Construction Method Statement

Onshore and offshore

Project:	**P0044 – EMEC - TFS**
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Contents

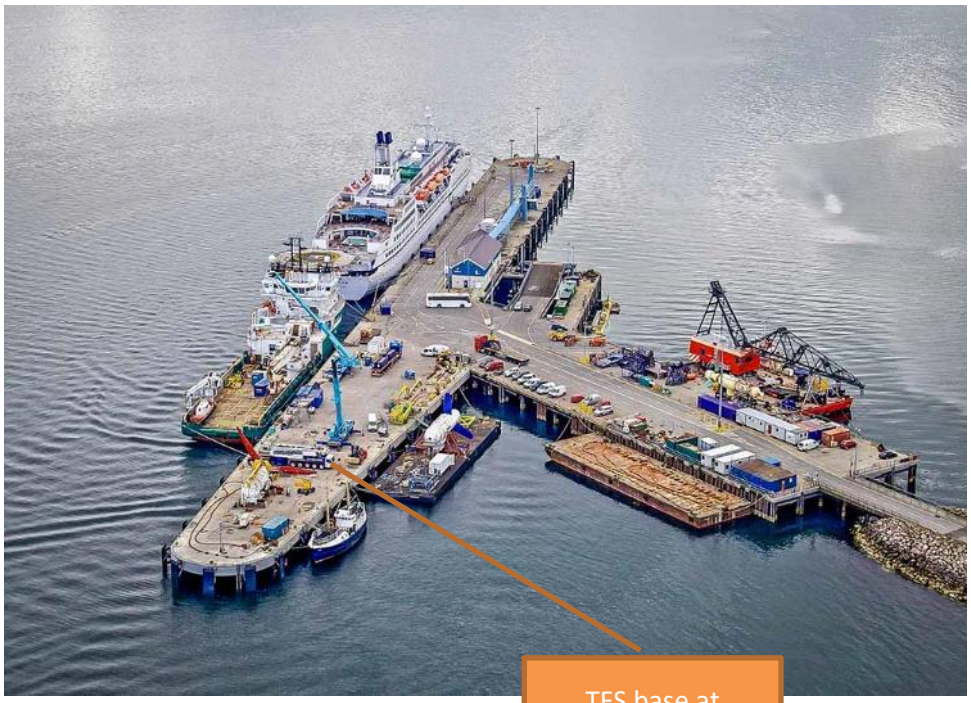
1. Introduction

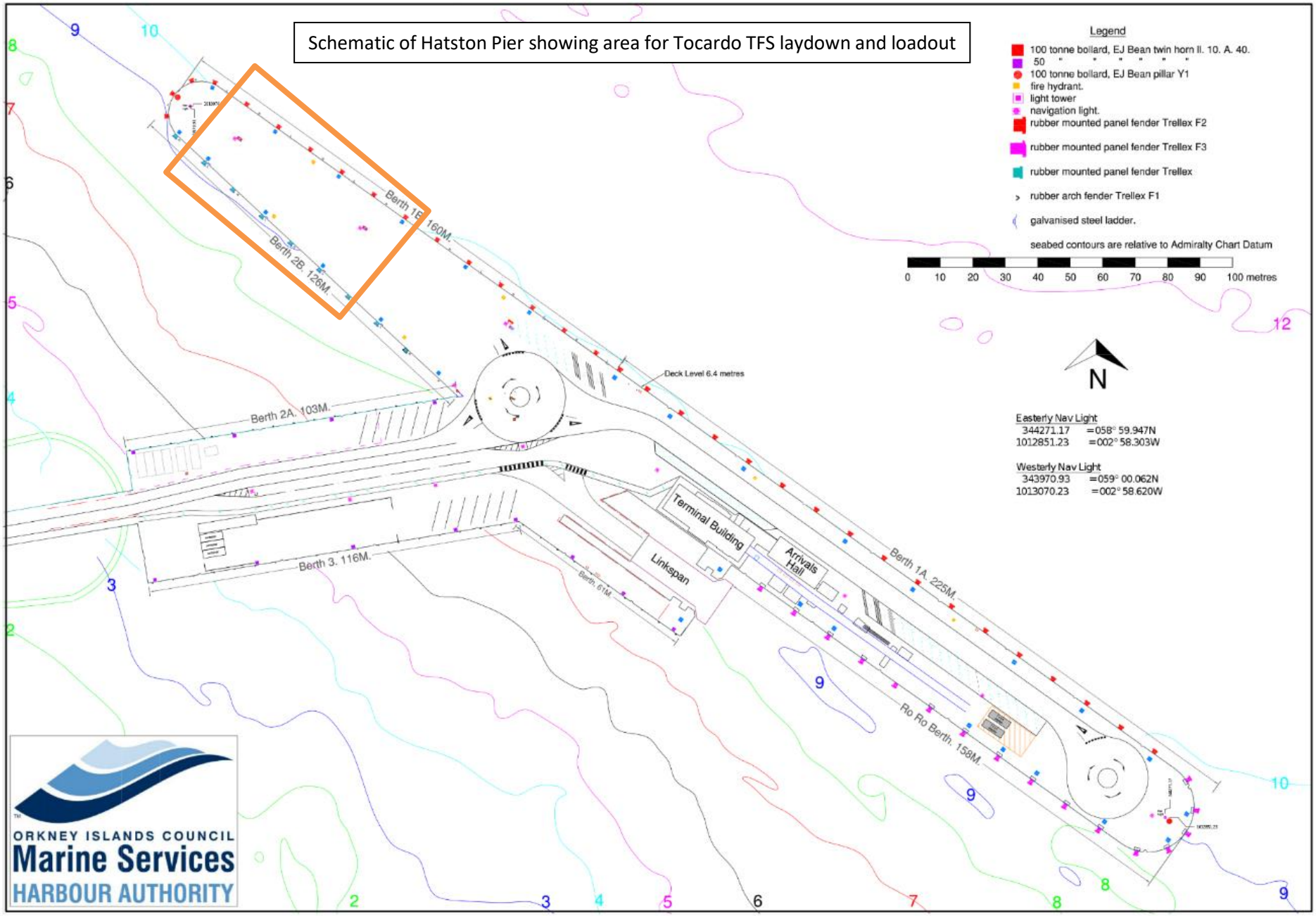
This document describes the various steps needed to install the TFS at berth 8 at EMEC. One part describes all on-shore works, the second part describes the offshore works. A part of the offshore works will happen during or even before the onshore works commence.

