ARCADES MARINE
Management Consultants Ltd

Decommissioning Penguin WEC 1 and Mooring Components

Method Statement

fortum

OP286

This method statement is issued to:	
Company	Marine Scotland
Address	375 Victoria Road
	Aberdeen
	AB11 9DB
Contact Name	Debbie England
Position	Marine Renewables Casework Officer
Telephone	+44 (0) 300 244 244 5046
Email	debbie.england@gov.scot

This method statement was issued by:	
Company	Orcades Marine Management Consultants Ltd.
Address	Innovation Centre Orkney
	Hatston Pier Road, Kirkwall
	KW15 1ZL
Contact Name	Alexandra Thomson
Position	Operations Director
Telephone	+44 (0) 1856 874884
Email	Alexandra.thomson@orcadesmarine.co.uk

Prepared by	**Checked by**	**Authorised by**	**Date**
David Thomson	Alex Thomson	David Thomson	20.02.2020
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Company	Responsible Person	Distribution List Index Number
Fortum Energy	Mikko Muoniovaara	1
EMEC	Caitlin Long	2
EMEC	John Scuse	3

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1. Introduction

Wello Oy WEC 1 "Penguin" was installed at the EMEC wave test site in 2012 to undergo trials, in 2017 the WEC 1 "Penguin" sunk due to a suspected breach of the hull. The WEC 1 "Penguin" Is still attached to its mooring system on the seabed. The following method statement details at a high level the methods for removing the mooring components and WEC 1 "Penguin" and disposing of all components in an environmentally and economic manner.

1.1 Location

The WEC 1 "Penguin" and mooring system components are lying on the seabed at Berth 5, at the EMEC Test Site, Billia Croo, Orkney, Scotland.

The Billia Croo test site consists of five cabled test berths in up to 70m water depth, located approximately 2km offshore and 0.5km apart. The five 11kv subsea cables feed into the EMEC substation which houses the main switch gear, back-up generator and communications room. These cables feed the electricity generated by the wave energy converters testing on site directly into the national grid.

Three "Wave rider" buoys are located on site measuring the wave height, period and direction, and a purpose-built weather station provides real-time met data for the site. This data is fed into a sophisticated SCADA (Supervisory, Control and Data Acquisition) system, with live data feeds on the wave and met conditions available to view on the EMEC website.

Figure 1 EMEC Test Site Billia Croo Shown on Map

Figure 2 Wello Oy Penguin, Berth 5

2. Descriptions of Systems

2.1 General

This section is for information only.

The rotational movement of a WEC 1 “Penguin” device is derived directly from wave motion, and its captured by the hull shape, instead of a mechanism. The WEC 1 “Penguin” has no hydraulics or joints and moving components do not come into contact with sea water. The device has direct conversion, which means the waves become electricity and goes straight into the grid.

The asymmetrical shape of the WEC 1 “Penguin” hull creates a gyrating motion which pushes the rotating mass inside the device with each passing wave. The converter captures kinetic energy, turns it into electrical power and immediately transfers it to the grid by a subsea cable.

3. Position of Components

3.1 Mooring Design Overview “As built”

The mooring design is a 6-legged catenary system. Each mooring leg is made up of similar components, with a clump weight as an anchor with a combination of chain lengths leading to a sub-surface buoy and then onto the connection at the WEC 1 “Penguin”

