Navigational Safety Risk Assessment for Sound of Islay Demonstration Tidal Array

ScottishPower Renewables Limited

Revision 3 - March 2013, Confidential

PMSS

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Document Control

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References

1	ARC Report 266-004 Rev 2 dated July 2010	Abbott Risk Consulting - Navigational Safety Risk Assessment for ScottishPower Renewables (UK) Limited Proposed Demonstration Tidal Array in the Sound of Islay
2	DECC (DTI) Guidance on the Assessment of the Impact of Offshore Wind Farms	Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms
3	Maritime and Coastguard Agency's (MCA) Marine General Notice MGN 371 (M+F)	Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response Issues
4	Admiralty Sailing Directions NP 66 15th Edition 2004	The West Coast of Scotland Pilot
5	Admiralty Tidal Stream Atlas NP222	Firth of Clyde and Approaches
6	Admiralty Tide Tables NP 201	Vol 1 UK and Ireland
7	RPS Consulting Report – Extreme Wave Analysis	RPS Consulting – ScottishPower Renewables – Sound of Islay Tidal Stream Site Analysis – Extreme Wave Analysis
8	The Underwater World Publication – Dive West Scotland	Lawson Wood
9	Dive Islay Wrecks	Steve Blackburn
10	RYA UK Atlas of Recreational Boating	Recreational Cruising Routes, Sailing and Racing Areas around the UK Coast; 2005
11	International Maritime Organisation (IMO) IRPC 1972	International Regulations for Preventing Collisions at Sea 1972 as amended. "ColRegs".
12	Statutory Instrument 2007 No. 1948	Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007
13	Admiralty Publication 5011	Symbols and Abbreviations used on Admiralty Charts
14	IALA Recommendation O-139	Marking of Man-Made Offshore Structures; Edition 1 December 2008

Abbreviations

AHH	Andritz Hydro Hammerfest
ALARP	As Low as Reasonably Practicable
MSL	Mean Sea Level
AtN	Aid to Navigation
DECC	Department of Energy and Climate Control
DP	Dynamic Positioning
DTI	Department of Trade and Industry
EMEC	European Marine Energy Centre
GLA	General Lighthouse Authority
IALA	International Association of Lighthouse Authorities
LAT	Lowest Astronomical Tide
MBS	Maritime Buoyage System
MCA	Maritime & Coastguard Agency
MGN	Marine General Notice
MSI	Maritime Safety Information
MW	Megawatt
NLB	Northern Lighthouse Board
NM	Notice to Mariners
NSRA	Navigational Safety Risk Assessment
PMSS	Project Management Support Services
OREI	Offshore Renewable Energy Installation
SPR	ScottishPower Renewables Ltd
TCE	The Crown Estate
THLS	Trinity House Lighthouse Service
UKC	Under Keel Clearance
UKHO	United Kingdom Hydrographic Office

1. Introduction

1.1. Background

ScottishPower Renewables Limited (SPR) is proposing to develop a Demonstration Tidal Array in the Sound of Islay, between the islands of Islay and Jura on the west coast of Scotland. The tidal array will consist of ten tidal stream generating devices that will be fully submerged on the seabed just south of Port Askaig. The candidate device is the HS1000 tidal turbine, developed by Andritz Hydro Hammerfest (AHH) and the proposed array will have the capacity to generate 10MW of power. In July 2010 an application for consent for this project was submitted to Marine Scotland and was consented on the 16th March 2011.

SPRL and AHH have recently revised some of the device characteristics and the device installation methodology as a result of experience and lessons learnt in the deployment of the device at the European Marine Energy Centre (EMEC) in Orkney. In addition, the cable corridor and landing point have been revised as a result of further studies.

As a result of these revisions, SPR require the Navigational Safety Risk Assessment (NSRA), developed for the initial consent submission, to be reviewed and revised to reflect these changes and to determine whether the risk estimates in that report require to be revised in the light of those changes.

1.2. Aim

The aim of this report is to review the differences between the revised device/array/cable characteristics and the installation methodology and those described in the previous study and provide arguments as to the tolerability (or otherwise) of the risks arising from those changes. Where appropriate, the report will identify any changes required to the controls and risk mitigation measures previously proposed in the July 2010 study and report.

1.3. Scope

The scope of work involves the review and revision of the NSRA report undertaken in July 2010 by Abbott Risk Consulting (ARC Report 266-004 Rev 2 dated July 2010 - Navigational Safety Risk Assessment for ScottishPower Renewables (UK) Limited Proposed Demonstration Tidal Array Sound of Islay - Reference 1).

The methodology used for the assessment process follows that in the DTI/DECC guidance DECC (DTI) Guidance on the Assessment of the Impact of Offshore Wind Farms "Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms" (Reference 2 and the Maritime and Coastguard Agency's (MCA) Marine General Notice MGN 371 (M+F) – "Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response Issues" (Reference 3).

The report will be intended for submission to the consenting authority and the appropriate statutory stakeholders (e.g. Maritime and Coastguard Agency (MCA) and the Northern Lighthouse Board (NLB)) as part of a revised/updated submission required in the light of the changes.

2. Risk Claim

2.1. Navigational Risk Claim

The navigational risks from the original demonstration array for the installation, operational and decommissioning phases were considered as "Tolerable with monitoring"[1]. These, however, were predicated on the use of a DP vessel during installation and the original dimensions of the proposed devices. The change to the device installation procedures now include the use a barge, tugs and mooring which will, to a greater extent than a DP vessel, impede traffic in the channel during device installation. The introduction of an unpowered barge and mooring with tug assistance introduces new hazard scenarios which have been addressed in a recent Hazard Identification and Risk Assessment workshop. However, as the on-site duration of the barge will not change significantly from that proposed for the DP vessel i.e. short duration "on-task" windows, and the arrangements for the mooring remove the hazard in the intervening periods, then the risk to shipping from the installation process is still considered as "Tolerable with Monitoring".

The installation methodology also now includes the concept of a "staging location" area between the construction yard (yet to be determined) and the array site. This will involve the temporary offload and storage of the support structures (see Section 4) in a sheltered inshore facility somewhere as the structures are built until there are sufficient structures available to commence the installation process. Staging locations being considered include Campbeltown, Belfast Lough and Oban. This phase of the pre-installation activities has been examined and, given the application of suitable controls agreed with the Port Authorities responsible for the waters in which structures will be stored, is considered as "Tolerable with Monitoring".

There is also now a requirement for "standby" moorings within the Sound of Islay adjacent to the project area so that the installation spread can, after arrival from the staging location with items for installation, secure to a buoy and wait for the installation window to "open". The areas being considered for this are the anchorage areas designated on the chart at Bunnahabhain Bay, Whitefarland Bay and McDougall's Bay.

The effect of the increase in overall height of the individual devices has been, to an extent, mitigated by micro-siting using the detailed bathymetric information available. Hence, the <u>minimum</u> Under Keel Clearance (UKC) for the deepest draught vessel known to have used the area on a single occasion is now 6.1m (as opposed to 8m) and for the CalMac ferries using the area on a regular basis it is now 10.1 (as opposed to 12m). It should be noted that such clearances would only occur in a specific combination of circumstances i.e. a negative surge occurring at LAT and during the passage of an infrequent visitor to the sound which manages to pass over the single turbine sited in the least depth.

The reduction in depth was considered to have changed the assumptions in the previous report that the potential Under Keel Clearances (UKC) between the devices and the deepest draught vessel were such that further analysis of the theoretical possibility of contact in various sea states and swell conditions was not necessary. Hence, this report has addressed that issue in greater detail. That analysis has concluded that, if the new dimensions of the turbines were applied to <u>all</u> turbines in all the positions, even assuming a combination of extreme conditions, there is no risk of collision between even the deepest draught vessel (7.5m) and the shallowest turbine.

Given the siting and depths of the other turbines, the normal range of tidal heights and, hence the clearances which exists for the greater part of the time, the risk to shipping from the presence of the array as a whole is considered as remaining "Tolerable with Monitoring".

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[1] Risk Tolerability definitions throughout this report are taken from DTi/DECC publication - Guidance on the Assessment of the Impact of Offshore Wind Farms (Reference 2) Table C.4.4. These are also contained at Annex D.

There does, however, remain the same level of risk to vessels engaged in creeling activities in the sound where, in circumstances involving a fishing vessel stopped in the water to recover a fleet of creels which have become entangled or snagged, the vessel may drift with the tide over the devices in the array causing the gear to become entangled and, potentially, lead to vessel capsize. This represents the worst case scenario.

There is also a risk to recreational divers if they were to undertake one of the dives identified in a diving guide for the area. This recommended the use of the area where the devices are to be sited to conduct a "deep" dive. However, with the application of the controls identified in this report, the risks to these two activities are considered to remain as "Tolerable with Monitoring".

Risk controls necessary to achieve the acceptable level of risk for the demonstration array are identified in this report and are required to be implemented prior to installation and operation and will require to be checked periodically. The impact of the siting of the array will be monitored throughout its deployment.

2.2. Supporting Reasoned Argument and Evidence

The supporting arguments for the original assessments were made in the original report (Reference 1) and were derived from qualitative analysis based on a number of sources of data including expert opinion (both written and oral) of the marine users of the area and quantitative data regarding vessel movements. Those arguments have been updated in this report to reflect the changes specified in Section 4.2.

3. Description of the Marine Environment

3.1. Current Marine Environment

3.1.1. General

The source of much of the data in the following section is derived from:

- Admiralty Sailing Directions NP 66 – The West Coast of Scotland Pilot (Reference 4);
- The Admiralty Tidal Stream Atlas NP222 – Firth of Clyde and Approaches (Reference 5);
- Admiralty Tide Tables NP 201 – Vol 1 UK and Ireland (Reference 6).

The Sound of Islay separates the islands of Islay and Jura. The sound is used by mariners to avoid the open sea west of Islay and forms part of the Inshore Traffic Route[2]. It is not recommended for medium or large size vessels[3] on account of a rocky bank, with a least depth over it of 9.1m situated in the fairway and extending for 2.5 n miles south from the north entrance to the sound and due to the strength of the tidal streams.

The main harbours and slipways in the sound comprise the following:

- Port Askaig;
- Feolin Slipway;
- Bunnahabhain Bay Pier.

The general layout is shown at Figure 1.

[2] The Inshore Traffic Route along the West Coast of Scotland connects the Mull of Kintyre at the north end of North Channel with Rubha Reidh at the south end of North Minch. This route is only recommended for “small” vessels. (See Admiralty Sailing Directions –West Coast of Scotland Pilot NP 66, (Reference #))

[3] Vessel categories as used in ASD are not considered as standard, internationally accepted definitions but the following provides a rough guide to vessels sizes. Tonnage used here is displacement tonnage (in metric tons). “Small” = <2000te, “Medium” = 2000 – 20,000te, “Large” = > 20,000te.

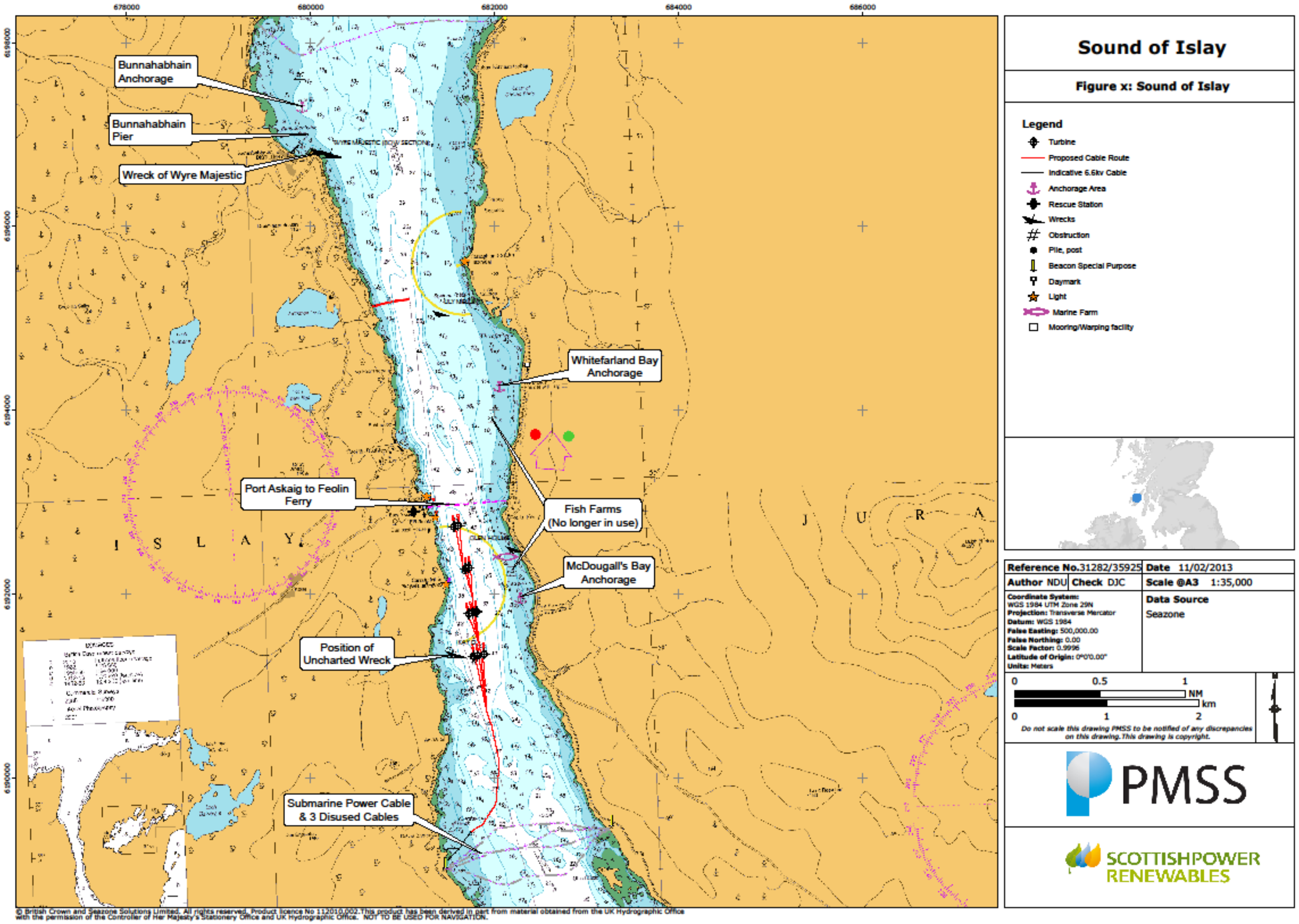

Figure 1 Sound of Islay

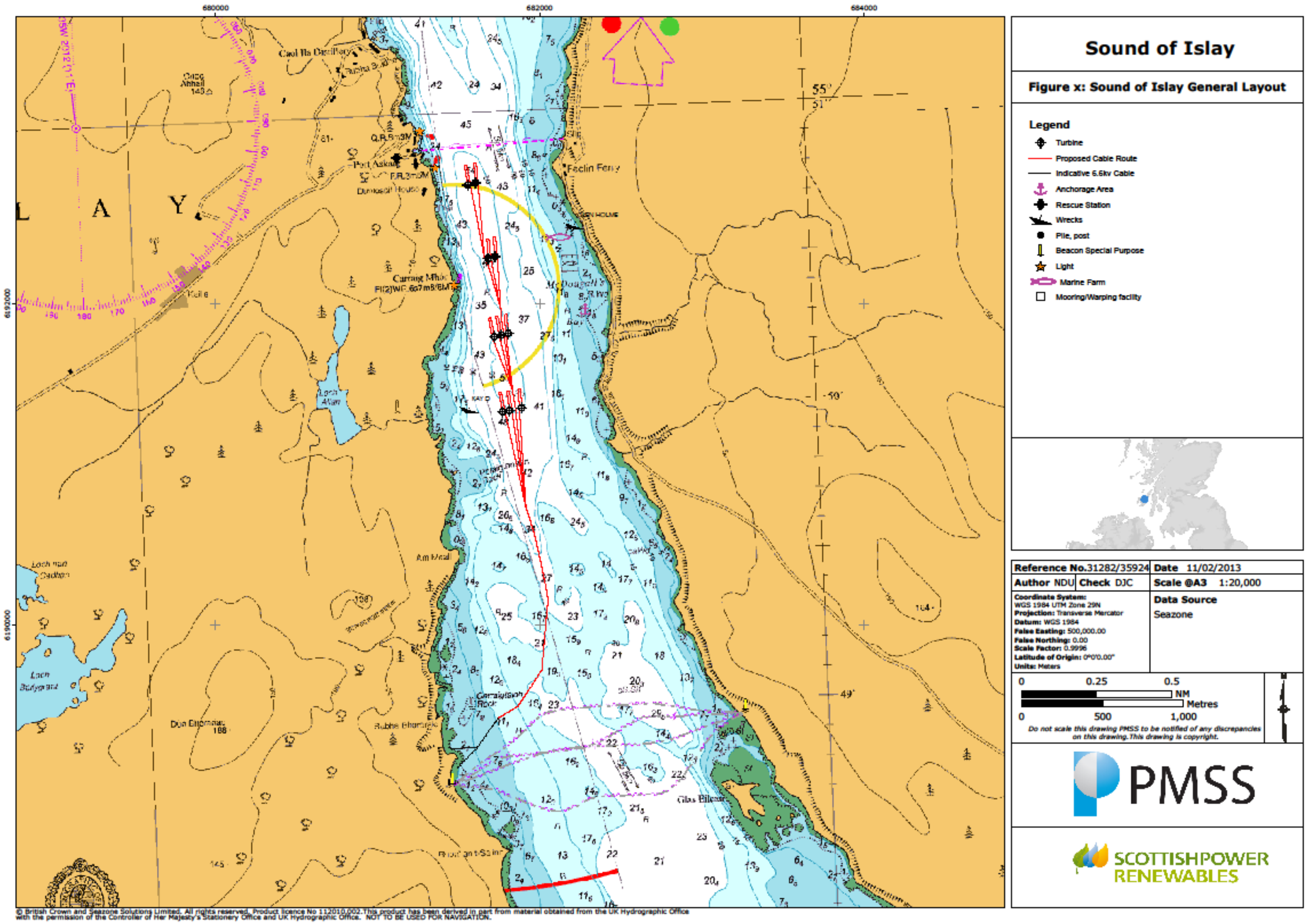

Figure 2 Array Location Showing Export Cable Landing Location

3.1.2. Search and Rescue

The Sound of Islay area lies within the UK Maritime Search and Rescue operational area administered by the Clyde Maritime Rescue Co-ordination Centre (MRCC) based at Greenock. The issues surrounding the impacts on SAR activities are discussed in Section 9.