Although this document is drafted with 'installation' in mind, it can also be referred to for unplanned maintenance actions and decommissioning. The decommissioning will largely be the same plan in reversed order.

2. Locations

Hatston pier, Kirkwall, Orkney




Schematic of Hatston Pier showing area for Tocardo TFS laydown and loadout
Legend
100 tonne bollard, EJ Bean twin horn II. 10. A. 40.
50 " " " " " "
100 tonne bollard, EJ Bean pillar Y1
fire hydrant.
light tower
navigation light.
rubber mounted panel fender Trellex F2
rubber mounted panel fender Trellex F3
rubber mounted panel fender Trellex
rubber arch fender Trellex F1
galvanised steel ladder.
seabed contours are relative to Admiralty Chart Datum
0 10 20 30 40 50 60 70 80 90 100 metres
N
Easterly Nav Light
344271.17 =058° 59.947N
1012851.23 =002° 58.303W
Westerly Nav Light
343970.93 =059° 00.062N
1013070.23 =002° 58.620W
Berth 1E. 160M.
Berth 2B. 126M.
Berth 2A. 103M.
Berth 3. 116M.
Berth. 61M.
Deck Level 6.4 metres
Terminal Building
Arrivals Hall
Linkspan
Berth 1A. 225M.
Ro Ro Berth. 158M.
ORKNEY ISLANDS COUNCIL
Marine Services
HARBOUR AUTHORITY

3. Onshore assembly

3.1 Planned TFS assembly

The onshore execution plan for the work on Hatston pier is as follows:

Day 1

- The crane (100t) will arrive at Hatston Pier to stack the 2 sets of 10ft containers and a lower offload staging.

Day 2

- Put the 40 ft long TFS mid module on the lower staging
- Lift FRONT and AFT on plateau and attach sections together to form complete TFS
- Lift 6.6kV transformer inside TFS

Day 3

- Lift the strut in place for assembly to the bottom of the mid module.
- Lift the turbine in close proximity of the strut
- With 3 lifting slings the turbine will be lifted in place and hold in position for making up the connection to the pre-welded adapter plate.

Day 4-5-6-7

- The cables will be connected up.
- Outfit internal TFS (electric)
- Outfit externals TFS (railing, lighting)

The cables are ready in a spaghetti bundle so that these can be pulled in place and secured to the cable tray during the turbine assembly stage.

Tocardo personnel to electrically hook up the turbine to the cabinet in the LER and test the system. Ensure turbine is on brake and blades are horizontal. The pressure of the brake should be at the compressor stop level. Transformer is switched off (using lock out).

Day 8

- Prepare and install cable tail.
- Prepare and install mooring lines

Day 9

- 220t crane will be deployed
- Hoist TFS into water

With a 2 days' notice to the port and the crane supplier on day 9 the TFS will be lifted of the 10ft containers into the water.

After final inspection and check on water tightness and interlocking mechanisms, the TFS unit is ready for tow out to the final location.

Tocardo and their installation contractor will proceed to leave Hatston Pier once tides and weather are at the desired conditions.