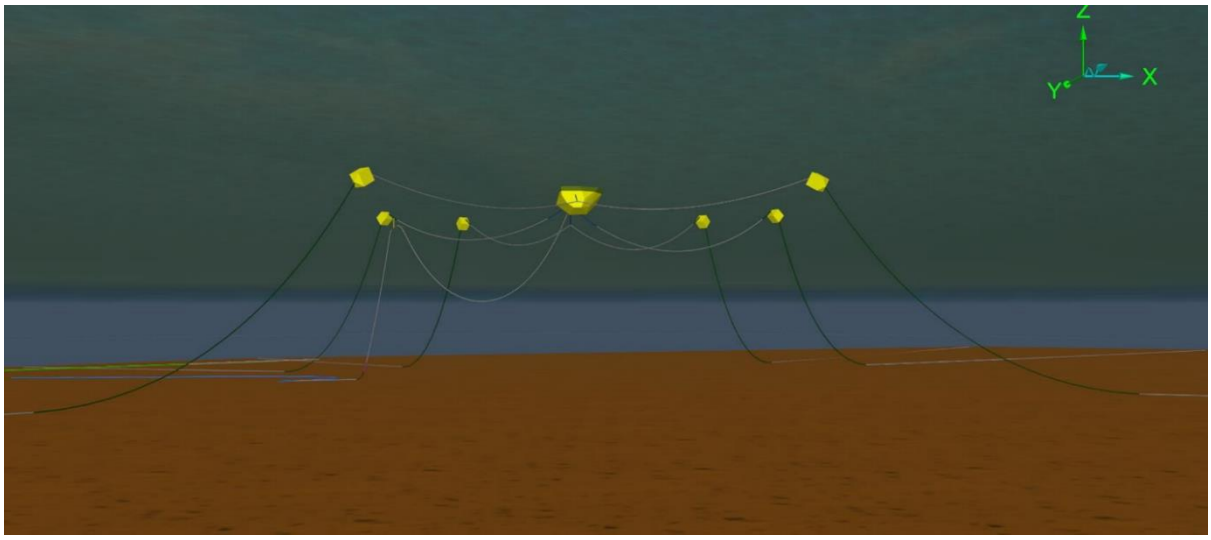


Figure 3 Schematic of mooring and umbilical looking West

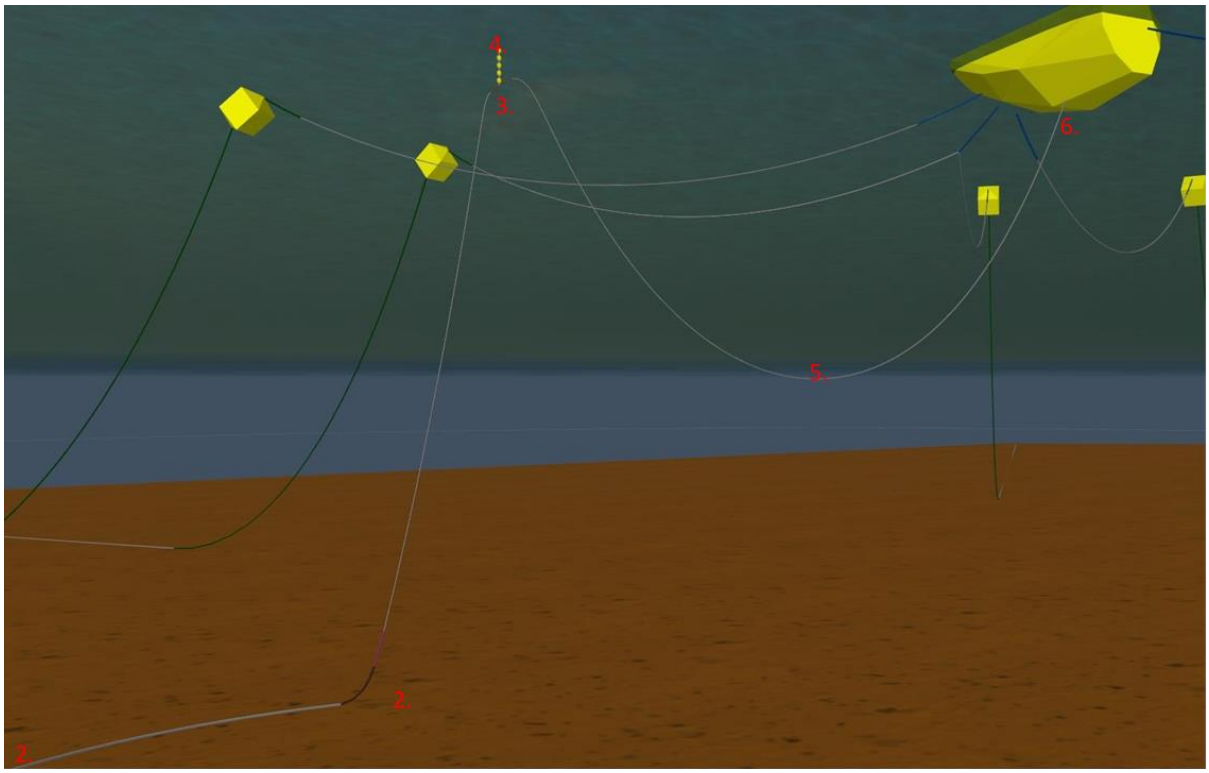
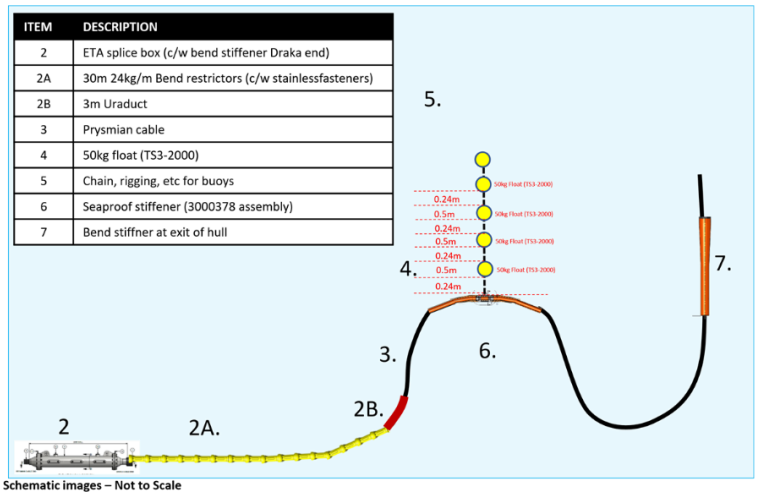


Figure 4 Umbilical arrangement



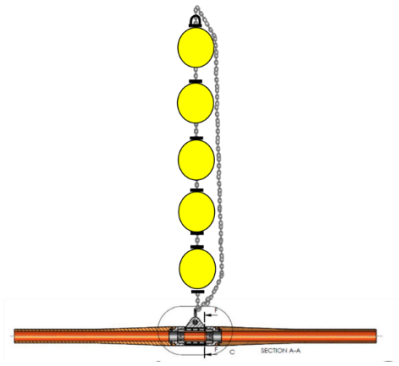


Figure 5 Umbilical Components- Mid Water Arch

3.2 Umbilical Arrangement "As built"

An umbilical cable runs from under the stern of the Penguin (which is now in an upward facing aspect) in a buoyed loop to connect into the EMEC export cable via a connector to the shore, as shown in the schematic above. The buoyed loop is stabilised by a chain leading from under the buoy column to a small weight on the seabed.