3.1.3. Anchorages

The sound is not recommended for anchorage except during fine weather in the summer as the tidal streams are strong and the bottom of gravel, rock and shells encumbered with long seaweed is very uneven and is not good holding ground.

The following anchorages within the sound are marked on Admiralty Chart 2481 and are described in the Admiralty Sailing Directions (Reference 4):

- McDougall's Bay provides sheltered anchorage for small craft. It is approximately 1 cable offshore in a depth of 7m and lies out of the strength of the tidal stream.
- Whitefarland Bay affords shelter for small craft. It is on the east side of the sound opposite Caol Ila distillery in 7 - 8m water depth and out of the strength of the tidal stream.
- Bunnahabhain Bay affords good anchorage for small craft whilst awaiting slack water for passage southwards through the sound. It lays 2 cables off the shore in 10m water depth.

3.1.4. Wrecks

There are a number of wrecks marked on Chart 2481 within the sound. In addition, SeaZone hydrospatial data indicates the presence of a wreck some 4.2 cables (778m) south of Carraig Mòr in 25m of water immediately adjacent to the proposed array area. The wreck lies just outside of the area surveyed by IX Survey on behalf of SPR (see Figure 1).

3.1.5. Submarine Cables

A submarine power cable carrying the grid supply from Jura to Islay and three unused submarine cables cross the sound between a point on the east shore, 2.5 cables (463m) north of Glas Eilean and a point on the west shore as shown in Figure 2.

3.1.6. Tidal Stream

The tidal stream sets generally in the direction of the channel. The rates at spring tides in the area of the sound under consideration are in the order of 5kn as indicated on Chart 2481. Eddies occur in McDougall's and Whitefarland Bays. In the former, an eddy sets south during the north going stream and in the latter an eddy sets north during the greater part of the south going stream. There are no other tidal data associated with the sound (e.g. tidal diamonds on the chart or observations recorded in the Tidal Stream Atlas for the area (Reference 6).
A tidal stream survey was conducted between May/June 2009 using Acoustic Doppler Current Profilers (ADCPs) at a number of locations in the proposed deployment area in order to understand the tidal stream throughout the entire water column. The average tidal stream rates obtained by that survey are shown at Table 1.

Tidal Stream – Average Flow		
Spring Peak	2.7m/s	5.25kn
Neap Peak	1.6m/s	3.11kn

Table 1 Tidal Stream Rates from May/June 2009 Survey

3.1.7. Tidal Height

Tidal height data for Port Askaig, adjacent to the proposed site, for average meteorological conditions, is shown at Table 2. It is reported in the Admiralty Sailing Directions (Reference 4) that the height of tide in the sound is greatly affected by the wind and barometric pressure. A south westerly wind and/or low pressure raises the level by up to 1m and a wind from the north east and/or high pressure reduces it by a similar amount.

	LAT	MLWS	MLWN	MSL	MHWN	MHWS	HAT
Standard Port – (OBAN)	0.0	+0.7	+1.8	+2.4	+2.9	+4.0	+4.5
Secondary Port Differences (PORT ASKAIG)		-0.3	-0.8		-1.4	-1.9	
Heights relative to Chart Datum		**+0.4**	**+1.0**		**+1.5**	**+2.1**	
			Mean Range (Neaps) 0.5 metres				
		Mean Range (Springs) 1.7 metres					

Table 2 Tidal Height Data - Port Askaig

3.1.8. Wave Climate

SPR commissioned an extreme wave analysis study (Reference 7) from RPS Consulting as part of the site investigation work. The findings of this study for the site off Port Askaig are shown in Tables 3 and 4. As can be seen the maximum wave heights (Hmax) predicted by the modelling occur at slack water and are in the order of 2m with a significant wave height (Hs) of around 1m.

Time in relation to slack tide	Direction of current flow	Significant wave height [m]	Max wave height [m] *	Peak wave period [sec]	Mean wave period [sec]	Peak wave direction [°]	Mean wave direction [°]
-6	353	0.93	1.88	3.45	2.87	167	162
-5	353	0.83	1.69	3.18	2.64	163	156
-4	353	0.72	1.48	3.14	2.60	163	154
-3	353	0.69	1.41	3.12	2.59	163	154
-2	353	0.74	1.50	3.11	2.58	163	155
-1	352	0.82	1.68	3.17	2.63	163	156
slack water	-	1.04	2.10	3.60	2.99	167	161

Table 3 Extreme Wave Condition (1%AEP) at Site for Wave Approaching from a Southerly Direction

Time in relation to slack tide	Direction of current flow	Significant wave height [m]	Max wave height [m] *	Peak wave period [sec]	Mean wave period [sec]	Peak wave direction [°]	Mean wave direction [°]
slack water	-	1.02	2.04	4.17	3.46	350	356
+1	174	0.77	1.58	3.13	2.60	2	5
+2	174	0.69	1.42	3.03	2.51	4	8
+3	174	0.63	1.30	2.90	2.40	5	9
+4	174	0.66	1.36	2.86	2.37	5	8
+5	175	0.70	1.44	2.91	2.42	2	4
+6	174	0.85	1.74	3.27	2.71	356	1

Table 4 Extreme Wave Condition (1%AEP) at Site for Wave Approaching from a Northerly Direction

3.1.9. Weather Data

The climatic data at Table 5 is an extract of data for Orsay on the south west coast of Islay taken from the Admiralty Sailing Directions for the West Coast of Scotland (Reference 4). The Sound of Islay is, to an extent, protected from the full force of the conditions affecting Orsay. It should be noted that, according the Admiralty Sailing Directions, the prevailing wind at Port Askaig is from the south east i.e. blowing up the line of the sound.

Month	Av Press	Mean Daily Max Temp (°C)	Mean Daily Min Temp (°C)	Average Precipitation (mm)	Mean Wind Speed (Kn)	Number of Days with Gales	Number of Days with Fog
Jan	1007	8	3	136	20	10	1
Feb	1007	7	3	97	20	9	1
Mar	1009	8	4	126	19	6	1
Apr	1012	10	5	83	15	2	3
May	1013	12	7	52	16	1	3
Jun	1014	14	9	74	13	0	4
Jul	1013	16	11	91	13	Rare	6
Aug	1014	16	12	121	14	1	3
Sep	1012	14	10	94	16	2	1
Oct	1008	12	9	129	18	4	Rare
Nov	1007	10	6	112	19	6	Rare
Dec	1008	9	5	118	19	8	Rare

Table 5 Climatic Table for Orsay, Islay

3.1.10. Bathymetry

The bathymetric data on the Admiralty chart was obtained from surveys conducted in 1955-56. A detailed hydrographic survey has been undertaken of the proposed deployment area by IX Survey Ltd in July 2008. The resultant bathymetry, covering the proposed area of deployment is shown at Figure 3.

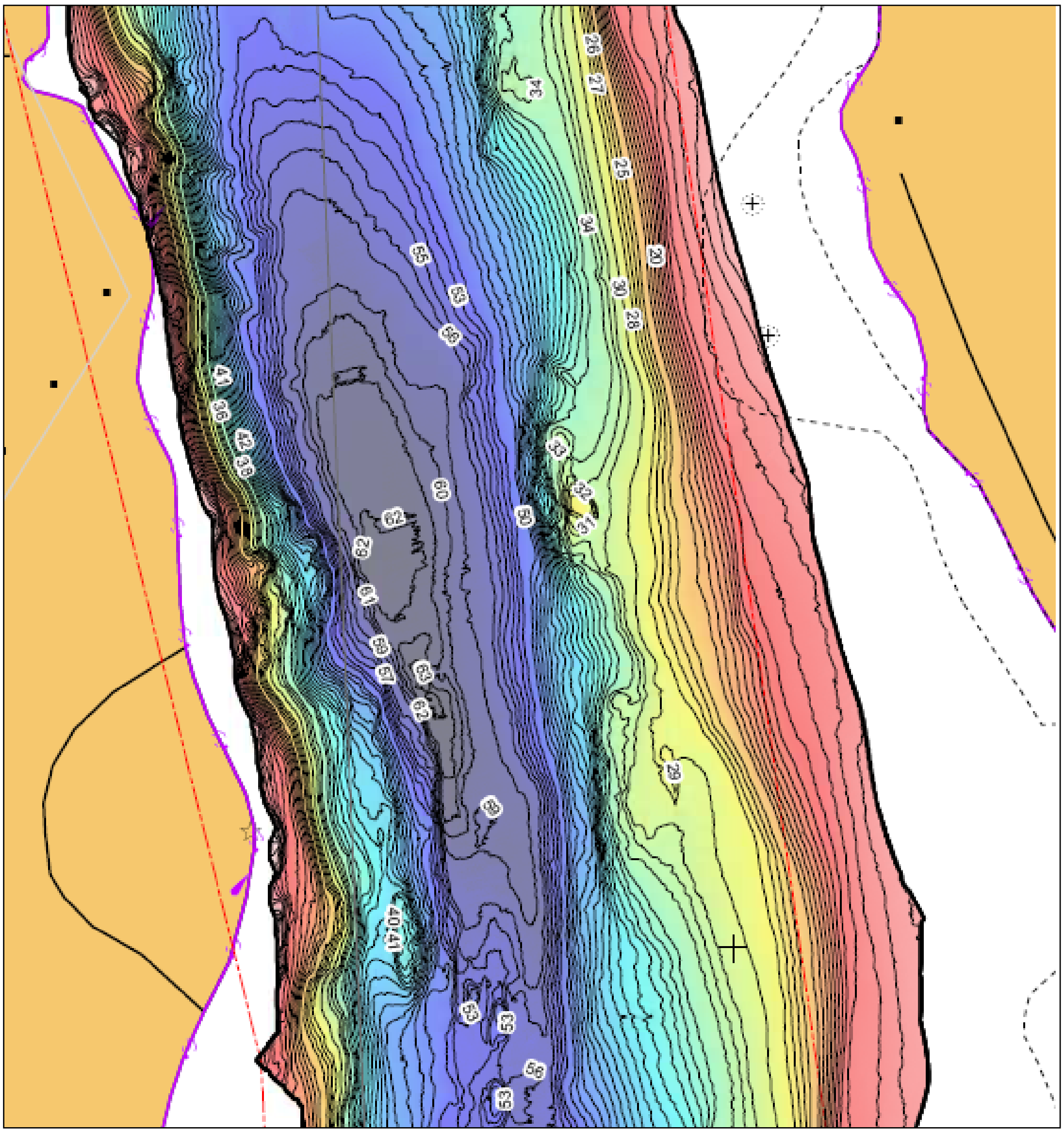

Figure 3 Sound of Islay Bathymetric Survey

It should be noted that limiting depths for vessels using the sound are set by the relatively shallow areas in the north of the sound where there is a rocky bank running along the line of the sound with least depths of 9.1m at the northern end whilst the navigable channel to the east of the bank has a least depth of 10.2m.

4. Description of the Development and the Impact on the Marine Environment

The proposed demonstration array consists of the shore facility element and an offshore element. The position of the shore facility has no impact on the navigational issues. The offshore element comprises a subsea cable and the devices situated within the overall demonstration area.

4.1. The Demonstration Array Area

4.1.1. Array Area Selection

An extensive site selection study was carried out by SPR. It examined areas around the coast of the United Kingdom and Ireland to identify potential sites for the location of the tidal site. The following constraints were considered:

- Technical (including tidal resource, grid and accessibility);
- Environmental (habitats, species and seabed profile including bathymetry);
- Commercial (including fishing, shipping and recreation);
- Economics;
- Policy and Designation.

A range of external environmental organisations were also consulted during this study. Information and comments received from the consultees were considered during the site selection process. Based on the above study, three areas around the United Kingdom were identified as having potential for the location of the tidal array: Pentland Firth, North Channel and Islay.

A further review of these areas resulted in the selection of the Sound of Islay for the location of the demonstration tidal array.

4.1.2. Array Area

The criteria for the site included appropriate depths of water to accommodate the device intended for deployment. In general, the device requires water depths of greater than 40m. Within the Sound of Islay, the area identified as suitable is bounded by the 48m contour and is shown in Figure 2. The devices are arranged in 4 sub-arrays as shown. The individual positions and depths for each device are shown at Table 6. It should be noted that the least charted depth in which the devices will now be sited is now 52.6m (as opposed to 50m) due to further micro-siting studies that have taken place using the detailed bathymetry.

Turbine	Depth (CD)	Lat/Long (DMS)		Lat/Long (DD)	
1	55.4	55° 50' 47.00N	6° 6' 02.28W	55.84638879	-6.100632114
2	55.6	55° 50' 47.07N	6° 5' 59.41W	55.84640864	-6.099834920
3	59.9	55° 50' 33.28N	6° 5' 56.46W	55.84257692	-6.099016429
4	56.8	55° 50' 34.56N	6° 5' 52.26W	55.84293416	-6.097850661
5	52.6	55° 50' 13.82N	6° 5' 53.11W	55.83717117	-6.098085372
6	53.7	55° 50' 13.88N	6° 5' 50.24W	55.83718922	-6.097288501
7	52.6	55° 50' 13.95N	6° 5' 47.37W	55.83720815	-6.096491562
8	52.8	55° 50' 02.99N	6° 5' 50.08W	55.83416416	-6.097245667
9	53.8	55° 50' 03.00N	6° 5' 47.21W	55.83416780	-6.096448334
10	52.8	55° 50' 03.02N	6° 5' 44.02W	55.83417202	-6.095561507

Table 6 Device Positions and Depth

4.2. Tidal Energy Device

SPR intend using a tidal turbine device developed by Andritz Hydro Hammerfest (AHH). Details of the device and the array are given below.

4.2.1. Andritz Hydro Hammerfest Device & Array Details

The tidal device to be deployed has been designed and developed by Andritz Hydro Hammerfest (AHH). The device is a development of a 1MW commercial scale prototype, currently undergoing a period of research, development and testing at EMEC (Figure 4). This device was installed in December 2011 and is in turn the evolution of a highly successful 300kW device that was installed and has operated continuously from 2004 to 2007 and again from 2009 until the present day in Norway (Figure 5). The existing 1MW prototype device will be developed to provide a device of 1MW output to be deployed at the Islay site in a demonstration array of up to 10 devices. Figure 6 shows an artist's impression of the deployed array of devices.

Since the previous report submitted as part of the consent application in 2010, there have been some revisions to the characteristics of the device which have resulted in an increase in its dimensions. The rotor hub height has increased by 4m from 22m to 26m whilst the rotor diameter has increased by 3m from 23m to 26 m. This has resulted in an overall increase in the height above the seabed of 5.5m to 39m.

The main parameters of the device and support structure are given at Table 7.

Item	Dimension
Height of Tripod Structure (without nacelle)	24m
Nacelle Hub centreline height above seabed	26m
Rotor diameter	26m
Height of device above seabed (to top of rotor swept arc)	39m
Estimated mass of device	320te
Gravity base securing masses	450te

Table 7 Main Device Parameters

Figure 4 Andritz Hydro Hammerfest 1MW EMEC Tidal Turbine

Figure 5 Andritz Hydro Hammerfest 300kW Tidal Turbine

Figure 6 Artists Impression of Islay Array

4.2.2. Tripod Sub-Structure

The generating turbine is mounted on a tripod support structure as shown at Figures 4, 5 & 6. The structure may incorporate a self-levelling device to ensure that the turbine nacelle is horizontal.

The device substructure has been designed using data gained from the lengthy testing of the prototype 300kW device in Norway and the European Marine Energy Centre (EMEC) 1MW device. The design will be subject to third party validation by Det Norske Veritas (DNV) and has been undergoing testing at the EMEC tidal test site in Orkney prior to being deployed in the Sound of Islay.

It is anticipated that the structure will be secured to the seabed by means of ballast weights placed on each foot. However, if seabed conditions show that this is not appropriate, alternatives, such as pinning, will be considered.

