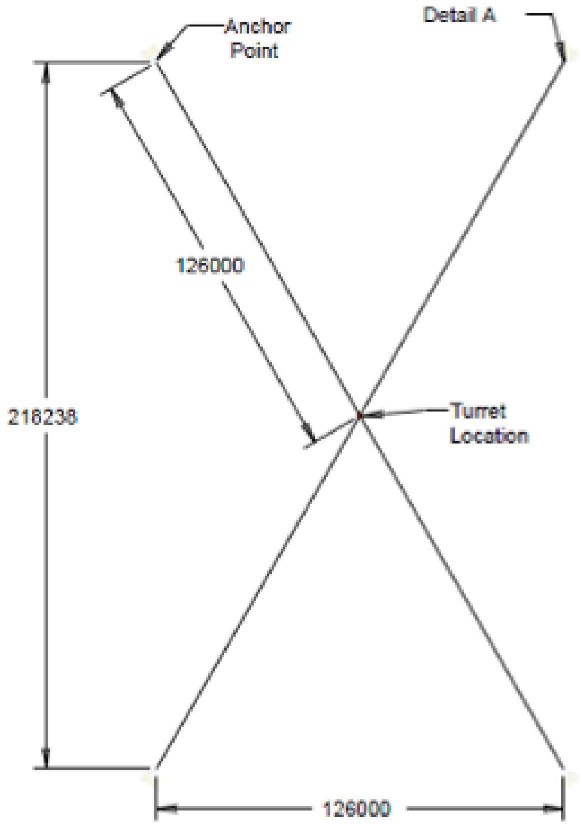
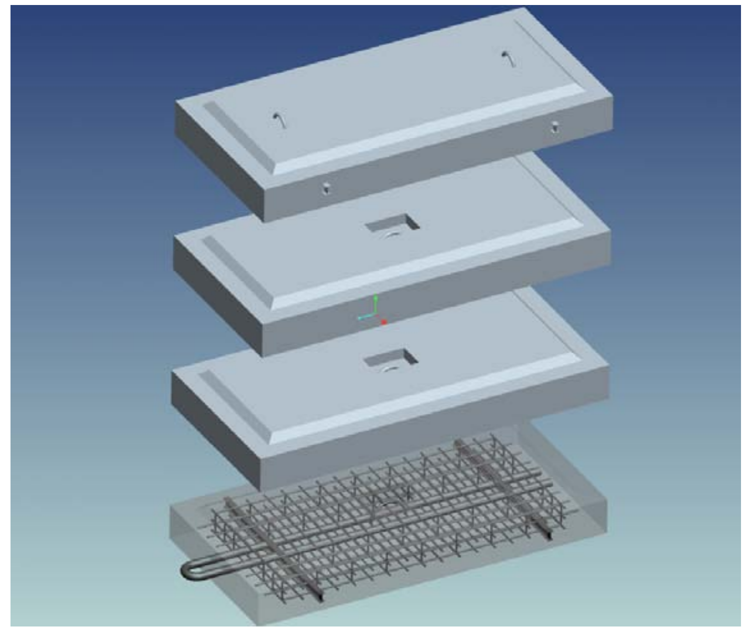


Figure 4.9 Turret Detail

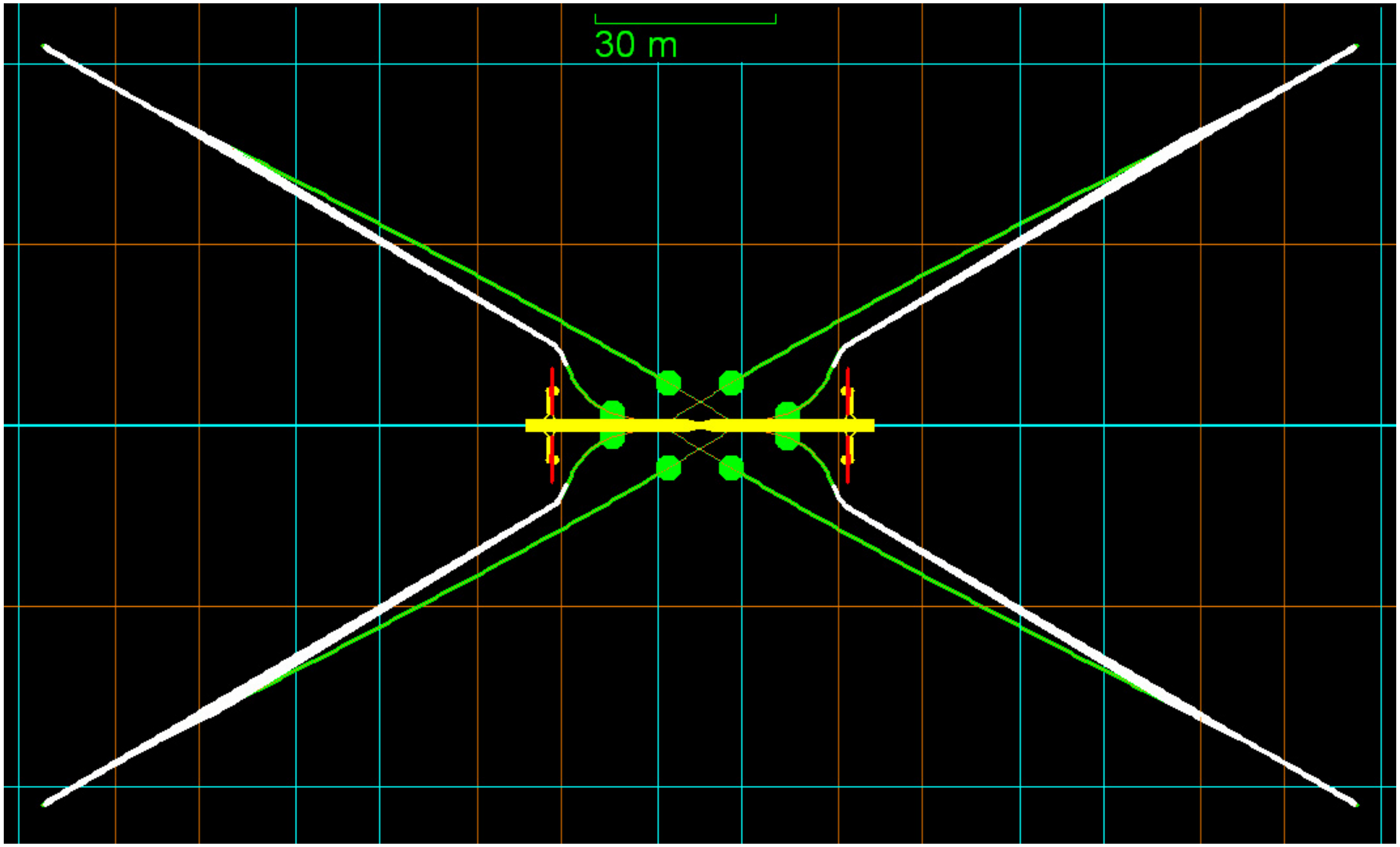




Units in mm

Detail A – 4 reinforced concrete slices 2.4m x 5m x 0.5m

Figure 4.10 Mooring System Specification and Gravity Anchor



White regions - indicate the known areas of seabed contact over the course of a tidal cycle.
Green lines - indicate the envelope, within which the mooring lines could contact with the seabed, over the course of wave cycles or when the mooring turret is detached from the device and floating below the sea surface.
Yellow bodies - are the SR250 aiming in the two tidal directions (the rotors are indicated in red).
Green bodies - represent the clump weights which are not deemed likely to contact with the seabed other than when the turret is disconnected, at which point they are not expected to move around.

The green lines only indicate the excursion of the mooring system at maximum current loading and do not include the effects of wave loading. It should however be noted that wave response motions are low along the direction of the SR250 tube at these excursions. This is due to the increased stiffness of the overall mooring system as the SR250 is dragged away from the centre of the mooring layout by the current. The result is that the magnitude of the motion is too small (>0.5m) to be discernable in the above figure.

Figure 4.11 Plan View of SR250 Deployed System

4.4.3 SR250 Technical Specification

The full scale SR250 prototype comprises a 34m long horizontal, free-floating, cylindrical steel tube with a 2.3m diameter (see Appendix 1 for full dimensional drawings) constrained at one end by a catenary mooring system. The other end of the tube supports two angled beams (rotor legs) that protrude down into the water. The rotors are each suspended from these separate hydraulically retractable rotor legs attached to the buoyancy tube, which raise and lower the rotors from transport to operation modes (see Figure 4.12). The rotors are used to extract power from the tidal flow and turn generators housed within subsea nacelles. The device can rotate on the mooring system; allowing it to turn to face the current, following the same principal as a wind vane. The system has a transport draught of 3.9 m, thereby facilitating rapid transport from site to most harbour facilities for maintenance. The rotors will be 8m in diameter, with a swept area of 50m^2 which is expected to capture 37% of the available tidal energy (ratio of energy flux based on a tidal current of 2.5 m/s for the site). The tip of the rotors will be approximately 4m below the surface.

The SR250 concept is entirely scalable however in general larger grid connected models are designed for deployment in any water depths of >20m and mean spring tidal velocities of 2.5m/s to over 5m/s. Maximum rotor rotation speed will be 24RPM. The SR250 prototype will have a total displacement of approximately 80 tonnes. In commercial deployments, it is envisaged that a number of individual SR1000 (or bigger) devices will be moored to the sea bed and deployed together in 'tidal-flegs' sharing mooring anchors and maximizing packing density.

Full detail of the SR250 internal and external components can be found in Figure 4.13 (a and b), and in Tables 4.3 and 4.4.

Figure 4.12 (a) SR250 Transport/deployment and survival configuration

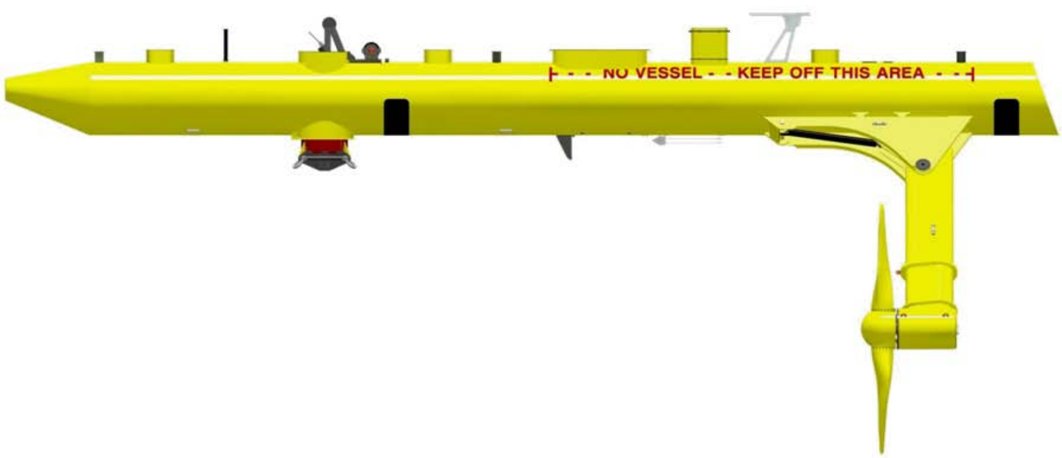


Figure 4.12 (b) SR250 Operation Configuration

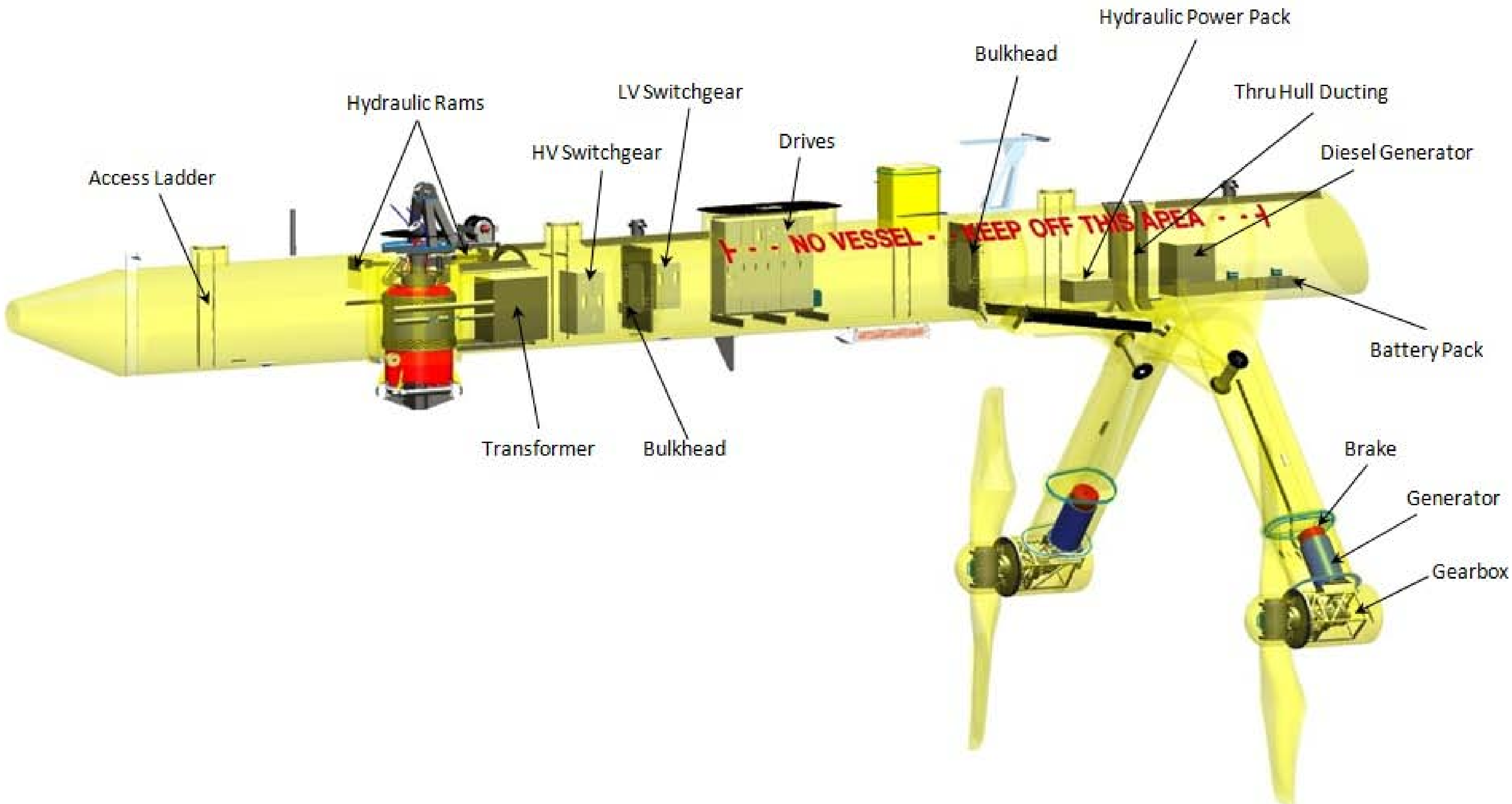


Figure 4.13 (a) SR250 Principal Internal Components

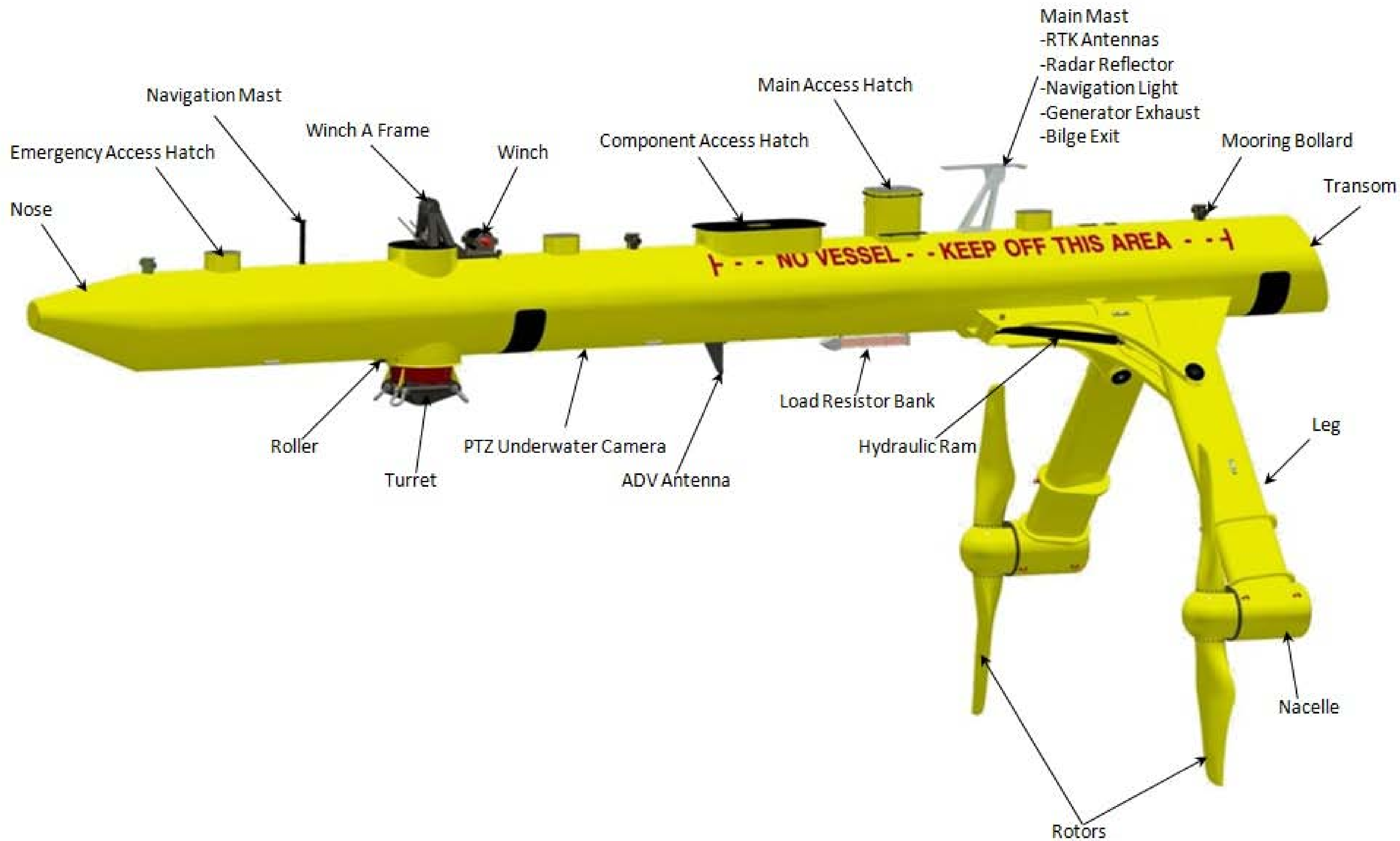


Figure 4.13 (B) SR250 Principal External Components

Item Description	No. of Units	Approx Mass (kg) each	Location
Rotor Shaft Seal	2	5	Nacelle
Rotor shaft thrust & radial bearing	4	40.5	Nacelle
Rotor shaft slip-ring	2	10	Nacelle
Gearbox & Brake	2	727	Nacelle
Generator	2	1520	Nacelle
Water cooling pump	2	5	Nacelle
Hydraulic cooling pump	2	5	Nacelle
External keel cooler	2	20	Nacelle
Nacelle wet-mate connector	2	10	Nacelle
Nacelle Porthole	2	20	Nacelle
Leg pin bearing	2	10	Rotor Leg
Hydraulic ram	4	1000	Rotor Leg
Ram Bearing	4	10	Rotor Leg
Hydraulic hosing (leg retraction)	30m	30	Rotor Leg
Hydraulic fittings / valves	8	10	Rotor Leg
Hydraulic power-pack and manifold	1	50	Hull
Hydraulic hosing (turret winch and clamps)	100m	100	Hull
Hydraulic fittings / valves	16	20	Hull
Generator drives	1	1830	Hull
Switchgear (HV)	1	700	Hull
Switchgear (LV)	1	500	Hull
6.6kV Transformer	1	1600	Hull
Control Cabinet	1	20	Hull
Instrumentation Cabinet	1	20	Hull
Communications Cabinet	1	20	Hull
I/O Box	4	30	Hull
24V Distribution Box	4	30	Hull
Bilge pumps	8	2.5	Hull
Cable / hosing trays	100m	100	Hull
UPS Power Supply	1	400	Hull
6kVA Diesel Generator	1	500	Hull
Lighting	10	50	Hull
Turret locking rams	2	50	Hull
Turret bearings	2	20	Hull
Turret winch	1	1000	Hull
Batteries (1m x 0.5m x 0.5m)	8	66	Hull

Table 4.3 SR250 Internal Components

Installation component	Materials and weight (were available)
Buoyancy tube	Steel, 66.5 tonnes
Rotor (x2)	GRP blades, steel hubs, 2 tonnes each
Nacelle (x2)	Steel, 2.8 tonnes each
Rotor Leg (x2)	Steel, 6.4 tonnes each
Rotor Leg Brace (x2)	Steel, 4.1 tonnes each
Mooring Turret	Steel, 3.0 tonnes
Antennae Mast (x2)	Steel tube, 1.6m x 40cm Ø Steel structure – H 1.6m x W2m x D1m
Mooring line (x4)	Hybrid synthetic fibre rope (25m length 113 mm Ø polyester)
	Steel ground chain (115m length 56mm Ø studlink U3 chain)
Anchor (x4)	Gravity anchor – 4 anchors each weighing 35.0 tonnes and measuring 2.4m x 5.0m x 2.0m

Table 4.4 SR250 External Components

4.4.4 SR250 Electrical Systems

The full scale SR250 prototype employs dual horizontal-axis counter-rotating rotors which drive seperate gearboxes and electrical generators within sub-surface nacelles. The control system, hydraulic power packs, generator drives and a transformer which steps up the voltage to 6.6kV (AC) are located within the main hull tube (see Figure 4.13 a). Wetmate electrical connectors connect the device through a turret type connection to a dynamic umbilical cable which transfers electricity to a seabed cable connected to the substation ashore.

The SR250 electrical systems comprise of the following:

<u>Power Generation</u>

The Power Take-Off (PTO) system applies a controlled torque and speed on the rotor shafts which will extract the maximum amount of energy for a given tidal velocity within given limits. The rotational energy of the rotors is converted into electrical energy via a planetary gearbox directly coupled to the rotor shaft which steps up the rotational speed of the rotor to a variable speed induction generator within the nacelles. The variable frequency 400V output from each generator in the nacelles will then be transferred to the hull via transmission cable to variable speed drive units which transform the variable frequency/voltage output from the generator to a grid compliant fixed frequency/voltage. The drives then connect to a 690V/6.6kV transformer. From here the 3-phase AC power will be transferred through an electrical slip-ring above the central mooring point to a wet-mate connector and from here to a dynamic umbilical cable and seabed cable to shore.

Auxiliary Systems

The auxiliary systems on board the SR250 are:

- Emergency bilge system -bilge suctions will be distributed throughout the device and in every watertight compartment. The activation of the bilge will send alarms to the SCADA system.
- Cooling water system - including freshwater pumps, piping, seawater intakes and outlets, heat exchangers, keel cooler and any other equipment necessary for the onboard cooling system.
- Internal and external lighting - general internal lighting for use during maintenance, emergency internal lighting supplied from the UPS (uninterruptible power supply) power source, navigational lighting, general external lighting for use during maintenance, and external inspection lighting for monitoring during operation.
- Fire detection/fighting system - a detailed fire detection and shutdown procedure will be produced so that the SR250 will respond in a safe manner on detection of a fire.