Figure 6 Umbilical Arrangement

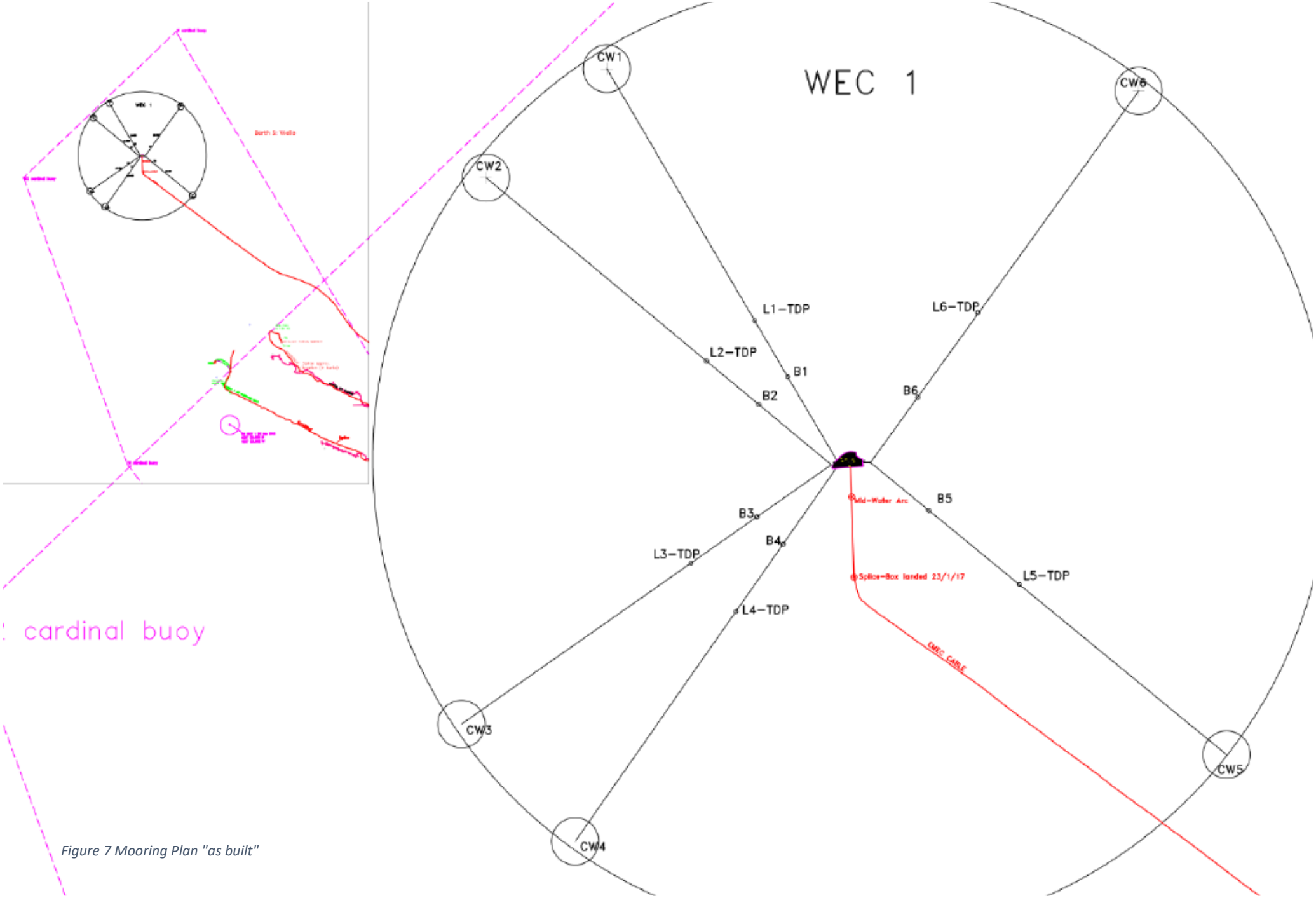


Figure 7 Mooring Plan "as built"

Abbrev.	Description	Easting	Northing
WEC 1 - Device			
WEC1	WEC Device - COG	476489	6539340
WEC 1 - Mooring System			
CW1	Clump weight 1	476282	6539670
L1-TDP	Touch Down Point Leg-1	476408	6539457
B1	10t Subsurface Buoy 1	476436	6539410
CW2	Clump weight 2	476180	6539578
L2-TDP	Touch Down Point Leg-2	476367	6539423
B2	10t Subsurface Buoy 2	476411	6539386
CW3	Clump weight 3	476159	6539116
L3-TDP	Touch Down Point Leg-3	476354	6539252
B3	10t Subsurface Buoy 3	476410	6539291
CW4	Clump weight 4	476256	6539016
L4-TDP	Touch Down Point Leg-4	476392	6539211
B4	10t Subsurface Buoy 4	476432	6539268
CW5	Clump weight 5	476808	6539090
L5-TDP	Touch Down Point Leg-5	476632	6539234
B5	10t Subsurface Buoy 5	476555	6539297
CW6	Clump weight 6	476733	6539652
L6-TDP	Touch Down Point Leg-6	476597	6539464
B6	10t Subsurface Buoy 6	476546	6539392
WEC 1 - Umbilical System			
MWA	Mid-Water Arc	476490	6539308
SB	Splice Box	476492	6539240

Figure 8 Mooring Plan and co-ordinates "as built"

4. "As Found" Condition

After the Penguin WEC 1 san, an ROV survey was undertaken of the site and all the moorings. The Penguin and all the moorings and the umbilical arrangement are all still on site and intact and the moorings are still attached to the Penguin. The Penguin is upside down on the sea bed with its "bow", which faced West when it was floating, now facing to the East. The new penguin position is calculated using the ROV footage and the data recorded (coordinates and water depth) from the ROV.

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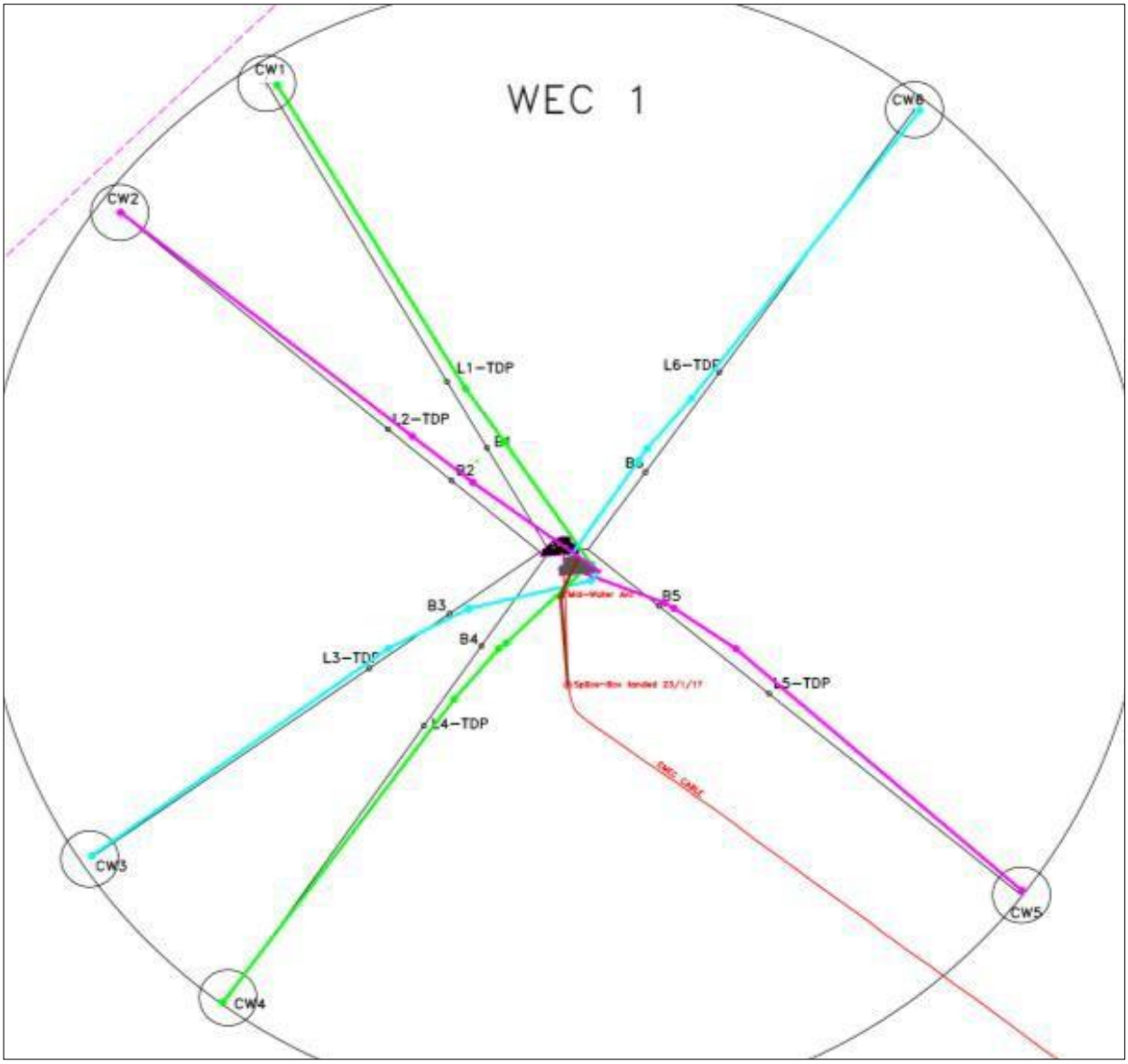