4.2.3. Nacelle Generator

The device consists of a single 1MW power train with a three-bladed rotor. The rotor hub, power train and electrical equipment form a single, long cylindrical nacelle structure, which is fixed to the tripod near its centre of gravity. The nacelle is able to yaw and will rotate with changes in tidal direction. The nacelle contains a shaft, bearings, gearbox, generator, power electrical equipment, and auxiliary systems. The auxiliary systems include hydraulic systems for blade pitch control and mechanical brake operation. The rotor blades are controllable in pitch in order to maximise the energy extracted from the tidal stream depending on the tidal direction and strength.

The rotor diameter chosen for each location is dependent on the tidal stream, required power output, the depth of water and the required clearance above the device. The rotor diameter for the devices proposed for deployment at Islay will be 26m (see Section 4.2.1). The rotor will be made out of either steel or a composite material.

A mechanical brake is located on the high speed shaft between the gearbox and generator. This, in conjunction with the pitch control system, allows the rotor to be stopped in an emergency or for maintenance and inspection purposes.

None of the nacelle components or elements of the rotor are buoyant. In the case of catastrophic failure of any part of the structure, the components will sink to the seabed and be subject to the forces of the tide.

4.2.4. Subsea Cabling

There will be no inter-array cabling, i.e. the devices will not be linked to each other. There will be no subsea or above surface substation, from where a single export cable will come to shore, as there is sometimes in offshore wind farms. Instead there will be ten separate subsea electrical cables, one export cable per device, in order to export power to the national grid.

These ten separate export cables will be a medium-voltage, armoured cable laid on the seabed with protection at specific locations or throughout the route, such as mattresses or cast iron bend restrictors which clamp around the cable. The landfall position for the subsea export cables will be on the Islay side of the sound in the vicinity of 55'48.743N 6'6.217W (see Figure 2).

4.2.5. Lifecycle

It is currently proposed that the array will operate for 25 years. At the end of this period, the array will be decommissioned and the tidal devices removed to a standard meeting industry best practice at the time. Alternatively, a fresh application may be made to extend the life of the array, or to replace the existing turbines.

4.3. Installation

4.3.1. Principals

The installation methodology has been developed from the experience gained from the 2011 deployment of the Andritz Hydro Hammerfest HS 1000 turbine at EMEC. This has included its recent retrieval in January 2013 for routine maintenance as well as other operational activities at EMEC by AHH and other marine and specialist operators.

The principals behind the methodology proposed for the Sound of Islay array are:

- A purpose built barge, ancillary steelwork and installation methods, designed specifically around the AHH machine and tidal turbines, will be employed rather than using vessels and standard methodologies from the oil and gas industry which are more suited for non or low tide sites.
- The installation activity will consist of short duration work packages as opposed to long periods of commitment at each turbine location.
- The installation activities/work packages are required to be interruptible with the capability to leave the device/site quickly and in a safe condition, with the objective of achieving a similar time on task as a DP heavy lift vessel.
- No reliance on divers or Remotely Operated Vehicles (ROVs).

Short duration work packages which are highly interruptible reduce / mitigate operational and navigational risks. This is achieved because the duration of commitment is engineered to be a fraction of the work package duration and an even smaller fraction of the entire construction process.

The advantages of this approach to installation methodology have been proved at EMEC. The successful deployment of the HS1000 turbine in the poor weather of October to December 2012 was achieved because of short duration work packages. The foundations for the turbine were installed in four 30 minute to one hour lifts, with the duration of commitment i.e. where the task cannot be interrupted once started, being a quarter of that. The nacelle installation had a longer duration of commitment and, whilst successful, was a higher risk activity due to the time of commitment. This activity therefore provided a valuable impetus for the short time on task mentality. The HS1000 was recently retrieved for routine maintenance in January 2013 and will be re-installed with a one hour duration of commitment on station.

Operations which are reliant on ROVs create an impractical level of downtime and a significant level of operational risk. The experience of AHH and other developers at Orkney in relying on ROVs has been one of significant challenges and incidents. The malfunction and loss of ROVs is not unknown and any operation that relies on ROVs is at a standstill in such circumstances. Restrictions in the ROV's operational envelope mean that ROVs can only fly at, or around, slack water, resulting in severely restricted windows of opportunity. The same restrictions apply to a greater or lesser extent to diver operations.

4.3.2. Installation Phases

The installation process consists of the following phases:

1. Pre-installation activity.
2. Subsea Cable installation.
3. Device Installation
4. Commissioning

The following sections describe in further detail the different installation activities, indicate the type of vessels that would, possibly, be involved and provide an indication of their time on site.

4.3.3. Pre-Installation Activity

Pre-installation activity will involve:

- Staging Location /“Wet Storage”
- Installation of temporary moorings (see Figure 1 and Section 4.3.3.2).
- Tow out of barge(s) with support structures and nacelles embarked.

The place of construction for the individual tripod substructures and the nacelles has not, at this time, been decided. However, the intended methodology involves the support structures being taken after build to an Installation Staging Location within reasonable sailing distance of the project site where they will be stored until the commencement of the array installation.

4.3.3.1. Staging Location / Wet Storage

On completion of build, the tripod support structures will be taken from the build yard to a pre-installation staging location, which is effectively a storage area, currently envisaged to be a harbour area. The structures will be stored on the seabed and, due to their size and the available depths of water, a considerable portion of the structure will be above water. The potential “wet storage” areas currently being considered are:

- Campbeltown
- Belfast Lough
- Greenock, Glasgow

The risks associated with these storage areas will be assessed by the developer in conjunction with the Port Authorities as part of the Port Marine Safety Code (PMSC) Safety Management System applicable to the port. As such, the specific risks associated with the “wet storage” are not addressed in this report.

4.3.3.2. Pre-Installation Mooring

For the array installation phase, the individual structures will be transported from the “Wet Storage” location to the vicinity of the array site by the purpose built AHH Installation barge designed specifically for tidal turbine installations. The installation barge will be assisted by a lead tow tug and a multicat work vessel.

It is proposed that there will be a pre-installation mooring and two further standby moorings in close proximity to the array area. The Pre-Installation Mooring has the primary function of enabling the installation spread to be in a position close to the array location, to enable the short duration operations to be executed with the shortest traverse from / to a safe haven. All moorings, both the Pre-Installation Moorings, and the two further Standby Moorings in the sound, have the function of accommodating any uncertainties in passage time from the Staging Location to Islay / Jura waters, and to enable the installation spread to standby to await an installation “window” (or to standby following an installation) which is dependent on tide and environmental conditions.

McDougall’s Bay anchorage, although not totally free of tidal influence, has been identified as the preferred Pre-Installation Mooring because of its close proximity to the array. Two further moorings fulfilling the task as Standby Moorings are also under consideration at:

- Whitefarland Bay
- Bunnahabhain Bay

All moorings are expected to consist of a single mooring buoy with appropriate ground gear sited in depths of between approximately 6m (McDougall’s and Whitefarland Bays) and 10m (Bunnahabhain Bay). This mooring will be in position throughout the installation phase of the project and is expected to continue in use during the operational phase as a staging location for such support vessels as may be required.

4.3.4. Subsea Cable Installation

The subsea cable installation work of the up to ten export cables is likely to be carried out by a specialist cable installation contractor, utilising either a DP vessel or a barge mounted spread assisted by modern conventional tugs or DP tugs.

The principle of short duration work packages will also be applied to the cable laying. Each cable run, with the maximum length of 4km, will be of short duration taking only a few hours to complete. The cable spread will be demobilised from the array location following each run, so as to avoid being committed for long periods on site. However, during the cable run the capability of the cable laying vessel(s) to manoeuvre is significantly restricted.

Short duration cable lays are facilitated by the fact that each length of cable will be cut and pre-prepared onshore with an electrical connector already attached to one end, to reduce the offshore time. The cable runs will therefore be required to be started at the location of the devices and then run to shore.

Each cable will have protection either along the whole length or at specific locations. The cable lay duration is therefore also dependent on the amount of protection required. However, the extent of this protection is being optimised and some protection, for example heavy concrete mattresses, can be installed following the initial lay.

The bathymetry and geography does not lend itself to spacing between each of the cables that is considered normal. Close to the shore landing the cables will therefore be required to be in close proximity or indeed on top of each other.

In the event of a damaged cable it is likely, therefore, to be more economic that, if the damage is in a congested area where retrieval of the cable is hindered by over-lapping cables, an additional separate cable will be required to be laid instead of a repair.

4.3.5. Device Installation

The initial plans for the installation of the devices outlined in the previous revision of this report proposed the use of a DP vessel. This was seen as having the advantage of short time on task for each activity (i.e. structure, ballast, nacelle) thus obviating the extended time at risk involved in a moored barge arrangement.

The latter option of a moored barge positioned on site with a traditional spread mooring system, was discarded due to, amongst other things, navigational safety issues involved with the mooring and the associated buoyage as well as difficulties involved in moving the barge and mooring between device deployments which result in the barge being on site for lengthy periods of time. The safety issues resulted in the risk for the moored barge option being assessed as “Tolerable with Additional Controls”.

However, the additional controls proposed required the closure of the channel for the duration of the barge’s time on task. Hence, it was deemed appropriate that a DP vessel should be used in order to reduce risk. However, experience at EMEC has shown that utilising a simplified mooring arrangement and tugs can offer the same advantage as a DP vessel.

Currently the principal installation methodology being considered by SPR to undertake the placement of the support structures and fitting of the nacelles is through the use of a system involving an unpowered barge stationed using a simple two point mooring and a tug and workboat.

Such a mooring system as now proposed is significantly different from a standard spread mooring and, combined with the methodologies proposed, aims to achieve the same short time on task as a DP vessel and therefore the same or similar navigational risks and considerations.

4.3.5.1. Islay Mooring System

A traditional spread mooring system consists of four or six mooring lines with some of those lines at 45 degrees to the vessel and consisting of long riser wires leading to long ground chains, at the end of which is a mooring anchor receiving only purely horizontal load.

The overall length of a traditional spread mooring can be over 1000m from the vessel. This situation will, as was discussed in the previous NSRA report, cause an unacceptable impediment or risk to passing shipping from both the extent of the mooring and the presence of the vessel/barge in the channel for considerable periods of time, due to the difficulties of connecting and disconnecting the barge to the mooring spread using tugs and mooring winches on the barge, and the continued presence of the mooring buoys and lines.

The mooring arrangement envisaged for the installation of the Islay tidal array is very different from a spread mooring. (See Figure 8.) Instead of four or more moorings two chain clump weights with an individual weight of 30-50t will be positioned 200-250m south of each device (the rows of which will be spaced approximately 500m apart) and each pair of clumps approximately 20-40m apart (10m-20m East or West of the structure). This equates to 3-9degrees from the vessel centre-line, which is significantly different from a standard spread mooring. The two clumps are effectively acting as one with the redundancy of two. Chain clumps as opposed to anchors have been selected because they offer an increased seabed coefficient of friction compared with a concrete clump and clumps offer a more reliable solution to anchors in predominantly rocky and gravel seabed conditions.

Figure 7 Example chain clumps used by AHH and other contractors in Orkney

4.3.5.2. Installation Vessels & Installation Overview

The 10 turbines will be installed using an installation barge that has been designed specifically for the installation of the Andritz Hydro Hammerfest Islay turbines. The hull and lifting equipment is designed around the geometry and weight of the Islay turbines and the installation methodology.

The AHH Installation Barge is a propulsion-less vessel with a hydro-dynamically identical bow and stern but with an open stern moonpool. It will be fitted with A-frames driven from three winches. The moonpool is designed to accommodate the substructure or nacelle, which will be secured in the moonpool for transport.

Prior to arrival at the site the structures will be loaded out at an Installation Staging Location as discussed in Section 4,3,3,1. The substructure load-out will take the form of the structures being offloaded onto the seabed next to the quayside prior to being lifted up under and between the hulls of the installation barge for transport to the site
.
The nacelle load-out will be more conventional with the structures lifted or trailered onto the barge.

The installation barge will be towed from the staging location to the installation site bow first (i.e. with the structures at the stern). For the substructures the tow out of the barge with the structure underslung will conform to limiting depths or conditions as required by the port authorities.

Following arrival at the Site, the AHH Installation barge will secure to the Pre-Installation Mooring outside of the main Islay channel (preferred option is McDougall's Bay).

The offshore operations are then split into discrete and separate periods with variable levels of commitment, as shown in Figure 8.

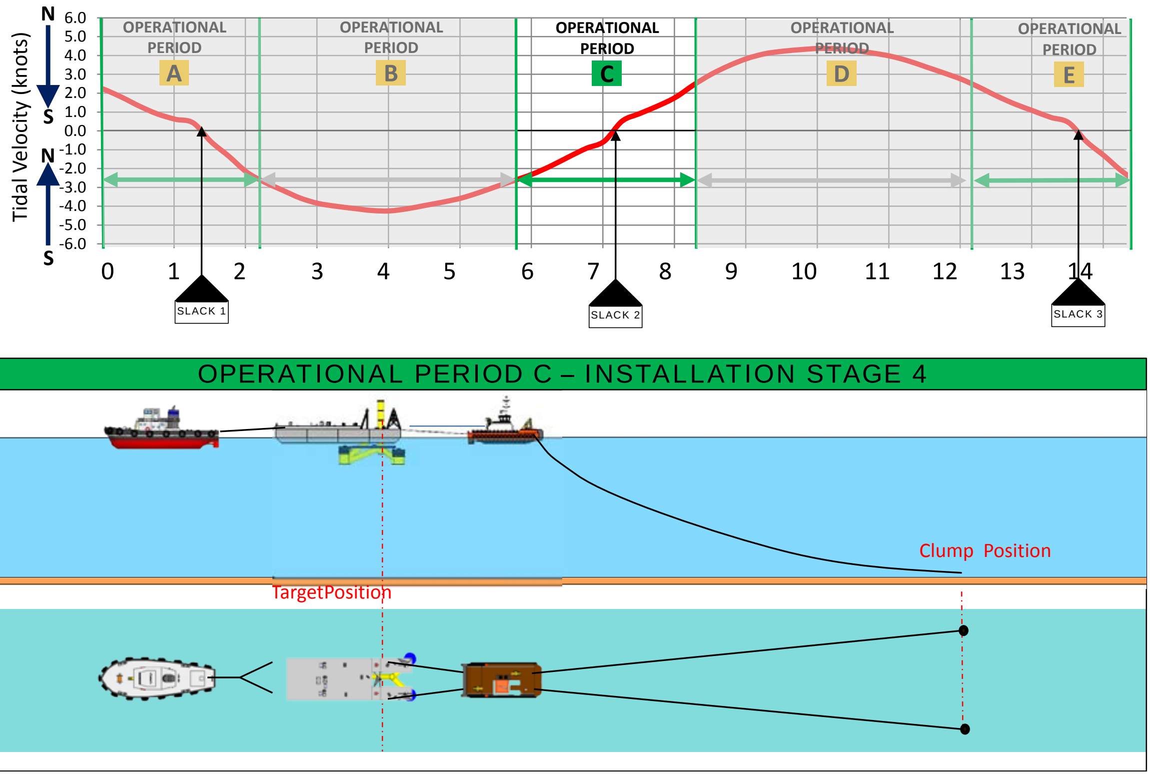

Figure 8 Schematic of mooring arrangement

1. In the first slack water (Operational Period A) the multicat will connect to, or install the chain clump moorings at the specific turbine location and then remain connected to the mooring during the period of higher tidal rate (Operational Period B).

2. During Operational Period B (4-6hours) the AHH Installation Barge will make ready for lowering operations by releasing hydraulic sea-fastenings and carrying a number of checks to ready the winch system and identify and potential malfunctions.

3. Prior to (approx. 2hours) the second operational window in Operational Period C, the installation barge will be towed the 300-500m to the array from the Pre-Installation Mooring by the lead tow tug and will be connected on site. The connection of the installation barge will not be directly to the moorings, but rather to the multicat that has already been connected on the moorings in Operational Period A.

4. The connection of the barge to the multicat will be via fixed length lines of approximately 20m, as opposed to winches, enabling quick connection and disconnection. Prior to connection the tug will be towing the AHH Installation Barge into a reducing tide of approx. 2knots and falling. Following connection, the tide will be exerting a force on the

moorings for 6 hours, with redundancy provided by two moorings and two vessels which also provide positional control.

5. The structures will then be lowered to the seabed via three winches. The lowering and docking operation takes less than one hour. Any failure resulting in delay of 1-6hours can be countered via standby during operational period D and disconnection during the low tidal velocities of operational Period E, or in an extreme failure, such as a jammed winch, a controlled rotation of the moored system during Operational Period E (the turbine spacing prevents impact of mooring lines with the devices).

6. The installation barge will then leave the site towed by the tug, followed by the multicat.

7. For the nacelles, there is one further operation following the lowering operation. The multicat will remain on station to perform the dry mate connection of the pigtail from the nacelle to the export cable.

8. Following the lowering operation the mooring lines will be disconnected and the ground chains lowered to the seabed.

There are two possibilities with regards to the installation of the chain clumps in Stage 1 above. The first is that they will be permanently installed on the seabed (but retrieved periodically for maintenance), and the mooring lines retrieved at each installation via subsurface buoys or other remote equipment (without the use of ROVs) when required. This would result in two anchors per device (or three shared between two devices). The advantage of this is positional accuracy (i.e. the clumps will always be in exactly the same location). The disadvantage is maintenance and the greater complexity of remote connection. The second option is that they will be installed by the multicat in the slack water just prior to the installation window, as has been proven to be possible on numerous occasions in the Fall of Warness in Orkney.