SR250 Power Supply

The SR250 will contain a battery bank consisting of 8 x 12v sealed gelled electrolyte lead acid batteries which will power the bilge pump, instrumentation and control systems. The batteries will be charged by one of three methods:

1. When the SR250 is generating (rotors down and turning) this will power the batteries.
2. When the SR250 is not generating but grid connected the 6.6kV cable will keep the batteries powered up.
3. When the SR250 is neither grid connected nor generating (e.g. during towing trials) for an extended period then the 100 litre capacity diesel back-up generator

will be used.

SR250 Electrical Connection

The SR250 will be connected through the subsea power export cable to the Grid. The onboard generation voltage will be 400V which will be transformed onboard to 6.6kV and transmitted over the umbilical to the shore facility. The onshore transformer will step up the voltage from 6.6kV to 11kV for export to the Grid.

Slip Ring

A slip ring is required to allow the device to rotate with respect to the umbilical cable. Otherwise the umbilical cable will eventually get tangled as the device turns with the tide.

4.4.5 Instrumentation & Control Systems

The control system is an industrial PC (embedded) based system, where a controller (software PLC) will be in charge of the whole control of the SR250. This component will monitor the operating state of the device reading the information coming from the different sensors and other components installed, and manipulate this information in order to keep the system working within specified operational limits.

The operation of the whole system will be monitored and controlled remotely via a SCADA system which will run permanently on a dedicated PC located onshore. This SCADA application will be able, amongst other things, to show the instantaneous state of the system, acknowledge warnings and alarms from it, give the operator the option to record them or not and print reports when necessary.

The PTO control system will include all systems necessary to control the extraction of energy from the tide. The control system will be flexible to allow for ongoing changes as the testing progresses.

As the SR250 is a prototype, various sensors will monitor the environmental parameters and how the SR250 responds to environmental inputs. This will include:

- Tidal current speed;
- Motions in the 6 degrees of freedom;

- Wave height and period;
- Rotor torque, speed and thrust;
- Rotor blade deflection;
- Mooring line loads;
- Structural forces; and
- Electrical power generation.

As part of the control system, certain parameters will be monitored solely for the safe and reliable operation of the SR250. These parameters will include:

- Hydraulic pressure, temperature and reservoir levels;
- Cooling water temperature;
- Equipment space temperature/humidity;
- Generator temperature;
- Generator voltage and current; and
- Bilge level alarms.

Leg Retraction System

The Leg Retraction system will consist of a simple configuration where each leg will have sensors in charge of detecting if the legs are in the critical positions, i.e. totally retracted or extended in the optimum position for operation. The system should have interlocks to prevent the legs being retracted when not in their "home" position.

Turret Control

The turret control system will control all systems necessary for winching the turret in place, clamping the turret into the turret sheath and performing the electrical connection procedure. The turret connection procedure will be an automated process called by the operator via the SCADA system. If the control system detects a problem, e.g. winch line tension too high, which could indicate that the turret is stuck it will produce an alarm on the SCADA system and the procedure will be aborted. When the turret disconnection procedure is called by the user, the control system will perform a system check to determine if it is safe to disconnect the turret and when all checks have been performed, the control system will disconnect the electrical connection then disconnect the mechanical latching system. The turret winch can then be spooled out to drop the turret to the desired water depth and the winch line disconnection procedure can be performed.

Shut Down Control

Device shut down will be fully automated. There will be 4 shut down scenarios:

- Planned at the end of each tidal cycle;
- Planned at cut out tidal velocity (the velocity above which generation of power is stopped due to the increased loads and strain on the structure and control system);
- Survival shutdown of rotor above critical sea state; and
- Emergency.

4.4.6 SR250 Lubricant/Fuel Requirements and Chemical Usage

Lubricants and fuel

The use of lubricants and fuel will be kept to a minimum, as detailed in Table 4.5. The device has been designed and will be rigorously tested prior to deployment to ensure that there is no ingress of water into the tube. Experience with the 5th scale tests have shown that there were no system failures, however, in the unlikely event that sea water does gain entry into the tube bilge pumps have been installed. The importance of ensuring that any bilge water released into the marine environment is not contaminated is recognised and appropriate mitigation has been put in place (see Table 4.5). In addition to these measures, all oil changes and re-filling of diesel tank will be undertaken during routine in-shore maintenance. There will be no discharges from the hydraulic systems.

A composite bearing will be used on the hydraulic rams on the rotor legs so there will be no requirement for lubrication.

	Specification	Location*	Pollution control
Hydraulic oil	Biodegradable vegetable oil suitable for marine environment – supplier still to be finalised.	In hydraulic power pack - max usage 250l.	Hydraulic oil will be in sealed compartment with spill tray. In the unlikely event of a spill this will be removed during routine harbour maintenance.
Gearbox oil	Biodegradable vegetable oil suitable for marine environment – supplier still to be finalised.	Rotor leg	Gearbox will be in sealed compartment with spill tray. In the unlikely event of a spill this will be removed during routine harbour maintenance.
Diesel (100l capacity)	-	Diesel generator	Spill tray to be included to capture fuel in the unlikely event of accidental spill or leakage to prevent bilge contamination.
Batteries	24v sealed gelled electrolyte lead acid.	In battery bank at front of hull.	Solid nature of gel will ensure no leakage.

** See Figure 4.13*

Table 4.5 SR250 Lubricants and Fuel

<u>Device coating</u>

The commercially available International paint range typical used by marine vessels will be used to coat the hull exterior and rotors. Four separate coats will be applied as detailed in Table 4.6 below – the different colours are used to ensure even coverage at each application stage. It is estimated that this paint will last for 10 years without the need for re-application, well beyond the lifespan of the device. The top coat will be the Intersleek®900 (ISO 3233:1998) foul release paint described in Section 4.1.3.

Coat	PRODUCT	COLOUR	COATS	Volume (lt)
1	Intershield 300	Aluminium	Undercoat	694
2	Intershield 300	Bronze	Undercoat	694
3	Intersleek 737	Pink	Undercoat	585
4	Intersleek 970	Yellow	Outercoat	676
			TOTAL	**2649**

Table 4.6 Paint Specification

4.4.7 SR250 Seals & Gaskets

Scotrenewables will be using a combination of seals and gaskets derived from elastomeric (nitrile butadiene rubber NBR) and polymeric (polytetrafluorethylene - Virgin PTFE) plastics as detailed below. The preferred supplier is Aberdeen based Swan Seals Ltd who have been manufacturing and supplying seals and seal products to the offshore oil and gas industry for over 20 years.

Rotor shaft (x2)	1 x Main seal (NBR)	1 x Secondary seal (PTFE)
Nacelle Front Plate to Nacelle Housing (x2)	1 x PTFE Gasket	
Nacelle Housing to Nacelle Top (x2)	1 x PTFE Gasket	
Bulkhead Head Covers (x2)	1 x PTFE Gasket	
Main Equipment Hatch Cover	1 x PTFE Gasket	

4.4.8 SR250 Cathodic Protection

In order to protect the external metal components from the corrosive properties of the marine environment 12 x 5kg standard aluminium sacrificial anodes will be evenly distributed over hull, legs and braces (see Section 4.1.4). It is likely the anodes will be supplied by MG Duff International (ISO accredited 9001:2000) who have been at the forefront of marine cathodic protection since the early 1950's and continues to be one of the largest suppliers of systems and services to the marine market in the UK and throughout the world. The lifetime of the anodes will be around 2 years so should not need to be replaced during the testing period.

4.4.9 Communication Masts

There will be 2 communication masts situated on the SR250. The first will be located above the rotors, be 1.6m high and 2 m wide and will hold 3 GPS antenna, 1 navigation light, 1 radar reflector, the bilge exit pipe and the generator exhaust pipe. The second (also 1.6m high) will be on the forward end and this will be a simple steel pole holding the second navigation light (see Figure 4.13 b). Onshore, there will be four small antennae on the top of the control/communications container – 1x wireless antenna, I x GPS antenna, I x GMS antenna and I x VHF antenna (see Section 4.5.2).

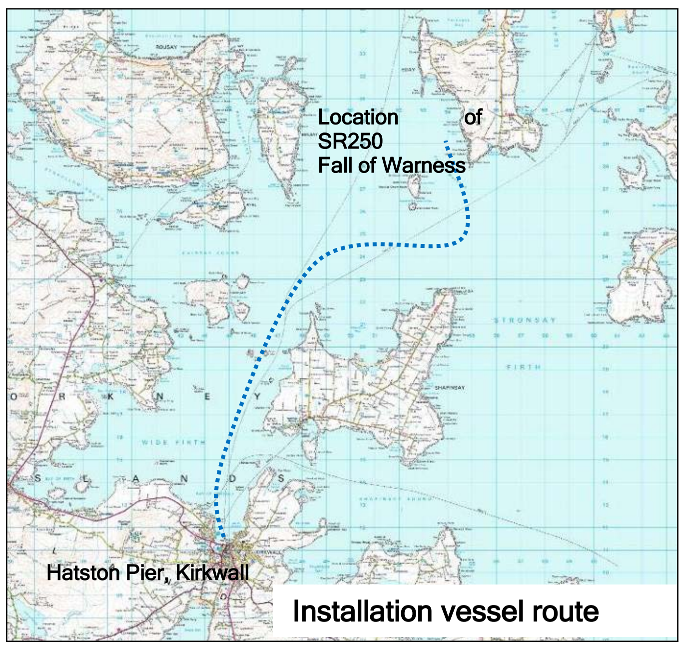
4.5 Installation Activities

The installation activities will be undertaken in 4 phases as detailed in Table 4.1 and below.

4.5.1 Mooring Installation

It is anticipated that the installation of the mooring system will take up to one week and be carried out between January 2011 and February 2011. A multi – cat work vessel will be used (see Section 4.6.5). This activity will be weather dependent and undertaken during neap tides.

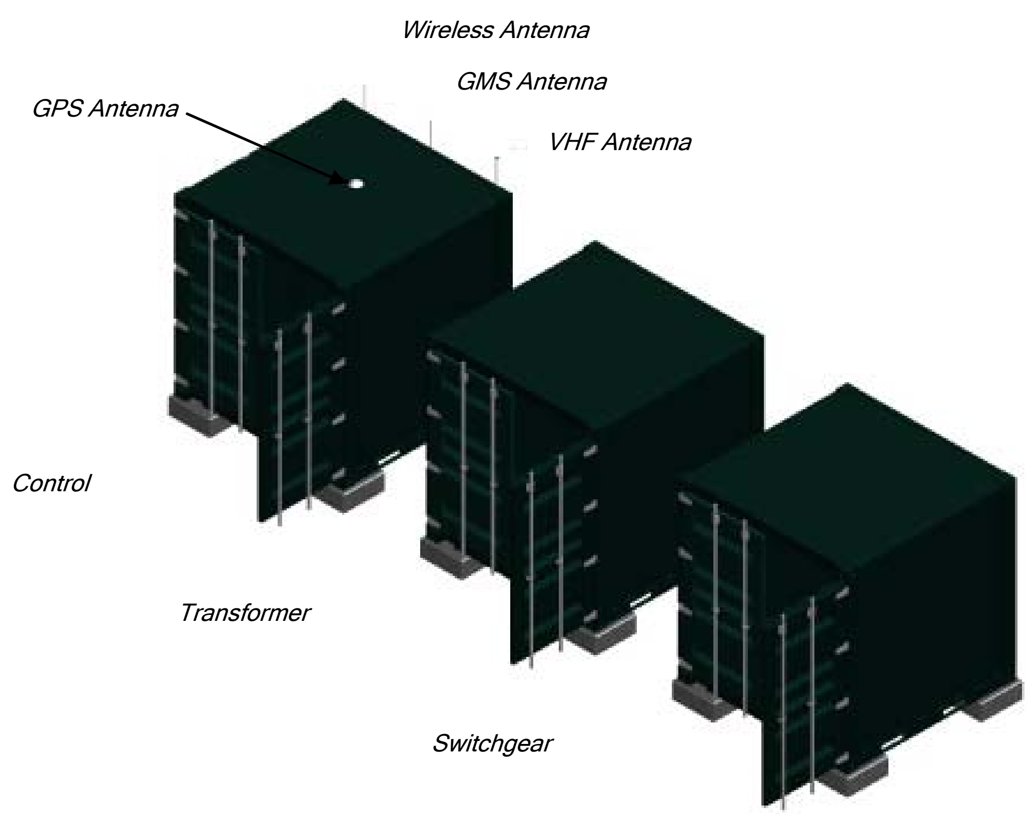
The synthetic and chain spread mooring lines (see Figure 4.7) will be attached to the each of the 4 gravity anchors and placed on the seabed using a GPS to ensure precision siting (see Figure 4.5). The 4 anchors will be transported out to the site one at a time and installed during periods of slack water. The 4 blocks which comprise each anchor will lifted off pier onto the seabed at Hatston pier and combined together. The front roller of multi-cat equipped with a bow winch will lift the combined anchor blocks for transport to the site, one anchor at a time, where the chain/rope element of the anchor system will be attached prior to being dropped on the seabed. The end of the chain will be marked with a buoy to allow for retrieval later. It will take approximately 2 hours to install each anchor at the site.



Once all four anchors are in position a winch mechanism will be used to bring the chains/ropes together at a central point where the turret will be attached and lowered to 10m (LAT) and marked with a buoy to allow for retrieval. The anchors will maintain their position by gravity so no additional fixing will be required. The mooring system will remain in place for the duration of the testing period. Once the turret has been attached (see Section 4.5.4) this will also remain in place for the duration of the testing period, and be will be lowered to 10m below LAT when the SR250 is not connected at the site (see Section 4.4.2 and Figure 4.8).

4.5.2 Cable Connection to On-shore Facility

Scotrenewables will be provided by EMEC with an area of hard standing to house 3 standard 8ft shipping containers as shown below, one for the transformer, one for control systems/communications and one for switchgear adjacent to the main EMEC sub-station. The containers will be painted green (colour RAL 6005) in compliance with EMEC site planning conditions. EMEC installed 2 new cables and 2 cable ducts in the summer of 2010, and one of the ducts will be made available for the new Scotrenewables cable. The transformer will convert the power from 6.6kV to 11kV and a cable will be installed to connect with the EMEC sub-station. The adjacent building on the site holds the Scottish and Southern (SSE) transformer where the 11KV is transformed to 33KV. Eday is linked to both Westray and Sanday by subsea cables that form a ring through the Northern Isles and feed into the national grid.



4.5.3 Cable Laying

It is anticipated that the duration of the cable laying activities will be two days. This activity will be weather and tide dependent and expected to be carried out sometime during January to February 2011. Approximately 3km of new cable will be laid, and follow the route detailed in Figure 4.5 which was determined following the dive and ROV surveys (see Sections 4.5 & 5.2.2 and Appendix 8) and in consultation with EMEC.

Due to the relatively small size of the proposed cable (see Section 4.4.1) it will not be necessary to use a large DP vessel to undertake the cable laying works. Instead a much smaller multi-cat work vessel (see Section 4.6.5) will be utilised.

The overall weight of the cable will offer good stability against movement by seabed currents. However, a desktop study undertaken on the drag on the cable indicated that additional weight was required to limit the movement further. 50kg chain 'sinkers' (consisting of 3x 56mm diameter steel chain links) will be clamped to the cable at 50m intervals (60 in total).

The procedure for laying the new additional cable for the new berth will be as follows:

- On arrival to site the vessel will anchor as close to shore as possible. A simple concrete block gravity anchor (max 2x2x2m) will be temporarily placed on the seabed and recovered once the vessel is ready to move on.
- The cable end will be passed from the vessel to personnel on the Scotrenewables inflatable boat and taken to the diver who will be positioned at the end of the cable duct.
- The diver will attach the cable to a rope which has been passed through the duct from the on-shore facility and the cable pulled through. It is probable a loadall will be used to perform this task.
- The cable will have chain 'sinkers' (see above) attached to keep it on the sea bed once installed. For this part of the procedure however the cable will have buoys attached to keep it to the water surface to aid with manoeuvring the cable into position.

- Once the cable has been successfully drawn into the on-shore duct the buoys will be cut off the cable sinking it to seabed.
- The vessel will now proceed towards the test site with the cable with the chain sinkers attached payed over side. A GPS system will be used to ensure the cable is laid in the right location.
- Once vessel reaches the centre of the site, the cable will be terminated into the mooring turret which will be located at the centre of the mooring system.
- This operation will be undertaken during neap tides.

<u>Additional protection</u>

The armoured cable will be additionally encased in cast-iron protectors from the onshore cable pit, through the shore landing and out to 5m water depth giving the cables good mechanical protection. Where the cable crosses the EMEC cables the cast-iron will be replaced with a marine grade plastic housing (max diameter 150mm) to limit the risk of causing any damage to the EMEC cables. In addition, at the point where the umbilical touches down onto the seafloor below the device approximately 20m of polyurethane housing will be attached to the cable at this point (maximum diameter75mm).

If the cable needs additional stability where it crosses the EMEC cables a 1 tonne steel clump anchor may be attached to the cable post installation. A dive survey will be undertaken of this area to establish if this is needed.

I tonne steel clump weight

1.08m W x 0.84m D x 0.20m H

4.5.4 SR250 Construction, Delivery and Installation

Construction of the device is currently being undertaken by the Belfast ship builders Harland and Wolff Heavy Industries Ltd and is due to be completed early January 2011.

The SR250 will be launched via a dry dock which will be flooded and allow the watertight integrity of the hull and other seals to be checked in a controlled environment.

The completely assembled device will be towed by multicat from Harland and Wolff during a 2-3 week period in January/February 2011. Direct transportation is not anticipated to take longer than 8 days, but extra time is being allowed for sea-trials to be incorporated. Once the SR250 arrives in Orkney it will be moored at the quayside at Hatston pier (see Figure 1.1) and sea-trials continued prior to deployment at the test site in March 2011 (see Section 4.6.1).

Figure 4.14 SR250 Delivery

Once the device is ready to be tested at the test site, the multi-cat will tow the SR250 to the Fall Of Warness, and the turret retrieved and attached to the device.

When the SR250 is not at the site (see Section 4.6.1), the turret will be will be lowered to 10m below LAT (see Section 4.4.2 and Figure 4.8).and attached to a buoy which will act as a marker to notify its presence to other sea users and to allow for retrieval.

During all sites works the multi-cat will anchor off the mooring system anchor blocks.

4.6 SR250 Operation

4.6.1 Testing Plan and Routine Operation

Upon completion of the device construction, the launch will be followed by towing trials prior to first installation at the EMEC site. The testing of the SR250 device will be undertaken in a controlled and staged manner starting in March 2011 with an initial 2 year testing programme. The device will then be installed onsite at EMEC for numerous short-term test periods possibly 6 – 12 hours at a time, where possible during daylight hours. Initially the device will be connected to the mooring system at EMEC but NOT grid connected. These tests will involve the following steps:

- The SR250 will be towed to site using a multi-cat vessel.
- Arrival onsite will be timed to coincide with slack tide. The first connections will be timed for neap tides.
- The mooring connection procedure will involve retrieving a pick-up line from the onsite mooring turret, and bringing this slack line to the winch line on the device side. Once these lines are connected, the tow line from the multi-cat to the SR250 will be released and the onboard winch activated to pull the mooring system into place.
- Once the mooring connection is completed, the rotor legs will deployed and when all systems are checked, the rotor brakes will be released to begin generating power.
- For these tests the electrical energy will be dissipated to an onboard resistive load bank avoiding the extra complexities of a grid connection. Testing will continue for several hours with the support vessel onsite at all times and the operation will be monitored through onboard cameras and sensors. Marine wildlife monitoring will also take place during these tests both independenly by Scotrenewables and in participation with EMEC projects (see Section 9.3).
- The device will then be disconnected at slack tide by dropping the mooring turret and disconnecting the winch line. The device will then be towed back to harbour.
- These non grid-connected tests will be weather dependent, and could take place over two to three weeks, most likely during February 2011.

- Once satisfied that an efficient and safe connection and disconnection procedure has been achieved for the mooring system the SR250 will then be connected to the grid. The testing procedure for these tests will be as above but when the mooring turret is connected, a wet-mate electrical connector from the device will be connected to the umbilical termination in the turret. The cable will then be energised to connect to the grid and power generation from the rotors will be fed into the grid rather than into the onboard resistor.

The duration of test periods will gradually increase to the point where a continuous three-month grid connected deployment is achieved during 2012 (see Table 4.2). This represents a staged and risk minimised technical development plan led by the development of the technology.

All operations will be contained within the device test berth area.

4.6.2 Device Marking and Lighting

The marking and lighting of the device, given the low freeboard when floating on the surface, will be of particular importance. In addition, the device radar signature will be quite small, and even with a radar reflector fitted to one of the masts the navigation safety of other sea users has been raised by consultees as a cause for concern (see Section 2). The surface visibility of the device will change depending on the position that it is in whilst secured at the mooring berth. Whilst in use, the device will tilt and therefore alter the trim, and the amount of the visible hull that is in view on the surface. Figure 4.15 show the device's position in current flow with the legs down. The highest point above the sea water line is calculated to be 1.09m

5th scale model testing

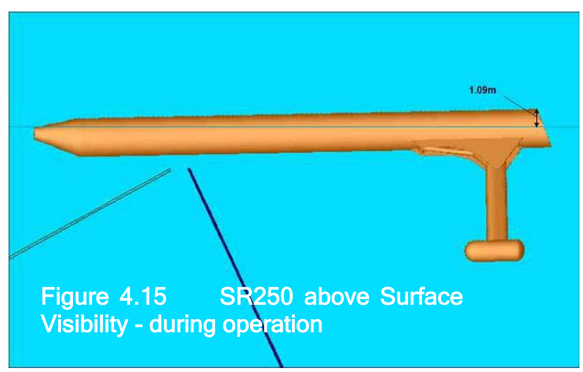


Figure 4.15 SR250 above Surface Visibility - during operation

Carmanah M650 Solar Lantern H170cm Ø 176cm

Echomax EM305 PE Radar Reflector H 68.5cm Ø 33.3cm

Following advice from the Northern Lighthouse Board during consultation, the SR250 will be predominantly yellow in colour and lit by 2 Carmanah M650 self contained solar lantern yellow lights (positioned as shown in Figure 4.13) flashing once every five seconds (Fl Y 5s) with a nominal range of 2 nautical miles. These lights will be mounted 1.5 metres above the waterline on the antenna mast (see Figure 4.13 b). Additionally, the Echomax EM305 FPMS yellow PE radar reflector will be fitted to the device at a similar elevation to increase the conspicuity of the device on marine radar. The EM305 has a maximum Radar Cross-section (RCS) of $62m^2$ and an average RCS+/- 3° at $10m^2$.

The site will be marked in accordance with Northern Lighthouse Board (NLB) recommendations (see Appendices 2 and 3) in compliance with IALA 0139. NLB will give their formal recommendation for lighting and marking through the Coast Protection Act 1949 – Section 34 consultation process. At this point the decision will be made whether the 4 anchor points will be marked with a buoy, and the size of buoys including the turret pick-up buoy and whether they need to be lit.