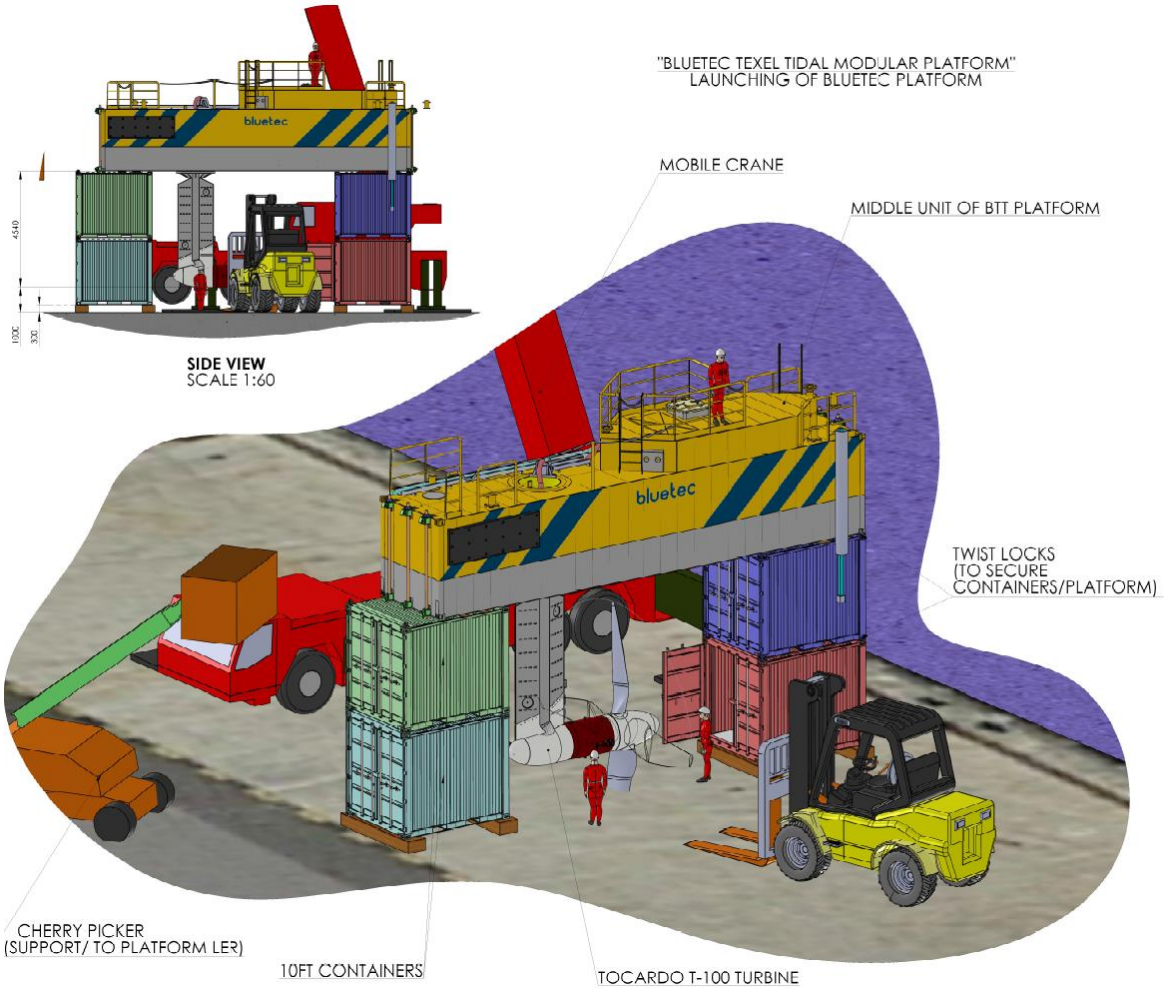


Image of TFS Load out in the Netherlands

3.2 Equipment

- Forklift
- 100t crane
- 220t crane (temporary)
- Cherrypicker
- Pallets
- Fencing
- 10'' or 20'' containers
- Rain cover for cabinets (sail of 3mx4m)
- Hand winches
- Pallet trolley to move cabinet around
- Movable scaffolding (2m in height)
- 32A extension cord (where the plug can be removed)
- Electrical tools
- Cable cutters
- Big cable cutters
- Cable lung crimping tool
- Drill with magnetic stand
- Hightorc wrench with m56 key