In terms of navigational hazard and time on site, the installation barge is expected to be on site for between two and three hours. This is based on operational experience with similar operations, in the Fall of Warness at EMEC

- Operational Period A and B (6-8hours) is a multicat on site connecting to or installing two chain clumps moorings, within the channel and standing by in and operation that can be disconnected in seconds.
- Operational Period C (2-3hours) is the planned commitment of the installation barge on site to transit 300-500m, connect to a vessel via heaving lines, carry out a lowering operation of less than 1 hour, disconnect and transit back or away from the site assisted by the tide.
- Operational Period D (6-8hours) is a contingency period to standby in a failure scenario to enable disconnection of the installation barge from the site.

In terms of hazards to other shipping:

- During an installation / lowering operation of 1-2 hours duration the moorings will be tensioned for positional accuracy. The spacing between the mooring components during an installation operation is 10-20m. A DP vessel has a beam of 20-30m making the obstruction and required passing distance during a lowering operation the same.
- Prior to an installation / lowering operation (i.e. Operational Period B or Operational Period D) the tension in the mooring lines will be reduced lowering all components to the seabed
- During all operations the mooring components are subsurface. The system does not rely on any buoys above surface.

4.4. Commissioning

The commissioning processes have no implications for navigation as all commissioning activities occur subsea or on land and require no marine intervention.

4.5. Operation/Maintenance

It is assumed that, once in position, monitoring of the technical performance and function of the device will take place over the life of the device. Planned interventions for inspection or maintenance are currently estimated as requiring recovery of the nacelle every 5 years. It is estimated that the average number of interventions requiring the use of the special purpose installation/ recovery barge and tug vessel will be in the order of 2 per year. It is probable that visits to the devices by workboats will also be undertaken for remote survey and inspection of the devices and for environmental monitoring purposes.

4.6. Decommissioning

At the end of the device/array lifecycle, the devices will be decommissioned. The decommissioning of devices involves a reversal of the installation process and is expected to have a reduced timescale.

5. Analysis of Marine Traffic

An analysis of marine traffic was undertaken for the original NSRA report. As agreed in discussion with the MCA regarding this revision to the study and report, no additional data has been obtained or analysed.

The initial study used the following data:

- AIS Traffic Survey (total of 28 days data).
- Fishing vessel VMS data.
- RYA Cruising Routes
- Discussions with West Highlands Anchorages and Mooring association (WHAM)
- DECC Maritime Traffic Database

5.1.1. Stakeholder Comment and Meetings

For the first study in 2010, information was obtained from the following marine users:

- Argyll and Bute Council Transportation Department (Statutory Port Authority responsible for Port Askaig);
- Caledonian MacBrayne (CalMac) Marine Operations Manager;
- The Masters of CalMac Ferries MV HEBRIDEAN ISLES and ISLE OF ARRAN (Kennacraig to Port Askaig);
- ASP Management (Operators and Masters of EILEAN DHIURA) ferry (Port Askaig to Jura);
- Clyde Fishermen's Association (CFA) representative;
- Local creel fishermen;
- Station Manager of Port Askaig Lifeboat.
- Royal Yachting Association (RYA) representatives including the West Highlands Anchorages and Mooring association (WHAM) and the Clyde Yacht Clubs Association (CYCA

Given the nature and scale of the proposed changes, it was considered appropriate that further discussions were undertaken with the marine users (see Section 6.1).

5.1.2. Hazard Identification and Risk Assessment

A key part of the risk assessment methodology is the Hazard Identification and Risk Assessment (HIRA) process intended to investigate the potential hazards, identify the possible consequences and the likelihood of such an event occurring and to estimate the associated risks. The methodology used was in line with the recommended methodology in the DTI/DECC Guidance (Reference 2).

The initial HIRA used the available information on the array/device positioning and installation/operation, maintenance and decommissioning activities to ensure that, the hazards presented to marine users were identified using a structured process and an assessment made of the risks involved and any controls appropriate to control the risk by the stakeholders.

Due to the changes to the device, cable route and installation methodology which have occurred since the initial risk assessment, a further HIRA workshop was organised in order to examine in detail the proposed changes and to establish the differing hazards and changes to resultant risks. Therefore a HIRA workshop was held on the 2nd November 2012 which involved the key marine users and stakeholders (see Section 6.1). The results of the HIRA review were used to revise the "Hazard and Risk Control Log" (B) required by the DTI/DECC guidance (Reference 2).

5.2. Current Traffic Densities and Types

The Admiralty West Coast of Scotland Pilot (NP 66) (Reference 4) states that the Sound of Islay "*is used by mariners to avoid the open sea west of Islay and forms part of the Inshore Traffic Route*". It further states that *"the sound is not recommended for medium sized vessels and above, due to a rocky bank, with a least depth over it of 9.1m situated in the fairway and extending for 2.5 n miles south from the north entrance to the sound and also due to the strength of the tidal streams.*"

The average numbers of transits of the sound is in the order of 6 per day – 2 coasters and 4 CalMac ferry movements. This does not include ferry crossings between Islay and Jura.

The significant users were described in the previous revision of this NSRA but are repeated below as the information is relevant to the arguments concerning risk developed later in the report.

5.2.1. Ferries

Caledonian MacBrayne (CalMac) run ferry services between Kennacraig and Port Askaig /Port Ellen and Kennacraig to Oban and Colonsay via Port Askaig. The total number of movements in and out of Port Askaig amount to, approximately, 22 per week during the period April to October and 18 per week between the end of October and the end of March.

The ferries used on this route currently are:

Name	Length/Beam/Draught	Capacity
MV Finlaggan	89.8m x 16.3m x 3.3m	62 cars/659 passenger
MV Hebridean Isles	85.2m x 15.8m x 3.1m	85 cars/550 passengers
Lord of the Isles	84.6m x 15.8m x 3.1m	54 cars/506 passengers

Table 8 CalMac Ferry Details

The Port Askaig to Feolin ferry is operated by ASP Ship Management on behalf of Argyll and Bute Council. It crosses the sound up to 40 times per day in summer. The ferry running this route is the EILEAN DHIURA (see Figure 9) which has a capacity 41t (approximately 6 cars or 1 road tanker). The direct route between Port Askaig and Feolin is some 200m north of the northern sub-array. However, due to the effects of the tide, the route over the ground can be as much as 200m north or south of the direct line.

The Eilean Dhuira ferry is a twin engined, twin screw and twin rudder vessel with a draught of around 1.5m fully laden.

Figure 9 Eilean Dhuira Ferry

5.2.2. Fishing vessels

Fishing activities within the sound consists of creeling. No trawling, net or line fishing is reported to occur, or has occurred in the recent past, in the sound. Creeling in the sound is conducted by small, locally based, day-fishing vessels. These vessels range between 6m single handed to vessels over 10m manned by 3-4 people. The number of creel boats operating out of Port Askaig harbour is approximately 10 with the majority of fishing in the Sound of Islay taking place during the winter months.
Creeling involves the placing of long lines of creels (pots) on the seabed with a buoyed clump weight at each end. These lines may consist of up to 50 creels on a line of over 1000 metres in length overall. It is normally laid parallel to the land and relatively close-in to the shoreline of the sound in waters up to 30m in depth. However, some of the creel fishermen have stated that they do lay fleets of creels across the sound and in waters of greater than 30m charted depth. The creels are normally recovered, checked and re-laid daily.

5.2.2.1. Fishing Vessel Monitoring System (VMS) Data

VMS data has been obtained for the area and was described in the previous report. No fishing other than creeling takes place in the sound.

5.2.3. Cargo Vessels

There a number of cargo lines which have vessels which use the sound on a regular basis as part of the inshore traffic route. They include:

- Aasen Shipping and Chartering (Norway)
- Seatrans (Norway)
- Lys Line (Norway)

- Scotline Marine Holdings (UK)
- Arklow Shipping Ltd (Ireland)

Of the vessels observed during the survey period the deepest draught was the MV Nornews Leader (since renamed MV Ohm Leader) at 6.6m (See Annex A table C1). There were nine vessels with a draught in excess of 5m. The average draught was 4.53m.
The breakdown of all vessels by draught is as follows:

Draught	Jan (2 weeks)	July (2 weeks)	Total
2.5 – 5m	13	48	61
>5m	10	23	33

Table 9 Vessel Traffic by Draught

The passage through the Sound of Islay is limited by the shallow waters in the north of the sound where, even if vessels navigate with care to avoid the shallow bank with a minimum depth of 9.1m, the maximum charted depth of navigable waters is in the order of 10.2m.

5.2.4. Royal National Lifeboat Institution (RNLI)

The RNLI Islay Lifeboat is a Severn Class vessel (Helmut Schroder of Dunlossit II) berthed at Port Askaig within a few hundred metres of the proposed array.

5.2.5. Recreational Diving

There are a number of diving sites associated with the Sound of Islay. The Underwater World Publication – Dive West Scotland by Lawson Wood (Reference 8) identifies two dive sites. The first is the "Port Askaig Deeps" and involves a "deep" dive within the proposed development area. The second is a drift dive undertaken at an average depth of 12 -15m in the shallower waters to the south of the proposed site in the vicinity of Glas Eilean.

The diving guide "Dive Islay Wrecks" by Steve Blackburn (Reference 9) identifies the wreck of the Wyre Majestic in position 55 53.0N, 006 07.22W site as a site of interest to divers. (See Figure 1).This is some 4.3 n miles to the north of the proposed development.

5.2.6. Sailing and Motor Yachts.

The Sound of Islay is identified in Royal Yachting Association UK Atlas of Recreational Boating (Reference 10) as a route classified as a "Light Recreational Use". There are no yacht anchorages recommended by the RYA in their routing information.

Discussions with a representative of the RYA (the Chairman of the RYA Scotland Cruising Committee who is the RYA "Coastwatcher" for the area as well as the Secretary of the West Highlands Anchorages and Moorings Association (WHAM)) indicated that the level of recreational vessel traffic was, approximately in the order of 6 – 7 craft per day during the season between April and September. It was stated that such vessels do not frequently anchor in the sound except, on occasion, to avoid adverse tides by using the anchorages between Am Fraoch Eilean and Brosdale Island, Bunnahabhain Bay and MacDougall's Bay. Such leisure craft are usually below 15m in length and draw up to a maximum of 2.5m.

5.2.7. Military Usage

There are no military, surface Practice Exercise Areas (PEXAs) covering or immediately adjacent to the proposed area and there are no indications of the area as being a transit route for other than surface vessels. The Defence Estates (now Defence Infrastructure Organisation (DIO)) Safeguarding department was consulted with regard to the proposed deployment during the scoping comment exercise conducted by ScottishPower Renewables in the initial phase of this project. They stated that they have no concerns regarding this development as it falls outside of a safeguarding area. That said, Naval vessels do transit the sound. Figure 10 shows the largest naval vessel known to have navigated the sound in recent years - HMS Bulwark (Length overall (LOA) 177m x 32m beam x 7.5m draught).

Photo Courtesy of Graham Paterson

Figure 10 HMS BULWARK on Passage through the Sound of Islay

5.3. Future Traffic Patterns, Densities and Types

There are no indications from the users of the sound that there are any planned, significant changes to the level and types of traffic currently experienced. Neither is it envisaged that there will be any changes to the vessel types or size. Vessel draughts are constrained by the limiting depths in the northern area of the sound. CalMac is planning on a replacement vessel to be used on the Kennacraig/Islay route which will have a draught of 3.4m.

5.4. Effect on Current Traffic Densities and Types

The effects of the proposed development on the traffic densities and types are considered to be the following:

- Additional construction/decommissioning vessel traffic including a cable laying vessel, a deployment barge and tugs, installation mooring over a period of, approximately 4 months;
- The presence of a work boat for inspections and maintenance activities over the life of the array;
- The occasional presence of a specialist barge and tugs for maintenance and unplanned repair interventions.
- The presence of a single buoy mooring in one of the Bays at the edge of the sound.

Such activities will, when present, both add to the current traffic levels, and cause vessels using the sound to deviate to the eastern side of the sound from their standard routes potentially increasing traffic density in that area. The risks from this potential effect are addressed in Section 6.

5.4.1. Construction and Installation

The construction phase will temporarily reduce the width of the navigational channel available to vessels passing the proposed array site when transiting the sound.

The CalMac ferry, when approaching Port Askaig takes a route close to the shoreline off Carraig Mòr. This would entail passing through part of the proposed array area.

The construction traffic could, dependent on where such traffic would be based, affect the operations of Port Askaig. As such, the operations may impact on assumptions behind the safety response and oil spill contingency plans put in place by Argyll and Bute Council for Port Askaig.

5.5. Effect of the Development on Future Traffic Densities

The levels of traffic using the sound are not expected to rise significantly in the foreseeable future. The inshore traffic route, of which the sound is a part, is used by general cargo and wood carriers operating between Scandinavia and the west coast ports. There are no indications of developments that would be likely to significantly increase traffic levels in the future.

The extent to which operational, maintenance and decommissioning activities impact on marine traffic and the subsequent potential increase in risk is briefly considered below, and examined in more detail in Section 6.

5.5.1. Operations

The operation of the array will involve little or no activity that may present a hazard to marine users with the exception of the presence of the turbines themselves. However, there may also be some "funnelling" effect on traffic during the life of the array caused by vessels wishing to avoid the area of the turbines despite the fact that they would not be at risk from the presence of the devices (see Section 6). Given the current traffic density this effect is not considered to be significant.

5.5.2. Maintenance

The siting of the array and the associated maintenance activities will, to an extent, constrain the traffic using the Sound of Islay. This would include occasions when a range of support vessels are involved in, for example, routine surveys or inspections.

5.5.3. Decommissioning

It is expected that the impact of decommissioning activities will be similar to those arising from the construction and installation phases.

6. Navigation Risk Assessment

6.1. Hazard Identification

In order to identify the impacts of the potential hazards related to the proposed demonstration array, structured discussions were held with the key local stakeholders who use the Sound of Islay. These discussions aimed to identify the perceived hazards presented by the siting of the array. Those included in the hazard identification and risk assessment workshops/discussions (held in 2010 and 2012) were representatives from:-

- Caledonian MacBrayne (CalMac) Ferries.
- Local fishermen.
- RNLI.
- Argyll and Bute Council.
- Clyde Fishermen' Association.
- RYA/WHAM/CYCA .
- Islay/Jura Ferry (Argyll and Bute/ASP Management).
- Northern Lighthouse Board

The hazard identification process was conducted against the key issues identified in MGN 371 (Reference 1) and using the guidance contained in DTI/DECC publication - Guidance on the Assessment of the Impact of Offshore Wind Farms (Reference 2). These issues were used to generate keywords for assessing each activity phase (construction, operations & maintenance and de-commissioning) associated with the array or individual devices. The hazards associated with the array were then assessed for the risk that they presented to other mariners. The outcome of that assessment is tabulated in the Hazard Log at Annex D of the original NSRA Report (Reference 1).

That Hazard Log was reviewed against the proposed changes to the proposed development in a HIRA workshop on the 2nd November 2012 at Bowmore on Islay. Present were:

- Mr Dario Spadavecchia - Assistant Marine Manager for CalMac Ferries.
- Mr Archie McFarlane - Secretary of Clyde Fishermen's Association.
- Mr Steven Driver, Northern - Lighthouse Board.
- Mr Andy MacDonald – Islay Energy Trust and FLO for SPR.
- Mr Rupert Raymond – Andritz Hydro Hammerfest.
- Mr Nicol MacKinnon – Islay Sea Safaris.
- Mr Islay McEachern – RNLI Station Manager, Islay.
- Dr Douglas Watson – SPR.

The meeting was chaired by Mr David Cantello, PMSS.

The purpose of the meeting was to review the HIRA undertaken in 2010 as part of the navigational safety risk assessment included with the Consent Submission to Marine Scotland, in the light of proposed changes to the project. These include:

- Overall height of the individual devices
- Installation methodology.
- Cable route.
- Slight changes intended to the individual positions of the devices within the previously consented area.

The revised Hazard and Control Log is at Annex B.

6.2. Construction/Installation

The navigational hazards and consequent risks arising from the construction/installation phase identified in the previous Hazard Log were reviewed and the following changes to the hazards and risk identified.

6.2.1. Pre-Construction Activities

The establishment of the "wet storage" and the hazards and consequent risks would be identified and assessed as part of the Port Authority risk management processes for the nominated port areas under consideration.

The Staging Location mooring proposed to be sited in one of the Bays on the periphery of the sound introduces a new hazard in the form of the mooring itself and the vessels which would be using it. The mooring is proposed for areas which are already identified as anchorages and which are outside of the main channel. They are, however, in areas used by small craft such as yachts and vessels engaged in creeling. It was strongly recommended at the HIRA that any mooring buoy should be lit.

Given that the barge with support structure would draw more than vessels which generally anchor or use the Bays, it was considered at the most recent HIRA that the bathymetric data for the area should be evaluated to ensure that the standard and extent of the current survey data is adequate and, where this is not so, to undertake further bathymetric survey work to ensure that the risk of grounding is minimised.

Risk Control Measures for Staging Location Mooring:

- ❑ Mooring Buoy to be lit.
- ❑ Submission of information to the UKHO and other authorities in good time to enable promulgation of national and local NMs/Radio Navigational Warnings.
- ❑ Submission of information to the UKHO to allow charting of the mooring buoy.
- ❑ Review bathymetric data for the mooring location to ensure that it is appropriate to the activity and, where it is not, to undertake further bathymetric survey.