Figure 9 "As found" positions overlaid on "as built" positions

SUMMARY:

- The penguin is up-side-down and heading to the east. The estimate shows the device is moved 16m away from the designed static position.
- Each mooring line is still currently connected to WEC1, although the pin of the shackle holding the buoy on leg 1 has nearly come all the way out (Ref: Figure 4-1.
- Leg 5 and 6 are trapped under the device.
- The buoys for legs 1 to 4 are closer to the device, while buoys for leg 5 and 6 have moved away. Each buoy is deeper. This movement has affected the touch-down points.
- The Mid Water Arch of the umbilical is nearly in the same position as designed and the cable is clear from entrapment.

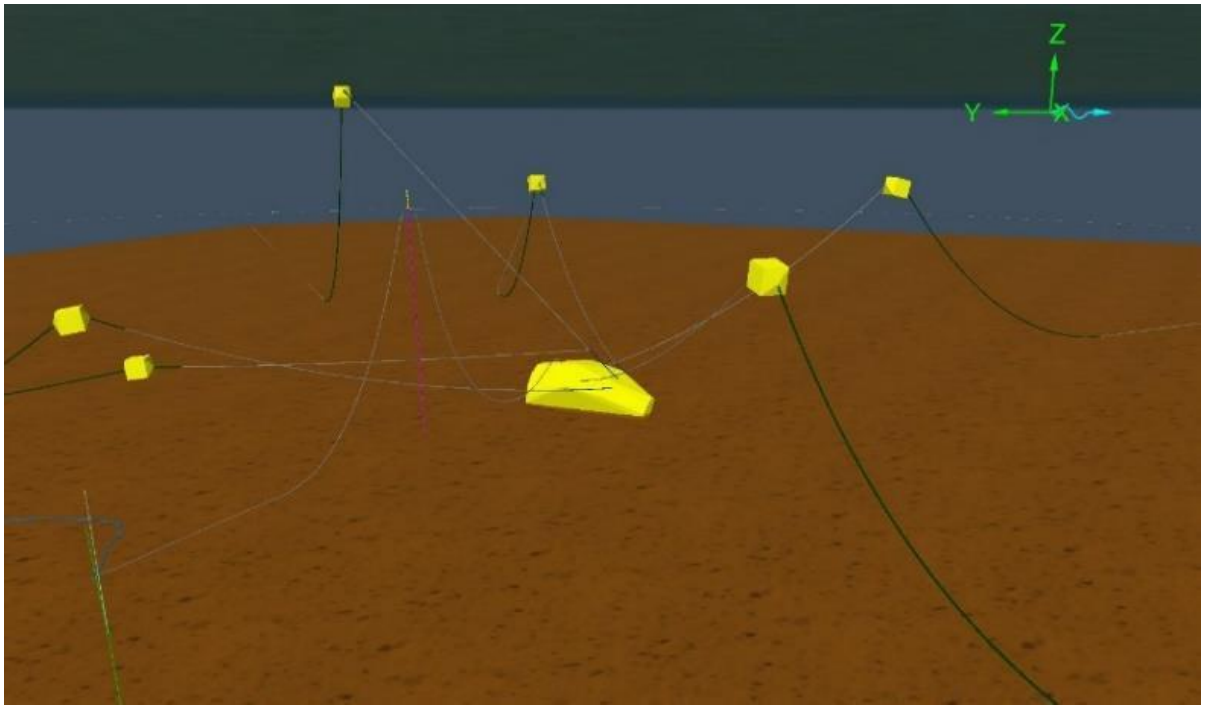


Figure 10 "As found" Representation 1

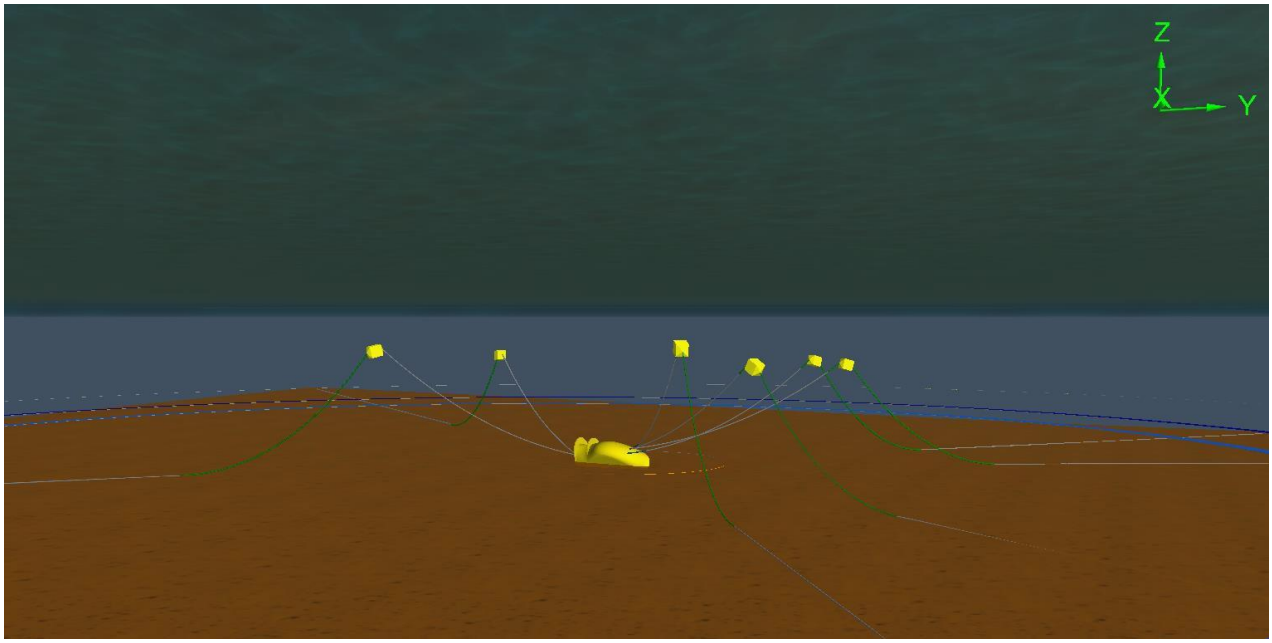


Figure 11 "As found" Representation 2

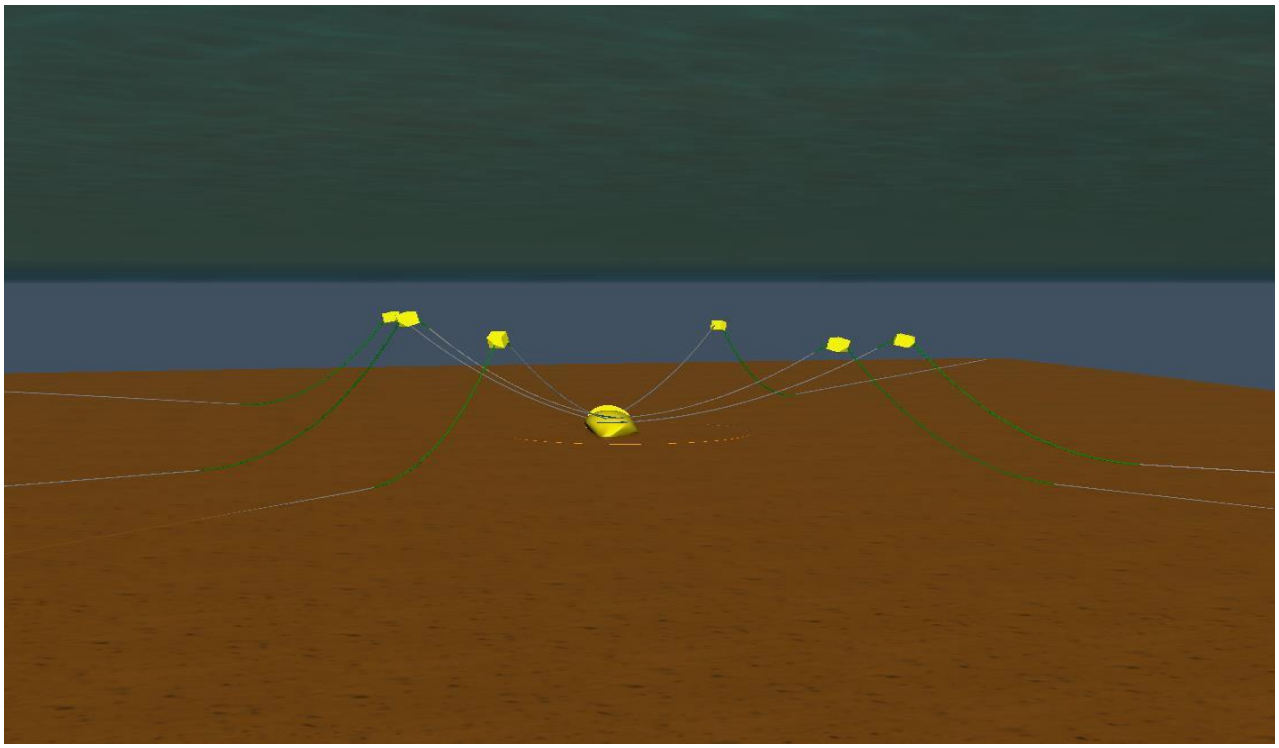


Figure 12 "As found" Representation 3

4.1 New Co-ordinates

There is a tolerance of approx. 5m since the coordinates are taken from the ROV which might have been in a distance of 5m from the moment of the snapshots. Note: These positions were taken from the ROV Survey in April 2019, but it was reported that there had been no movement in the position of the components during the ROV survey in December 2019.

Abbrev.	Description	Easting	Northing
WEC 1 - Device (Assumption)			
WEC1	**Approx. WEC Device Position**	476500	6539324
WEC 1 - Mooring System (ROV Snapshots)			
CW1	**Clump Weight 1**	476290	6539669
L1-TDP	**Touch Down Point Leg-1**	476421	6539452
B1-L	**10t Subsurface Buoy 1**	476448	6539414