All surface buoys will be non-damaging to vessels and Notices to Mariners will be issued prior to their establishment.

4.6.3 Communication System

The communications system will consist of:

- *Radio Frequency Link* - will control emergency shutdown system, main start-up procedure;
- *Wireless LAN* - will be used for control and data communication/video monitoring, when the umbilical is not connected (towing to site, tow testing) and as a backup to the hard-wired communication link;

- *Long Distance Ethernet* - will be used for control and data communication/video monitoring, when the umbilical is connected; and
- *GSM Mobile Communication* - the independent alarm system uses mobile phone communications from a standalone transmitter/receiver based on the device. This will send alarms to highlight emergency situations (bilge, fire etc).

When the umbilical is connected to the device the data will pass down the umbilical and connect to onshore Scotrenewables communications equipment where the data may be stored or communicated over the EMEC internet connection located in the data rack in the EMEC facility.

The SCADA system has the facility to set up user configurable alarms that can be transmitted by email, automated phone call or text message to a dedicated duty holder's mobile. All parameters of the system can be monitored through the SCADA system and limits or ranges can be setup and alarms can be generated if the parameter goes outside this limit or range. E.g. we can setup operational parameters (temperature, oil levels and pressures, etc) that if the values go out with normal ranges it raises an alarm at the SCADA monitor, we can setup additional parameters like bilge alarms or fire detection alarms that display alarms on the SCADA system and additionally sends an alarm to the Scotrenewables Duty Manager's mobile.

There will be a separate alarm system that will be independent of the SCADA/communication system which will send a text messages or call multiple mobile numbers on detection of water ingress or smoke/fire.

A stationing verification system will allow the device to be monitored with control system alerts to the dedicated duty manager. Through the use of a GPS system, this function will observe the movement of the device and provide an alert if the system strays from the predefined operational area.

4.6.4 Routine Maintenance

Due to the floating nature of the device and its low mass, it will be possible to tow the device to Hatston to undertake all maintenance activities. Once in the harbour, the device will stay in the water. All maintenance activities involving lubricants or fuel will be undertaken in compliance with SEPA Pollution Prevention Guidelines (see Section 9.2). The rotors and nacelles have been designed to require minimal diver intervention. If, however, any maintenance be needed where the rotors and nacelles have to be removed divers and a crane will be deployed to release the components and lift them clear. During this operation the stability of the device will need to be monitored and may be controlled using additional buoyancy units. Any onshore maintenance activities will either be carried out on the quayside or at the Orkney Energy Gateway building (due to be completed Spring 2010) located a short distance from the pier where Scotrenewables have their office and workshop facility (see Figure 4.16).

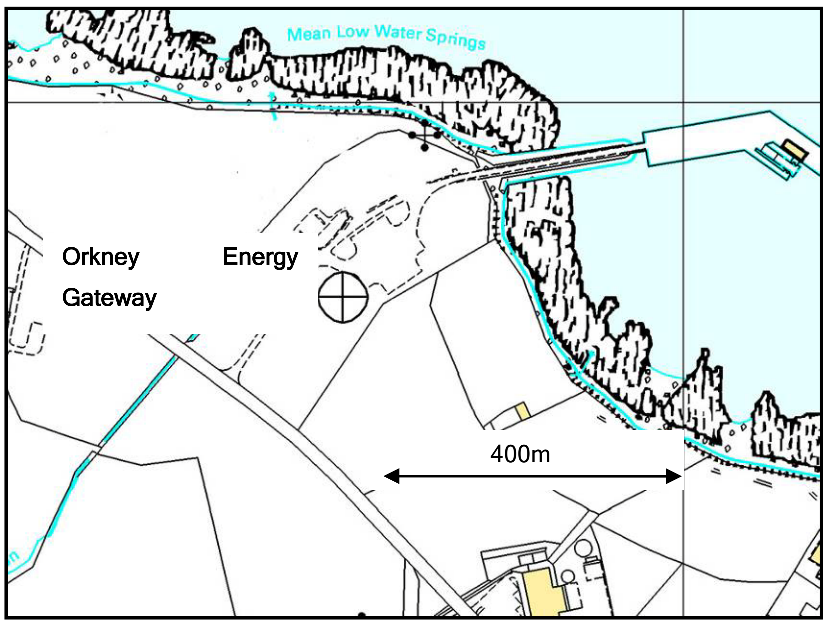


Figure 4.16 Location of Onshore Maintenance Facilities

Within the planned two-year test programme there will not be a need for extensive routine maintenance as the design life of the majority of components will be at least 5 years. Also as the device is a prototype it will have a low duty cycle, probably 20 – 30% throughout the test period. This will mean that seals, bearings, oil filters should not need to be maintained or replaced during the test programme. Maintenance activities that may be undertaken are outlined below:

Harbour-side – device in the water

- Internal equipment checks (monthly) - Personnel enter the hull through top access hatch to check condition of internal equipment such as variable speed drives, instrumentation and control equipment, pumps, cameras etc.;
- External camera checks (monthly) including cleaning of perspex covers if required;
- Any activities involving inspection of HV equipment will require the equipment to be electrically isolated prior to inspection;
- Purging of cooling water system as required (annually) - involves filtering or replacing the freshwater used in the cooling system;
- Diesel generator fuel top-up /oil change (monthly);
- Cleaning of the hull with underwater pressure wash by divers (possibly twice annually); and
- Corrosion protection measures - replacement of sacrificial anodes; touch-up of paintwork in splash zone as required (twice annually).

Harbour-side - nacelles / complete device out of the water (not expected to be required during the test programme but may occur)

- Removal of generators / gearboxes from nacelles for repair / replacement of oil / filters / bearings; and
- Touch-up of paintwork on underside of hull / legs / nacelles.

All external bearings will be composite type and will not require greasing.

Seabed maintenance

No requirement for seabed maintenance is anticipated (see Section 5.2.2) however should routine monitoring of the mooring system reveal significant scouring has occurred appropriate mitigative action will be taken.

Waste disposal

Any waste generated either onshore or offshore will be disposed of onshore in the appropriate manner in compliance with current legislation.

4.6.5 Work Boats

Scotrenewables will use a Multi-cat type work vessel for all installation, towing and maintenance operations. Multicat type vessels are relatively small but very powerful workboat tugs that typically have large deck areas, high capacity hydraulic cranes and large winches. It is anticipated that a vessel 26m long, weighing 515 tonnes, with a 2.5m draft will be utilised. The vessel used will comply with the MCA Code of Practice for the Safety of Small Workboats & Pilot Boats (MCA 2010a) and the MCA Small Commercial Vessel and Pilot Boat Code of Practice (MCA 2010b). A noise level of 65dB(A) will not be exceeded.

Typical multi-cat vessel


Scotrenewables rib - 5th scale device testing

In addition it is likely the Scotrenewables inflatable rib will be used during routine operations.

Although the majority of activities associated with the proposed programme of works will take place between Hatston pier and the test site, very occasionally the work boats may have to berth for short periods at Eday or Loth (Sanday) piers (see Figure 1.1 and Section 5.3).

4.6.6 Monitoring

Device Monitoring

During the operation phase, the vast majority of the 24 hour monitoring will be conducted remotely via equipment installed on the device and ethernet/WIFI connection. Internally there will be up to 10 fixed cameras and externally 2 pan/tilt/zoom cameras, one on the top and one underneath near the turret which will provide continuous monitoring of rotor performance.

Scotrenewables may consider deploying an ROV to inspect the moorings and the device at some stage throughout the test period. There may also be instances where Scotrenewables wish to conduct other subsea surveys i.e. taking underwater video footage of the device. In the event of fault detection, the surveillance system will alert the Scotrenewables Duty Manager to the fault which will then execute the emergency procedure (see Sections 4.6.3).

SR250 Energy Generating Performance

The Scotrenewables Tidal Turbine has been extensively tested from 1/40th scale, to 1/20th, and 1/7th scale in wave & current flumes and towing tanks for power generation capability. A 1/5th scale 4kW model has been on trial in the open sea in Orkney since May 2009. This model has successfully achieved its target power coefficient of approximately 35% (SR250 equivalent at full-scale).

A power curve for the proposed SR250 device is shown in Figure 4.17 below. This has been derived using real data from 1/5th scale testing, using the achieved 35% power coefficient and multiplying by the scaled up SR250 design parameters of 8m rotor diameter and 2.5m/s rated tidal current speed. Actual test results from 1/5th Scale prototype showing power generation (without optimization) scaled up to equivalent SR250 prototype is shown in Figure 4.18.

As a floating technology which is always subject to the strongest tides at the sea surface, the device has a big advantage over seabed devices which see lower speeds due to current shear. Up to 50% less energy is available to seabed mounted devices due to this physical effect.

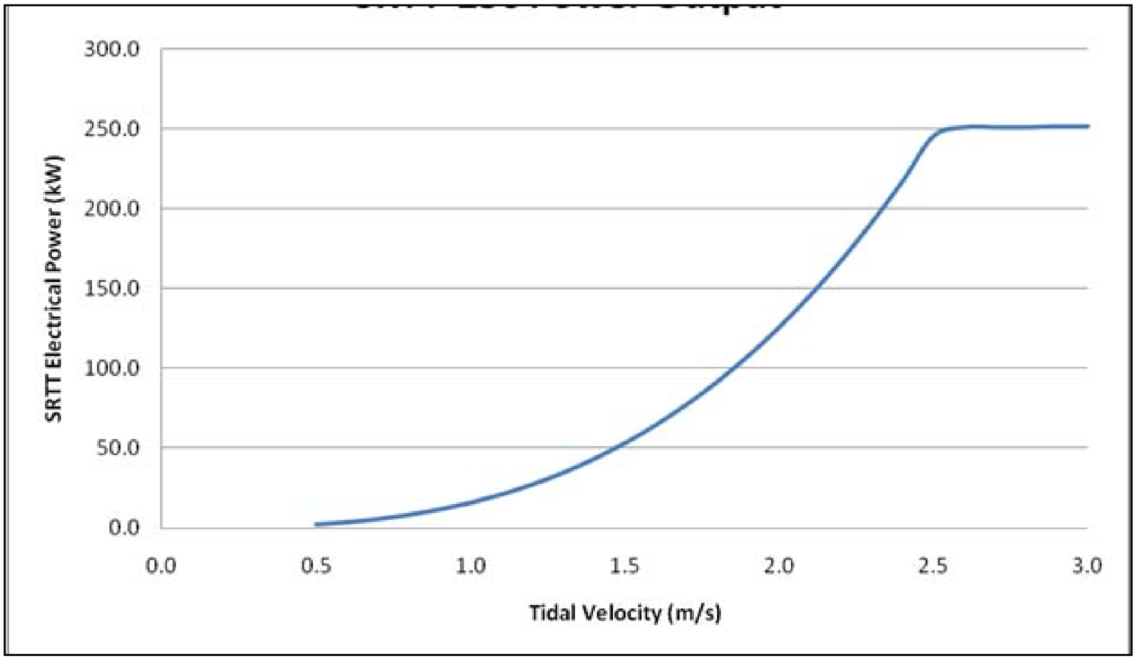


Figure 4.17 SR250 Power Curve

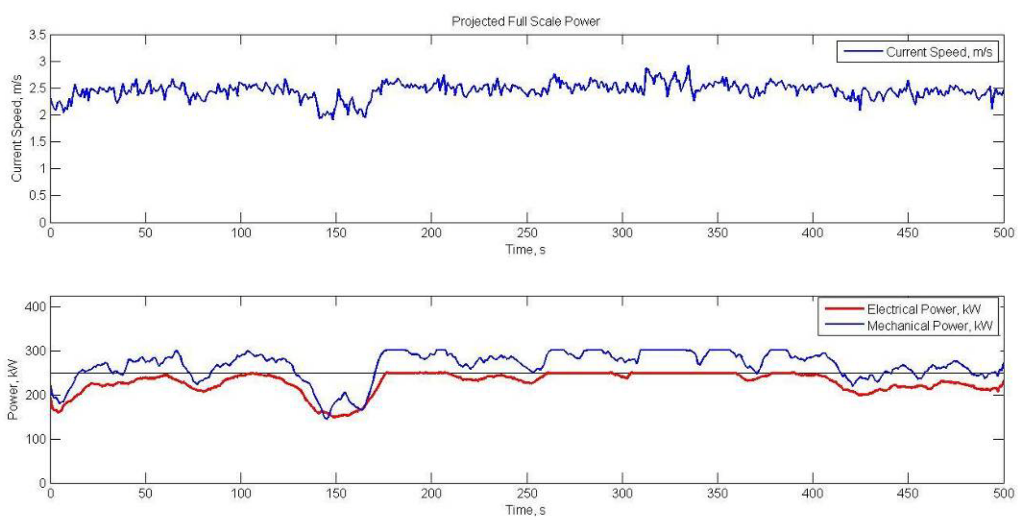


Figure 4.18 Actual Test Results from 1/5th Scale Prototype Showing Power Generation (without optimisation) Scaled up to Equivalent SR250 Prototype

The SR250 does encounter waves which can effect power generation but scale model testing suggests that overall energy loss due to wave effect will be limited. The low response to wave induced motion during power generation is a unique feature of the SR250 (see Figure 4.19).

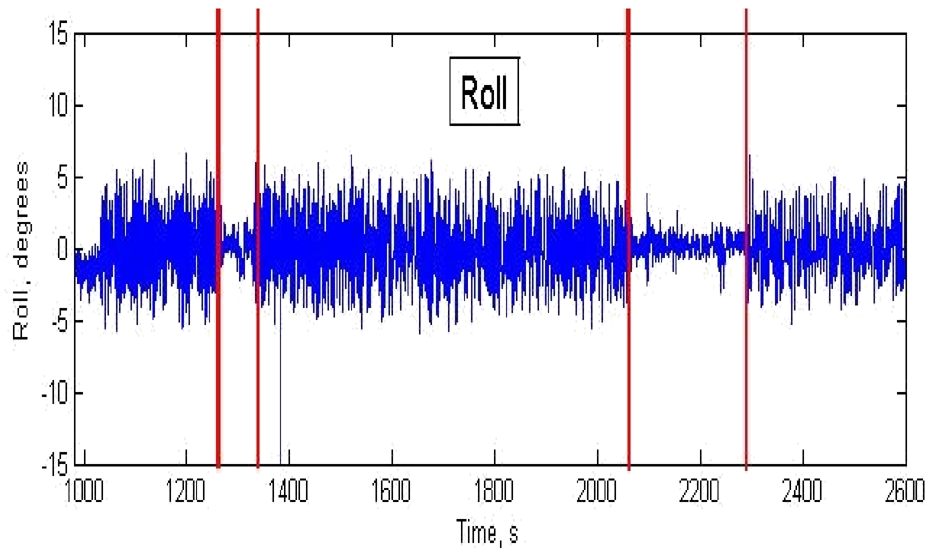


Figure 4.19 Actual Test Results From 1/5th Scale Prototype Showing Power Extraction Between Red Lines and Subsequent Reduction in Roll

The performance target for the proposed SR250 device will be to achieve the same 35% power coefficient at 2.5m/s rated speed. The energy generation target for the SR250 device will be to achieve a minimum a continuous three-month period of operation equivalent to approximately 165MWh.

Environmental Monitoring

Environmental observation work has been undertaken for the 5th scale testing and this will continue with the full scale prototype. This is however a very high level assessment and Scotrenewables will agree a more comprehensive monitoring strategy with Marine Scotland in consultation with SNH and EMEC prior to the start of project activities in order to be able to take advantage of the latest guidelines and technology available (see Sections 7.1 and 9.3).

4.6.7 Electromagnetic Emissions

The two main sources of electromagnetic radiation will be:

1. The generator cables which run from the nacelles up to the main tube and feed Variable Speed Drives (VSDs) in the main tub; and
2. The HV subsea cable running to the shore connection.

The fields created by these cables can have a detrimental effect on sensitive instrumentation electronics located around the device. Because of this, great steps are taken to limit the electromagnetic field created by these. Steps include using specialised cable with conductors arranged in a trefoil and earthed overall screens to minimise stray electromagnetic fields. In addition the proposed HV cables are protected by a 2 layer steel wired armour which protects from any electromagnetic and electric fields which may be emitted, and locating cables in steel conduit where possible.

4.6.8 Noise Generation

Use of work boats

Scotrenewables will use a multi-cat type work vessel for all installation, towing and maintenance operations. The vessel used will comply with the MCA Code of Practice for the Safety of Small Workboats & Pilot Boats which states that noise levels of 65dB(A) will not be exceeded (MCA 2010). An assessment of the noise generated by the work-boats is undertaken in Section 7.1.2.

Device operation

Due to the novel nature of the device it is not possible to predict with any degree of accuracy either the frequency or amplitude of any noise generated. The moving parts of the device that will generate some noise are (see Figure 4.12):

- Rotors;
- Generators;
- Diesel generator;
- Hydraulics including the turret and leg mechanisms; and
- Gearboxes.

Post operational noise studies will be undertaken to inform future deployments (see Section 7.1).

4.6.9 Integration with EMEC Systems

Scotrenewables is familiar with the EMEC Integrated quality, health, safety and environmental management system (IMS) and will work closely with EMEC to ensure their activities are fully compliant with this system.

4.7 Decommissioning

As the device is a floating structure and non-piled gravity anchors are intended for use in the mooring system, the decommissioning process is expected to be relatively straightforward. A suitably sized multicat work vessel (see section 4.6.5) will be contracted to carry out the operational aspects of the decommissioning plan. All operations will be contained with 50m of the device test berth area, with the exception of the removal of the sub-sea cable.

Once the testing activities of the SR250 have been completed all materials will be completely removed from the tidal test site. It is considered unlikely that seabed reinstatement will be required due to the nature of the seabed (see Section 5.2.2) and limited movement of the mooring system (see Section 4.4.2 and Fig 4.11). As far as is possible operational activities will be conducted in safe weather and swell conditions and will be timed to begin at or before slack tide.

Prior to starting installation activities Scotrenewables are required to prepare a Decommissioning Programme under Section 105 of the Energy Act 2004 for the submission to the Secretary of State. As part of this process consultation is required with a number of bodies specified by DECC. A separate report has been prepared for this purpose and the responses received will inform the final report. The consultation report will be supplied direct to consultees, and be available to view electronically on the EMEC website and as a hard copy at the EMEC offices in Stromness.

5 Environment Description

EMEC have undertaken a comprehensive Environment Description for the Fall of Warness (EMEC 2009). This section provides a summary of this information with the addition of site specific data provided by Scotrenewables.

5.1 Physical Environment

5.1.1 Location

The Fall of Warness, where the EMEC tidal test facility is located, lies between the southwest coast of Eday and the islands of Muckle Green Holm and Little Green Holm. The onshore facility is sited adjacent to Cauldale on the west coast of Eday.

5.1.2 Geomorphology

The bedrock is exposed throughout the majority of the Fall of Warness test bay area, with occasional boulders, but is swept of any bed load transport as there is little mobile material available (Wallingford, 2005). To the north and east of the deep basin there are some deposits up to 11m thick of boulders, cobbles, gravel and interstitial shelly sand, presumed to be glacial till deposits with a reworked surface layer. Dive and Remotely Operated Vehicle (ROV) surveys show these rocks to be well covered with flora and fauna, indicating long-term stability and minimal transport of sand or gravel. Close to shore there are sand deposits within the gullies formed by the rock ridges.

5.1.3 Bathymetry

The chart depth readings decrease steadily from 1m to between 34-52m where the tidal test devices are being deployed. The proposed Scotrenewables test site is at a depth 35m (LAT).

5.1.4 Hydrodynamics

<u>Tidal Currents</u>

The tides around Orkney are the result of the interaction of two independent tidal systems in the North Sea and the North Atlantic. The tidal waves of both systems have anti-clockwise rotations and they both reach Orkney's coastline with similar strengths, but moving in opposition. The northward Atlantic wave peak arrives roughly 2-3 hours earlier than the southward travelling North Sea wave, producing a net flow of water from east to west and complex interactions among the island sounds.

Admiralty chart data indicates that the typical maximum strengths of the tidal streams through the Fall of Warness channel on the spring tides are 7.2kn (3.70m/s) on the SE going stream and 6.5kn (3.34m/s) on the NW-going stream. For the neap tides the typical strengths are in the order of 2.8kn (1.44m/s) and 2.5kn (1.29m/s) respectively (Royal Haskoning 2006). At the SR250 test site to maximum sea surface current is 2.5m/s. A few metres above the seabed the currents will be weaker, a maximum of 1.5m/s at the test site (35m contour) decreasing along the cable route to 0.7m/s between the 30 and 20m contour lines, and then down to just 0.3m/s from the 5m contour line to the shore. The area is affected by tidal surges, with the 50 year return period surge level given as about 1.35m.

Waves

The test facility area is directly exposed to wind and sea swell from the northwest and the southeast due to the orientation of the channel. Waves from other directions can reach the area due to diffraction and refraction, making the area very dynamic. Overfalls are not common in the test site area but do occur in teh vicinity eg at the southern tip of Eday. The landfall area is much more protected than the Fall area. Shelter from the westerly sector is provided by the intertidal rock out crop at Seal Skerry, but wind, sea and swell can still reach the nearshore from Stronsay Firth and beyond. Locally generated waves from the south are also significant (HR Wallingford 2005). The mean significant wave height in the months of December-March is 2.5-3m in the surrounding waters of Orkney. Wave heights in these waters are similar throughout the year, with 2-2.5m in April and September-November, and 1.5-2m in May-August (British Oceanographic Data Centre 1998 in Aurora 2005).

Metocean data for proposed Scotrenewables site

The proposed Scotrenewables test site will have more protection from exposure to prevailing wind and wave conditions than sites in the centre of the Fall of Warness.

Detailed data for the precise SR250 location was obtained from a wave-current interaction study at the Fall of Warness completed by DHI for EMEC, which has been validated against onsite recorded wave and current data. The data is from 2005 and was provided at 20 minute intervals. It is understood that 2005 was a worse than average year in terms of weather.

Summary plots of this data are presented in Figure 5.1 and Figure 5.2 In terms of wave heights, the average significant wave height in 2005 was in the range 0.5-1m, within only a 0.3% exceedence of 3m. The average maximum wave height was between 1-2m with approximately 1% exceedence of 5m. The average peak wave period in 2005 was just over 6 seconds, corresponding to a wave length of approximately 60m. The peak wave direction was NW. Predominantly current directions are NW and SE although the speeds at the SR250 location are much lower than further west within the channel, typically between 0-2 knots.

5.1.5 Meteorology

Wind

The Orkney Islands are subject to a high frequency of gales (>34knots / 17m/s) from the southwest to west, and strong winds (>18knots / 9m/s) from the west-southwest and southeast, particularly from October to March.

Visibility and daylight hours

On the longest day, there are approximately 18 hours of daylight and proper darkness is absent; on the shortest day only 6 hours of daylight is experienced (MET office, unpublished). Damp sea fog (Haar) can occur all year round, but is more frequent in the warmer summer and early autumn months when the winds are less forceful. The eastern coasts of Orkney are more prone to fog than the west, again this can be attributed to wind direction and strength.