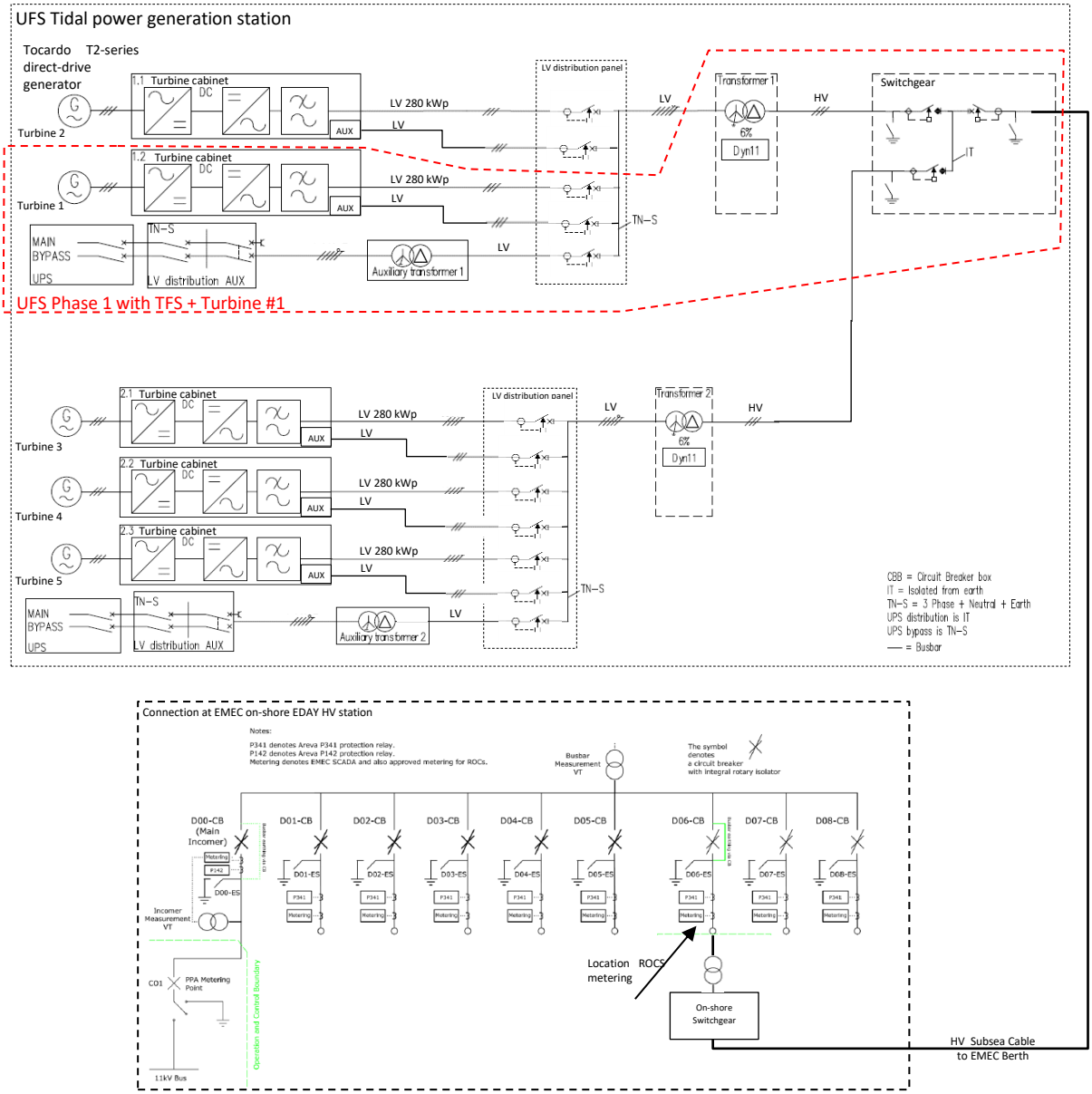
4. Eday shore station

All electrical connections need to be verified by EMEC before being approved. The installation of the equipment at the Eday substation will be done by Bryan Rendall Ltd, based in Kirkwall.

Bryan Rendall Ltd
Tel: +44 (0)1856 879086

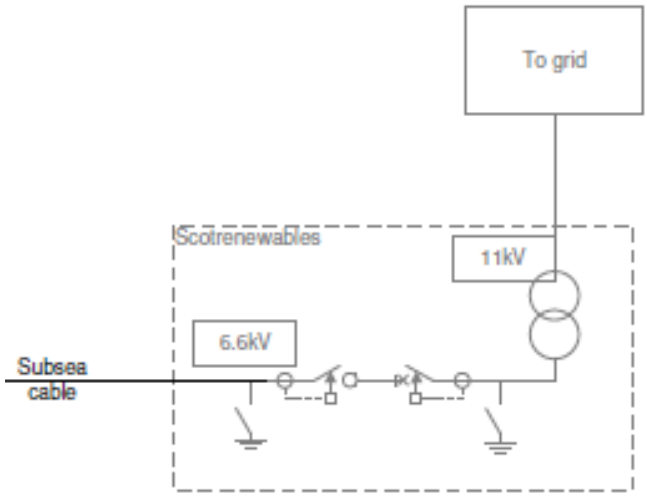
4.1 Single line diagram

The next figure shows the single line diagram for the tidal power generation equipment and auxiliary equipment, including subsea export cable and on-shore connection with metering location.