B1-U	**10t Subsurface Buoy 1**	476429	6539400
MAP1	**Mooring Attachment Point 1**	476506	6539338
CW2	**Clump Weight 2**	476181	6539578
L2-TDP	**Touch Down Point Leg-2**	476384	6539418
B2-L	**10t Subsurface Buoy 2**	476426	6539385
CW3	**Clump Weight 3**	476161	6539118
L3-TDP	**Touch Down Point Leg-3**	476367	6539266
B3-L	**10t Subsurface Buoy 3**	476423	6539294
B3-U	**10t Subsurface Buoy 3**	476423	6539295
MAP3	**Mooring Attachment Point 3**	476502	6539308
CW4	**Clump Weight 4**	476252	6539013
L4-TDP	**Touch Down Point Leg-4**	476413	6539230
B4-L	**10t Subsurface Buoy 4**	476444	6539266
B4-U	**10t Subsurface Buoy 4**	476449	6539270
CW5	**Clump Weight 5**	476808	6539093
L5-TDP	**Touch Down Point Leg-5**	476609	6539266
B5-L	**10t Subsurface Buoy 5**	476566	6539295
B5-U	**10t Subsurface Buoy 5**	476559	6539299
MAP5	**Mooring Attachment Point 5**	476510	6539338
CW6	**Clump Weight 6**	476737	6539651
L6-TDP	**Touch Down Point Leg-6**	476578	6539445
B6-L	**10t Subsurface Buoy 6**	476547	6539409
B6-U	**10t Subsurface Buoy 6**	476541	6539400
WEC 1 - Umbilical System (ROV Snapshots)			
MWA	**Mid-Water Arc**	476487	6539304
CE	**Umbilical Cable Entry**	476496	6539341

Figure 13 As found positions

4.2 Buoy Depths

Abbrev.	Description	Water Depth	Depth from Surface	Depth from Seabed
B1	10t Subsurface Buoy 1	**59**	**21.5**	**37.5**
B2	10t Subsurface Buoy 2	**60**	**24**	**36**
B3	10t Subsurface Buoy 3	**60.5**	**33.5**	**27**
B4	10t Subsurface Buoy 4	**61**	**27**	**34**
B5	10t Subsurface Buoy 5	**58**	**28**	**30**
B6	10t Subsurface Buoy 6	**57.5**	**22**	**35.5**
MWA	Mid-Water Arc Buoys	**59.5**	**15.5**	**44**