6.2.2. Subsea Cable Installation

There were no changes to the hazards presented by, and risks arising from, the subsea cable laying activities.

Subsea cable installation will be carried out by a suitably equipped cable laying vessel. Given that the vessel may be required to operate out towards the centreline of the sound, the vessel would present a hazard to shipping when engaged in cable operations when its ability to manoeuvre would be compromised. However, the vessel would be required to comply with the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) (Reference 11) and would show the appropriate signals and lights for such an activity. The marine contractor responsible for the cable lay activity would notify the UK Hydrographic Office (UKHO) of the activity using the Maritime Safety Information (MSI) system for promulgation to all vessels by Notices to Mariners (NMs) and radio navigational warnings. This would also include the promulgation of the information regarding the installation activities over the marine VHF radio by the Maritime & Coastguard Agency. Given the width of the available channel (approximately 450m between the 20m contours) and the fact that the cable laying operation would be planned to be undertaken in the most favourable conditions of tide and weather, it is considered that with the risk control measure mentioned above, the risks from the cable installation activity would remain tolerable with monitoring.

6.2.3. Array/Device Installation

The change to the installation methodology from a DP vessel to a purpose built installation barge and mooring arrangement has, to an extent, changed the hazards presented during the installation phase. However, the time on task for deploying each structure or nacelle has not changed. The presence of the installation spread for each support structure/ nacelle deployment will, as with the DP vessel, be of relatively short duration (i.e. a matter of hours) and hence there is no significant change to the time at risk.

The minimum available width of the navigable channel (reduced by the presence of installation vessels) was determined in the previous report as being in the order of 170m (see Figure 11). As can be seen by Figure 12, there has been no significant change to those values. (i.e. a minimum of 163m as opposed to 170m and commensurate reductions in other positions.

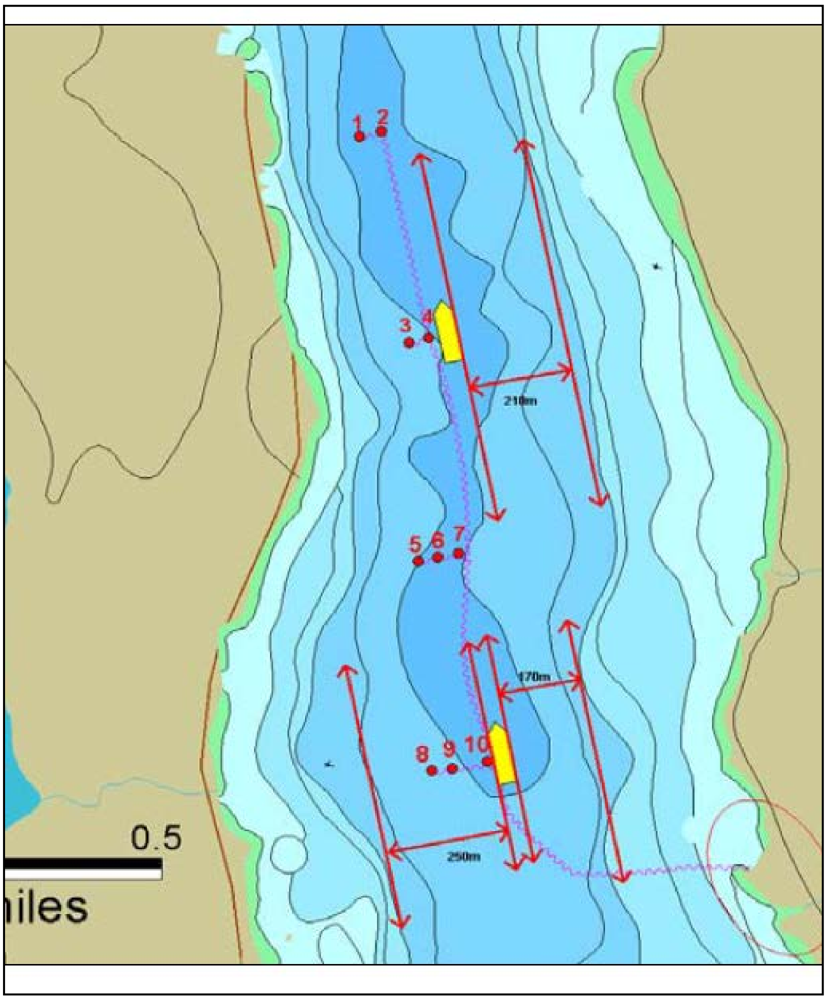

Figure 11 Channel Clearances - DP Vessel

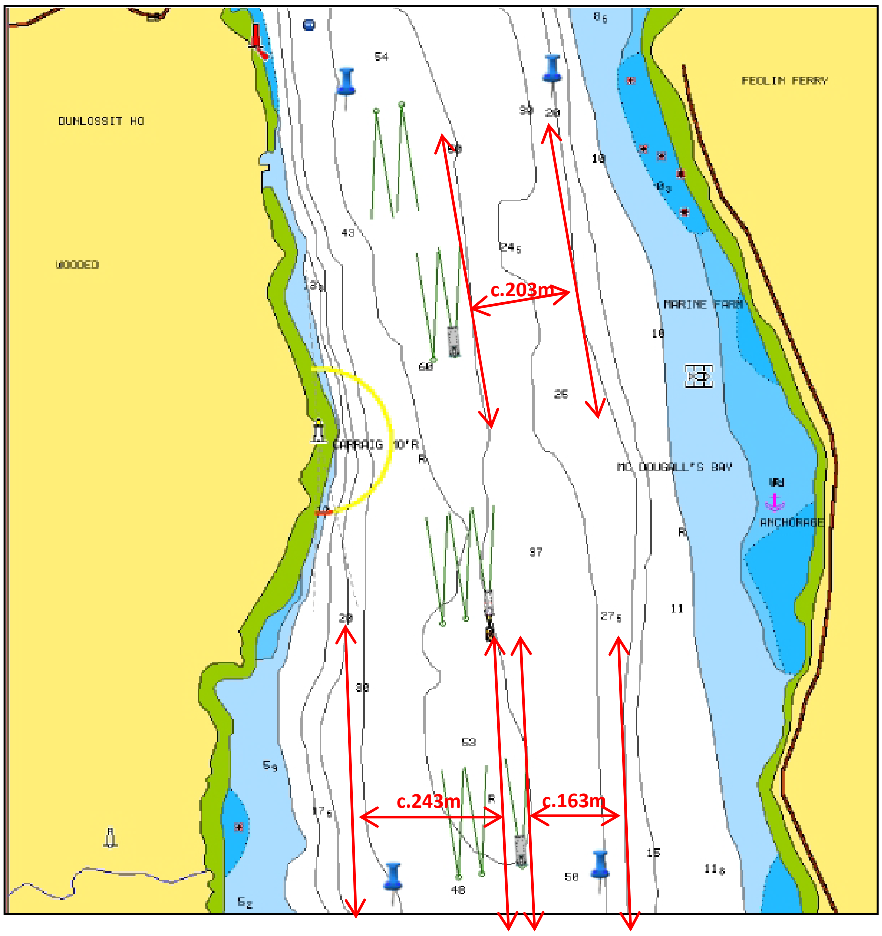

Figure 12 Vessel Clearances – Installation Barge and Mooring

6.2.4. Risk Controls During Installation

6.2.4.1. Management and Coordination of Concurrent Activities

The management of coordination of activities associated with installation around those of CalMac ferries arrivals and departures would obviate many of the instances where installation activities could be conducted concurrently with ferry arrival and departures to/from Port Askaig. Close liaison at both the initial planning and day-to-day management phases of the installation programme would be used to ensure that such activities were planned, in so far as is possible, to not occur concurrently.

Where it became impossible to de-conflict such activities at the planning stages, (e.g. the installation barge is detained on site for a reason), then procedures would be in place which ensured that concurrent operations were assessed for their acceptability by suitable qualified and experienced personnel from both parties. In the last resort, CalMac has the option of re-routing arrivals to port Ellen on the south of the Island.

6.2.4.2. Maritime Safety Information

Notice of the works would be promulgated through the UKHO Maritime Safety Information system (i.e. Notices to Mariners (NMs) and Radio Navigational Warnings (NavWarns/WZs)). The installation vessels would comply with the COLREGS (Reference 11) in that they would display the appropriate lights and marks for vessels engaged in such activities.

Vessels may be at risk of collision if they either violate or incorrectly apply the COLREGs in a situation involving two vessels passing in the sound. Given the traffic density, this is most likely to occur in a situation involving a vessel in transit and the installation barge and vessels. However, the conspicuous nature of the (stationary) vessels involved and their proximity to the shore on the westerly side of the sound is considered as being unlikely to lead to any ambiguity about the construction vessels activities which could result in the violation or incorrect application of the manoeuvring rules.

Vessels could also be put at risk if they were to suffer propulsion failure such that they were set down onto the construction vessel. However, the dwell time of vessels passing the spread in the “window” whereby failure of propulsion would cause them to be set down (by wind or tide) onto the spread, is small due to the limited extent of the spread and the fact that the prevailing wind and tides are likely to set vessels “not under command” (NUC) along the line of their planned route and not towards the construction vessels. The traffic density is such that the likelihood of such an occurrence can be considered as remote and, therefore, a probabilistic assessment is not considered appropriate.

6.2.4.3. Safety Zones

The establishment of a Safety Zone, in accordance with the Energy Act 2004 and Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007 (Reference 12), has been considered as a potential control for the reduction of such risks as arise from the installation and de-commissioning phases. The size of the “standard” zone for construction (500m) would, effectively, close off the sound to other traffic completely. Even if a smaller zone were to be implemented the least distance between the device positions and the 10m contour, on what is a relatively steep-to shore, is in the order of 300m and any safety zone would reduce the navigable channel significantly. It is considered therefore that, with the promulgation of Maritime Safety Information through the normal means (i.e. NMs and NavWarns) and the presence on site of manned vessels capable of monitoring and advising the other marine traffic using the sound of Islay, the establishment of a Safety Zone in accordance with Reference 12 is not appropriate in that it provides little or no additional reduction in risk beyond the normal measures that will be employed in the circumstances. In fact, it would further constrain vessels when passing the construction site to an extent that the risk of grounding on the Jura shore would be significantly higher than if they were free to navigate in accordance with the COLREGs. It may, also, cause vessels to re-route to the west of Islay in less sheltered waters.

6.2.4.4. Safety Vessels

The requirement for a dedicated safety vessel was re-considered for this operation. The previous study has concluded that a DP vessel, given the capability of its radar, communication (including AIS receivers) and manning as well as the limited time it would spend in deploying the support structures and turbines, would be capable of providing the roles of monitoring and warning other traffic. However, it was considered by those undertaking the HIRA review, that the workboat/ tug and installation barge would not be similarly placed and so it was considered that a dedicated Safety (Guard) Vessel would be required in order for these roles to be adequately discharged.

6.2.4.5. Emergency Response Coordination Plan

In the event of any incident occurring, SPR are required to have in place an Emergency Response Coordination Plan (ERCoP), covering the construction, operations & maintenance and decommissioning phases of the array. It requires to be agreed with the MCA’s regional Maritime Rescue Coordination Centre (MRCC) for the Clyde based at Greenock (or with the appropriate Maritime Operations Centre (MOC) to be established under current MCA re-organisation plans). The ERCoP is required to address such issues as:

- Details of companies involved (i.e. marine contractors, client etc)
- Responsibilities
- Points of contact (e.g. names, posts).

- Communication plan (e.g. VHF IMM Channels, MF Radio, mobile phone)

The risk from the construction and installation phases is, therefore, considered to be “tolerable with monitoring” provided the following risk control measures are put in place.

Risk Control Measures for Cable/Device/Array Installation:

- ❑ Liaise with CalMac concerning the planned activities to ensure de-confliction of CalMac ferry operations to/from Port Askaig or,
- ❑ Where this was not possible, by establishing a procedure between the developer and CalMac for assessing the risk of allowing ferry operations to take place at the same time as installation activities.
- ❑ Submission of adequate information to the UKHO and other authorities (e.g. MCA) in good time to enable promulgation of national and local NMs/Radio Navigational Warnings.
- ❑ Installation vessel marked and lit in accordance with COLREGs.
- ❑ Provision of an appropriate, dedicated Guard vessel to monitor and warn traffic of the activities being conducted
- ❑ Emergency Response Coordination Plan (ERCoP) in place.
- ❑ Environmental limits for the installation process are developed and implemented.

6.2.4.6. Effects of Tide and Tidal Stream

The installation operations will be limited by the capability of the installation vessel to conduct the required activities in the prevailing tidal stream. At the time of this report those limitations have not been defined for the conduct of the various operations i.e. cable laying, structure offload, final positioning and nacelle/rotor installation. These limits will be established by, amongst other things, the testing to be conducted at EMEC and the capabilities of the vessel chartered. However, it is unlikely that the operations would be conducted in tidal stream rates which, for instance, present specific difficulties to vessels such as the CalMac and Jura ferries when approaching or departing Port Askaig such that they are hampered in their ability to manoeuvre. The conduct of the installation operations in less vigorous tidal conditions will also mean that, in the case of mechanical failure of such vessels as the ferries on approach to and departure from Port Askaig, there is a greater time margin for vessels to take such avoiding action as is possible given the distances involved.

6.2.4.7. Effects of Weather

Adverse weather, e.g. gales, heavy precipitation or fog, would reduce visibility and could increase the risk of collision. If the construction activities were to be conducted in the months when the risk of gales was at the minimum i.e. April to September, the risk of fog would be at its highest (1 – 6 days per month). However, the construction activities would be subject to daily review against stated environmental limits. In low visibility the vessels would be expected to act in accordance with the COLREGs and take appropriate action with regard to speed, lookout, sound signals, etc.

Risk Control Measures:

- ❑ Establish environmental (including tidal) limits for the conduct of each installation activity
- ❑ Monitor meteorological forecasts such that operations will only be conducted in the appropriate, agreed environmental conditions.
- ❑ Develop and implement procedures for adverse weather avoidance.
- ❑ Ensure that a risk assessment is carried out for the vessel to ensure that the vessel is fully able to operate in any reasonably foreseeable environmental conditions.

6.2.4.8. Effects on Communications, Radar and Positioning Systems

There would be no adverse or unusual effects on communications, radar and positioning systems caused by the vessels or equipment used during the construction phase with the exception of the issue of the use of inappropriate International Maritime Mobile (IMM) VHF channels. The use of IMM VHF during construction for communication between ship and shore or between vessels could interfere with other marine activities. The Principal Contractor will liaise with local organisations (e.g. ferry companies) and the MCA (MRCC) to ensure that suitable working channels are selected to avoid compromising authorised communications.

Risk Control Measure:

- ❑ Liaise with MCA and local organisations to establish suitable working channels for construction related activities.

6.3. Array Operational Phase

The operational phase presents several potential hazards to other marine users.

6.3.1. Collision with Tidal Device

Whilst the vertical dimension of the turbines have been increased from 33.5m to 39m, micro-siting using detailed bathymetric information has resulted in the shallowest turbine being sited in waters of 52.6m Charted Depth as opposed to 50m – a net reduction in clearance of 2.9m. Given that the minimum depth of 52.6m, the least depth above any of the devices in the array is now expected to be 13.6m. This is some 3.4m greater than the channel depth which exists in the sound i.e. 10.2m at the north end of the sound.

This clearance will apply to two turbines (numbers 5 and 7; see Table 10) of the array of ten. The other eight turbines will have clearances ranging between 13.8m and 20.9m.

Given that the greatest draught of any vessel known to have used the sound is 7.5m (see Section 5.2.7 – HMS Bulwark), this would ensure an underkeel clearance (UKC) depth at Lowest Astronomical Tide (LAT) of 6.1m for such a vessel. Taking into account a possible negative surge of -1m (see Section 3.1.7) occurring simultaneously with LAT, the worse case would result in a UKC of 5.1m. This is illustrated at Figure 13.