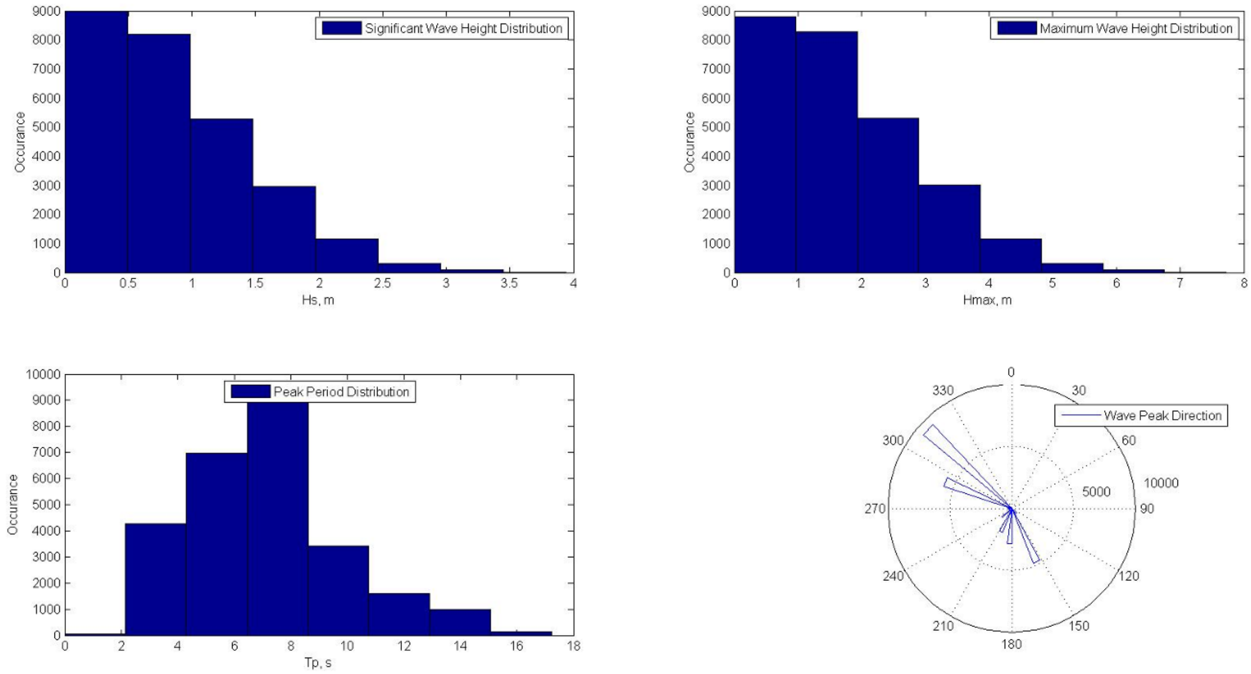


Figure 5.1 Wave Data for SR250 Site (2005)

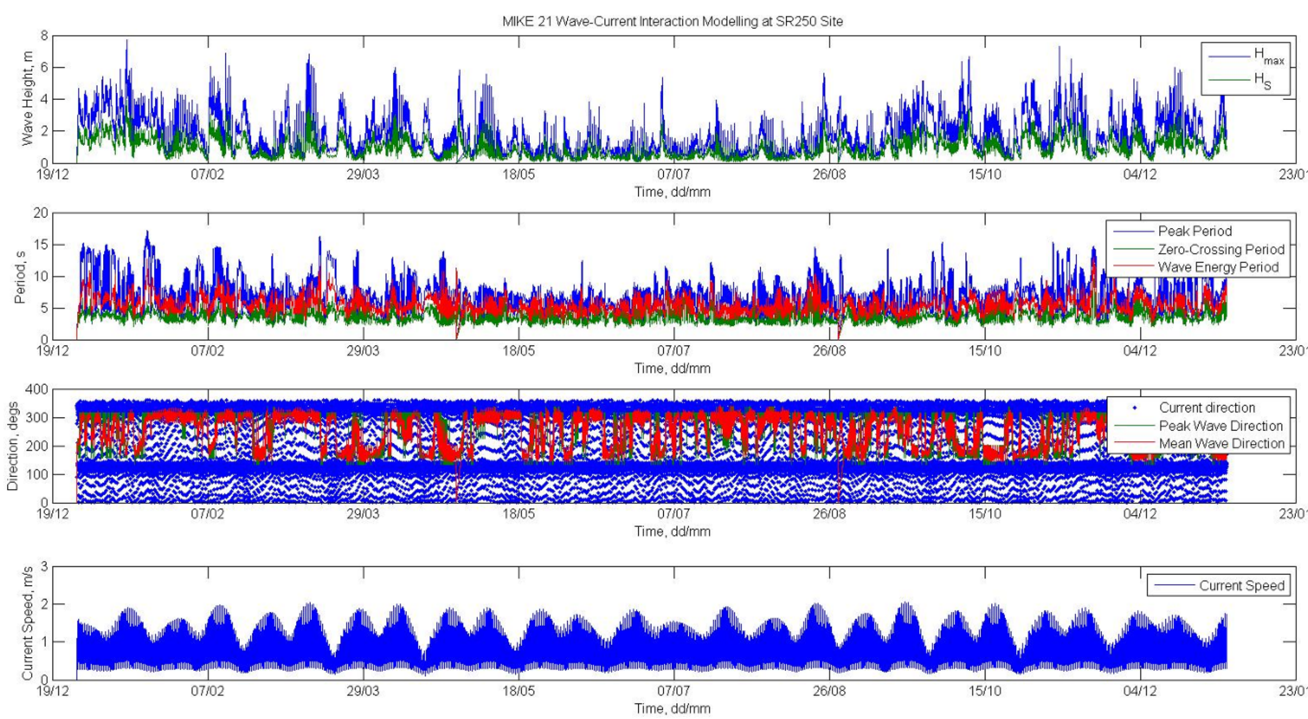


Figure 5.2 Wave and Current Data for SR250 Site (2005)

5.2 Biological Environment

5.2.1 Seabed Surveys and Assessment

Seabed surveys undertaken in 2005 identified the sub-littoral areas at the Fall of Warness as sparsely inhabited with no species of conservation value (Aurora, 2005). In 2010 diver and ROV (Remotely Operated Vehicle) surveys of the Fall of Warness area were undertaken on behalf of Scotrenewables by Sula Diving and Roving Eye Enterprises between July and August 2010. The purpose was to collect video footage of the seabed both along the potential cable route and in the vicinity of the proposed installation site for the SR250 and associated mooring system prior to the commencement of development activities at the site (see Figure 5.3). The output from these surveys was assessed by Aquatera Ltd whose report, which can be found in full in Appendix 8, gives an indication of the seabed habitats and topography present in the area.

<u>Cable Route - Dive/ROV Survey Results</u>

The potential cable route bisects a range of different habitat types ranging from near-shore macrophyte dominated communities to the hard, rocky seabed habitats encountered in the tidal swept deployment areas. The near-shore/shallow water (<20m) environment is dominated by kelp forests that support a relatively diverse community of fauna, including many species of crustacea, molluscs and fish. The seabed communities observed further offshore in deeper water (>20 m) are more typical of the offshore deployment sites and dominated by encrusting invertebrates (see Figure 5.4). Some fragments of maerl were found in this zone at around 25m water depth, but they appeared to be dead and were probably swept in by tides from elsewhere.

<u>Installation Site – Dive/ROV Survey results</u>

The site is located in a water depth of approximately 35m within a tidal-swept inter-island trough. The seabed is mainly hard and rocky with pebbles, cobbles and boulders interspersed with patches of coarse shelly sand. The faunal community recorded in the vicinity is typical of such habitats in Orkney waters and is dominated by sponges, anemones, bryozoans, encrusting invertebrates and associated species such as urchins and starfish.

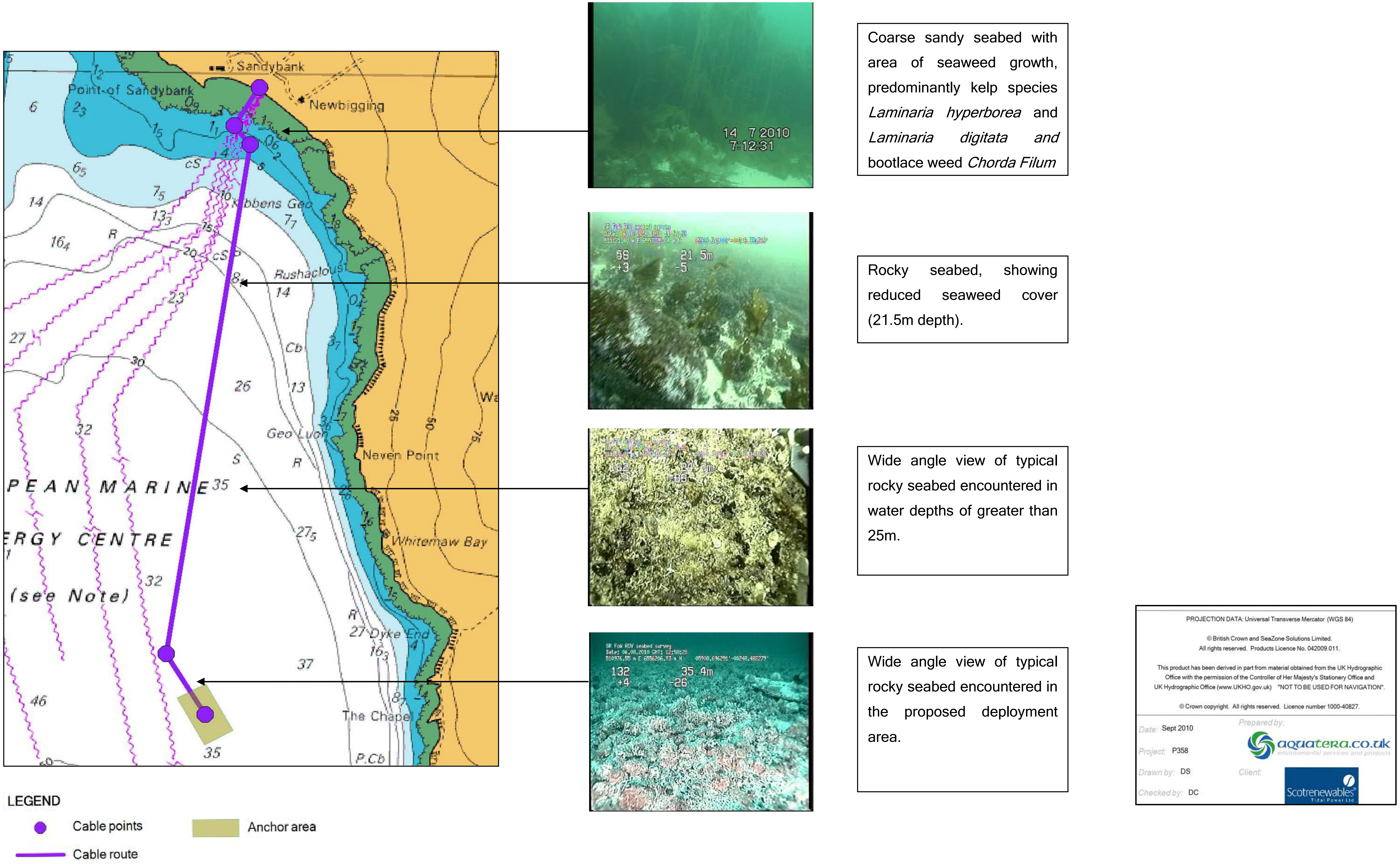


Figure 5.3 Typical Species and Habitat Along Cable Route and at Deployment Site

Overall, the footage collected during the survey operations indicates the presence of a range of habitats and communities typical of the Fall of Warness area and other such sites around Orkney. No particularly sensitive species or communities were recorded in the vicinity of the planned deployment areas or cable route. The fragments of maerl that were encountered are not numerous enough to constitute a maerl bed and may have been swept in from adjacent areas.

5.2.2 Plankton

The zooplankton in this region are composed of neritic (coastal water) and intermediate (mixed water) species. The spring increase of phytoplankton (mainly diatoms) begins in March and peaks between April and May. This is followed by a decline in June to steady levels until another peak in September, with the dominant species present including barnacle larvae.

5.2.3 Fish and Shellfish

Finfish

Fish fauna studies are poorly represented for this part of Orkney, however general statements can be made considering the exposed locality and bedrock conditions. Fish species likely to be found include mackerel (Scromber scrombus) herring (Cluepa harengus) during the summer and autumn periods. Other fish species without defined spawning grounds, but widely distributed in the waters around Orkney, include haddock (Melanogrammus aeglefinus), ling (Molva molva), saithe (Pollachius limanda) and cod (Gadus morhua). Flat fish species such as plaice (Pleuronectes platessa) and dab (Limanda limanda) occur on sandy areas of the seabed, such as the cable landfall site, with juveniles living in nursery areas close inshore. In addition to the commercially important fish species, the inshore waters of Eday are also likely to support populations of smaller fish species that provide a food source for birds and mammals present in the area.

Shellfish

The nature of the seabed in the vicinity of the Fall of Warness creates a habitat for Lobster (Homarus gammarus), edible crab (Cancer pagurus) and velvet crab (Necora puber). Scallops (Pecten maximus) and queen scallops (Aequipecten opercularis) live on sandy/gravelly areas in the Fall of Warness.

<u>Basking shark</u>

Basking sharks (Cetorhinus maximus) are a coastal-pelagic species found in arctic to warm temperate waters of the continental and insular shelves. Commonly observed at or near the surface both far offshore and close to land during summer months basking sharks are very rarely seen during the winter. Basking sharks have been observed using the Fall of Warness. Basking sharks have full protection from international capture or disturbance in British waters (up to 12miles off shore) under a 1998 listing on Schedule 5 of the Wildlife and Countryside Act (1981). They are also listed under CITES Appendix III in UK waters.

5.2.4 Birds and Shore Birds

The coastline between the east end of the Bay of Greentoft and the west end of Sealskerry Bay provides shelter, nesting and feeding sites for a variety of bird species (See Appendix 5). The birds most likely to be directly affected by project activities are the diving birds - in particular the cormorants (Phalacrocorax carbo). Cormorants are known to dive to up to 9 m below the sea surface when feeding. They are protected under the general provisions of the Wildlife and Countryside Act, 1981, and are listed as a local priority species due to declining numbers. Aerial surveys carried out between 1985 and 2000 show a decline in cormorant numbers of approximately 30% (1985 at 570, 1995 at 491, and 2000 at 412) (Pers comm., Eric Meek). Due to the proximity (2km) of the breeding colony on Little Green Holm to the SR250 site these species are potentially at risk particularly during feeding.

The potential for tidal stream devices to displace marine mammals and birds from their habitual waters was recognised as a subject of concern and EMEC has developed and established a programme of wildlife observations at the test site from which it will be possible to assess effects of devices being tested. The land-based surveys over the Fall of Warness have been carried out on behalf of EMEC from the 11th July 2005. The observational programme and methodology were produced with significant input from the Sea Mammal Research Unit (SMRU) at St Andrews University (Duck, 2006). The first three year’s data (to 2008) have been analysed and a report produced by SMRU and DMP. Table 5.1 below details the species recorded in the latest report produced.

However, it should be noted that these figures only give an indication of abundance. The latest DMP Statistical Solutions UK report makes it clear that absolute abundance cannot be derived from the data available for reasons including:

- The possibility of repeatedly counting the same individuals through time; and
- The apparent relationship between the distance from the observer and the observed abundance i.e. predicated bird abundance is higher near land.

Birds	Frequency		Birds	Frequency
arctic tern	68		little auk	6
black guillemot	7911		long tailed duck	551
common guillemot	2489		phalacrocorax	3306
common scoter	1		puffin	1874
cormorant	2891		razorbill	269
diver	34		red breasted merganser	242
eider	3568		red throated diver	1502
gannet	2651		shag	5899
goldeneye	46		slavonian grebe	6
great northern diver	573		unknown bird	35
kittiwake	38			

Table 5.1 Bird species recorded during 2007/8 survey period (DMP 2009)

5.2.5 Marine Mammals

<u>Otters</u>

The otter is well distributed and fairly common in Orkney on both the coastal and inland waters. The most recent otter survey undertaken in February 2010 concluded that there was a healthy population of otters in the area of the onshore facility and route of the inshore section of the new Scotrenewables cable. Otters will regularly use the inshore waters from Warness to Sealskerry bay for feeding, normally between dawn and dusk, out to a depth of 10m (Aurora 2005). The Eurasian otter (Lutra lutra) is listed on Appendix 1 of CITES, Appendix II of the Bern Convention and Annexes II and IV of the Habitats Directive. It is protected under schedule five of the Wildlife and Countryside Act (1981) and Schedule 2 of the Conservation Regulations (1994) (Regulation 38).

Seals

Apart from exposed, steep, west-facing shores, harbour/common and grey seals can be found distributed throughout Orkney and can be seen at all times of the year. During their breeding season, mothers with young pups are susceptible to disturbance. Pups abandoned or separated from their mothers may suffer increased mortality rate and prolonged disturbance can lead to the abandonment of haul-out sites (Renouf et al. 1981).

Grey seals range considerably further than harbour seals, which appear to be more faithful to particular haulout sites (Thompson & Miller, 1990). The closest harbour seal haulout sites to the test facility, from the most recent breeding and moulting surveys, are: Seal Skerry; along the south-west coast of Eday; just east of The Graand on Eday's south coast and on Muckle and Little Green Holm. The survey indicated that a small number of single adult males were present along the south west coast of Eday (Aurora, 2005). The presence of these males close to a haulout with a large number of pups strongly suggests that the sea around the Fall of Warness is used as an underwater display area for harbour seals. Male harbour seals have underwater display sites where they maintain station, possibly in an underwater territory, and are thought to attract females by a series of complex underwater vocalisations (Van Parijs et al., 2000). The females mate approximately four weeks after giving birth to their pups (Thompson, 1988, Thompson & Miller, 1994). Thus the important time when males are attracting females in oestrus will fall between mid June and the end of July, and this is followed by the moulting period in late July and early August.

The grey seal breeding season begins in early October in the northern Scottish islands and attracts large numbers through to late November. The moulting period follows in January to March (females), and March to May (males). Muckle Green Holm and Little Green Holm also act as a haul-out area during the summer for grey seals, as does Seal Skerry but to a lesser extent. Grey seal pups begin their offshore life independently and are notoriously inquisitive, so it is possible they may be attracted by moving objects in the water column.

Both grey and harbour (common) seals are protected under European legislation and are listed in Annex II of the European Habitat Directive. They are also protected under the

Conservation (Natural Habitats, etc.) Regulations (1994) and the Conservation of Seals Act 1970. The islands of Muckle Green Holm and Little Green Holm are designated SSSI sites, contributing around 3% of UK annual pup production (SMRU, 2005). The islands of Faray and Holm of Faray also have national protection from SSSI designation. In addition, the inshore waters surrounding Faray and the Holm of Faray, have been designated as a marine Special Area of Conservation (SAC). Both designations are due to the grey seal population found there, which is the second largest breeding colony in the UK, contributing to around 9% of UK annual pup production.

To the east of Eday lies the island of Sanday where the inshore waters have also been designated as a marine SAC. The area supports the largest group of common seal at any discrete site in Scotland. The breeding group represents over 4% of the UK population and the nearshore kelp beds are important foraging grounds for the seals. From their European Protected status, these islands were included despite being some distance from the proposed tidal test site.

The most recent survey data on the status on seal populations in Scotland and Orkney detailed in the Special Committee on Seals (SCOS) Report for 2008 shows that:

- Scotland has more grey seals than previously estimated but that harbour seals are still in decline;
- It is now estimated that there are around 164,000 grey seals in Scotland, more than previous reports suggested and 90 % of the estimated UK mean population. Analysis of grey seal pup production in 2007, which is the basis for all population modelling, indicates the underlying population trend is stable or increasing slowly;
- There are a minimum of 20,000 harbour seals in Scotland, based on seals found ashore during the surveys. The localised decline in the Northern Isles is continuing and seal numbers have now declined by between 40% and 50% since 2000 in Orkney; and
- The main causes of these local reductions are unclear at present but predation by killer whales in the Northern Isles and competition for food supplies with larger, more abundant grey seals could be significant factors (SCOS 2008).

In the survey commissioned by SNH of harbour seals around Orkney in 2008 (Callan Duck 2010) the following was shown:

- In Orkney in 2008, 2867 harbour seals were counted compared with 3371 in 2007 and 4256 in 2006 (a decline of 33% between 2006 and 2008); and
- Initial analysis of digital still photographs taken during the 2007 and 2008 surveys indicated that grey seals were frequently interspersed in groups of harbour seals and that numbers of harbour seals were overestimated.

Table 5.2 below shows the numbers of seals counted in the Orkney sub-regions in the immediate vicinity of the proposed development during the 2001 – 2008 surveys.

	Harbour seals				Grey seals			
Orkney sub-region	**2001**	**2006**	**2007**	**2008**	**2001**	**2006**	**2007**	**2008**
Eday & Calf	184	59	66	65	132	70	255	230
Muckle & Little Greenholms	2	49	30	15	67	21	95	23
Faray, Fara, Holm, Rusk Holm	14	10	9	1	520	529	486	506
Sanday *(East Sanday SAC)*	1247 *(1152)*	519 *(479)*	470 *(435)*	312 *(260)*	88 *(88)*	462 *(395)*	646 *(625)*	452 *(421)*
Total Orkney population	**8523**	**4256**	**3379**	**2867**	**2913**	**9579**	**7109**	**8012**

NB Surveys carried out during the harbour seal annual moult using a thermal imaging camera.

Table 5.2 Seals Counted During August Surveys (Source: Callan Duck 2010)

The Potential Biological Removal (PBR) for harbour seal numbers in the Northern Isles metapopulation (SMRU 2008) was calculated from 2007 counts as 23 individuals. This figure has been revised and now the PBR stands at 13 individuals for the whole of the North Isles of Orkney. This was based on the last complete count (2008) and this is to cover all unnatural deaths of adult harbour seals (Ruth DeSilva, SNH pers comm.). The PBR for grey seal numbers in the Northern Isles metapopulation (SMRU 2008) was calculated from 2007 counts as 885 individuals, a much healthier figure than that for the common seal.

Cetaceans

The harbour porpoise is the most commonly observed cetacean in Orkney waters, although in relatively small numbers. There are records of occurrence throughout the year, but the majority of sightings are from April to September. It has been suggested that this species moves offshore during the winter, with consistently fewer sightings. The numbers of individuals reported are usually between one and five, although groups of up to 17 have been observed. Harbour porpoises use the area for passage between Westray and Stronsay Firths for feeding on shoaling fish such as sand-eels and sprats (Booth 2005, unpublished data).

Killer whales (Orcinus orca) have been recorded between March and August, especially over the last five years. These animals were probably in transit and are associated with attacks on common seals at haulout sites to the east of Egilsay and Papa Westray. There have been occasional sightings of minke whales and pilot whales (Globicephala melas). There has also been a live stranding of a pilot whale near Ferness Bay. Unidentified dolphins (possibly white beaked and Risso's (Grampus griseus) dolphins) have also been reported on several occasions between May and August (Booth 2005, unpublished data). During the EMEC wildlife observations July2005-6, harbour porpoises (Phocoena phocoena), minke whales (Balaenoptera acutorostrata), white beaked dolphins (Lagenorhynchus albirostris), killer whale (Orcinus orca), and risso's dolphin (Grampus griseus) were all recorded. All species of dolphins, porpoises and whales are listed in Annex II of CITES, Appendix II of the Bern Convention Annex, and in Appendix IV of the European Habitats Directive as species of interest and in need of strict protection. They are also protected under Schedule 5 of the Wildlife and Countryside Act, 1981. The harbour porpoise is covered by the terms of ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas). It is thought that sound from anthropogenic sources can interfere with echolocation and masks intra-species communication (Whale and Dolphin Conservation Society, 2004).