Figure 14 Buoy Depths

4.3 Mooring Components List

SUBSET	Component	Qty/Leg	MBL (kN)
ANCHOR	Concrete Clump	1	4169
GROUND CHAIN	100m 76mm	100m	2230
	50mm studlink chain	150m	2698
	35Te SB LR Shackle	1	1717
	35Te SB LR Shackle	1	1717
LOWER CATENARY CHAIN	76mm studlink chain	68m	2230
	85Te SB LR Shackle	1	4169
	76mm studlink chain	10m	2230
SUBSEA BUOY	12.5t Subsurface Buoy	1	667
UPPER CATENARY CHAIN	85Te SB LR Shackle	1	4169
	85Te SB LR Shackle	1	4169
	35Te SB LR Shackle	1	1717
	48mm studlink chain	13.75m	2698
	48mm studlink chain	27.5m	2698
	48mm studlink chain	27.5	2698
	48mm studlink chain	13.75	2698
	35Te SB LR Shackle	1	1717
MOORING TAILS	55te Tri-plate	1	1079
	64mm Anchor Shackle Type-D	1	3551
	64mm Stud-Link	1	3551
	150te 'Super Shackle'	1	7358

Figure 15 Mooring Component List

5. Methodology

5.1 Overall Scope of Work

This section deals with the marine operations required to remove the mooring components and the WEC 1 "Penguin" and dispose of all components in an environmentally friendly and economic manner. The method statement described is high level and is subject to change on appointment of a Marine Contractor.

Phase 1

1. Support vessel proceeds to site and sets its own moorings or sets up on dynamic positioning
2. Vessel makes connection to first Penguin mooring clump
3. Mooring clump weight moved towards Penguin
4. Subsea buoy disconnected
5. Vessel lifts lower catenary chain and clump weight
6. Clump weight and chain recovered to deck or transported to reception facility in Orkney (Lyness or Stromness)
7. Subsurface buoy recovered to deck or transported to reception facility in Orkney (Lyness or Stromness)
8. Process repeated until all clump weights, lower catenary chains and buoys are removed to port
9. Support vessel positions over umbilical mid water arch.
10. Using an ROV the umbilical is cut close to the Penguin hull.
11. Second cut is made in umbilical on other side of mid water arch
12. Buoyed mid water arch section is recovered to surface and brought to port
13. Umbilical end on seabed is capped
14. All recovered items are disposed of in an environmentally sustainable way

Phase 2

1. The primary support vessel proceeds to site and picks up the remaining six upper catenary chains which were left buoyed off
2. A suitable entry point is located or cut into the lowest point of the Penguin hull using an ROV
3. Air is pumped into the Penguin hull to reduce its in water weight
4. The upper catenary chains are transferred to a heavy lift barge
5. The Penguin is lifted above the seabed and transported to shallow waters
6. A submersible barge is ballasted down into the water and the Penguin is lifted onto the deck of the submersible barge
7. The submersible barge is raised with the Penguin on deck and towed to a suitable port for disposal in an environmentally sustainable way

Phase 3

There are other items of mooring equipment and roll plates which have been lost to the seabed over the period of the Penguin operation. That is 6 x 24 tonne (14 tonne in water) clump weights and three roll plates 122 tonne (74 tonne in water). Assuming these are safely and environmentally accessible for recovery they will be removed for disposal.

1. The support vessel will position over the first clump weight to be recovered
2. The ROV will be deployed and line attached

3. The clump weight is lifted under the support vessel and recovered to port for disposal
4. The same method is applied to the remaining clump weights
5. The support vessel will position over the first of the roll plates
6. Cables will be attached to the roll plates using the ROV
7. Each roll plate will be lifted under the support vessel and transported to port for disposal

On completion of all phases of decommissioning an ROV survey will be carried out across a radius of 550 metres from the centre position.

5.2 Marine Operations Reporting Lines

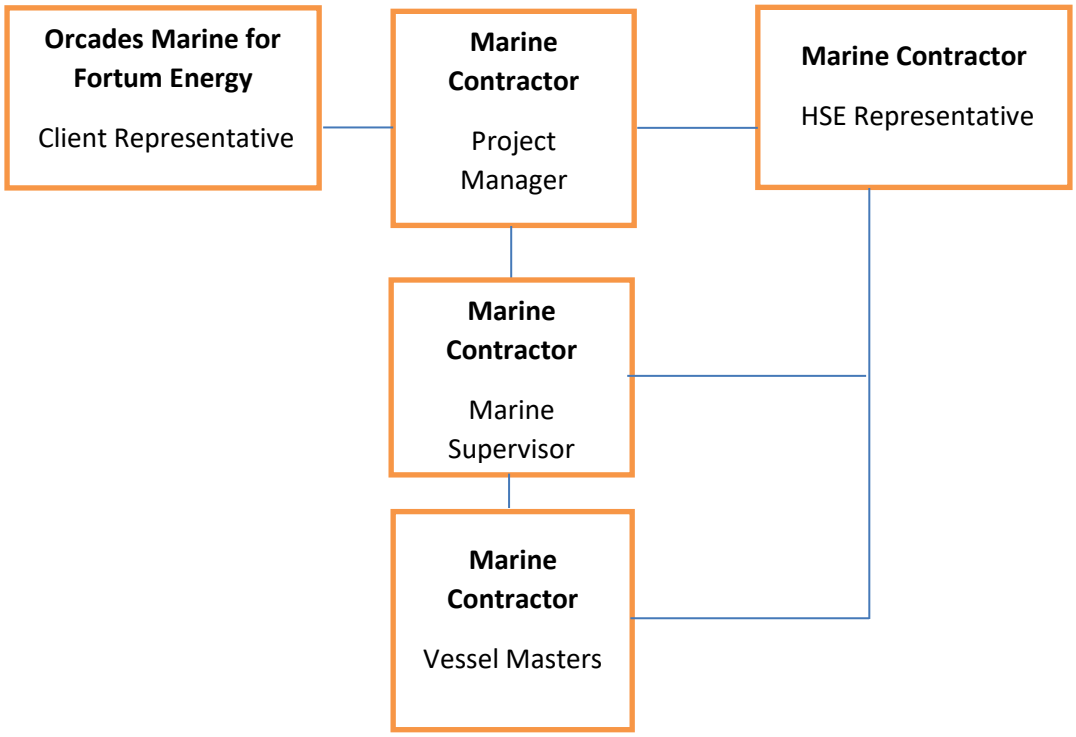


Figure 16 Reporting Lines

5.3 Key Roles Specification

The following organisations and personnel will be responsible for ensuring that the operations scope of work is followed:

Client Representative (Orcades)

The Client Representative will ensure that the project proceeds safely and in an environmentally friendly manner and that all works are performed according to the contractual arrangements, between the Client and the Contractor.

Project Manager (Marine Contractor)

The Project Manager will provide oversight of the marine operation and control movements of all vessels. They will be responsible for ensuring that EMEC and the Harbour Authority are notified of activities at all relevant times.