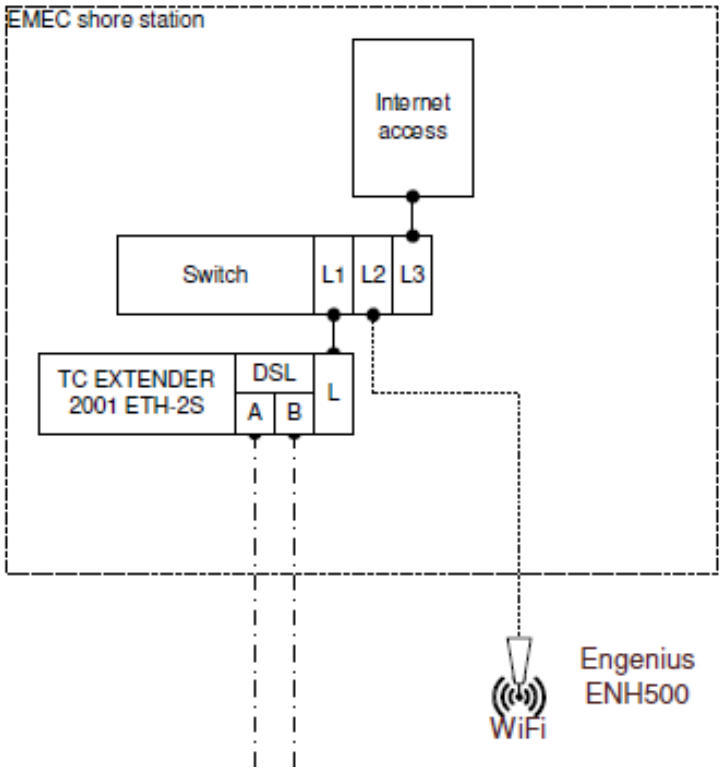


The first turbine installed using the TFS is shown as 'Turbine 1' on the single line diagram above. The TFS will have on-board the turbine cabinet of turbine 1, a smaller LV distribution panel and also a LV distribution AUX panel, a LV-HV transformer and switchgear. This is indicated in the above single line diagram in the red dashed section. The UFS and TFS subsea export cable will be connected to the same connection point at EMEC EDAY HV station as shown in the diagram. The meter and meter location will remain the same.

4.1.1 Onshore power electronics



4.1.2 Communication to shore station



4.2 Equipment list

The following table shows the main on-board equipment with power generation rating or power consumption rating if applicable for the UFS. Certain equipment will continuously need to consume power in for functionality of the power generation systems. Other equipment is sometimes required to operate and is normally on stand-by.

Equipment	No.	Power generation rating	Power consumption continuous	Power consumption intermittent/ stand-by
T2 series direct drive tidal turbine generator	5	280kWp (grid side of converters)	-	-
Turbine auxiliary systems (hydraulics, sensors, heaters, etc)	5	-	0.8-1 kW	2 – 2.3 kW
Converter cooling system	5	-	3.1 kW	9.3 kW
Turbine control system	5	-	0.7 kW	0.2 kW
Array control system	1	-	0.3 kW	0.2 kW
Anti-Condensation heaters (inside cabinets)	11	-	-	0.2 kW
On-board lighting	1	-	-	0.2 kW
Nav aid systems with GPS	2	-	0.1 kW	-
UPS system	2	-	1.9 kW	-
ADCP (flow speed measurement)	5	-	0.3 kW	-

Other than the tidal turbine generators, there are no other power generation systems on board.

4.3 Metering location

The location of the ROCS meter is in front of the on-shore switch gear as shown in the single line diagram in section 2.1. At this location, the meter will measure the sum of power production and power consumption.

4.4 Planning

To be provided by Bryan Rendall Ltd before start of work.

5. Offshore works

The offshore works are based on the method statement by LEASK. A detailed planning is being drafted and will be updated over time. It is of essence to keep the offshore work companies updated on the progress onshore.

5.1 Equipment

All installation is done by use of a combination of one or two multicat vessels, a workboat, a RIB. Reference is made to the Vessel Management Plan for the description of these vessels.

Deployment of the TFS gravity anchors and device will be undertaken using a multi-cat vessel assisted by a support vessel such as a workboat and a RIB. The multi-cat is likely to be (or similar to) Leask Marine's MV C-vessels shown in Figures B.1-B.3 and a typical RIB is shown in Figure B.4. Vessel information is provided in **Error! Reference source not found.**.

Example multi-cat vessel

Example support vessel – Workboat

Example support vessel – rigid inflatable boat (RIB)

The selection and contracting of vessels is primarily driven by market conditions, vessel availability and ultimately, cost. Therefore, the actual vessels will be selected near to the time of works. Tocardo will confirm the project vessel spread with Marine Scotland at the earliest possible opportunity prior to works commencing as required (as per normal maintenance activities).

5.2 Communication and safety

Portable handheld VHF radios will be utiised.
Contact details amongst each party will be shared.

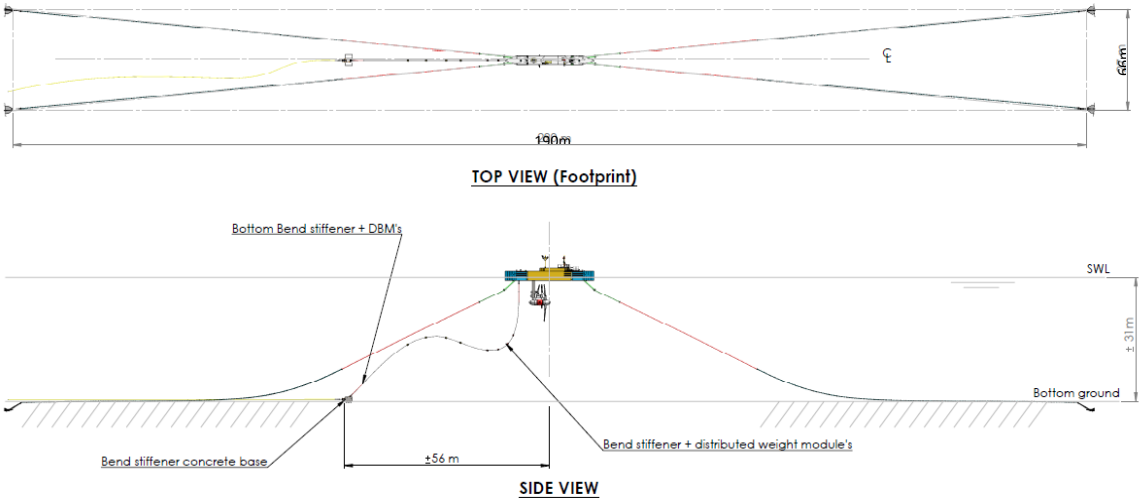
Prior to daily works commencing, the operations team will carry out Toolbox meetings to be led by the Offshore Project Manager.
An OIC vessel will be arranged by the marine contractor for a 24-hour standby in case of emergency.