5.2.6 Conservation

Details of the conservation and protected sites on Eday are provided in Figure 5.4. The main areas highlighted are the islands of Faray, Holm of Faray, Muckle Green Holm and Little Green Holm. These are all sites with important colonies of grey and/or common seals that are afforded statutory protection at national and European level. Little Green

Holm is also considered of local conservation importance due to the colony of cormorants. A survey of the area (Dargie 1998) concluded that the conservation interest of the site is low to moderate. However, more recent evidence suggests that there has been a decline in cormorant numbers (see Section 5.2.5). In addition to the sites detailed in Figure 5.5 is the island of Sanday where much of the surrounding inshore waters have been designated as a Special Area of Conservation for harbour seal, intertidal mudflats and sandflats, reefs, and subtidal sandbanks.

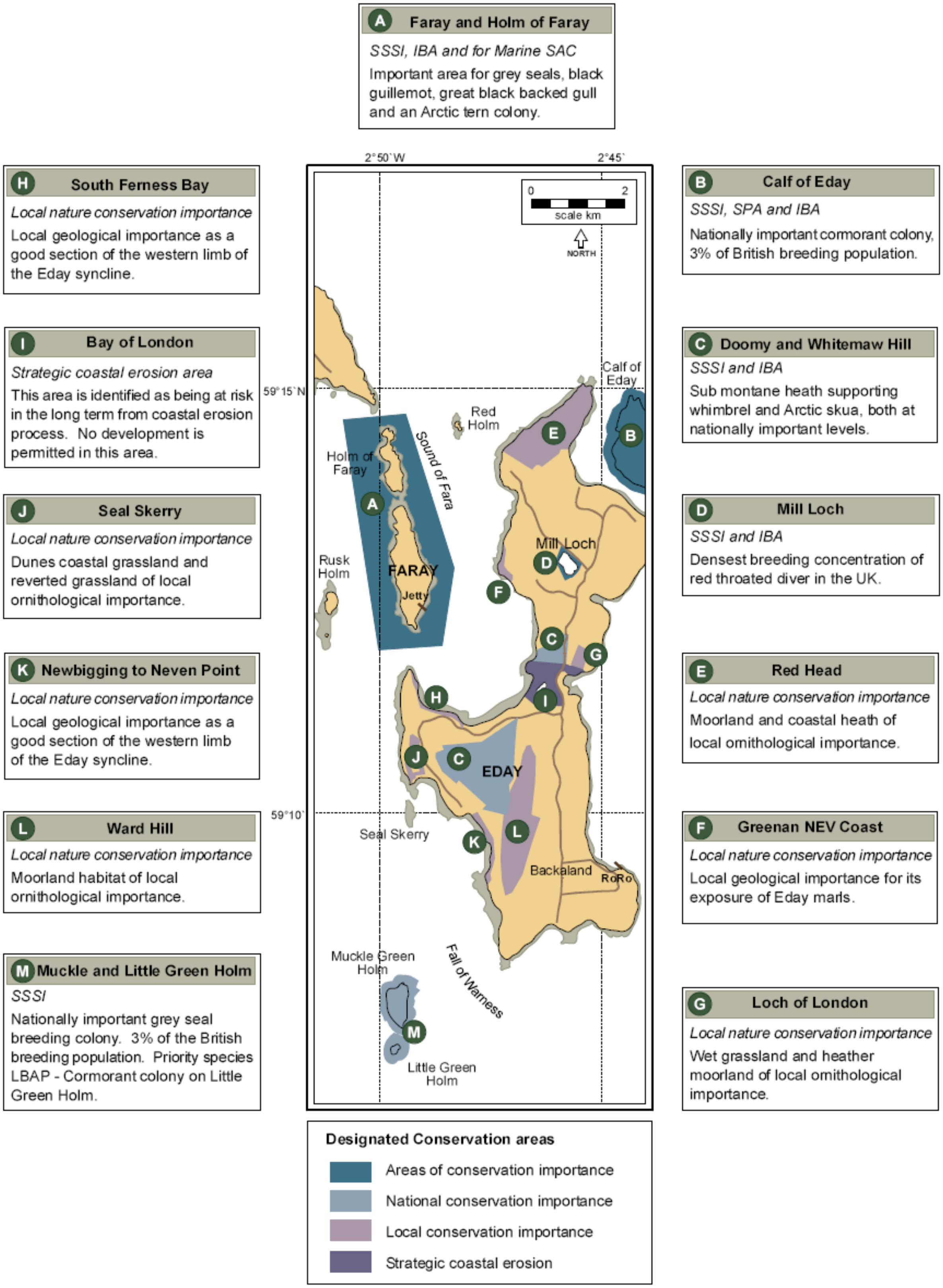


Figure 5.4 Conservation and Protected Areas Surrounding Eday (*NB Sanday SAC lies to the east*)

5.3 Human Environment

5.3.1 Population and Development

In common with many of the more remote islands in the Orkney, Eday has faced the problem of depopulation. The 2001 census recorded a permanent population of 121 people a decline of 27.11% since the 1991 census (166 people). However, in recent years the community controlled Eday Partnership has been working hard to improve the social and economic outlook with encouraging results.

5.3.2 Other Sea Users

<u>Fisheries</u>

Approximately 12 creel fishing boats from Mainland Orkney and one from Westray regularly fish on the SW coast of Eday within the Fall of Warness, with the catch amounting to upwards of 30% of their total catch throughout Orkney. Individual vessels may have a greater reliance on the fishing stocks in the area, estimated as up to 50% in some cases (Orkney Fishermen's Association). The creel fishing boats only operate out as far as the 30m contour, just inshore of the agreed EMEC tidal site boundary.

With the recurring effects of paralytic and amnesic shellfish poisoning (PSP and ASP), the scallop fisheries in Orkney have shown a general decline. The number of vessels has declined from 14 to 5 in recent years. Due to the strength of the tidal stream, scallop diving does not routinely take place in the Fall of Warness. However, Orkney Fishermen's Association have reported (see Section 2.2 and Appendix 2) that when tidal/weather/visibility conditions permit dive boats do operate in the area as shown in Figure 5.5. The proposed test site location is now 750m from this scallop ground.
There is no aquaculture taking place within the test site area.

<u>Other vessel traffic</u>

The local North Isles ferries use alternative routes through the Fall of Warness (see Appendix 3 Figure 5.7) in poor weather and devices could present navigational challenges in heavy seas and poor visibility if appropriate navigation aids are not used.

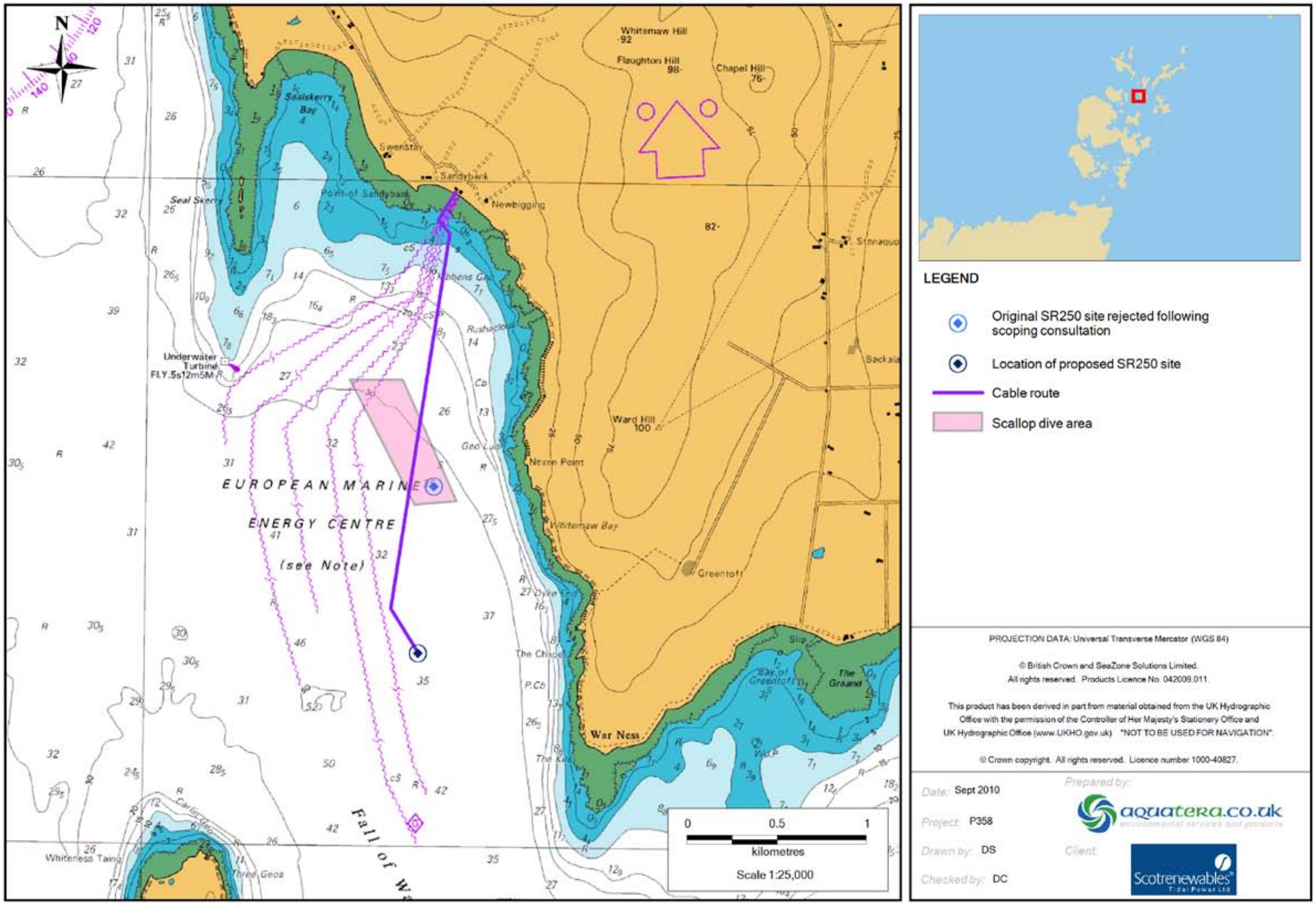


Figure 5.5 Scallop Fishing Ground– Fall of Warness

The Fall of Warness is classed as an 'Area To Be Avoided' by the International Maritime Organisation (IMO). This requires all vessels over 5,000 GT, carrying oil or other hazardous cargo, to avoid the area designated.

The inherent nature of the channel makes it hazardous for small craft. The RYA Coastal Atlas indicates no cruising routes through the area, although local consultation identified that the area is used on occasion. The area is used by larger vessels and cruise ships and pelagic fishing vessels use the channel for passage (see Appendix 3 Figures 5.1-5.6).

Harbour facilities

There are three local harbour facilities that may at some time be used during the project lifetime. The Hatston pier will be the most routinely used, although the Loth (Sanday) and Eday piers may be used for short periods of time (see Figure 1.1). Not only are these piers close to the test site, but they also have deep enough berths (greater than 4m) to accommodate the SR250 in transport mode (see Figure 4.12). These activities will be undertaken in consultation with the local harbour authority, and times of usage will be determined to avoid use by the regular ferry services which operate between Kirkwall and the North Isles.

5.4 Key Environmental Sensitivities Summary

The table below indicates the relative importance of the environmental sensitivities that exist at the EMEC tidal test site.

Common Seals		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Common seals pup in early June -July and this is followed by a moulting period in late July-early August. The closest haulout sites are at Seal Skerry, The Graand (on the south coast of Eday) and on Muckle and Little Green Holms, with a European protected population on the nearby island of Sanday. The key issues of concern to consider are collision risk and construction/operation/decommissioning disturbance.													
Grey Seals		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The grey seal breeding season is from early October to late November. The moulting period follows in January to March (females), and March to May (males). Grey seal breeding colonies are located adjacent to the site on Muckle and Little Green Holms, with a European protected SAC to the north on the islands of Faray and Holm of Faray. The key issues to consider are collision risk and construction/operation/decommissioning disturbance.													
Harbour Porpoise		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
There are no resident populations of Harbour Porpoise. However, observations of a moderate number of sightings have been recorded between July and September. This species has a large ranging nature and it has been suggested that they move offshore during the winter. They are also a European protected species. The key issues of concern to consider are collision risk and construction/operation/decommissioning disturbance.													
Cetaceans		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minke whale, Risso, Orca and White-beaked dolphins have been recorded in the Fall of Warness during the summer months. They are present in extremely low numbers, occurring only sporadically, but must be given serious consideration due to their European protected species status. The key issues to consider are collision risk and construction/operation/decommissioning disturbance.													
Birds	*See Note*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bird species are present all year round. It is important to note that there is a cormorant breeding colony on Little Green Holm (April-June) adjacent to the test site. The key issue to consider is collision risk and potential for displacement from feeding and breeding grounds.													
Finfish & Shellfish		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The site (and Orkney as a whole) is located within spawning and nursery areas of a number of fish species.													
Basking Sharks		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The site wildlife observations show that low numbers of basking sharks have been sighted in late summer. They are a UK BAP priority species and the key issues to consider are collision risk and construction/operation/decommissioning disturbance.													
Otters		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
A few sporadic otter sightings have been recorded over the past few years in the shallow site waters. Otters normally cub in the winter months in Orkney, although they can breed at any time of the year. They are a European protected species and the key issue to consider is disruption caused by any shore-based works.													

KEY	Sensitivity	Importance to be placed on consideration of the species when planning test site works
	Low	No immediate consideration required
	Minor	Detailed consideration of all potential impacts are required
	Moderate	Careful consideration of potential impacts are required
	High	Detailed consideration of all potential impacts are required

Figure 5.6 Tidal site sensitivities, based on the EMEC Tidal Test Facility Environmental Statement (Aurora 2005) and amended according to data from EMEC Tidal Site Wildlife Observations (2005-ongoing). (Source: EMEC updated 2010) *Note: All birds are protected, so any potential effects must be considered, with particular attention given to diving species.*

6 Impact Assessment

This section attempts to systematically identify and rank all the potential environmental and socio-economic impacts which could arise directly or indirectly from the development based on the project activities described in Section 4 above. Environmental interactions were identified and are presented in a simple matrix which also presents the significance ranking for each interaction (Table 6.2 below). Table 6.1 below gives details of the assessment criteria used to define each ranking.

Major significance	(brown)
▪ Substantial environmental or socio-economic negative impacts which cannot be reduced with the resources available to the project ▪ Recovery not achieved until several years following cessation of activities ▪ Major gaps and uncertainties in the data - Serious irresolvable stakeholder concerns ▪ Possible non-compliance with environmental legislation ▪ Impact on habitat and/or species of national and/or international conservation importance	
Moderate significance	(red)
▪ Discernable environmental and socio-economic negative impacts ▪ Recovery expected to be well underway within 1-2 years of the cessation of activities ▪ Some mitigation available within the scope of the project ▪ No major gaps or uncertainties in the data ▪ Concerns expressed by stakeholders which can largely be resolved ▪ Compliance with environmental legislation ▪ Possible impact on habitat and/or species of local conservation importance	
Minor significance	(orange)
▪ Environmental or socio-economic negative impact within the scope of natural variability ▪ Recovery expected well within one year of the cessation of activities ▪ Mitigation available within the scope of the project ▪ No major gaps or uncertainties in the data ▪ No major concerns expressed by stakeholders ▪ Compliance with environmental legislation, guidelines and company environmental policy ▪ Possible impact on habitat and/or species of local conservation importance	
Negligible	(yellow)
▪ Any potential effect arising which is unlikely to be detectable or measurable	
Positive	(green)
▪ Overall effect of project to enhance or improve environmental or socio-economic receptor	

Table 6.1 Assessment Criteria

6.1 Summary of Impacts

The majority of the impacts predicted from all phases of the development are ranked as minor or negligible significance. Table 6.3 details the justification for the low ranking, and the impacts ranked as moderate or above are discussed further in Section 7 next.

Table 6.2 Ranking of Potential Environmental impacts

Significance rating			
Major significance	(brown)	Negligible	(yellow)
Moderate significance	(red)	Positive effect	(green)
Minor significance	(amber)		

Project activity or action	Physical environment				Biological environment							Human environment				
	Air quality	Water quality	Sediment distribution/movement	Hydrographic processes	Coastal species	Benthic species	Water column species	Fish	Sea birds	Sea mammals (incl. Otter)	Protected species/designated sites	Tourism and recreation	Harbour facilities	Other sea users/fishing interests	Other developers	Local community/economy
Cable and mooring system - installation and long term presence																
Physical presence/routine operation of vessels	Negligible	Negligible					Negligible	Negligible	Negligible	Minor	Negligible	Negligible	Minor	Minor	Minor	Positive effect
Deployment of vessel anchors			Negligible			Negligible										
Noise from vessels										Minor	Minor	Negligible				
Placing/ long-term presence of cable on sea-bed			Negligible			Negligible		Negligible	Negligible	Negligible	Negligible			Negligible	Negligible	
Placing of concrete mattresses			Negligible			Negligible										
Placing/long-term presence of gravity anchors on sea-bed			Negligible			Negligible			Negligible	Negligible	Negligible			Negligible		

Table 6.2 Ranking of Potential Environmental impacts

Significance rating			
Major significance	(brown)	Negligible	(yellow)
Moderate significance	(red)	Positive effect	(green)
Minor significance	(orange)		

	Physical environment				Biological environment							Human environment				
Project activity or action	Air quality	Water quality	Sediment distribution/movement	Hydrographic processes	Coastal species	Benthic species	Water column species	Fish	Sea birds	Sea mammals (incl. Otter)	Protected species/designated sites	Tourism and recreation	Harbour facilities	Other sea users/fishing interests	Other developers	Local community/economy
Installation/long-term presence of mooring lines			Negligible		Negligible	Negligible		Moderate	Moderate	Moderate	Moderate	Negligible		Negligible	Minor	
Installation/long-term presence of turret when *not* attached to SR250								Moderate	Moderate	Moderate				Moderate	Minor	
Workforce presence									Negligible	Negligible	Negligible	Negligible				Positive
SR250 installation, operation and maintenance																
Physical presence of SR250								Moderate	Negligible	Moderate	Minor	Positive		Major	Minor	
Operation of rotors				Minor			Negligible	Moderate	Minor	Major	Minor			Moderate		
Presence/operation of work boats	Negligible	Negligible					Negligible	Negligible	Negligible	Minor	Negligible	Negligible	Minor	Minor	Minor	Positive
Maintenance of device (ex situ)		Negligible											Minor			Positive
Mooring chain movement			Minor								Minor					

Table 6.2 Ranking of Potential Environmental impacts

Significance rating			
Major significance	(brown)	Negligible	(yellow)
Moderate significance	(red)	Positive effect	(green)
Minor significance	(orange)		

Project activity or action	Physical environment				Biological environment							Human environment				
	Air quality	Water quality	Sediment distribution/movement	Hydrographic processes	Coastal species	Benthic species	Water column species	Fish	Sea birds	Sea mammals (incl. Otter)	Protected species/designated sites	Tourism and recreation	Harbour facilities	Other sea users/fishing interests	Other developers	Local community/economy
Noise from device operation and work boats								Moderate	Moderate	Major		Negligible				
Electromagnetic emissions										Negligible	Negligible					
Electrical energy dissipation							Negligible									
Workforce presence									Negligible	Negligible	Negligible	Negligible				Positive
Clean energy generation	Positive											Positive				Positive
Decommissioning																
See cable and mooring installation		Negligible	Negligible			Negligible		Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Positive
Cumulative/'in combination' issues																
Cumulative/'n combination' issues associated with other developments in the Fall of Warness								Moderate	Minor	Major	Major		Moderate	Moderate		Positive

Table 6.2 Ranking of Potential Environmental impacts

Significance rating			
Major significance	(brown)	Negligible	(yellow)
Moderate significance	(red)	Positive effect	(green)
Minor significance	(orange)		

Project activity or action	Physical environment				Biological environment							Human environment				
	Air quality	Water quality	Sediment distribution/movement	Hydrographic processes	Coastal species	Benthic species	Water column species	Fish	Sea birds	Sea mammals (incl. Otter)	Protected species/designated sites	Tourism and recreation	Harbour facilities	Other sea users/fishing interests	Other developers	Local community/economy
Accidental events																
Shipping collision with device resulting in significant damage/oil spill		Major				Major	Major	Major	Major	Major	Major	Major		Major	Major	
Loss of items overboard		Negligible			Negligible			Negligible	Negligible	Negligible	Negligible	Negligible				
Wildlife entanglement with sub-sea cable/mooring system								Moderate	Moderate	Moderate						
Wildlife collision with device								Major	Moderate	Major						
Hydraulic oil/fuel leakage from SR250		Minor					Negligible									
Device structural failure								Major		Major	Major			Major	Major	

Table 6.3 Justification of minor/negligible significance impacts

Project activity	Potential environmental and socio-economic impact	Proposed mitigation
Installation of subsea cable/mooring system	Disturbance/modification to benthic habitats and communities from temporary use of vessel anchors and physical activity of laying cable, cable protection and gravity anchors.	Seabed at test site identified in 2005 EMEC survey as 'generally featureless coarse sand and gravel' and of no nature conservation interest. This was confirmed in the dive/ROV seabed surveys undertaken in July/August 2010. These surveys also confirmed that there were no protected habitats or species on the proposed new cable route (see Section 5.2.2). Chain/rope lengths may cause some minor disturbance to seabed during installation process, but this will be very localised (see Figure 4.11). Due to coarse nature of substrate the installation activities are not expected to add to the sediment load in the water column. The use of GPS technology will ensure that the gravity anchors are placed accurately and will not need to be moved thus reducing any disturbance to a minimum.
	Disturbance (noise/physical presence) to wildlife including birds, pinnipeds, otters, large fish species and cetaceans.	The installation works and any physical disturbance will be of short duration (see section 4.2). A noise study undertaken (see Appendix 9) indicated that the zone of mild disturbance will be limited to at most a few metres (see section 7.1.2). The timing of operations (January - March) will coincide with the sensitive time periods for some of species as identified in Figure 5.6. It will coincide with grey seal moulting, however, the nearest site of potential disturbance at Muckle Green Holm is approximately 2 km away, and given the short duration of activities, and low level of potential noise generation, no disturbance is anticipated. Cetaceans and harbour porpoise are ranked in Figure 5.6 as MODERATE sensitivity all year round, but are known to be present in much greater numbers in the summer months. Harbour seals are also ranked as MODERATE during the period of installation activities, but the timing avoids the breeding season and subsequent moulting between June and August. An MMO will be present during all installation activities to watch for seals, cetaceans and basking shark, and will ensure activities are delayed if these species enter the mitigation zone until such time as they are at a safe distance.