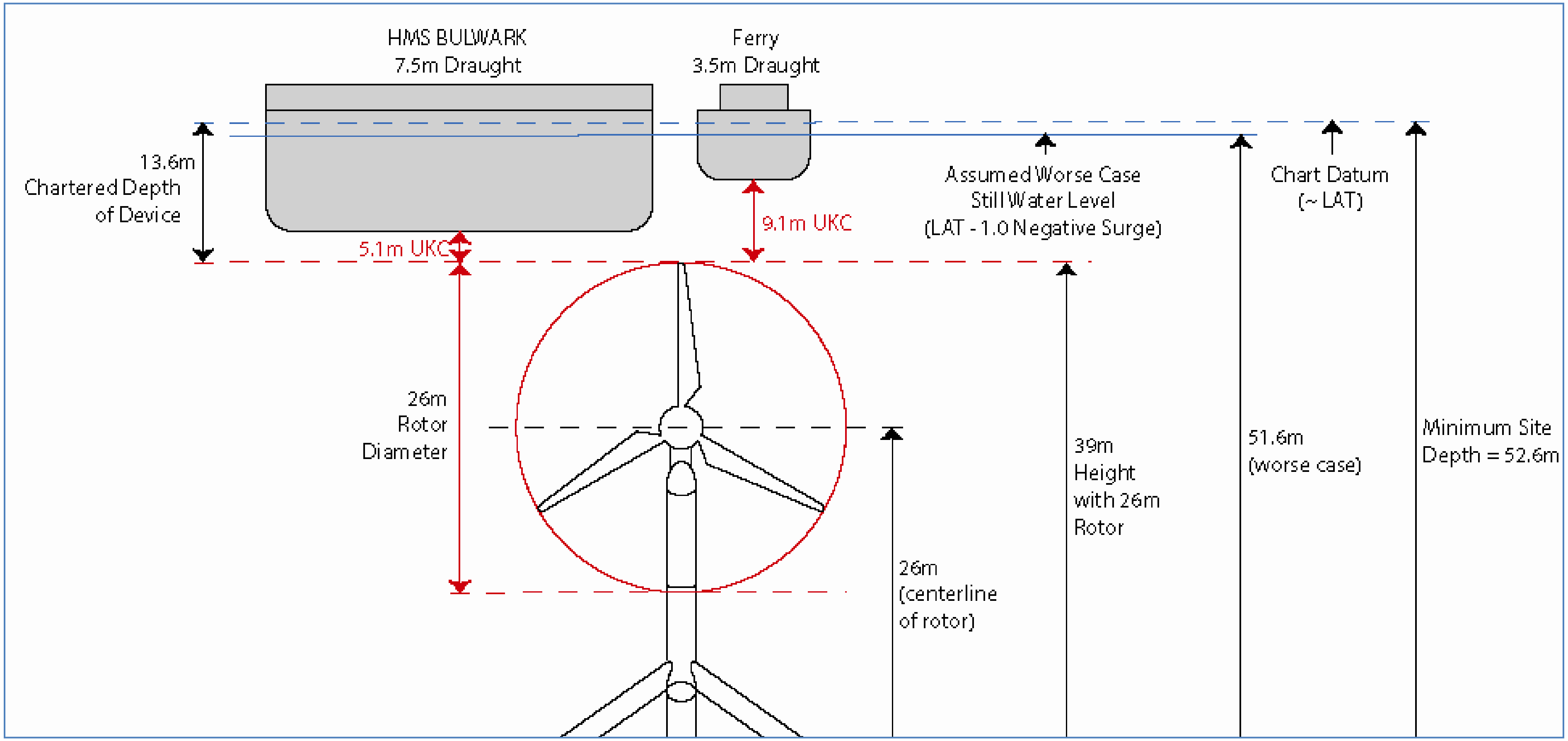

Figure 13 Minimum Device Clearance

A CalMac ferry would have a worse case still water clearance of 9.1m whilst typical vessels using the sound with draughts of 5 - 6.5m would have clearances of 7.6m - 6.1m respectively.

The UKC figures that previously applied before the changes to the device dimensions were such that it was considered that the likelihood of vessel wave induced vessel pitch and heave motions reducing the still water clearance to an unacceptable level such that there was a risk of collision was not credible.

Given the reduction in the clearances caused by the dimensional changes, it is considered necessary to re-examine the issues arising from the combination of extreme tide levels, negative surges and extreme wave events to determine whether the risk level has changed from what was previously assessed as “tolerable”.

In order to determine the theoretical possibility a number of factors were considered. These factors included, in addition to the extreme tidal/surge/wave spectrum events mentioned above, the type of vessels which are known to have used the sound and the wave spectrum that they may encounter.

Section 3.1.8 showed that the wave climate for this area of the sound, gave rise to significant wave heights (Hs) of around 1m and with a periodicity of between 3 - 4 seconds. This is a very short sea and is unlikely, given the wavelength associated with such a period[4] and in waters of that depth, of around 14m to 25m to give rise to significant pitch and heave motions in the vessels using the area. Severe motions are usually associated with wavelengths which are greater than half the vessel LOA and most of the vessels with draughts which could be of concern are 60-70m LOA or greater. However, a conservative approach has been taken in that it has been assumed that induced motions may induce an overall increase in draught of 50% of the vessel draught. As can be seen in Table 8 that, even allowing for such a conservative margin, whilst there are a number of circumstance where the clearance is reduced to less than 50% of the vessel’s draught (highlighted in amber), there are no circumstances in which the vessel’s pitch and heave motions reduce the UKC to such an extent that the vessels could collide with the devices.

If it were to be the case that such a possibility existed then such vessels transiting the sound in such conditions would, inevitably, ground in the northern end of the sound where the least depth in the navigable channel is some 3.4m less than the individual charted depth of the shallowest device. Also, the northern entrance to the sound is subject to considerable Atlantic sea swell (which does not reach down to the Port Askaig area) which would lead to greater pitch and heave motions in that area.

It should be stated that determining whether such an event is theoretically possible is different to establishing whether it is likely to happen. Even if it were to be considered as theoretically possible, the concurrence of a number of factors would be necessary for the event to occur. This would include:

- The tidal level would be at or approaching LAT at the time of transit.
- There would be a negative surge of approximately 1m within the sound caused by a combination of strong persistent winds and low atmospheric pressure.
- The presence of a wave spectrum that would induce pitch and heave motions in a particular vessel.
- That the vessel would pass over the top of the devices for which the reduction in UKCs caused by the above would result in contact occurring.

Hence, the risk of collision with the devices in exceptional sea states is considered to be substantially less than the background risk of grounding in the northern area of the sound.

[4] Wavelength has been derived using the formula of $L=1.56xT^2$ where L is the Wavelength and T is the wave period.

					Still Water UKC at MLWS			Still Water UKC at LAT			Still Water UKC at LAT - 1m Neg Surge			UKC at MLWS with 1m Hs (0.5m trough) & assuming pitching motion increases draught by 50%.			UKC at LAT with 1m Hs (0.5m trough) & assuming pitching motion increases draught by 50%.			UKC at LAT - 1m Neg Surge with 1m Hs (0.5m trough) & assuming pitching motion increases draught by 50%.		
Turbine	Siting (Charted) Depth (m)	Clearance above Rotor at CD (LAT)	Clearance above Rotor (-1m Neg Surge)	Clearance above Rotor at MLWS (+0.4m)	Ferry (3.5m Draught)	Coaster (6.5m Draught)	HMS Bulwark (7.5m Draught)	Ferry (3.5m Draught)	Coaster (6.5m Draught)	HMS Bulwark (7.5m Draught)	Ferry (3.5m Draught)	Coaster (6.5m Draught)	HMS Bulwark (7.5m Draught)	Ferry (3.5m Draught)	Coaster (6.5m Draught)	HMS Bulwark (7.5m Draught)	Ferry (3.5m Draught)	Coaster (6.5m Draught)	HMS Bulwark (7.5m Draught)	Ferry (3.5m Draught)	Coaster (6.5m Draught)	HMS Bulwark (7.5m Draught)
1	55.4	16.4	15.4	16.8	13.3	10.3	9.3	12.9	9.9	8.9	11.9	8.9	7.9	11.05	6.55	5.05	10.65	6.15	4.65	9.65	5.15	3.65
2	55.6	16.6	15.6	17	13.5	10.5	9.5	13.1	10.1	9.1	12.1	9.1	8.1	11.25	6.75	5.25	10.85	6.35	4.85	9.85	5.35	3.85
3	59.9	20.9	19.9	21.3	17.8	14.8	13.8	17.4	14.4	13.4	16.4	13.4	12.4	15.55	11.05	9.55	15.15	10.65	9.15	14.15	9.65	8.15
4	56.8	17.8	16.8	18.2	14.7	11.7	10.7	14.3	11.3	10.3	13.3	10.3	9.3	12.45	7.95	6.45	12.05	7.55	6.05	11.05	6.55	5.05
5	52.6	13.6	12.6	14	10.5	7.5	6.5	10.1	7.1	6.1	9.1	6.1	5.1	8.25	3.75	2.25	7.85	3.35	1.85	6.85	2.35	0.85
6	53.7	14.7	13.7	15.1	11.6	8.6	7.6	11.2	8.2	7.2	10.2	7.2	6.2	9.35	4.85	3.35	8.95	4.45	2.95	7.95	3.45	1.95
7	52.6	13.6	12.6	14	10.5	7.5	6.5	10.1	7.1	6.1	9.1	6.1	5.1	8.25	3.75	2.25	7.85	3.35	1.85	6.85	2.35	0.85
8	52.8	13.8	12.8	14.2	10.7	7.7	6.7	10.3	7.3	6.3	9.3	6.3	5.3	8.45	3.95	2.45	8.05	3.55	2.05	7.05	2.55	1.05
9	53.8	14.8	13.8	15.2	11.7	8.7	7.7	11.3	8.3	7.3	10.3	7.3	6.3	9.45	4.95	3.45	9.05	4.55	3.05	8.05	3.55	2.05
10	52.8	13.8	12.8	14.2	10.7	7.7	6.7	10.3	7.3	6.3	9.3	6.3	5.3	8.45	3.95	2.45	8.05	3.55	2.05	7.05	2.55	1.05

Where UKC = <50% of Vessel Draught

Theoretical possibility of physical contact between vessel and Turbine

Table 10 Underkeel Clearances

As with the construction phase, the establishment of a Safety Zone has been considered as a potential control for the reduction of risks during the operational phase. It is considered that no particular benefits would be conferred by the application of such an instrument and, indeed, such a measure would have an adverse effect on the safety of navigation of those vessels, such as the CalMac ferries, whose passage plan to and from Port Askaig would require them to pass over the devices (which they can do without risk) but which they would be prohibited from doing by the establishment of a Safety Zone. Such vessels are not put at risk by the presence of the devices but would be at considerable disadvantage in having to undertake their passage away from their well tried routes which make best use of the area to avoid the effects of tide.

Therefore, the application of Safety Zones is not recommended for use in these circumstances.

Risk Control Measures:

- ❑ Appropriate charting of devices. (See Section 7).
- ❑ The designed clearance height above devices provides an adequate safety margin allowing for exceptional circumstances including concurrent extreme events.
- ❑ The designed clearance height above devices at LAT is greater than that which exists in the northern area of the Sound.

6.3.2. Fishing Gear Entanglement

The fishing activities conducted in the Sound of Islay consists only of creeling. As previously described, this is undertaken by small craft (usually under 10m in length) using fleets of creels up to 1000 metres in length.

The main safety concern is that the presence of the devices presents a significant hazard to the creel fishermen if they were to have a problem when recovering their gear. In normal circumstances they would drift with the tide whilst they cleared the snag with the gear. Drifting with gear over the side into the array area obviously presents a possibility of entanglement leading to vessel capsize given the tidal rates experienced in the area and the rotating blades of the devices.

With regard to general entanglement with the device, the fishermen would be required to treat the structures as they would other hazards with which fishing gear could become entangled. That is, to cut their gear if there was a perceived danger to their vessels from the turbines. In addition, the fitting of rope cutters to the devices (similar to cutters fitted to vessels' propellers) would, to a certain extent, mitigate the risk of the turbines "reeling in" the gear. Even with such mitigations the likelihood of capsize if a vessel's gear were to become entangled with either the support structure or rotor is still significant. The designation of the area around the array as a "No Fishing" area is addressed in Section 7.

Subsea cables provide a potential snagging hazard for fishing gear and that entanglement with them could cause fishing vessels to capsize when hauling in. If the subsea cables were not in full contact with the seabed (bridging) the potential for snagging is greater. Cable movement (caused by the force of the tidal stream) could endanger fishing gear when laid. The cables will be sited such that bridging is avoided so far as is possible. This will be achieved by careful sea bed survey and accurate positioning of the cables. Movement of the cables (particularly where they will be at an oblique angle to the direction of the tidal stream) will be assessed for likelihood of movement and the requirement for cable protection (e.g. mattressing, ductile iron protectors).

Risk Control Measures:

- Appropriate charting of devices (see Section 7).
- Provision of device positional data to Kingfisher Information Services
- Fit rope cutters/anti-snagging devices to the individual devices.
- Cable protection where appropriate.
- Avoidance of bridging during cable lay.

6.3.3. Diving

The area of the proposed development is, as was stated in Section 5.2.5, identified in diving reference books as a recommended dive site. The dive is intended to make use of the depths available in this precise spot as opposed to the rest of the sound which is, generally, less than 20m. Diving in an area where up to 10 turbine devices may be sited presents a risk of injury or fatality.

Risk Control Measures:

- Appropriate charting of devices as an area in which diving is prohibited (see Section 7).
- SPR to inform, and invite comment from, representatives of relevant diving organisations.

6.3.4. Failure

The design of the turbine and support structure will be subject to third party verification by Det Norske Veritas (DNV). Any failure of the device, either whole or in part, would be indicated by the device Supervisory Control And Data Acquisition (SCADA) system. Responses to such failure would include the shutting down of the individual device (or the array as a whole, where appropriate) by the application of the shaft brakes thus stopping the rotor and, hence, power generation.

In the unlikely event of a catastrophic failure of the device, any parts which become detached are unlikely to become a hazard to shipping as no component is positively buoyant. Any debris will sink to the seabed and be subject to the effects of the tide.

Risk Control Measures:

- Third party design verification.
- AHH design stage analysis of failures.
- ScottishPower Renewables to have appropriate maintenance procedures for safety critical components e.g. nacelle locking.
- ScottishPower Renewables to develop and implement Emergency Response Procedures in case of device failure.

6.3.5. Anchoring

There is a designated anchoring area in McDougall's Bay on the Jura side of the sound in 10m of water some 2.6 cables (480m) away from the closest device. The area where the array is proposed to be sited would not, in normal circumstance, be considered as a suitable anchorage due to its depth and the nature of the seabed. Between the point where the cable crosses the 20m contour and the possible landing point on the Islay shore, the seabed is charted as "rock" and relatively steep-to. Hence, it is unlikely that it would be used as an anchorage out of choice given that more suitable areas exist close by in other parts of the sound.

However, the possibility exists that, in an emergency such as a total loss of power, a vessel could consider using its anchor in the area to avoid going aground. It is considered unlikely that, given the depth of water, any vessel would attempt to anchor over the array but would wait until they had drifted into shallower water before doing so. There is, therefore, a potential risk to vessels anchoring in an emergency although, given the traffic density and the likelihood of such an event, the risk can be considered broadly acceptable.

6.3.6. Electro-Magnetic Interference (EMI)

The devices generate alternating current and with the nacelle at below 26m charted depth and the cable sited on the seabed, there is not expected to be any adverse EMI effects on navigational equipment from the devices or the cable.

6.3.7. Acoustic Interference

There are no known adverse effects on navigation systems from acoustic interference arising from the ANDRITZ Hydro Hammerfest device. The Ministry of Defence (MoD) (Defence Estates – now known as Defence Infrastructure Organisation (DIO)) response to the scoping document is assumed to include the assessment of any impacts on MoD acoustic monitoring equipment and other vessel equipment.

6.3.8. Effects on Communications, Radar and Positioning Systems

As the individual devices comprising the array are sub-surface they are not considered to present any hazard to communication, radar and positioning systems during operations.

6.3.9. Maintenance

Maintenance, requiring the use of the special purpose installation/recovery barge and tug vessel for recovery of the nacelle will average 2 per year. It is probable that visits to the devices by workboats will also be undertaken for remote survey and inspection of the devices and for environmental monitoring purposes.

The hazard presented to shipping by the recovery/re-installation process will be similar to that arising in the installation phase. The proposed controls will, therefore, be similar.

Risk Control Measures for Maintenance involving Barge/workboat/tug:

- ❑ Liaise with CalMac concerning the planned activities to ensure de-confliction of CalMac ferry operations to/from Port Askaig; OR
- ❑ Where this was not possible, by establishing a procedure between the developer and CalMac for assessing the risk of allowing ferry operations to take place at the same time as installation activities.
- ❑ Submission of adequate information to the UKHO and other authorities (e.g. MCA) in good time to enable promulgation of national and local NMs/Radio Navigational Warnings.
- ❑ Maintenance vessels marked and lit in accordance with COLREGs.
- ❑ Provision of a appropriate, dedicated Guard vessel to monitor and warn traffic of the activities being conducted.
- ❑ Emergency Response Coordination Plan (ERCoP) in place.
- ❑ Environmental limits for the installation process are developed, implemented and adhered to.

6.4. De-commissioning Phase

It is intended that when the lifecycle of the array is complete, the devices and associated cables will be removed. The decommissioning phase is, therefore, a reversal of the installation process. The risks from the decommissioning activity are expected to be the same as for the installation process. Hence, similar control measures would be implemented.

7. Charting, Marking and Lighting

7.1. Charting

The charting of the individual devices and the arrays as a whole has been discussed with the key marine users of the area and with the UKHO. The fishermen attending the HIRA were keen that extensive areas of the sound are not removed from potential use by the application of any type of area which would exclude them fishing in the general area. They stated that they would prefer data on the precise positions of the devices in order that they can enter them into their chart plotters and thus ensure their safety by maintaining a distance appropriate to their activities and the conditions. The Masters of the CalMac ferries require only to know the general location of the devices as they would not consider them a hazard to navigation and would be happy to maintain their present passage plans passing over the devices.

In general, marine users subscribe to the philosophy that the chart should provide them with the appropriate information on the position and nature of the hazards and to allow them to make the decision on the appropriate distances and clearances required to ensure the safety of their vessels.