5.3 Installation

Technical details of the TFS device can be found in Section 4.1 of the Project Information Summary (Tocardo, 2017).

5.3.1 Anchoring

During the onshore works and successful award of the marine licence consent, the gravity anchors will be installed at the site. Each anchor consists of 30-40t clump weight in the form of scrap chain and 100m ground chain. Both sets of chain can be hoisted on board the multicat at Hatston pier. The multicat sails out to the site where it lowers the chain to the bottom at the correct coordinates. The installation of the 4 anchor points will take 4 days. It requires 3 engineers (vessel crew), 1 foreman and 1 crane operator.



Mooring view of TFS, gravity anchors not shown here, but will be used

5.3.2 Electrical

For this deployment the existing ScotRenewables SR250 electrical cable will be connected through a tail cable to the TFS device. The cable end is hoisted up to the multicat and fitted with a dry-mate wet connector. The end of the tail cable is plugged into the connector. The tail cable has the same specification as the subsea cable, but is supported by thick rubber bend stiffeners. The bend stiffeners prevent damage to the tail cable from bending, vibrations and inline tension. The tail cable is connected on board the TFS at the junction box when the TFS arrives.

Summarizing:

- Safe padlock the electrical works;
- Locate end of cable with divers
- Attach hoist to end of cable
- Lift the export cable onto the vessel deck;
- Splice the cable and fit the dry-mateable connector;
- Connect the tail cable;
- Lower connector and cables to seafloor while holding the end of the tail cable;
- Hoist the end of the tail cable through the TFS; and
- Connect it.

Note that this requires divers.

5.3.3 TFS installation

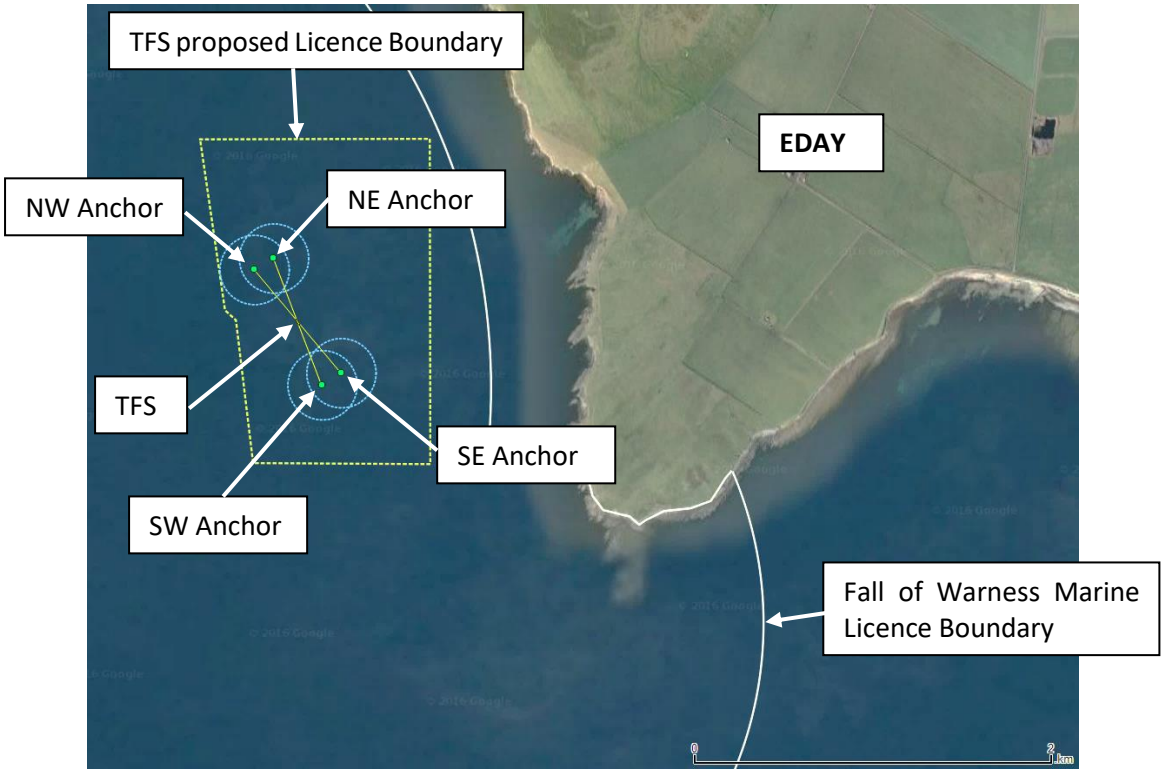
After the onshore works at Hatston pier, the device will be crane-lifted into the water and then one workboat or multi-cat vessel will be used to tow the platform. A small support craft such as a RIB, will help during the tow. A crew of 4 technicians and 1 operations manager is needed.
At site;

- The mooring lines will be attached and tensioned
- The tail cable end is hoisted into the TFS

5.4 Coordinates

The coordinates of the anchor points and TFS are given in the table below.