HSE Manager (Marine Contractor)

The HSE Manager provides functional support on all Health & Safety matters and ensures compliance with the Contractor QA HS Management System. He/She is the Designated Health and Safety Representative for this project

Marine Supervisor (Marine Contractor)

The Marine Supervisor will take charge of the deck operations on board the vessel and liaise with the Project Manager.

Vessel Masters (Marine Contractor)

Each individual vessel Master will be responsible for the safety of his vessel and crew. He will liaise with the Marine Supervisor and Project Manager or Marine Superintendent on any matters that affect the performance of the vessel including any mechanical or other failure of the vessel.

5.4 Communications

Offices

OMMC Ltd	+ 44 (0) 1856 874884	Office
Marine Contractor	TBC	Office

Mobiles

David Thomson	[redacted]	OMMC Client Representative 1
Alexandra Thomson	[redacted]	OMMC Client Representative 2
Dave Cousins	TBC	OMMC Client Representative 3
Marine Supervisors	TBC	TBC
Vessel Master	TBC	TBC
Vessel Master	TBC	TBC

External Numbers

Orkney Harbour Authority Harbour Office Orkney VTS	+44 (0) 1856 873636 VHF Ch 11
HM Coastguard MRCC Shetland Shetland Coast Guard	+44 (0) 1595 692976 VHF (DSC 70) and Ch 16, call sign
HM Coastguard MRCC Aberdeen Aberdeen Coast Guard	+44 (0) 1224 592334 VHF (DSC 70) and Ch 16 call sign
EMEC	+ 44 (0) 1856 852060

5.5 Site Controls/Access to EMEC Site

All vessels will maintain a listening watch on marine VHF radio Channel 16 and communicate by marine VHF radio on a suitable inter ship frequency. Orkney VTS transmits and receives on VHF Channel 11.

5.6 High Level Scope Phase 1

5.6.1 Connection to mooring clumps

The support vessel to locate above the subsea clump weight anchors, an ROV will be deployed and will thread a messenger line through upper pad eye of clump. The support vessel will then lift clump about 2-3 m above seabed.

5.6.2 Move of mooring clumps

The support vessel will move the clump weight approximately 50m along the mooring line to commence to raise the buoy to the surface. It may be necessary to recover the clump higher in order for the buoyancy to overcome seabed friction of the chain holding down the buoy. The support vessel will then continue on another 50m so the buoy can continue to the surface, total move of 100m.

5.6.3 Disconnection of subsea buoy

The mooring clump will be deployed back to seabed with recovery riser left in place on the seabed with small clump weight marked with a surface buoy ready for later recovery. The support vessel will locate at the buoy and disconnect the buoy from the 76 mm chain, leaving it attached to the vessel or to a smaller support craft for later recovery. The 76mm chain will be transferred to a winch wire ready to commence recovery.

5.6.4 Recovery and lifting of chain and clump weight

The support vessel will recover the 76mm chain until back at the deployment location. The support vessel will then secure to recovery line to mooring clump ready for clump weight, then will commence recovery of the clump whilst still recovering the remainder of the 76mm chain. The support vessel will then lift the clump until it is at such a position it can be transported back to port.

5.6.5 Removal of subsurface buoy

The support vessel will make its way back to site to recover the mooring buoy. After buoy disconnection, the upper catenary mooring chain leading to the Penguin will be left with small clump and surface buoy which may be used to assist lifting the WEC 1 “Penguin” during its recovery.

5.6.6 Removal of the Umbilical Assembly

The support vessel positions over the umbilical mid water arch and deploys an ROV with cutting tools. Using the ROV the umbilical cable is cut close to the Penguin hull. A second cut is made in the umbilical on shore side of the mid water arch. The buoyed mid water arch section is attached to a recovery winch wire deployed from the support vessel using the ROV. The mid water section of the umbilical is recovered along with the small clump weight attached to the cable supporting buoys. The umbilical cable end closest to the shore and remaining on the seabed is capped.

5.6.7 Removal and Disposal

All parts recovered during the Phase 1 operation will be recovered to a port in Orkney probably Stromness or Lyness. They will then be batched and disposed of in an environmentally sustainable way.

5.7 High Level Scope Phase 2

5.7.1 Recover mooring lines and remove excess

The upper catenary's will be buoyed off once the mooring components have been removed in phase one. The mooring lines will be recovered to the deck of the support vessel using a grapnel. Excess mooring lines not required for the lift will be cut, removed and stored safely on deck.

The mooring lines still attached to the WEC 1 "Penguin" will be secured to the deck of the support vessel and the vessel will keep position in preparation for deploying the ROV.

5.7.2 Deploy ROV with air hose to reduce submerged weight

Once the vessel is holding position the ROV will be deployed with the air hose, the air hose is inserted into umbilical I tube. The air hose pumps air into the device subsequently reducing the submerged weight to 200te. This will allow the WEC 1 "Penguin" to be moved under the water at a reduced weight. The air hose and ROV will be recovered.

5.7.3 Transfer chains to heavy lift barge

The mooring chains will be passed from the support vessel to the heavy lift barge and secured to the lifting points.

5.7.4 Lifting device to shallow waters

The heavy lift barge will lift the WEC 1 "Penguin" 3m above the seabed and will move towards shallower waters maintaining a 3m clearance above the seabed until the heavy lift barge reaches 20m water depth.

5.7.5 Lower on to submersible barge

A submersible barge will be lowered onto the seabed to allow the heavy lift barge to float the WEC 1 "Penguin" above the submersible barge. The WEC 1 "Penguin" is then lowered onto the submersible barge.

5.7.6 Raise submersible barge and tow to port

Once the WEC 1 "Penguin" has been released from the heavy lift barge the heavy lift barge will move away and the submersible barge will be raised. Once the submersible barge has been successfully raised it will be towed safely to port.

5.8 High Level Scope Phase 3

5.8.1 Raising clump weights

The support vessel to locate above the subsea clump weights, an ROV will be deployed and will thread a messenger line through upper pad eye of clump. The support vessel will then lift the clump under the bow or onto deck. This process is repeated for the remaining clump weights.

5.8.2 Raising Roll Plates

The support vessel will position over the first of the roll plates. Cables will be attached to the roll plates using the ROV threading a messenger through lifting points (if accessible)

5.8.3 Removal and Disposal

All parts recovered during the Phase 3 operation will be brought to a port in Orkney probably Stromness or Lyness, for disposal in an environmentally sustainable way.

6. Site Clearance Check – and Reception Ports

Prior to demobilisation of vessels and equipment a thorough seabed survey will be undertaken using an ROV to ensure all items required to be removed are clear of the seabed.

During the operation and at the port of recovery an itinerary of all items recovered will be checked against the available list of items that have been deployed, to ensure as reasonably practicable that all items are accounted for.