Project activity	Potential environmental and socio-economic impact	Proposed mitigation
		The timing of the inshore cable laying works will take into account the sensitivities of otters that are known to be most active at dusk and dawn.
	Pollution of water column from anti-foulants, hydraulic fluids and lubricants. Disturbance of substrate leading to increased sediment load in water and thus reduction in water quality.	Scotrenewables will ensure that the vessel hired for the works complies with all IMO/MCA codes. SEPA will be immediately informed of any incidents that have had or that could have had an environmental impact. Any waste generated on board the work vessels will be disposed of on-shore in the appropriate manner. Due to the coarse nature of substrate (see Section 5.2.2) the installation activities are not expected to add to the sediment load in the water column. The use of GPS technology should ensure that the gravity anchors are placed accurately and will not need to be moved thus reducing any disturbance to a minimum.
	The vessel installing the mooring system provides a physical obstruction/navigation hazard to other vessels that normally use the area for transit including other developers.	The installation will be of short duration (see Section 4.2). The works will be promulgated by appropriate Notices to Mariners and Navigational Warnings. Appropriate marking, lighting and aids to navigation to be installed in accordance with Northern Lighthouse Board requirements. EMEC operational control systems in place to ensure vessel movements and developer activities are managed safely (see Section 7.3).
	Obstruction to local fisheries.	NRA undertaken (see Appendix 3). Consultation has been undertaken with local fisheries organizations. Cable route bisects scallop dive area (see Section 5.3.3) – OFA to be notified when cable laying activities to take place. The installation will be of short duration (see Section 4.2). The works will be promulgated by appropriate Notices to Mariners and Navigational Warnings. EMEC operational control systems in place to ensure vessel movements and developer activities are managed safely (see Section 7.3).
	Work vessels cause congestion/interfere with routine ferry	Work vessels may need to use the piers at Sanday and Eday (see Section 5.3.3) during installation activities. If these facilities are needed it will only be on a temporary basis and carried out in liaison with

Project activity	Potential environmental and socio-economic impact	Proposed mitigation
	operations at Northern Isles pier facilities.	OIC Marine Services to ensure that routine activities are not disrupted.
	Presence of workforce	Workforce will be made aware of the environmental sensitivities in the area (see Section 5). Workforce numbers will be less than 10 individuals at any time. Any noise generated by the workforce will be masked by background noise levels and vessel noise.
Long term presence of subsea cable/mooring system	Disturbance/modification to benthic habitats and communities. Chain/rope lengths may cause some disturbance to seabed when turret is attached due to variations in sea depth caused by tidal regime.	Seabed identified as consisting of coarse sand material of no nature conservation interest (see Section 5.2.2). When the turret (and thus the rest of mooring system) is detached from the SR250 the potential for scouring will be limited. The mooring system will occupy a relatively small area of seabed. Mooring analysis undertaken indicated the area of potential damage will be very localised and given the coarse nature of the seabed material the seabed is expected to quickly revert to its former state (see Section 4.4.2 and Fig 4.11). When the turret is disconnected there will be very little movement of the mooring chain, and any movement will be well within the outer limits of the excursion area for when the device is connected.
	Electromagnetic and electrical effects on wildlife navigation systems.	Proposed cables have a 2 layer steel wired armour which protects from any electromagnetic and electric fields which may be emitted (see Section 4.6.7).
Presence and operation of SR250	Physical hazard/obstruction to local fisheries.	NRA undertaken (see Appendix 3). Consultation undertaken with OFA. Proposed site far enough away from identified fishing area so will not impact on local fisheries (see Sections 2.2 and 5.3.3).
	Physical hazard/obstruction to recreational vessels.	NRA undertaken (see Appendix 3). The works will be promulgated by appropriate Notices to Mariners and Navigational Warnings. Appropriate marking, lighting and aids to navigation to be installed in accordance with Northern Lighthouse Board requirements.
	Work vessels cause congestion/interfere with routine ferry operations at Northern Isles pier facilities and Hatston pier.	Work vessels may need to use the piers at Sanday and Eday (see Section 5.3.3) during operation/maintenance activities. If these facilities are needed it will only be on a temporary basis and carried out in liaison with OIC Marine Services to ensure that routine activities are not disrupted. In addition, Hatston pier will be used to berth the device for longer periods when not deployed at the test

Project activity	Potential environmental and socio-economic impact	Proposed mitigation
		site. This will be agreed in advance with OIC Marine Services.
	Pollution of water column from anti-corrosives lubricants and hydraulic fluids both from the device and work boats. Disturbance of sediment leading to a reduction in water quality. Generation of waste from work vessels.	The risk of water pollution will be minimised by the following: • Only biodegradable oils will be used in the SR250 (see Section 4.4.6 and Appendix 4) with a maximum volume of 250l. • Capacity of diesel tank limited to 100l. • Use of internal spill trays, bunding and sealed compartments (see Sections 4.3.8 & 9.3.2) to prevent contamination of the bilge water. The use of sealed gelled electrolyte lead acid batteries (see Section 4.4.6). • Composite bearing will be used on the hydraulic rams on the rotor legs so no requirement for lubrication. • All maintenance activities including oil/hydraulic fluid treatments will be carried out on-shore (see Section 4.5.4). • Sacrifical anodes may emit salts which can accumulate in sediment and bioaccumulate in benthic species – due to fast flowing nature of water any salts emitted are expected to disperse rapidly with negative effects (see Section 9.2.2). • No harmful biocides used in anti- fouling system (see Section 4.1.3). • Scotrenewables will ensure that the vessel hired for the works complies with all IMO/MCA codes. In the unlikely event of an oil spill from the SR250 this will be cleared up promptly. SEPA will be immediately informed of any incidents that have had or that could have had an environmental impact. • Mooring analysis undertaken which indicated the area of potential damage will be very localised and given the coarse nature of the seabed material and fast flowing water no increase in sediment load and reduction in water quality is anticipated(see Section 4.4.2 and Fig 4.11) • Any waste generated on board the work vessels will be disposed of on-shore in the appropriate manner.

Project activity	Potential environmental and socio-economic impact	Proposed mitigation
	Electrical energy generated initially at the test site will be dissipated into the sea through an onboard resistive load bank (see Section 4.6.1) and may cause a localised heating effect.	The maximum power generated will not exceed 250kW, producing a comparable localised heating effect as from the engine of the work boat. The heat will be quickly dissipated into the surrounding sea water due to the strength of the tidal conditions. No environmental impacts are anticipated from this action.
	Electromagnetic emissions can interfere with some cetaceans that rely on the Earth's magnetic fields for navigation.	Electromagnetic emissions will be kept to a minimum (see Section 4.6.7) so any impact on cetaceans is considered to be negligible.
	Extraction of energy from the marine environment	Due to small scale of development the operation of the SR250 is not expected to have any impact on hydrographic processes, but as was detailed in Section 1.7 this issue is outwith the scope of this study.
	Presence of workforce.	Workforce will be made aware of the environmental sensitivities in the area. Workforce numbers will be less than 10 individuals at any time. Any noise generated by the workforce will be masked by background noise levels and vessel noise.
Decommissioning	*See installation impacts.*	The timing of decommissioning activities (November-December) will coincide with the sensitive time periods for some of species as identified in Figure 5.6. It will coincide with the grey seal breeding season however, the nearest site of potential disturbance at Muckle Green Holm is approximately 2 km away, and given the short duration of activities, and low level of potential noise generation, no disturbance is anticipated. Cetaceans and harbor porpoise are ranked in Figure 5.6 as MODERATE sensitivity all year round, but are known to be present in much greater numbers in the summer months. Harbour seals are also ranked as MODERATE during the period of decommissioning activities, but the timing avoids the breeding season and subsequent moulting which will be over by the end of August. An MMO will be present during all decommissioning activities to watch for seals, cetaceans and basking shark, and will ensure activities are delayed if these species enter the mitigation zone until such time as they are at a safe distance.

7 Discussion of Potentially Significant Impacts

The following section provides a more detailed discussion of the potential issues identified in Section 6. Mitigation measures for each aspect are also suggested here to reduce any potential impact and taking these into account a residual impact is also given using the significance criteria outlined in Section 6.1.

As the concept of tidal energy conversion devices is relatively new many of the adverse impacts on the marine environment are not known or fully understood at this stage. In the absence of long-term operational and related research activities, the industry has drawn on experience gained in the oil and gas and offshore wind sectors to predict the potential negative impacts on marine life. Experience drawn from these industries includes the following:

- Generation of harmful levels of underwater and surface noise;
- Displacement of wildlife from habitual breeding/feeding grounds;
- Entrapment and entanglement;
- Collision with operational device;
- Electrical and electromagnetic disturbance (see Table 6.3);
- Habitat degradation (see Table 6.3); and
- Contamination of the local environment (see Table 6.3).

In addition to the potential impacts on marine life, the construction and operational activities of tidal devices may also impact on other sea users as follows:

- Disruption to routine activities due to the establishment of temporary or permanent exclusion zones;
- Collision risk with construction/maintenance vessels; and
- Collision risk with devices.

When assessing the potential impacts of the SR250 in Section 6 most of the above were ranked as Moderate or Major, with the exception of the 3 potential impacts dealt with in Table 6.3. The following section provides a more detailed discussion of the potential issues identified and mitigation measures for each aspect suggested to reduce any potential impact. Taking these into account a residual impact is also given using the significance criteria outlined in Section 6.1.

7.1 Marine Wildlife

The interactions of deployed tidal devices with marine wildlife are largely unknown. Potential impacts that have been identified include the risk of disturbance or displacement as a result of noise generated by the device operation and associated activities. Direct interactions include the potential for entanglement, and also for collision which has clear implications at a population level. Characterisation of these interactions is therefore vital in terms of both small scale behavioural and large scale population effects, and any information gathered as a result of the proposed testing will inform future the larger scale commercial developments.

As was discussed in Section 5.2 there are a number of species afforded protection either locally, nationally or at European level that may be at risk of harm. There are protected populations of both grey and harbour seals that use the Fall of Warness and surrounding beaches to haul out, for moulting, for breeding and also for feeding (see Section 5.2.6). The decline in harbour seals is of particular concern currently. The Potential Biological Removal (PBR) for harbour seal numbers in the Northern Isles metapopulation stands at just 13 (2008 count). In addition, many cetacean species that are afforded protection at European level have been recorded using the Fall of Warness for transit and feeding (see Section 5.2.6). There is a cormorant breeding colony on Little Green Holm (see Figure 5.10). These diving birds are listed as a local priority species due to declining numbers. Basking shark have also been recorded in the Fall of Warness.

7.1.1 Timing of Installation, Operational and Decommissioning Activities

Background

EMEC has produced a table of Seasonal Variations of Key Environmental Sensitivities (see Figure 5.6) which gives an indication of which months of the year which species need to be considered when it comes to planning and undertaking installation, operational and decommissioning activities.

Mitigation

Installation activities

The timing of operations (January – March) will coincide with the sensitive time periods for some of species as identified in Figure 5.6. Harbour seals may be present on Seal Skerry and Muckle Green Holm haul out sites, but the timing avoids the breeding season and subsequent moulting (June to August). Individuals could be feeding in the Fall of Warness. The Grey seal breeding season will have finished in late November, but will be moulting between January and March on Muckle Green Holm. Seal Skerry is 1km from the closest point on the new cable route and 2.5km from the site centre where the device will be deployed. Muckle Green Holm is 2 km from the site centre (see Figure 5.5). It is considered that given the distances from the proposed area of works to these sensitive sites, and the relatively small scale of the works as discussed further below, that seals will not be disturbed. Cetaceans and harbour porpoise are ranked in Figure 5.6 as MODERATE sensitivity all year round, but are known to be present in much greater numbers in the summer months. An MMO will be present during all installation activities to watch for seals, cetaceans and basking shark, and will ensure activities are delayed if these species enter the mitigation zone until such time as they are at a safe distance.

Operational activities

The SR250 has been designed to be remotely operated, so during the time periods when the device is installed at the site the only time vessels will be present will be to install or disconnect the device either as part of the testing programme (see Section 4.6.1) or for maintenance. Testing and maintenance activities will take place all year round. However, as all maintenance will take place in harbour, there will be minimal disruption at the site. Staff will be made aware of the environmental sensitivities and seasonal variations.

Decommissioning activities

The timing of decommissioning activities (November-December) will coincide with the sensitive time periods for some of species as identified in Figure 5.6. It will coincide with the grey seal breeding season however, the nearest site of potential disturbance at Muckle Green Holm is approximately 2 km away, and given the short duration of activities, and low level of potential noise generation, no disturbance is anticipated. Cetaceans and harbour porpoise are ranked in Figure 5.6 as MODERATE sensitivity all year round, but are known to be present in much greater numbers in the summer months. Harbour seals are also ranked as MODERATE during the period of decommissioning activities. The timing avoids the breeding season and subsequent moulting which will be over by the end of August, but individuals could be feeding in the Fall of Warness or hauled out on Muckle Green Holm. An MMO will be present during all decommissioning activities to watch for seals, cetaceans and basking shark, and will ensure activities are delayed if these species enter the mitigation zone until such time as they are at a safe distance.

<u>Residual impact</u>
With a distance of over 1km from the nearest beach used by seals, the presence of a MMO and harbour maintenance, the residual impact of the timing of SR250 operations is considered to be NEGLIGIBLE.

7.1.2 Underwater and Surface Noise

<u>Background</u>
The emerging marine renewable industry recognises that there is considerable scientific uncertainty regarding the nature and magnitude of the actual impacts of anthropogenic sound on the marine environment. Current sources of anthropogenic sound include seismic surveys, oil and gas production, military operations, sonar, pile-driving and dredging. The Scottish Strategic Environmental Assessment for wave and tidal power considered that noise arising from construction and operational noise from tidal turbines may be a significant risk to marine mammals particularly in narrows or other constrained areas utilised by migrating or foraging species (Faber Maunsell and METOC PLC 2007). It is known that acoustic disturbance can influence the behavioural, acoustic and physiological response of marine mammals, and lead to cause temporary or permanent hearing loss, and in some cases stranding and death.

As hardly any light penetrates depths of greater than 200m cetaceans rely on sound as their primary sense. Sound is used to detect and catch prey, to 'see' objects (e.g tidal devices and supporting infrastructure) and as an aid to navigation. Cetaceans also use a range of vocal calls both within and between species for social interactions (breeding, mother/calf cohesion, group cohesion, individual recognition and danger avoidance). The communication calls of the odontocete (toothed whales) are mainly at moderate to high frequencies (1-20kHz), and many have highly developed echolocation systems operating at high and very high frequencies (20-150 kHz). Mysticetes (baleen whales) appear to be sensitive to low and moderate frequency sounds (12Hz to 8kHz) and do not have a high frequency echolocation system (Richardson et al 2005). Odontocete species dominate in the Fall of Warness (killer whale, risso's dolphin, white-beaked dolphin and harbour porpoise), although the minke whale representing the mysticetes has also been recorded (see Section 5.2.6).

In addition to cetaceans, sensitive seal populations have the potential to be disturbed or displaced from breeding and haul-out sites identified within the Fall of Warness (see Sections 5.2.6, 7.1.1 and Figure 5.10).

Potential sources of acoustic disturbance from the proposed development include:

- Cable laying activities;
- Increased vessel activity during installation and maintenance;
- Device operational noise; and
- Decommissioning activities.

These activities may have the potential to disturb or displace marine mammals and large fish species, or to interfere with the natural functions detailed above. In addition, the collision risk (in particular with the rotors) for marine mammals may be increased by ambient noise levels that mask the location of the tidal energy device (Shields *et al* 2009).

At this pre-commercial stage of development it is important that mitigative measures are put in place until the impacts are better understood.

Mitigation

Due to the relatively small scale of the proposed development and design of the SR250 and supporting infrastructure the potential for acoustic disturbance will be a lot less than is evident in other marine energy devices currently being developed.

Installation, maintenance and decommissioning activities

- **Cable-laying** - Due to the relatively small size of the proposed cable (see Section 4.5.3) it will not be necessary to use a large DP vessel to undertake the cable laying works. Instead a much smaller multi-cat work vessel (see Section 4.6.5) will be utilised.
- **Foundations** – the use of gravity anchors means that there will be no piling.
- **Mooring installation** – this activity will take approximately 1 week with vessel activity at the site only for a few hours each day (see Section 4.5.1).
- **Maintenance** – the SR250 control systems can all be operated remotely which means there will be no need for a boat to be present at the site apart from

when the device is disconnected and towed to harbour for maintenance activities (see Section 4.6.4).

- **Decommissioning -** activities will generate the same level of potential acoustic disturbance as the installation activities. As discussed in Section 4.7, it will take approximately 1 week to remove all traces of the mooring system from the seabed with no use of explosives or cutting gear required.

The installation, maintenance and decommissioning activities will all be of a short duration (see Section 4.2) with the only noticeable sound generated from the small work vessel typical of vessels routinely used in the area by local sea users. Professor Jon Side of ICIT, Heriot Watt University conducted a study to ascertain the attenuation of sound from the operations on site during the installation works of the SR250 (see Appendix 9). The study focussed on the influence of transmitted noise on seal haul-outs on Seal Skerry, and throughout the year on nearby seal activity. The study was centred on the site rejected following consultation (see Section 4.1), however it is considered that the findings are still relevant to the proposed site, and also can be used to deduce that cetaceans will be equally unlikely to be disturbed or harmed by noise generated from the work boats. This study concluded:

- that there is little risk of any auditory impairment of harbour seals even in the immediate vicinity of the workboat operations;

- that the zone of mild disturbance will be limited to at most a few metres, and thus the physical presence of the workboat may have a more significant influence on seal behaviour than any noise generated during installation of the SR250; and

- the attenuation of noise from the workboat is such that levels of background noise are likely to be reached within 200m (preferred approach) to 250m (worst case) of the site and at some distance seaward of the Muckle Green Holm (2km) and Seal Skerry (1km from the start of the cable route and 2,5km from the site centre) haul-outs.

Richardson *et al* (2005) consider that sea mammals can tolerate occasional brief periods of man-induced disturbance, with prolonged or repeated disturbance a greater cause for concern.

Device operation noise

The level of noise generated by the device during operation is unknown at this stage. It is unclear whether the noise levels will be high enough to disturb or possibly even harm seals and cetaceans, or so low that the presence of the device is masked by background noise that results in the device being undetectable.

The small enclosed diesel generator will be the most likely source of any vibrations, but will be housed within the body of the device and be mounted on shock absorbers which should minimise this effect. The major source of any noise will be the rotors. Scotrenewables are intending to undertake both background and device operational noise studies when the SR250 has been installed (see Section 9.3).

As part of the environmental monitoring strategy (see Section 9.3) to be developed and undertaken in consultation with SNH and MS-LOT, the behaviour of marine mammals will be monitored. This will help the Company gain a better understanding of how they interact with the device and this will inform future larger scale developments.

Residual Impact

Although noise associated with installation, maintenance and decommissioning activities is considered to pose only a mild, very localised disturbance to marine mammals, given the importance of species known to use the Fall of Warness, and the unknowns surrounding the impact of operational noise the residual impact remains ranked as MAJOR.

7.1.3 Displacement

Background

It is possible that a combination of activities during installation, operation and decommissioning could cause disturbance and possible displacement of cetaceans, seals, basking shark and sea birds from habitual feeding or breeding grounds in the Fall of Warness. Boat disturbance has been shown to affect behaviour and displace dolphins (Lusseau, 2005). It remains unknown what effect the presence of the operational SR250 device will have on marine mammal behaviour. The following mitigation has been put in place to reduce any impacts based on what is understood at this time, but it is only once the device is operational that the actual impact will be better understood on analysis of the monitoring data.

Mitigation

- **Cable-laying** - Due to the relatively small size of the proposed cable (see Section 4.4.1) it will not be necessary to use a large DP vessel to undertake the cable laying works. Instead a much smaller multi-cat work vessel (see Section 4.6.5) will be utilised. Works will be of a short duration of approximately 2 days.
- **Mooring installation** – this activity will take approximately 1 week with vessel (multi-cat) activity at the site only for a few hours each day (see Section 4.5.1).
- **Maintenance** – the SR250 control systems can all be operated remotely which means there will be no need for the multi-cat vessel to be present at the site apart from when the device is disconnected and towed to harbour for maintenance activities (see Section 4.6.4).
- **Device operation** – operational noise (see Section 7.1.1) and the physical presence of the device may have a displacement effect on marine mammals, but this is currently unknown. The relatively small scale of the development and the testing programme (see Sections 4.2 and 4.6.1) which will not involve the device being on site on a continuous basis should reduce any impact.
- **Decommissioning** - it will take approximately 1 week to remove all traces of the mooring system from the seabed with no use of explosives or cutting gear required and with only a single multi-cat vessel required to carry out all activities.

As part of the environmental monitoring strategy (see Section 9.3) to be developed and undertaken in consultation with SNH and MS-LOT, the behaviour of marine mammals will be monitored. This will help the Company gain a better understanding of how they interact with the device and this will inform future larger scale developments.

Residual impact
The installation, maintenance and decommissioning activities are considered to pose only a mild, very localised disturbance to marine species. Although the scale of the development is relatively small and the device will not be deployed for a continuous period during the testing programme given the importance of species known to use the Fall of Warness, and the uncertainty that surrounds this issue the residual impact is ranked as MODERATE.

7.1.4 Entrapment and Entanglement

Background

There is potential for marine mammals, diving birds and basking shark to get entangled in the mooring system and also in the cable with potentially lethal effects.

Mitigation

Umbilical cable

The umbilical cable because of its steel armour cannot be bent to form a loop of less than 1200mm diameter (see Section 4.4.1), so it would be impossible for even a very large marine species to become entangled or trapped.

Mooring line tension

- From an operational perspective it is critical that mooring lines remain taut so there is no risk of mooring lines becoming entangled with either the umbilical or rope from the turret marker buoy.
- Experience from the 5th scale testing and modelling undertaken for the SR250 has shown that there will be little movement of the mooring system (see Section 4.4.2 and Figure 4.11).
- The combination of clump weights and inherent buoyancy of the turret will ensure mooring lines remain taut.
- Combining the tautness of the lines along with a synthetic rope diameter of 113mm and 100kg line tension it is considered very unlikely any entanglement will take place.
- The mooring system has been deployed at the 5th scale site for over 18 months, and no marine species have become entangled.

In the very unlikely event that an animal does become entangled in the mooring system, there will be systems in place to detect this. There will be a load cell attached to the connection between the mooring lines and the turret. When the turret is connected to the device, should an increased load be experienced on any of the lines it will trigger an alert in the control / monitoring system and be relayed to Scotrenewables staff via the SCADA system. A drop-down camera will be deployed as soon as the anomaly is detected to establish if an entanglement has taken place. Appropriate emergency response measures will be put in place to deal with wildlife entrapment as part of the monitoring strategy to be agreed with MS-LOT and SNH.

Residual impact

Although it is considered very unlikely that marine mammals, diving birds or basking shark could become entangled in either the cable or mooring system, as this is an untried technology at this scale the residual impact is ranked as MINOR.