			North	East
Anchors	NW	WGS84	59.144644	-2.80749
		WGS84	59°8.6786	-2°48.4494
		UTM30N	511014	6556174
	NE	WGS84	59.144952	-2.806502
		WGS84	59°8.6971	-2°48.3901
		UTM30N	511070	6556209
	SW	WGS84	59.141667	-2.804075
		WGS84	59°8.5000	-2°48.2445
		UTM30N	511210	6555844
	SE	WGS84	59.141972	-2.803119
		WGS84	59°8.5183	-2°48.1871
		UTM30N	511265	6555877
TFS	TFS	WGS84	59.143291	-2.805273
		WGS84	59°8.5975	-2°48.3162
		WGS84	59°8'35.85''N	2°48'18.97''W
		UTM30N	511141	6556024
Cable	Subsea cable end	WGS84	59.1430166	-2.805916
		WGS84	59°8.581	-2°48.355
		UTM30N	511104	6555993



5.5 Planning

A high level plan is given in appendix A.

5.6 Routes

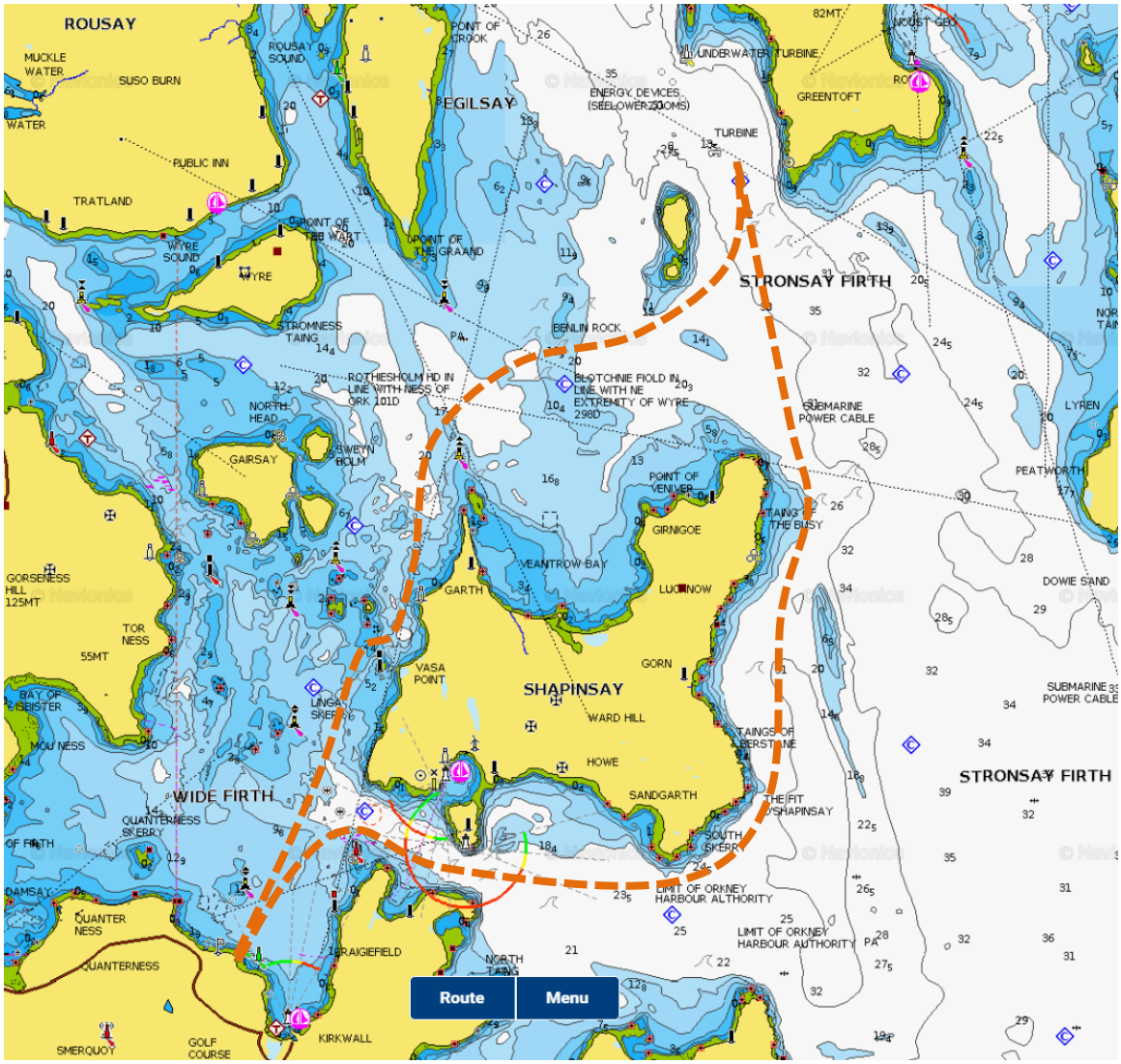
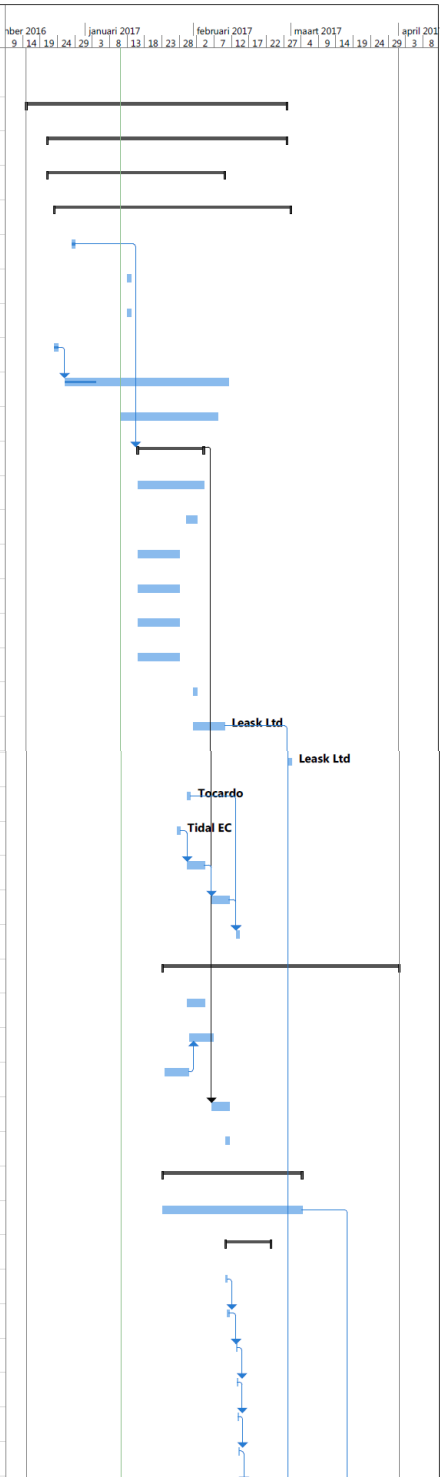