There are a number of ports in Orkney that could be used to land and process the recovered items for disposal, but the most likely ports are Stromness and Lyness. Lyness on the island of Hoy may be particularly useful for the larger items or for processing, as this has a deep water berth and quayside with some heavy lift capability, and a large lay down area.

7. Vessel Specifications

Exact specifications of the vessels will be dependent on the Marine Contractor appointed and the detailed method statements produced by them. However, examples of the types of vessel that may be utilised are attached in the Appendix.

8. Contingency Plans

A fully worked contingency plan is required to be completed once method statements and the Hazard Identification and Risk Assessment (HIRA) process has been completed for all phases of the operation.

9. Risk Management

9.1 Hazard Identification and Risk Assessment

A Hazard Identification and Risk Assessment workshop will be held with all stakeholders prior to carrying out each phase of the project. This method statement, the risk register and any other supporting documentation will be issued to all participants and interested parties prior to project commencement. During operations there will be a daily briefing at the start of each day or each shift which informs all interested parties of the proposed activities and provides an opportunity to identify tasks or hazards that require a Task Risk Assessment (TRA) or to ensure that the mitigation measures for tasks on the risk register are in place and effective. Tasks that are classified as high risk before mitigation will usually have a separate toolbox talk before the job starts.

9.2 Management of Change

The management of Change process is designed to ensure that everyone is working from the same procedures and the appropriate personnel are aware of any procedure changes that might create risk.

Change control is managed through regular review meetings and encouraging the project team to use their judgement as to how best to share information within the project. Once procedures are frozen, then significant changes are managed through the change control process. A change control form is completed that:

- Identifies the proposed change.
- The reason for the change.
- How the proposed changes might affect HSE hazards and risk.

- Distribution list of who and what might be affected.
- Provides checkboxes to ensure that all potentially affect parties have seen the proposed change and have made arrangements for any additional risks to be recorded on the risk register.
- Tasks Change Control Authority to provide assurance the all respondents have taken appropriate action to identify and mitigate any new risks arising from the change.
- Formal approval of change signed off by Project Manager.

10. Appendix

10.1 Phase 1 (and 3) - Typical Vessels and Equipment

Figure 17 Multicat

Figure 18 Multicat

Figure 19 Small workboat

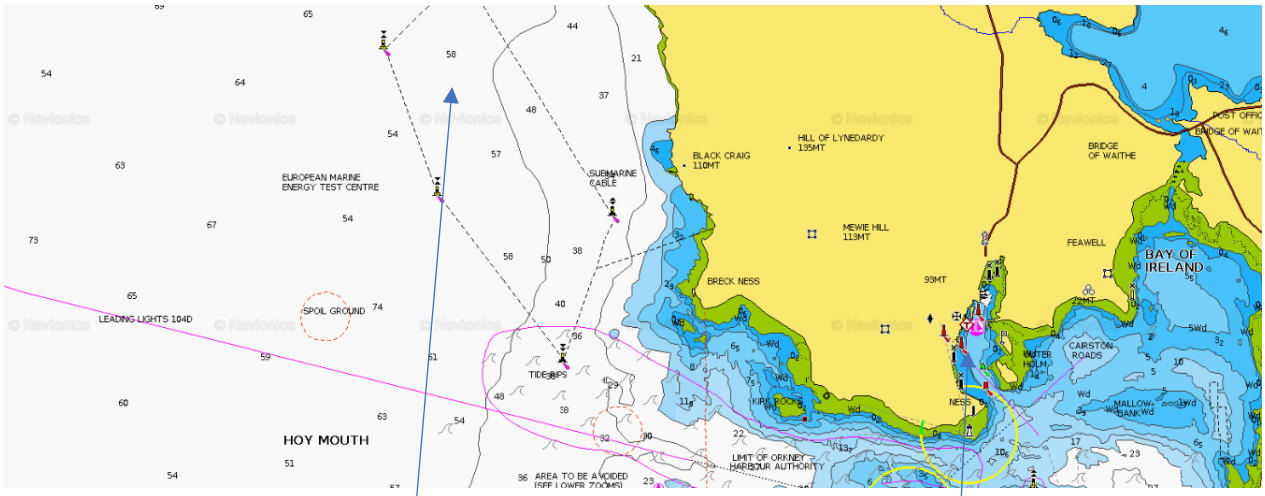
Figure 20 Work Class ROV

10.2 Phase 2 (and 3) – Typical Vessels and Equipment

Figure 21 Heavy Lift Crane Barge

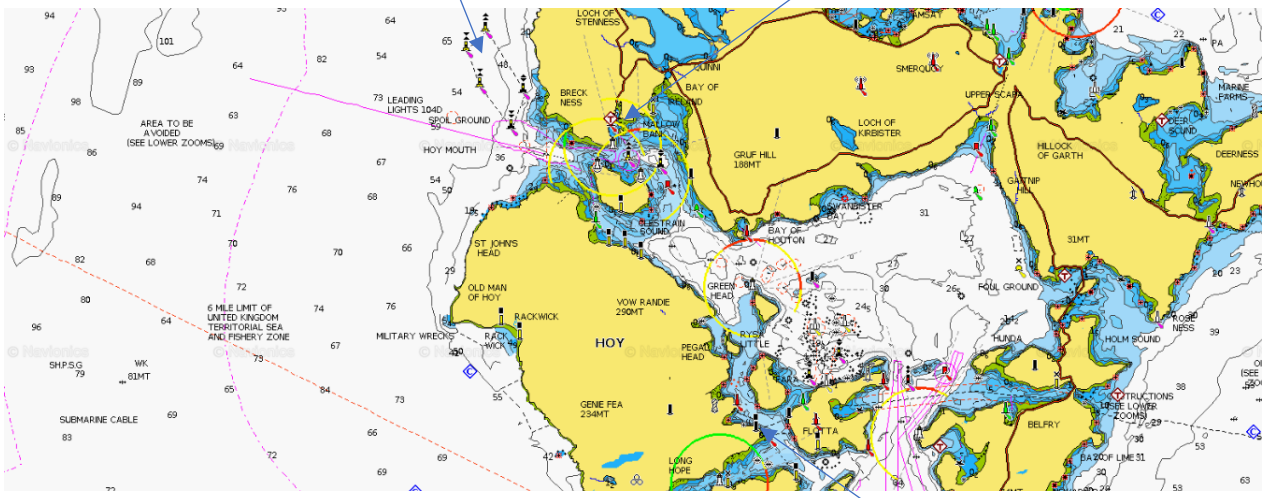
Figure 22 Submersible barge

10.3 Charts of Site and nearby Ports



EMEC Test Site Berth 5, Billia Croo

Port of Stromness, Orkney



Port of Lyness, Orkney