7.1.5 Collision with Operational Device

Background

Of the potential environmental interactions between operational tidal energy devices and marine mammals and diving sea birds, the most acute is likely to occur if wildlife and machinery collide. Given the embryonic status of the marine renewables industry it is unclear whether the potential collision problem will be rare or sufficiently common to be of conservation concern. It is unclear, how submerged marine mammals will respond to devices (avoid, ignore or even be attracted) and whether noise generated will impair the ability for some cetaceans to 'see' the device, so real collision rates remain unknown. At this stage in development it is critical that measures are put in place to help answer these questions, and also to establish if strikes (whether they result in harm or not) occur.

It is known that the clearance above the rotor sweep of the SR250 is 4m, and that with a rotor diameter of 8m and a rotor swept area of $50.3m^2$ (see Figure 7.1) there is a risk to both diving birds (most species dive to depths greater than 3.8m) from above and marine mammals from within the surrounding waters.

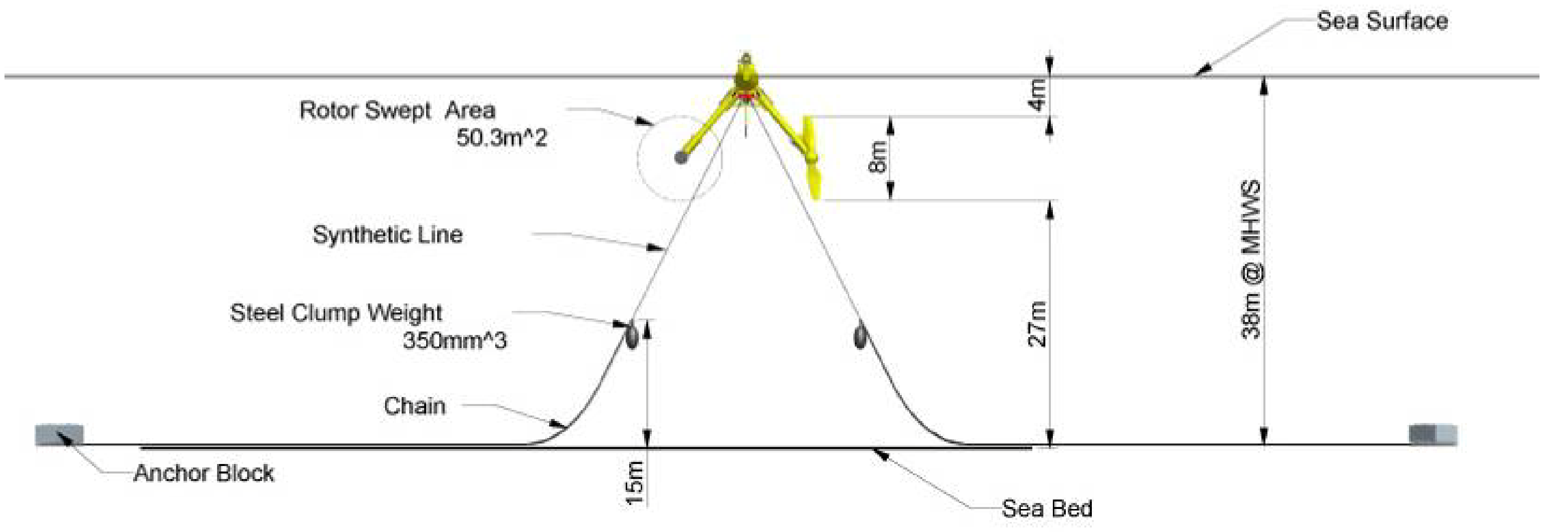
Due to the fast flowing waters within the Fall of Warness it is expected that both marine and anthropocentric derived debris will be present and may collide with the device.

Mitigation

Scotrenewables are proposing a number of measures to monitor collision risk.

Camera

A Pan/Tilt/Zoom (PTZ) underwater camera to be located on the hull will be directed primarily towards the rotors, and from which a live feed via the SCADA system will be provided 24 hours a day. The video streams from these are to be saved in files recognisable by date / time stamps. The footage will be routinely checked for evidence of any wildlife interactions.



<u>Key</u>

Rotor diameter: 8m

Rotor swept area: 50.3m^2 (each rotor)

Clearance above rotor sweep: 4m (to sea surface)

Distance between bottom of rotor sweep and sea floor: 23.2m (LAT) – 28.2m (HAT)

Diameter of hull/tube: 2.325m

Distance of hull that's subsurface (draught): 1.63m (tube draft)

Figure 7.1 SR250 Profile Drawing Relative to MHWS

The video footage will also prove invaluable if either hydrophones or strain gauges detect a possible interaction. The camera will be housed in a Perspex shell which will be cleaned during routine maintenance activities.

Hydrophones

Previous deployments of tidal energy devices have required a survey of the site and its environs for marine mammal activity, and in Strangford Lough the deployment of the SeaGen device additionally required the initial use of a manual emergency shut-down system so that an observer on the device would shut-down power generation if a seal was observed in close proximity. Neither of these approaches is able to determine the likely collision rate of marine mammals with the rotors of a tidal turbine.

Working with ICIT Heriot-Watt University, Scotrenewables propose to install a hydrophone in each nacelle and in the hull. Hydroacoustic data from the hydrophones will also be saved in date / time stamped files, and a search routine has been developed which will allow the automated processing of these and the programming of alerting software should an unusual sound be detected.

The search algorithm is designed to detect significant changes in the amplitude of the hydroacoustic signal in the time domain, but also detects sudden shifts in the frequency spectra. Of course these events may not correspond to a collision with a marine mammal but will in any event be of interest to the developer. Where such events are recorded the corresponding date / time stamped video files (from the PTZ camera) will be examined in order that the cause may be established.

While in general it is felt that collisions with marine mammals are likely to be extremely rare the use of this monitoring approach will provide the industry for the first time with reliable data on collisions, which is not at the moment possible from other monitoring studies. Additionally it will enable the industry to develop a clearer view of the likelihood of collisions with debris, seabirds and fishes.

Strain gauges

Scotrenewables have taken the decision not to strain gauge the rotor blades at this stage in the project because of the extra complications this would add to the construction of the device. It is intended to add strain gauges to the blades during the summer of 2011. Hydrophones are now considered to be a preferred means of impact monitoring over strain gauging as with a number of hydrophones placed in the nacelles and hull, these will have the ability to detect anomalous noises (due to impacts) from throughout the structure whereas strain gauges would be much more localised. It is also questionable whether the minor load peaks that might occur due to impact with small objects would even be detectable in strain gauge measurement. Hydrophones should have the ability to detect even small sound peaks above baseline levels and trigger an alert in the control / monitoring system.

Experience at 5th scale

During the 5th scale testing (see Section 9.3.1) only limited useful data was collected. However, during the time that testing was taking place no strikes occurred. Seals and harbour porpoises were seen in the area but on only one occasion was it necessary to shut down the rotors when a seal came briefly within the mitigation zone.

Strike contingency

The environmental monitoring strategy to be established (see Section 9.3) will include details of the contingency to put in place in the event of a strike (or suspected strike).

<u>Residual impact</u>

Given the uncertainly that surrounds the risk of collision with the device and the importance of identified protected species both at individual and population level the residual impact remains ranked as MAJOR.

7.2 Navigation Risk

The tidal test site is within an IMO Area To Be Avoided, has been established since 2006, is marked on charts and is well known to local fishermen and recreational sailors. As was discussed in Section 5.3, vessel activity within the Fall of Warness is limited primarily to inshore creel boats, local passenger ferries that use the area as an adverse weather route, occasional larger vessels including cruise ships and pelagic fishing vessels, and even more occasionally small recreational vessels and commercial dive boats. As more developers occupy berths at the tidal test site (see Section 7.3), the number of related work vessels of varying sizes is set to increase.

As a surface piercing device with a low freeboard the SR250 may present a navigation risk to surface vessels due to the strong tidal stream of the Fall of

Warness and lack of vessel manoeuvrability in rough seas. In order to fully assess the risk a site specific Navigation Risk Assessment (NRA) was undertaken by Anatec Ltd, the findings of which inform this section. The full report can be found in Appendix 3. This section reviews the navigational hazards and planned mitigation measures associated with the SR250 deployment at the Fall of Warness site.

7.2.1 Shipping Risks

The nearest ship identified from the 12 weeks of AIS track analysis was an inter-island ferry which passed at 210m SSW of the site. Using a combined six months of AIS data it was confirmed this was the closest passing ferry, although several other ferries passed within 0.5nm. Based on the survey data, the ferries naturally tend to avoid the location, even when re-routing in adverse weather conditions.

When the device is not on location, the turret will be a minimum of 10m under water at LAT. Based on the under keel clearance discussion presented in the generic Fall of Warness NRA and taking into account the wave height return periods presented (see Section 5.1.4) the turret should pose a minimal collision risk to the inter-island ferries (*Earl Thorfinn*, *Earl Sigurd* and *Varagen* with draughts ranging from 2.9m to 3.2m) in the event they passed directly over it.

Other commercial shipping, including passenger cruise ships in the summer, tend to pass 0.3-0.6nm to the WSW of the SR250 location. Therefore, the risk of a powered passing ship collision with the device is considered to be very low. The deeper draught cruise ships could potentially interact with the submerged turret at 10m below LAT but as they tend to keep towards the centre of the channel between Muckle Green Holm and Eday, clear of the SR250 location, this risk is considered to be very low.

In the event of a vessel transiting via the Fall of Warness to the WSW losing power and drifting, the drift direction is most likely to be NW-SE rather than towards the device. Any vessel drifting in the direction of the device is likely to be more at risk of grounding on the Eday shore.

7.2.2 Fishing Vessel Risks

As with commercial shipping described above, transiting fishing vessels heading NW/SE via the Fall of Warness naturally tend to avoid the location. This includes the larger pelagic trawlers, some of which have draughts that could interact with the submerged turret.

Creeling activity off the coast of Eday tends to be close inshore within the 15m contour, with occasional deployment out to 30m. The Fall of Warness lease area was shaped by EMEC to avoid infringing the 30m bathymetry contour which consultation had indicated was the main fishing area. The water depths at the SR250 site and within the mooring spread are greater than 30 metres.

In addition to creelers, small diving boats have been observed on occasion diving for scallops off the Eday shore. Scotrenewables have modified the SR250 location based on local consultation to avoid interfering with the scallop grounds.

Fishing vessels could also be exposed when transiting to and from fishing grounds. Watchkeeping logs indicated the main transiting routes are clear of the proposed site. Given this, the fact these are all local vessels, and the device will be marked and lit appropriately, the risk of collision should be low.

When the device is not on location the submerged turret should pose a minimal collision risk to these shallow draught local fishing vessels (draughts up to about 3m, similar to the inter-island ferries).

The marker buoy will assist fishing vessels in identifying the turret position when the device is not on location to avoid any potential risk of gear interaction.

7.2.3 Recreational Vessel Risks

From the consultation and baseline activity review carried out during the generic Fall of Warness NRA, it was identified the Fall of Warness area is not popular with recreational users due to the strong tides. The RYA Coastal Atlas indicates no cruising routes through the area.

However, local consultation identified the area is used on occasion in certain tidal and weather conditions, which was confirmed by the Eday Vessel Logs. Two key issues were raised regarding the proposed deployment:

1. Procedures to deal with vessels swept onto the site by adverse conditions; and
2. Marking and lighting of the site and device.

Based on marking and lighting the device appropriately, and the low frequency of recreational vessel passages through the area, the risk of collision should be assessed to be low.

When the device is not on location, the draughts of recreational vessels in the area (up to about 3m) mean the risk of collision with the submerged turret is minimal.

7.2.4 Cable Interaction

The armoured subsea cable from shore to the device is planned to be of relatively short length (approximately 3km). The cable route will be depicted on charts to ensure mariners are aware of its position.

Based on the local activity in the area, it is not expected to pose a significant hazard to fishing vessels or other mariners.

7.2.5 Maintenance and Decommissioning

No on-site maintenance is planned during the test period. When routine maintenance is required, the device will be removed from the mooring system and towed to a suitable harbour facility using a multi-cat vessel.

Therefore, the only time the multi-cat and the SR250 will be in close contact will be in sheltered waters/harbour for maintenance. On-site, as all the SR250 systems including connection to the turret are controlled remotely, the multi-cat can be moored a safe distance away.

The multi-cat has permanently attached fenders all round, and heavy duty fenders underwater on the strake (to protect against the edge of the hull impacting on a section of the SR250). In addition, semi-submerged 'Yokohama's' type fenders (c 3.5mx1.5m) will be used between the multi-cat and the SR250.

The device is fully compliant so any potential impact will result in the SR250 being moved away from the point of impact lessening the force, rather than absorbing the full force of any impact.

There are 4 separate watertight compartments in the SR250. In the event of any one of these being damaged and water ingress occurring the rest of the structure will not be compromised.

All materials will be completely removed from the tidal test site during decommissioning. The device has been designed so as to make removal and installation as simple as possible. Therefore, the SR250 will be disconnected and towed from the site using a multicat (or similar vessel). The mooring system including gravity anchors will then be completely removed from the berth. A decommissioning plan will be submitted to DECC under the Energy Act (2004).

7.2.6 SR250 Mitigation Measures

For the SR250 device, specific mitigation will include:

- Marking and lighting to NLB requirements based on IALA Recommendation 0-131 on the marking of offshore wave and tidal energy devices;
- Depiction on UKHO Admiralty Charts;
- EMEC procedures (e.g., Maritime Safety Information to ensure information is circulated to local mariners);
- Emergency Response based on mooring line failure / loss of station alarming via SCADA and GPS Monitoring; and
- Turret under keel clearance (minimum of 10m below LAT) when device is not on location.

7.2.7 Mooring Line Failure, Loss of Position and Loss of Station

The mooring system allows excursions of the device up to a maximum of 13m from its neutral position under steady and unsteady forces. In the event of a single line failure, the maximum excursion is approximately 25m.

If the two lines taking the load failed the SR250 would be pulled downstream until the two aft lines took the load which is the excursion plus the full length of the mooring system, roughly 230m from the neutral position of the mooring system. This would also mean breaking the power umbilical or ripping the junction box and cable off the seabed. This is not a design case, but an accidental failure case.

In the event of three line failures the device will still be anchored within a 300m buffer zone around the centre of the site.

Scotrenewables would be alerted initially about a line failure and EMEC notified. The tension present in turret's load cells will be monitored by the SCADA system. If one or more of the mooring cables is broken the load cells should show a near zero value. The GPS onboard will also have to capability to raise an alarm if the device strays from its normal operating area due to a line failure. Cameras onboard the device and onshore will also be available as a secondary check on position.

When the umbilical is connected to the device the data will pass down the umbilical and connect to onshore Scotrenewables communications equipment where the data may be stored or communicated over the EMEC internet connection located in the data rack in the EMEC facility.

The SCADA system has the facility to set up user configurable alarms that can be transmitted by email, automated phone call or text message to a dedicated duty holder's mobile. All parameters of the system can be monitored through the SCADA system and limits or ranges can be setup and alarms can be generated if the parameter goes outside this limit or range. For example, operational parameters can be setup (temperature, oil levels and pressures, etc) that if the values exceed normal ranges an alarm will be raised at the SCADA monitor. Also additional parameters like bilge alarms or fire detection alarms can be setup that display alarms on the SCADA system and additionally sends an alarm to the Scotrenewables Duty Manager's mobile.

The SR250 communication system (see Section 4.6.3) will ensure the Scotrenewables24/7 emergency response system will alert the Scotrenewables Duty Manager of any failure, who in turn will notify the EMEC 24/7 emergency response Duty Manager.

There will be a separate alarm system that will be independent of the SCADA / communication system which will send text messages or call multiple mobile numbers on detection of water ingress or smoke/fire.

A stationing verification system will allow the device to be monitored with control system alerts to the dedicated Scotrenewables Duty Manager. Through the use of a GPS, this function will observe the movement of the device and provide an alert if the system strays from the predefined operational area.

There is a battery bank and also a diesel generator on board for back-up power for emergency systems in the event of loss of grid power. The device should always be either on its moorings and connected to the grid or attached to a vessel via a tow rope. If it breaks free from either moorings or vessel the device should have approximately 10 – 12 hours of back-up power available for emergency systems.

In the event of even a single mooring line failure the device would automatically go into emergency state, and the rotors would retract. Any unusual event would lead to the system going into emergency mode as a precaution.

In terms of buoyancy, the device would be expected to float in either mode as long as there was no breach in the hull. The hull has four water tight compartments providing single compartmental failure, so a single hull breach would only result in one compartment flooding – the device will have sufficient excess buoyancy to stay afloat. Also each section will be fitted with 2 float-switch activated bilge pumps.

If a blade were to break off, the blade cavities are flooded and the density of the composite structure will be slightly heavier than water so the blades would sink.

The emergency response will include informing the Coastguard and OIC Marine Services so that vessels in the area can be alerted to the potential hazard. Scotrenewables staff and support vessel would be immediately deployed to recover the device.

7.2.8 Summary of Navigation Hazard Mitigation

Any vessels operating near the site will be made aware of it through the planned mitigation measures. For example, EMEC's Maritime Safety Information procedure will ensure the appropriate authorities, e.g., OIC Marine Services (Harbours and Ferries) and Shetland Coastguard, are informed of the device, its moorings and associated work activities such that the information is promulgated via appropriate channels to mariners.

Commercial ships including the inter-island ferries tend to keep well to the south or west of the location and therefore should not be at risk of collision with the floating device.

When not on the location, the under keel clearance of the turret (minimum 10m at LAT) is considered to pose minimal risk of collision based on the draughts of local vessels operating in the area and the wave conditions. Deeper draught vessels, such as passenger cruise ships and pelagic trawlers, tend to naturally avoid the location as they keep towards the centre of the channel

The risk of mooring line failure and potential device loss of station are safeguarded by the independent structural verification report and adhering to industry standards. In the event of a problem there are various systems in place to ensure the alarm is raised, at which time emergency response procedures would be implemented, which would include navigation warnings to vessels and recovering the device to a safe location.

Residual impact With the proposed mitigation in place it is considered that the risk posed to vessels operating in the area has been reduced to an acceptable level. However, given that this is an untried technology (at this scale) that will be operating in a challenging marine environment where other developers have failed the residual impact will have to remain ranked as MAJOR.

7.3 Cumulative and In-Combination Effects

Scotrenewables will not be operating in isolation in the Fall of Warness. A number of other developers with differing technologies are already or will shortly be deploying their devices at the test site as detailed in Table 7.1 below, and the impact on the Fall of Warness of their activities in-combination with those of Scotrenewables need to be considered.

Most of the impacts of the proposed development with mitigation in place have been ranked as MINOR or less (see Table 6.3). When these issues are looked at in combination with the impact of other developers activities it is not considered that

Scotrenewables activities would contribute to increasing the significance ranking for the test site as a whole. There are 2 issues however which need to be considered further - the impacts on marine wildlife and on other sea users.

7.3.1 Cumulative Impact on Marine Wildlife

It is very difficult to make any kind of assessment of what the cumulative impact might be of multiple operators on marine wildlife in the Fall of Warness when it is not known yet what the impact of the individual devices will be, particularly where many aspects of other developments remain commercially sensitive. Potentially, the combined activities could result in marine mammals being displaced, for example seal populations could stop using beaches in the Fall of Warness. In addition, potentially fatal strikes with operating devices could have a catastrophic impact on species populations. For example, the PBR for harbour seals is just 13 for the Northern Isles metapopulation.

Each developer will be putting in place their own environmental monitoring strategy, and EMEC will be continuing with their research projects. Hopefully by the end of 2011 when all the data available is viewed together a clearer picture of the actual impacts will emerge.

7.3.2 Cumulative Impact on Other Sea Users

<u>Navigation risk</u>

Risk of collision with operating devices

The SR250 is the only surface piercing device currently deployed or planned for deployment within the fall of Warness, apart from the Open Hydro research platform. This platform has been in place at the test site for 4 years and to date no navigation incidents have been reported, so in principal there should be no cumulative risk to surface vessels in the unlikely event that the SR250 has a structural failure. However, it is possible that that the rotors from the seabed mounted devices could become detached, float to the surface and present a risk to surface vessels, although it is not known due to commercial sensitivity what mitigation has been put in place to prevent this happening.

Use of work boats

There is potentially a greater cumulative impact from the numbers of work vessels, both big and small that will be used by developers during installation and operational activities. EMEC do however have in place a robust system for controlling vessel movements in the Fall of

Warness that is covered by the Permit to Work system to ensure activities are undertaken safely. Other sea users are kept fully informed of planned works in advance as detailed in the EMEC Marine Safety Procedure under which Notice to Mariners are issued for all significant works on the site.

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Use of local harbour facilities

There is potential for local harbours to get congested with vessels associated with marine renewables activities. OIC Marine Services are well aware of this, and will ensure that other sea users activities are not disrupted while ensuring that the needs of the marine renewables sector are accommodated.

Residual impact The four residual impacts ranked as MODERATE or MAJOR above in Sections 7.1 and 7.2 have the *potential* in combination with the impacts of the other developers to have a significant impact at a cumulative level, so cautiously the residual impact of the cumulative impact remains ranked overall as MAJOR.

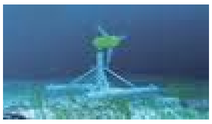
Developer	Device		Method of Deployment	Installation schedule
OpenHydro		1MW 'open centre' turbine	Housed in piled frame, later versions to be seabed mounted with gravity base/piled	Research platform installed 2006. Blank turbine placed on seabed 2008.
Atlantis Resources Corporation		1MW 3-bladed horizontal axis	Gravity base seabed mounted using DP (dynamic positioning) vessel	Installed 2010
Voith Hydro Ocean Current Technologies		1MW 3-bladed horizontal axis	Piled into seabed using jack-up barge	Installation planned 2011
Tidal Generation Limited Ltd		500kW 3-bladed horizontal axis	Piled base	Installation underway due for completion 2010
Hammerfest Strom UK Ltd		1MW 3-bladed horizontal axis	Gravity base foundation	Installation planned 2011

Table 7.1 EMEC Tidal Test Site Activity

8 Socio-economic and Environmental Benefits

Scotrenewables is an Orkney business, recognised by HIE as a 'Company of Growth Potential', which primarily employs local people and has and will continue to make use of local resources and services where ever possible. The proposed deployment and future commercialisation plans will contribute to both the Scottish and UK targets for energy generation from renewable energy sources.

8.1 Projected Socio-economic Benefits

8.1.1 Employment

Scotrenewables are a major employer in Orkney, with 15 staff currently involved in R&D activities. The project will create new and sustain all existing jobs. Recruitment will be necessary as the project develops and the intention is to develop in house expertise for deployment, marine based works and maintenance, training and developing the team alongside use of external specialist companies contracted for installation, operations and retrieval.

8.1.2 Links with Local Education

Scotrenewables was founded by the Orcadian engineering graduate Barry Johnston. He remains committed to providing work experience and employment opportunities to local students. Scotrenewables welcomes up to 3 student placements every year from Scottish Universities including Heriot-Watt University's Stromness campus the International Centre for Island Technology (ICIT), In addition, Scotrenewables has welcomed a Nuffield Foundation Science Bursaries student from Stromness Academy for the past three years. Students get to work alongside practising engineers and gain an insight into the world of scientific research and development. Indeed Barry Johnston first came to ICIT when he was 14 on a placement from his school, Stromness Academy, and the Company still maintains close links with ICIT staff.