The scale of the current Standard Nautical Chart (SNC) (Admiralty Chart 2481) covering the area is 1:25000. Given the extent of the proposed array, this presents issues regarding the amount of data that can be shown within the area on the chart encompassing the array and the potential obscuration of detail necessary for the mariner. For Electronic Navigational Charts (ENCs), these issues are, to an extent, overcome.

7.1.1. Charting the Array Area

Given the risks to fishermen presented by the devices (as discussed in Section 6.4.1.2), it is recommended that the area containing the array is charted as an area in which fishing is prohibited. A consultation process should, therefore, be initiated with the Scottish Government to discuss the possibility of designating the area as a “No Fishing” area. Similarly, with the potential risks to divers using the area, it is recommended that the area is also designated as a “No Diving” area.

The designation of an area to exclude specific activity requires Scottish Government approval. If such approval is not gained then the alternative would be to chart the area as a “Marine limit in general, usually implying physical obstructions” with a standard international symbol of a black pecked line (International Symbol N1.1 - Admiralty Publication 5011, Symbols and Abbreviations used on Admiralty Charts (Reference 13)). This would indicate to the marine users that potential hazards exist within the area. This proposal is subject to agreement with the UKHO and further consideration of the issues of obscuring data on the chart given the scale. An explanatory note is also recommended to be added to the chart explaining that subsea obstructions in the form of tidal turbines are sited within the area. The area would also be supplemented by the charting of the device positions (see below). Such an area and note will require to be clear in identifying the nature of hazards present.

7.1.2. Charting the Devices

Following the discussions with the UKHO, it has been agreed that, given the scale of the chart covering area and the practicalities of marking individual devices sited in 4 sub-arrays separated

by, approximately, 470m between them, it would be possible if the devices were to be marked using the symbol for an underwater obstruction (e.g. Symbol L21 or 24 from Admiralty Publication 5011 (Reference 14). The symbol could be annotated by text alongside indicating that it was a Tidal Turbine. As the scale of the chart would mean that symbols marking individual devices of the sub arrays would overlap, the UKHO stated that the symbols would be linked together with a single depth within the symbol indicating the least depth of the sub-array. Each sub-array could be annotated as "Tidal Turbines" if there was considered sufficient space on the chart. Otherwise such information could be included in the note mentioned above.
In order that fishing vessels are provided with accurate information on the position of the individual devices such that the device locations can be entered into their plotters with sufficient accuracy, it is further recommended that the individual device positions are provided to the Kingfisher Information Service which provides fishermen with information on subsea cables and other "introduced" hazards in the marine fishing environment.

7.1.3. Marking and Lighting

The issues surrounding the requirements for marking and lighting the proposed demonstration tidal array have been discussed with the Northern Lighthouse Board (NLB). The guidance on marking and lighting of offshore wave and tidal energy devices is laid down in the International Association of Lighthouse Authorities Recommendation O-139 "The Marking of Man-Made Offshore Structures" (Reference 14).

The IALA recommendation states that "*Areas containing surface or sub-surface energy extraction devices (wave and/or tidal) should be marked by appropriate navigation buoys in accordance with the IALA Maritime Buoyage System, fitted with the corresponding top-marks and lights. In addition, active or passive radar reflectors, retro reflecting material, Racons and/or AIS transponders should be fitted as the level of traffic and degree of risk requires*."
It further states that "*The boundaries of the wave and tidal energy extraction field should be marked by lighted navigational buoys, so as to be visible to the Mariner from all relevant directions in the horizontal plane, by day and by night. Taking the results of a risk assessment into account, lights should have a nominal range of at least 5 (five) nautical miles. The Northerly, Easterly, Southerly and Westerly boundaries should normally be marked with the appropriate IALA Cardinal mark. However, depending on the shape and size of the field, there may be a need to deploy lateral or special marks*."

The Recommendation makes no allowance for the risk (or absence of risk) presented by such arrays or devices to the vessels using the waters. Neither does it recognise the practicalities of establishing and maintaining such buoys in areas of strong tidal stream and depth where, in certain tidal states, buoys may be submerged due to the forces acting on them. In this case, where the channel is relatively narrow, the buoys would have to be sited a suitable distance clear of the array in order to ensure that the moorings cannot in any circumstances impact on the individual devices. The length of cable required to moor such buoys in the depths available - approximately 50m - using a standard mooring would be in the order of, at least, 200m. Such a mooring scope would, effectively, deny navigation of a much larger area than is required even for those vessels which either would wish to avoid the array or which could navigate without risk within the area.

It is also a case that the buoyage itself would present an additional collision hazard to vessels such as the CalMac ferries approaching and departing Port Askaig which would not be at risk from the devices themselves.

Given the low level of collision or other risk presented by the devices constituting the array, it is considered that the level of risk is in no way further reduced by the use of buoyage to mark the proposed array. In fact, it is considered that the risks are increased by the addition of buoyage in that:

1. They present a hazard to shipping approaching Port Askaig in strong tidal streams due to their closeness to the required approach track taken by CalMac Ferries.

2. The buoys and their moorings would present a further hazard to creel fishing vessels operating in the area.
3. They would present a hazard to shipping if they were to be submerged when subject to strong tidal streams.
4. They further constrain the available navigable waters of the sound due to the distance off the array they would require to be sited.

Risk Control Measures:

- ❑ Chart the sub-arrays as “Underwater Installations” (e.g. Symbol L21 or L24.
- ❑ Consult with the Scottish Government regarding designating the array area as a “No Fishing” (Int. Symbol N21) and “No Diving” area.
- ❑ If designating the array area as “No Fishing/No Diving” is not feasible, then the area should be charted as a “Marine Limit in General, implying physical obstructions” (Int. Symbol N1.1).
- ❑ Provide an explanatory note on the chart explaining the hazard.
- ❑ Device positional information provided to Kingfisher information service.

8. Status of Hazard and Control Log

The hazard and control log is at Annex B. The controls identified in the Log will be addressed by ScottishPower Renewables as part of the project risk management process. The major hazard and consequent risks arise from the installation process.

9. Search & Rescue (SAR) Overview and Assessment

9.1. Search and Rescue

The Sound of Islay is situated in the area of the UK Maritime Search and Rescue administered by Clyde Maritime Rescue Co-ordination Centre (MRCC). MGN 371 (M+F) Annex 4 (Reference 3) requires that an Emergency Response Co-ordination Plan (ERCoP) is established as part of the risk mitigation process for any OREI. The ERCoP is required to be in place for the construction, operation and decommissioning phases of the demonstration array (see Section 6.3.2.1).

The plan is required to address a number of issues depending on the type and characteristics of the array and devices. Given that the proposed devices are sub-surface tidal devices, the recommendations in MGN 371(M+F) on such matters as marking of individual devices and operational procedures require to be determined “on a case by case basis”, in consultation with appropriate stakeholders during the Scoping and Environmental Impact assessment processes.

The requirements for such a plan have been discussed with the Clyde MRCC Manager and will be incorporated into an agreed ERCoP prior to the commencement of installation operations.

Risk Control Measure:

- ❑ Develop and implement an ERCoP covering the construction, operation and decommissioning phases of the demonstration array in cooperation with the MCA/MRCC Clyde.

9.2. RNLI

The Port Askaig lifeboat can, in general, operate within the array area without risk. There is a potential risk if the lifeboat were to be conducting a tow and the towline was submerged such that the line became entangled with the device rotors. The catenary of the tow line would require to be greater than 13m below the surface in order for this to happen. This issue was raised with the station manager and lifeboat crew and it was considered that, due to the likely size of the vessels which could be taken in tow in the area, the length, size and weight of line and the probable destination/place of safety, that there would be little likelihood of getting entangled with the devices.

There are no issues which are considered as affecting the use of helicopters within the demonstration array area.

It is considered that the array as a whole or the individual devices do not present an unacceptable risk to SAR activities above the background risks of operating in the close inshore area of the sound.

10. Through Life Safety Management

10.1. Safety Management System

A Safety Management System (SMS) will be required to be established to cover the construction, operational and decommissioning phases of the demonstration tidal array lifecycle. This shall be required to address the hazards and risks identified in the Hazard and Risk Control Log (Annex B). Hence, amongst other things, it shall address the development and implementation of an ERCoP. Such an ERCoP would be required to be tested at suitable intervals.

The SMS shall also contain emergency procedures for the control of marine work and other activities conducted by the array developer or their authorised contractors within the array area. It will detail responses to emergency situations including collision between vessels and other vessels/devices within the area, failure of devices or loss of power and injury to personnel involved in construction of maintenance activities. The system would require to be considered robust and subject to management review.

Risk Control Measure: ❑ Develop and implement an appropriate Safety Management System covering the construction, operation and decommissioning phases of the demonstration array.

11. Search & Rescue (SAR) Overview and Assessment

It is considered that the array does not present any particular issues with regard to SAR activities.

It is considered that it would be appropriate for the RNLI to be informed of the presence of device installations such that, they are aware at all times of the location of devices and their associated hazards. This can be achieved by suitable liaison between SPR and the local RNLI station.

12. Status of Hazard and Risk Control Log

The Hazard and Risk Control log for the SPR Demonstration Tidal Array is intended to be kept as an active document which records and monitors the status of new and existing hazards to ensure that the risks remain tolerable and As Low as Reasonably Practicable ALARP. The updated Hazard and Control Log is at Annex B.

13. Major Hazards Summary

The major hazards are contained within the Hazard and Risk Control Log at Annex B. The top level risks for the array are considered as the following:

- Collision between transiting vessel and the installation “spread” (barge/workboat/tug);
- Creel fishing boats gear snagging on the devices or cables.
- The risk to recreational divers undertaking dives on sites recommended by various diving guides.

The risk of collision can, it is believed, be adequately mitigated by the application of appropriate controls as laid out in Section 6 and derived from the Hazard and Control Log.

The risk to fishing vessels is considered to be more problematic in that it is considered likely, given the evidence of the HIRA and discussions with fishermen and their representatives, that creel fishing would take place as close to the area as would be allowed by whatever means is used to chart the hazard. It is quite probable that the array area would, to an extent, act as a nursery for the target species thus encouraging fishing activities close to the area. In the event of a gear malfunction, there is a possibility of the fishing vessel drifting into the array with gear deployed over the side leading to entanglement and capsize. Whilst it is recommended that the charted area showing the hazard is of a size that just encompasses the hazards (devices), it is considered that a “No Fishing” area should be considered that provides a greater “buffer” area around the array such that the risk of entanglement is reduced. The exact size of the area would require to be agreed with the fishermen and their representatives. It is understood that such an area would require Scottish Government assent.

Given the issues of recreational diving it is recommended that a similar area, coincident with the “No Fishing” area is also established.

14. Conclusions

The following conclusions are drawn:

1. That the risk to navigation from the use of a purpose built, moored barge and tug / workboat arrangement during the installation phase is considered to be “Tolerable with Monitoring” subject to the application of such risk controls as are identified in this report;
2. That the risk to navigation (including vessels engaged in creeling) from the operational and maintenance phase is considered to be “Tolerable with Monitoring” subject to the application of such risk controls as are identified in this report;
3. That the risk to recreational divers is “Tolerable with Monitoring” subject to the application of such risk controls as are identified in this report;
4. That the individual devices/sub arrays require to be charted appropriately subject to the limitations of the scale of the chart and the need to avoid congestion of information;
5. That the area containing the demonstration array should be charted appropriately subject to a review of the issues involved with the UKHO;
6. That the use of buoyage as recommended by IALA guidance does not, in the circumstances, provide any benefit to the marine user and, in fact, adds to the hazards in a confined waterway;
7. That the scale and nature of the risks involved by the demonstration array, requires the development of a Safety Management System (including an ERCoP).

15. Recommendations

The following recommendations are proposed:

1. That the proposed development is given consent on the grounds that the installation and operational phases of this development do not represent an intolerable level of risk subject to the use of the installation methodology as described in this report and the implementation of the risk controls identified in this report;
2. That application should be made for the area containing the array to be designated and charted as a “No Fishing (International Symbol N21) and No Diving” area.
3. That each sub-array is charted as an “underwater obstruction” providing the least depth of each sub-array using International Symbol L21 or L24. Where possible, given the scale of the chart, the symbol for each sub-array should be annotated as “Tidal Turbines”. Where this is not possible, the explanatory note should be used to describe the type of device;
4. That, if Recommendation 2 is not accepted by the Scottish Government, the area containing the demonstration array should charted as a “marine limit in general, implying physical obstructions” i.e. International Symbol N1.1;
5. That buoyage in accordance with the IALA recommendations is not mandated for marking the demonstration array;
6. That a Safety Management System (including an ERCoP) appropriate to the scale and nature of the risks involved by the demonstration tidal array, is developed and put in place prior to installation of the array.

16. Statement of Limitations

The risks presented by the proposed installation have been assessed as “Tolerable with Monitoring” and ALARP for all phases of their development. However, this assessment is only valid under the following assumptions/limitations:

- Any major deviation in the technology or installation methodology applied (which differs significantly from the descriptions in this document) must be assessed for risk and the NSRA and Hazard Log must be revised accordingly;
- The risk controls as described in this document are applied in their entirety.