8.1.3 Use of Local Contractors

The installation, operation and maintenance of the SR250 will provide a number of opportunities for local and regional contractors. The applicant will use local contractors where possible provided they are of appropriate calibre and experience. Sectors of local industry which could benefit include:

- Civil engineering, design and construction companies;
- Electrical service companies including design, installation and maintenance;
- Quarries and concrete suppliers;
- Steel reinforcing suppliers and fixers;
- Vessel hire;
- Divers;
- ROV surveyors;
- Plant hire companies;
- Ancillary workers; and
- Accommodation, catering and retail businesses.

8.1.4 Sourcing SR250 Components

Throughout the lifetime of the project the use of preferred Orkney/Scottish suppliers will result in significant input into both local and national economies (see Table 8.1).

	Orkney	Scotland	Other UK	Europe
Mooring system	100%	-	-	-
Subsea cable	-	100%	-	-
Superstructure	-	-	100%	-
Control systems	-	50%	50%	-
Instrumentation	-	25%	25%	50%
Hydraulic components	-	-	100%	-
Power take-off System	-	-	100%	-

Table 8.1 Source of SR250 Components

8.1.5 Tourism

While the unspoilt scenery and cultural heritage of Orkney remains a major attraction for visitors, interest in renewables activity in the County is growing. With the exception of the Open Hydro research platform all other devices currently being deployed at the EMEC tidal test site are seabed based (see Section 7.5). The SR250 will be visible and a source of great interest, while being of a low enough profile not to detract from the unspoilt seascape views Orkney is famous for.

8.2 Reduction of Emissions

Offshore renewables have the potential to significantly contribute to the reduction of greenhouse gas emissions and consequently mitigate the impacts of climate change, an issue that could affect marine mammal distribution and abundance (Evans et al., 2007).

Each unit of marine generated electricity will displace a unit of conventionally generated electricity and thus saves the emissions associated with that form of generation.

A rough calculation predicts that the SR250 project will contribute emission reductions of 70 tonnes of CO_2 each year. This is based on the accepted figure for Carbon offsetting of 430g CO_2/kWh (BWEA).

The full-scale SR250 device will produce approximately 250 x 24 x 365 x 0.3 x 0.25 = 164,250kWh annually based on 30% capacity factor at the site and availability of 25% (as it's a prototype), so equivalent to around 70 tonnes of CO_2 offset annually.

9 Health and Safety & Environmental Management

9.1 Health and Safety

Scotrenewables has a Health and Safety Management System (H&MS) in place which will be strictly adhered to throughout the project life cycle. The Health and Safety Policy states the Company's commitment to ensuring the health and safety of all persons that might in any way be affected by the Company's activities. The Company has a dedicated health and safety officer who will ensure all procedures are adhered to. Systems will be adopted to identify specific project hazards, the assessment of the risks associated with those hazards, their management by elimination or reduction, control of any remaining risks, and the mitigation of potential consequences, including the establishment of the associated emergency procedures that are to be implemented should a hazard be realised (see Appendix 9 for Scotrenewables Statement of Policy on Health and Safety at Work).

Risk assessments will be subject to a continual review process to determine the measures required to rectify any identified deficiencies in the working of the H&SMS and the actions necessary to implement those measures.

Scotrenewables is familiar with the EMEC Integrated quality, health, safety and environmental management system (IMS) and will work closely with EMEC to ensure their activities are fully compliant with this system.

9.2 Pollution Prevention and Control

It is an offence to cause pollution of controlled waters, either deliberately or accidentally. 'Controlled waters' include all watercourses, canals, most lakes and reservoirs, estuaries, lochs and coastal waters out to three miles.

9.2.1 Relevant Legislation/Guidelines

SEPA has produced a series of Pollution Prevention Guidelines (PPG). The following are relevant to this submission:

- Marinas and Craft: PPG14; and
- Works and Maintenance in or Near Water: PPG5.

Also relevant is the Small Commercial Vessel and Pilot Boat Code of Practice published by the Maritime Coastguard Agency in accordance with the Merchant Shipping (Small Commercial Vessels and Pilot Boats), Regulations 2004, from which it draws its authority.

9.2.2 Project Activities and Mitigation

During the installation and operational phase of the works there is potential for the pollution of coastal waters from oil spills and chemicals associated with both the device and the service boat. In addition the physical presence of the mooring system could have a negative impact on water quality due to seabed disturbance. Table 9.1 below details the project activities that could have a potential polluting effect and the mitigation that has been put in place to control or eliminate the risks.

Activity	Potential polluting event	Mitigation
Use of work boats.	Atmospheric emissions – fuel combustion.	Any emissions will be of a relatively small scale and quickly dispersed.
	Small oil spills discharged to sea.	Scotrenewables will ensure chartered vessels have necessary equipment to deal with small hydrocarbon spills, and that any spills are dealt with promptly.
	Waste generated on board enters marine environment.	Any waste generated on board will be stored safely and disposed of appropriately on shore.
Diesel generator in SR250 used to meet internal power requirements.	Atmospheric emissions – fuel combustion.	Anticipated infrequent use of back-up power source (see Section 4,4,5). Any emissions will be of a small scale and quickly dispersed.
	Diesel spill/leak contaminates bilge water and is pumped into the sea.	Spill tray to be included to capture fuel in the unlikely event of accidental spill or leakage to prevent bilge contamination. Re-fuelling will take place during routine harbour maintenance activities (see Section 4.6.4). Diesel tank will hold 100l.
Presence of	Potential for leakage of	Sealed gelled electrolyte lead acid batteries

Activity	Potential polluting event	Mitigation
batteries in SR250.	battery fluid and contamination of bilge water.	to be used so no risk of leakage.
Use of hydraulic/gearbox oil in SR250	Oil spill/leak contaminates bilge water and is pumped into the sea.	Hydraulic and gearbox oil will be in sealed compartment fitted with spill trays. In the unlikely event of a spill this will be removed during routine harbour maintenance. Relatively small quantities of oil – max 250l. Only biodegradable oil will be used. Oil re-filling will take place during routine harbour maintenance.
Use of bilge pumps in SR250	Contaminated bilge water pumped into the sea.	There has been no ingress of water during 5th scale trials. The SR250 will be launched via a dry dock which will be flooded to allow a watertight check to be undertaken in a controlled environment. High quality marine standard seals/gaskets to be used (see Section 4.4.7). Bilge pimps fitted as a precautionary measure. Measures taken to ensure bilge water does not become contaminated (see above).
Use of anti-fouling treatments on SR250 hull and rotors.	Potential for release of harmful biocides into the marine environment.	Anti-fouling system to be used relies on use of ultra smooth paint exterior to prevent secure attachment of fouling organisms instead of use of biocides (see Section 4.1.3).
Use of anti-corrosives on SR250.	Sacrificial anodes emit some salts as part of their process – can accumulate in sediment on seabed and bioaccumulate in benthic species.	Aluminium alloy anodes to be used to reduce level of potentially harmful salts emitted (see Section 4.4.8). Fast flowing water will ensure any salts emitted will be quickly dispersed with no harmful effects.
Presence of mooring system	Potential for scouring of the seabed leading to increased sediment	Mooring system designed to ensure minimum excursion of mooring lines (see Section 4.4.2, Table 6.3 and Figure 4.11).

Activity	Potential polluting event	Mitigation
	load in the water column.	Seabed course material (see Section 5.2.2). No increase sediment load in water column anticipated.

Table 9.1 Potential polluting activities and control mitigation

In summary:

- Good working practice will be adopted and appropriate steps taken to prevent water pollution and disturbance to sensitive receptors;
- During deployment of the SR250 in the unlikely event of any accidental oil leaks these will be dealt with during routine onshore maintenance (sealed compartments will ensure no leakage into bilge water);
- Oil/hydraulic fluid treatments will be carried out onshore to reduce the risk of leakage into the sea;
- There are no plans to use any anti-foulant chemicals on the device;
- The testing regime does not involve any routine discharges to the marine environment;
- Biodegradable lubricants (or equivalent) will be used in SR250;
- SEPA will be immediately informed of any incidents that have had or that could have had an environmental impact; and
- Scotrenewables will ensure that the vessel chartered for the works complies with all IMO/MCA codes, and has the necessary on-board equipment for identifying, segregating, storing and handling refuse and waste, and for dealing with small spills of hydrocarbons.

With the mitigation detailed above in place and the small quantities of potential pollutants proposed it is considered that the activities of the proposed project will pose no risk of polluting the coastal waters of the test site.

9.3 Environmental Monitoring Strategy

There are 2 different groups of measurements that will need to be considered in the strategy – characterisation and impact monitoring (SMRU 2010). The first – characterisation – which provides basic information on the ecological features of the area have been covered largely by Section 5 of this report and EMEC's ongoing wildlife observation programme. The second – impact monitoring – will aim to establish if the ecological value is changed as a result of the development, and this will be the main focus of the Scotrenewables strategy.

Scotrenewables appreciate the importance of establishing a robust environmental monitoring strategy not just to minimise the risk of harm to protected wildlife (marine mammals, birds and large fish species), but also to inform future larger scale deployments of the tidal turbine. The strategy will consider:

- Entanglement risk with the mooring system and umbilical;
- Collision risk/physical interaction with the device;
- Noise generated by installation and operation activities (ie workboats), and also operational noise;
- Role of the Marine Mammal Observer (MMO) in all activities;
- Behaviour of wildlife as well as presence; and
- Survey of species present –in conjunction with the EMEC wildlife observation programme.

While elements of the above will be discussed further in this section, the detailed strategy will be agreed with SNH and MS-LOT in the next couple of months in order to take advantage of the latest guidelines, technology and information available.

Initially a review of the monitoring undertaken for the 5th scale testing is discussed to establish what lessons have been learnt that will inform the next phase of testing.

9.3.1 5th Scale Testing Monitoring Protocol

Scotrenewables has worked closely with SNH throughout the last 2 years testing of the 5th scale device and established a robust monitoring protocol. The purpose of the 5th scale testing was not to leave the device operational for extended periods, but to submit the device to short periods of study to gather data to inform the computer modelling, test the communications systems and instrumentation, do survivability testing and tow trials, and also to test the mooring system. As a result, the monitoring data gathered has been relatively meagre given that testing was routinely only few hours long at a time, and not undertaken on a regular basis. However, Scotrenewables staff are now well aware of the importance of monitoring for the

SR250 testing. Scotrenewables staff are familiar with the process of working with an MMO, have a good understanding of the marine wildlife that is afforded protection, developed good observational skills and have experience of ceasing operations when a protected species is reported in the mitigation zone. This experience will prove invaluable as the Company moves to the next phase of testing in the Fall of Warness.

9.3.2 Entanglement Risk

As was discussed in Section 7.1.3, risk of entanglement with either the mooring system or umbilical is considered very unlikely. However, should any unexpected change in mooring tension be detected by the SR250 remote monitoring systems, a drop-down camera will be used to establish if an entanglement has taken place. Appropriate emergency response measures will be put in place to deal with this situation.

9.3.3 Collision Risk

The monitoring of collision risk as discussed in Section 7.1.4 is potentially one of the most critical interactions between the device and the environment. The strategy will consider the following:

- Use of PTZ underwater camera which will be directed primarily towards the rotors, and from which a live feed via the SCADA system will be provided 24 hours a day;
- The ability to distinguish between hard and soft bodied impacts;
- The use of strain gauges on the rotors to detect impacts (to be retro fitted summer 2011);
- How the SR250 monitoring systems can be used to detect a change which may be the result of a collision (camera footage will be invaluable here); and
- Contingency to put in place in the event of a strike (or suspected strike) – how will it be detected, response time, action to be taken, who to inform et.c.

Scotrenewables will be working with ICIT-Heriot-Watt University to collect hydroacoustic data from hydrophones installed on the nacelles and hull to help in the detection of impacts (see Section 7.1.5).

9.3.4 Installation and Operational Noise

An assessment was undertaken to investigate installation noise which concluded that the zone of mild disturbance will be limited to at most a few metres, and that the physical presence of the workboat is more likely to have an influence on seal (and other marine mammals) behaviour than any noise generated during installation of the SR250 (see Section 7.1.2 and Appendix 9).

The potential impact of operational noise remains unknown. As discussed in Section 7.1.1, it is unclear whether the noise levels will be high enough to disturb or possibly even harm seals and cetaceans, or so low that the presence of the device is masked by background noise that results in the device being undetectable. Scotrenewables

Scotrenewables are intending to undertake both background and device operational noise studies when the SR250 has been installed. Currently baseline data of the Fall of Warness is being acquired as part of EMEC's Acoustic Characterisation and Monitoring project ('Drifting Ears') and this will be made available to Scotrenewables. Once the device is operational Scotrenewables will work with ICIT Heriot-Watt University to collect noise data using hydrophones deployed from a small work boat which will be used to produce noise models which will enable predictions to be made about the attenuation of sound over distance.

9.3.5 Wildlife Behaviour and Presence

EMEC has already developed and established a programme of wildlife observations at the tidal test site in conjunction with the Sea Mammal Research Unit (SMRU) at St Andrews which has been running since 2005. The purpose of this was to establish a baseline dataset from which potential future displacement resulting from device operation can be assessed.

The Scotrenewables monitoring strategy to be established will include observation work to record how mammals and birds interact with the device. This role will be jointly carried out by the vessel based MMO and an on-shore observer. The level of observation work will be agreed in the development of the Scotrenewables strategy, and will reflect the timescales and activities involved in the testing programme and also seasonal variations (e.g. some species only present during summer months).

In addition to this, the hull mounted underwater camera footage (which will be recording 24 hours a day) will be routinely checked for any evidence of wildlife interactions with the device.

9.3.6 Role of the Marine Mammal Observer (MMO)

An independent MMO will be employed during installation and operational activities. The role of the MMO will be to be present on the work vessel and act immediately to protect marine mammals should they enter the mitigation zone prior to and during operations. The MMO will advise personnel onboard to delay or shutdown operations until the animals are at a safe distance and also to record behaviour and sightings at other times. The monitoring and management measures will be set out in the strategy to be agreed with SNH and MS-LOT, and it will be the MMOs responsibility to ensure requirements are adhered.

9.3.7 EMEC Research

There are clear scientific, logistic and economic benefits for co-operating with current EMEC research at the tidal test site. On-going research projects include investigating acoustic output from devices, the use of sonar to investigate sub-surface interactions, and the wildlife observation programme. Scotrenewables are committed to supporting EMEC research once the SR250 device is operational.

9.4 Environmental Commitments

It is important that the findings of this report are incorporated into the final design of the proposed development through effective environmental management. Although some of the issues associated with this development can be mitigated effectively e.g. through best environmental practice other associated minor issues can be minimised or eliminated altogether. Table 9.2 below outlines a number of commitments which will be taken forward into the next phase of the development to ensure that environmental impact is minimised.

Aspect	Commitment
Seabed and benthic habitats and species	• Seabed disturbance to be monitored during routine mooring system checks. Should significant levels of scouring be observed SNH will be informed immediately and appropriate mitigative action will be taken.
Mammals and birds	• Installation activities to be limited where possible to daylight hours to minimise disturbance to marine mammals/birds/otters. • During installation activities a Marine Mammal Observer (MMO) will be present at all times to oversee operations and ensure no

Aspect	Commitment
	protected wildlife is disturbed or harmed. • Monitoring strategy to be agreed with MS -LOT and SNH post submission of consents application. This has been delayed in order to take advantage of the latest guidelines, technology and information available. • All staff involved with the project to be made aware of environmental sensitivities with regard to timing of operations. In addition, staff will immediately alert the Scotrenewables environmental team should routine monitoring of the device indicate a possible wildlife incident. • The Scotrenewables environmental team will inform SNH immediately should an incident occur resulting in harm to protected wildlife species. • If requested, Scotrenewables will suspend activities immediately in the event of significant harm/fatality to protected wildlife species. • Strain gauges to be added during summer 2011 which will add to existing wildlife collision monitoring controls. • An EPS licence will be applied for.
Pollution prevention	• Good working practice will be adopted and appropriate steps taken to prevent water pollution. • All relevant SEPA Guidelines to be adhered to. • Scotrenewables will ensure that the vessel hired for the works complies with all IMO/MCA codes. • In the unlikely event of an oil spill from the SR250 this will be cleared up promptly. • SEPA will be immediately informed of any incidents that have had or that could have had an environmental impact. • All wastes to be disposed of in line with current Waste Management Regulations. • All maintenance activities will be carried out at harbour side.
Noise	• The noise output from the SR250 to be assessed post installation.
Local harbour	• Liaison to be undertaken with OIC Marine Services with regard to

Aspect	Commitment
facilities	use of local harbour facilities to ensure that routine activities are not disrupted.
Fishing interests	• Cable route bisects scallop dive area – OFA will be routinely notified when cable laying activities to take place via the EMEC Marine Safety Procedure. • Information on the device position, mooring lines and cable to be provided to Kingfisher Information Services, who produce paper and electronic awareness charts for fishermen.
Navigation/other sea users	• Lighting and marking to be agreed with NLB as part of consent process. • Once the marking is in place it will be checked regularly to ensure it remains effective at all times. • EMEC standard operating procedures and emergency response procedures will be strictly adhered to. • EMEC to notify the UKHO of the precise device location upon issue of the post-installation Notice to Mariners. NB device will not always be present so chart marking should reflect presence of sub-surface mooring system. • As recommended in the NRA, Scotrenewables to liaise with the RNLI Kirkwall and the MCA about the development and provide any further information requested to assist SAR response. Once the device is on station, the lifeboat at Kirkwall should be invited to visit the site to view the device setup. • Scotrenewables to establish an Emergency Response Procedure (ERP) in the event of mooring line/device failure which will dovetail with the EMEC ERP.
EMEC operations	• Dive survey post installation of route crossing EMEC cables to establish if extra stability is required.
Work force	• Local contractors to be used where possible;
Testing timetable	• EMEC/SNH and MS-LOT will be routinely informed of changes/updates regarding testing activities and timescales.
Decommissioning	• A decommissioning plan will also be submitted to DECC under the Energy Act 2004 prior to device deployment.

Table 9.2 Environmental Commitments

10 Conclusions

10.1 Approach and Consultation

The main focus of this ES has been installation, operation and decommissioning of the SR250 tidal turbine.

Environmental criteria have had an important role to play throughout the decision-making process of this project and the project has strived to gather the most up to date information to provide a robust environmental baseline with which to inform the report including commissioning a number of individual assessments.

EMEC identified consultees and local stakeholder groups were consulted throughout the process and their input has informed the final report.

There are a number of positive aspects of the development both environmentally and socio-economically that will benefit local businesses and the wider community of Orkney, including:

- Scotrenewables is a significant employer in Orkney and provides work experience and employment opportunities for local engineering students;
- Where possible Scotrenewables are committed to using local contractors, expertise and suppliers; and
- The proposed deployment and future commercialisation plans will contribute to both the Scottish and UK targets for energy generation from renewable energy sources.

These positive aspects to the proposed development should also be considered when viewing the potential impacts project as a whole.

10.2 Residual Environmental Issues

Measures have been taken during the design process to mitigate and avoid environmental impact where possible. The six remaining residual impacts ranked Minor or greater are:

<u>Impact of surface and sub-surface noise on marine wildlife</u>

Although noise associated with installation, maintenance and decommissioning activities is considered likely to pose only a mild, very localised disturbance to marine mammals, given the importance of species known to use the Fall of Warness, and the unknowns surrounding the impact of operational noise the residual impact remains ranked as MAJOR.

Risk of displacement or disturbance to marine wildlife

The installation, maintenance and decommissioning activities are considered to pose only a mild, very localised disturbance to marine species. Although the scale of the development is relatively small and the device will not be deployed for a continuous period during the testing programme given the importance of species known to use the Fall of Warness, and the uncertainty that surrounds this issue the residual impact is ranked as MODERATE.

Risk of marine wildlife becoming entangled/entrapped in mooring system or umbilical

Although it is considered very unlikely that marine mammals, diving birds or basking shark could become entangled in either the cable or mooring system, as this is an untried technology at this scale the residual impact is ranked as MINOR.

Risk of marine wildlife colliding with operational device

Given the uncertainly that surrounds the risk of collision with the device and the importance of identified protected species both at individual and population level the residual impact remains ranked as MAJOR.

Navigation Risk

With the proposed mitigation in place it is considered that the risk posed to vessels operating in the area has been reduced to an acceptable level. However, given that this is an untried technology (at this scale) that will be operating in a challenging marine environment where other developers have failed the residual impact will have to remain ranked as MAJOR.

Cumulative impacts

It is very difficult to make any kind of assessment of what the cumulative impact might be of multiple operators in the Fall of Warness when the impact of the individual devices remains unknown, particularly where many aspects of the developments at the site remain commercially sensitive. The four residual impacts ranked as MODERATE or MAJOR above have the *potential* in combination with the impacts of the other developers to have a significant impact at a cumulative level. So cautiously the residual impact of the cumulative impact remains ranked overall as MAJOR.

Careful site selection and appropriate mitigation measures have ensured that the impacts of the proposed development will be NEGLIGIBLE or non-existent on seabed habitats, water quality, cultural heritage and fishing interests.

10.3 Summary

Scotrenewables is seeking permission to install and operate a 250kW tidal turbine, the SR250, at the EMEC tidal test site in the Fall of Warness, Orkney. The SR250 is an innovative, floating tidal energy converter with dual horizontal-axis counter-rotating rotors. The Scotrenewables tidal turbine has undergone extensive scale model testing and hydrodynamic modelling since 2002. The 1/5th scale model has undergone a comprehensive open-sea test programme at Burra Sound in Orkney with encouraging results that has thoroughly validated the design and concept. It is proposed that the SR250 prototype will be installed by March 2011 and be grid connected via the EMEC sub-station with a newly installed cable.

The aim of this report was to identify the environmental receptors which may be sensitive to the installation and operation of the SR250. While Scotrenewables have done all they can to ensure that the environmental impacts of the proposed development have been reduced to a tolerable level with robust mitigation and rigorous attention to design, they appreciate that this is an untried technology (at this scale) in a challenging marine environment where other developers have failed. Scotrenewables recognise how important it is that robust mitigative measures are put in place until the potential impacts on marine wildlife and implications for navigation safety are better understood.

The marine renewables industry is now at the pre-commercial stage, and the EMEC test site was established to allow the opportunity for the validation of technologies and so the industry could learn in advance the potential issues surrounding full scale commercial deployments. From the outset the Scotrenewables approach has been to de-risk the testing of the Scotrenewables tidal turbine by undertaking an incremental staged development plan in a safe and controlled manner. The information and experience gained from the SR250 deployment will give Scotrenewables the knowledge and confidence to take the step to a 1MW full-scale prototype at a more exposed and energetic location, before moving onto a larger commercial development.

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12 Appendices

Appendix 1: Dimensional drawing of full scale SR250

Appendix 2: Scoping Feedback

Appendix 3: Device Specific Navigation Risk Assessment

Appendix 4: Materials Specification Sheets

Appendix 5: Shore Birds

Appendix 6: Sanday SAC – Information to Inform Appropriate Assessment

Appendix 7: Faray and Holm of Faray SAC – Information to Inform Appropriate Assessment

Appendix 8: Seabed Survey Report

Appendix 9: Supplementary study conducted to ascertain the attenuation of sound from the operations on site during the installation of the SR250

Appendix 10: Scotrenewables Statement of Policy on Health and Safety at Work

<u>These appendices are available in Volume II of this report.</u>