Annex A – Traffic Survey Data

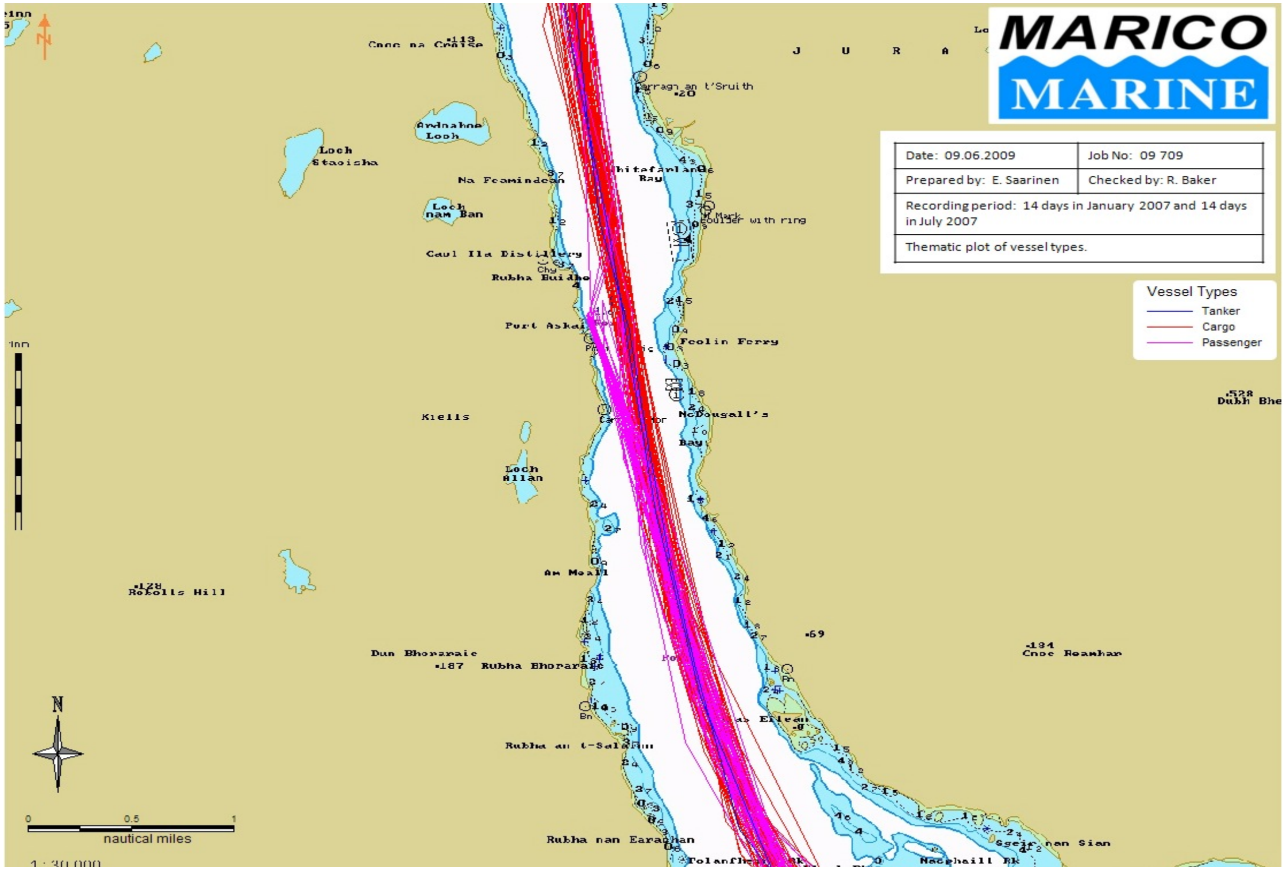

Figure A1 – AIS Track Data Showing Breakdown by Vessel Type

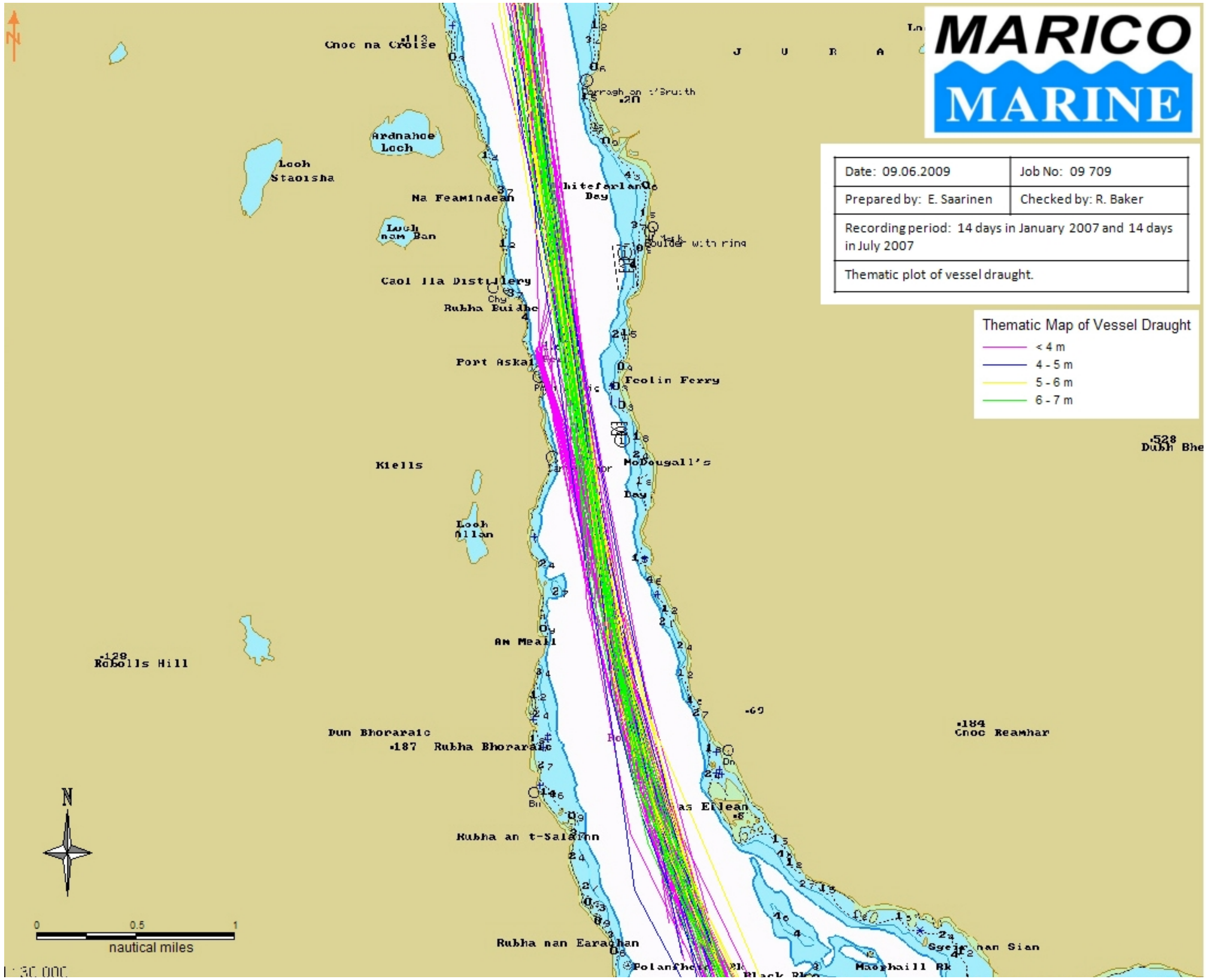

Figure A2 – AIS Track Data Showing Breakdown by Draught

VesseL Traffic Analysis - SOUND OF ISLAY

Across Gate defined by co-ords								
Total Vessels in Transit (4 weeks)	94		Total Vessels in Transit (2 weeks Jan)	23		Total Vessels in Transit (2 weeks Jul)	71	
Group Breakdown			Group Breakdown			Group Breakdown		
Dry Cargo	56	59.57%	Dry Cargo	21	91.30%	Dry Cargo	35	49.30%
Tankers	2	2.13%	Tankers	0	0.00%	Tankers	2	2.82%
Navy	2	2.13%	Navy	0	0.00%	Navy	2	2.82%
Passenger	34	36.17%	Passenger	2	8.70%	Passenger	32	45.07%
Total	94	100.00%	Total	23	100.00%	Total	71	100.00%
Speed Through Area			Speed Through Area			Speed Through Area		
5-10 Knots	25	26.60%	5-10 Knots	12	52.17%	5-10 Knots	23	32.39%
10-15 knots	38	40.43%	10-15 knot:	6	26.09%	10-15 knot:	22	30.99%
15-25 Knots	31	32.98%	15-25 Knot	5	21.74%	15-25 Knot:	26	36.62%
Total	94	100.00%	Total	23	100.00%	Total	71	100.00%
Draft Of Vessels			Draft Of Vessels			Draft Of Vessels		
2.5-5m	61	64.89%	2.5-5m	13	56.52%	2.5-5m	48	67.61%
5-10m	33	35.11%	5-10m	10	43.48%	5-10m	23	32.39%
Total	94	100.00%	Total	23	100.00%	Total	71	100.00%
North of Port Askaig								
Total Vessels in Transit (4 weeks)	66		Total Vessels in Transit (2 weeks Jan)	23		Total Vessels in Transit (2 weeks Jul)	43	
Group Breakdown			Group Breakdown			Group Breakdown		
Dry Cargo	56	84.85%	Dry Cargo	21	91.30%	Dry Cargo	35	81.40%
Tankers	2	3.03%	Tankers	0	0.00%	Tankers	2	4.65%
Navy	2	3.03%	Navy	0	0.00%	Navy	2	4.65%
Passenger	6	9.09%	Passenger	2	8.70%	Passenger	4	9.30%
Total	66	100.00%	Total	23	100.00%	Total	43	100.00%
Speed Through Area			Speed Through Area			Speed Through Area		
0-2.5 Knots	2	3.03%	0-2.5 Knots	0	0.00%	0-2.5 Knots	2	4.65%
5-10 Knots	26	39.39%	5-10 Knots	12	52.17%	5-10 Knots	14	32.56%
10-15 knots	21	31.82%	10-15 knot:	6	26.09%	10-15 knot:	15	34.88%
15-25 Knots	17	25.76%	15-25 Knot	5	21.74%	15-25 Knot:	12	27.91%
Total	66	100.00%	Total	23	100.00%	Total	43	100.00%
Draft Of Vessels			Draft Of Vessels			Draft Of Vessels		
2.5-5m	33	50.00%	2.5-5m	13	56.52%	2.5-5m	20	46.51%
5-10m	33	50.00%	5-10m	10	43.48%	5-10m	23	53.49%
Total	66	100.00%	Total	23	100.00%	Total	43	100.00%

Figure A3 – Vessel Traffic Analysis by Type, Speed and Draught

Annex B- Hazard and Control Log

Sound of Islay ScottishPower Renewables - Hazard & Control Log-Revised Nov 2012											
Element	**Phase**	**Guide word**	**Hazard**	**Consequence**	**Initial Risk**			**Controls / Mitigation**	**Residual Risk**		
					Frequency	**Consequence**	**Risk**		**Frequency**	**Consequence**	**Risk**
Subsea Cables	**Installation & Commissioning**	Shipping routes	Cable installation vessel Restricted in Ability to Manoeuvre (RAM)	Vessel in transit collides with cable installation vessel(s)	Remote	Major	**Tolerable with Additional Controls**	Installation vessel compliant with COLREGs. Issue NMs/Radio Navigation Warnings. Warn frequent users e.g. ferry operators/ fishermen. ERCoP SMS – Emergency Response Procedures	Extremely Remote	Major	**Tolerable with monitoring**
	Operation	Vessel engaged in fishing	Cable	Vessel capsize	Remote	Major	**Tolerable with Additional Controls**	Cable to be charted. Cable position to be provided to “Kingfisher” System No trawling takes place in area. Avoid “bridging”. Mattress protection at vulnerable points. ERCoP SMS – Emergency Response Procedures	Extremely Remote	Major	**Tolerable with monitoring**
		Anchorage	Cable	Vessel anchor snags on cable	Remote	Major	**Tolerable with Additional Controls**	Cable to be charted. Avoid “bridging”. Consideration of providing “mattress” protection at vulnerable points. ERCoP SMS – Emergency Response Procedures	Extremely Remote	Major	**Tolerable with monitoring**
Devices (Structures and Nacelle)	**Installation and Commissioning**	Shipping routes	Barge/workboat / tug conducting installation	Vessel (ferries/fishing vessels) collision with installation spread	Remote	Major	**Tolerable with Additional Controls**	Installation vessels compliant with COLREGs. Issue NMs/Radio Navigation Warnings. Warn frequent users e.g. ferry operators/ fishermen. ERCoP SMS – Emergency Response Procedures Use of guard vessels to warn vessels entering sound	Extremely Remote	Major	**Tolerable with monitoring**
		Shipping routes	Construction barges at Standby mooring	Vessel (coasters, ferries/fishing vessels) collision with moored barge / mooring	Remote	Minor	**Tolerable with Monitoring**	Issue NMs/Radio Navigation Warnings. Warn frequent users e.g. ferry operators/ fishermen. Use of guard vessels to warn vessels entering sound ERCoP SMS – Emergency Response Procedures	Extremely Remote	Minor	**Broadly acceptable**
		Shipping routes	Vessel not under command (NUC)	Collision between NUC vessel and installation vessel(s) leading to damage to vessel damage/injury /loss of life	Remote	Major	**Tolerable with Additional Controls**	Notice to Mariners (NTM)/ Navigation Warning(NavWarns) Monitoring of traffic by Guard vessel Emergency breakaway procedure Vessel Lighting and marking ERCoP SMS – Emergency Response Procedures	Extremely remote	Major	**Tolerable with monitoring**

Sound of Islay ScottishPower Renewables - Hazard & Control Log-Revised Nov 2012											
Element	**Phase**	**Guide word**	**Hazard**	**Consequence**	**Initial Risk**			**Controls / Mitigation**	**Residual Risk**		
					Frequency	**Consequence**	**Risk**		**Frequency**	**Consequence**	**Risk**
		Violation/ Mistakes/ Slips/ Lapses	Barge/workboat / tug conducting installation	Vessel transiting sound makes navigational error leading to collision with installation vessels and damage to vessel/injury /loss of life	Remote	Major	**Tolerable with Additional Controls**	Vessel marked and lit appropriately. Monitoring of traffic by Guard vessel Emergency breakaway procedure ERCoP SMS – Emergency Response Procedures	Extremely remote	Major	**Tolerable with monitoring**
		Radio Interference	Use of incorrect IMM VHF channels	Interference with IMM VHF ship/shore and ship/ship communications	Frequent	Minor	**Tolerable with Modification**	Installation vessel(s) to agree working channels with local operators/MCA	Remote	Minor	**Tolerable with monitoring**
Devices Structure s and Nacelle	**Operation**	Vessel NUC	Vessel not under command (NUC)	Vessel enters array area	Reasonably Probable	Insignificant	**Tolerable with Monitoring**	Devices sited with adequate clearance above for all traffic types. Devices/ array area appropriately charted	Reasonably Probable	Insignificant	**Tolerable with monitoring**
		Violation/ Mistakes/ Slips/ Lapses	Vessel enters array area	Vessel enters array area	Frequent	Insignificant	**Tolerable with Additional Controls**	Devices sited with adequate clearance above for all traffic types. Devices/ array area appropriately charted	Reasonably Probable	Insignificant	**Tolerable with monitoring**
		EMI	EMI Interference with navigational equipment	Potential for navigational error due to effects on navigation equipment e.g. .magnetic compass	Extremely remote	Insignificant	**Broadly Acceptable**	No evidence of EMI effects seen from other similar sub-sea cables in area. Power export cables are lower voltage than other inter-island power cables in area	Extremely remote	Insignificant	**Broadly Acceptable**
		Maintenance	Maintenance vessels restricted in their ability to manoeuvre (RAM)	Collision between transiting vessels and vessel conducting maintenance.	Remote	Major	**Tolerable with additional controls**	Maintenance vessel marking and lighting. Compliance with COLREGs ERCoP SMS – Emergency Response Procedures	Extremely remote	Major	**Tolerable with Monitoring**
		Acoustic noise	Interference with military/civil SONAR	Potential for navigational error due to inaccurate depth readings due to the effects on SONAR	Extremely remote	Insignificant	**Broadly Acceptable**	Acoustic output likely to be mainly low frequency broadband and unlikely to interfere with HF, narrowband navigational/depth finder sonars.	Extremely remote	Insignificant	**Broadly Acceptable**
		Device Failure	Loss of device or significant components	Surface vessel collision with floating objects	Reasonably Probable	Major	**Tolerable with Modification s**	Device subject to third party design verification against appropriate codes. Device components are not positively buoyant. Device provides indication of failure through SCADA system. ERCoP SMS – Emergency Response Procedures	Extremely Remote	Major	**Tolerable with Monitoring**
		Mooring Failure	Loss of buoy or significant components	Surface vessel collision with floating objects	Remote	Major	**Tolerable with Modification s**	Buoy designed to meet conditions. Buoy & Mooring subject to periodic Examination, Maintenance, Inspection and Test. ERCoP SMS – Emergency Response Procedures	Extremely Remote	Major	**Tolerable with Monitoring**

Sound of Islay ScottishPower Renewables - Hazard & Control Log-Revised Nov 2012											
Element	**Phase**	**Guide word**	**Hazard**	**Consequence**	**Initial Risk**			**Controls / Mitigation**	**Residual Risk**		
					Frequency	**Consequence**	**Risk**		**Frequency**	**Consequence**	**Risk**
Devices Structures and Nacelle	**Operation**	Anchorage	Device moorings/subsea cables	Vessels anchors snagging on device	Reasonably Probable	Minor	**Tolerable with Additional Controls**	Array area is too deep for normal anchorage. No anchorages adjacent.	Extremely remote	Insignificant	**Broadly Acceptable**
		Fishing	Devices present snagging hazard to fishing gear	Fishing vessel enters area by accident or design and fishing gear snags on devices causing vessel to capsize	Remote	Major	**Tolerable with Additional Controls**	Only creeling takes place in area. Devices / area charted. Device positions provided to Kingfisher system. Consideration of ropes cutters in design.	Extremely remote	Major	**Tolerable with Monitoring**
		Diving	Turbines present a hazard to recreational divers undertaking "deep" dive in array area	Fatality following collision with turbine	Remote	Major	**Tolerable with Additional Controls**	Devices/ array area appropriately charted and note on chart. Diving prohibited in area	Extremely remote	Major	**Tolerable with Monitoring**
		Diving	Turbines present a hazard to commercial divers undertaking dives in array area	Fatality following collision with turbine	Remote	Major	**Tolerable with Additional Controls**	Diving activities controlled by operator. Turbines made safe	Extremely remote	Major	**Tolerable with Monitoring**
	De-commissioning	Vessel NUC	Vessel not under command	Collision between NUC vessel and de-commissioning vessel(s) leading to damage to vessel damage/injury /loss of life	Remote	Major	**Tolerable with Additional Controls**	Notice to Mariners (NTM)/ Navigation Warning(NavWarns) Vessel Lighting and marking ERCoP SMS – Emergency Response Procedures	Extremely remote	Major	**Tolerable with Monitoring**
		Violation/ Mistakes/ Slips/ Lapses	Vessel collides with decommissioning vessel	Collision between vessel and de-commissioning vessel(s) leading to damage to vessel damage/injury /loss of life	Remote	Major	**Tolerable with Additional Controls**	Vessel marked and lit appropriately. Monitoring of traffic by de- commissioning vessels ERCoP SMS – Emergency Response Procedures	Extremely remote	Major	**Tolerable with Monitoring**

Risk Criticality and Risk Tolerability Matrices used in Risk Log

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

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

Record of Changes

Rev #	Date	Description	Approved
A	2013-02-28	Draft for Internal Review	D CANTELLO
B	2013-03-01	Draft for Internal Approval	N M CHIVERS
C			
D			
E			
F			
G			
0	2010-April	ARC Original Report	ARC Ltd
1	2010 -June	ARC Report - Client Comments included	ARC Ltd
2	2010 - July	ARC Report - Client Additional Comments included	ARC Ltd
3	2013-03-04	PMSS – Inclusion of Changes to Turbine/Array - Report for Client Comment	N M CHIVERS
4			
5			
6			

Distribution List

#	Function Title	Company	Name (optional)
1	Marine Development Officer	ScottishPower Renewables	Dr. Douglas Watson
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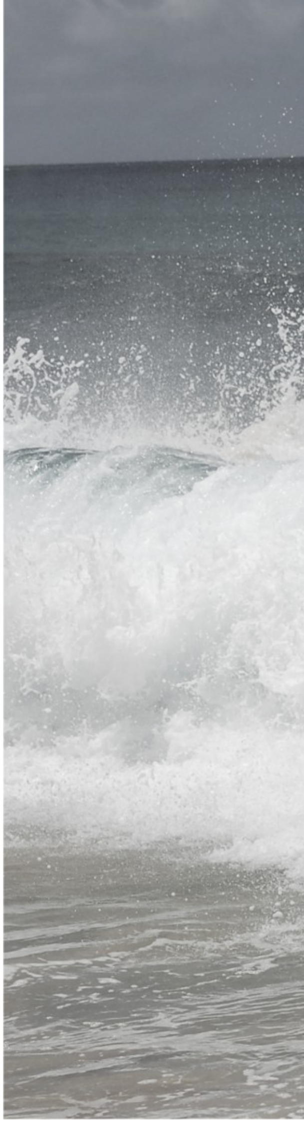
Notes:			



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