Chart image of likely routes to and from site. The east passage of Shapinsay Island allows for more depth, the west passage is very well possible too, when tide and weather window is correct.

The sailing routes are well known to the local marine contractor. Two routes can be taken, west or east of Shapinsay. The chosen route will be determined by the vessel's Super Intendent on the day and will be primarily based on weather conditions and tide tables.

6. Appendix – Planning

Id	Taak	Taaknaam	Duur	Begindatum	Einddatum	Voorafgaande taken
1		**EMEC**				
2		**Consenting**	**53 dagen**	**don 15-12-16**	**maa 27-2-17**	
14		**Financial activities**	**49 dagen**	**woe 21-12-16**	**maa 27-2-17**	
22		**Engineering**	**37 dagen**	**woe 21-12-16**	**don 9-2-17**	
34		**Construction activities**	**48 dagen**	**vri 23-12-16**	**din 28-2-17**	
35		Get TFS to warf	1 dag	woe 28-12-16	woe 28-12-16	
36		Anchor chain purchase at Leask	1 dag	vri 13-1-17	vri 13-1-17	
37		Order on-shore components (trafo etc)	1 dag	vri 13-1-17	vri 13-1-17	
38		Order trafo	1 dag	vri 23-12-16	vri 23-12-16	
39		Delivery trafo	35 dagen	maa 26-12-16	vri 10-2-17	38
40		Order subsea cable equipment	20 dagen	woe 11-1-17	din 7-2-17	29
41		**Construction works TFS**	**15 dagen**	**maa 16-1-17**	**vri 3-2-17**	**35**
42		Clean and paint parts	15 dagen	maa 16-1-17	vri 3-2-17	
43		Anodes	3 dagen	maa 30-1-17	woe 1-2-17	
44		Install frame inside TFS	10 dagen	maa 16-1-17	vri 27-1-17	
45		Install electronics	10 dagen	maa 16-1-17	vri 27-1-17	
46		Install communication	10 dagen	maa 16-1-17	vri 27-1-17	
47		Install lighting	10 dagen	maa 16-1-17	vri 27-1-17	
48		Install and connect LVDP	1 dag	woe 1-2-17	woe 1-2-17	
49		Construct clump weight anchors	7 dagen	woe 1-2-17	don 9-2-17	
50		Perform seabed survey to test anchor drag and location cables	1 dag	din 28-2-17	din 28-2-17	13
51		Get blades	1 dag	maa 30-1-17	maa 30-1-17	
52		Get T2 turbine	1 dag	vri 27-1-17	vri 27-1-17	
53		Transport turbine to NL	5 dagen	maa 30-1-17	vri 3-2-17	52
54		Adapt turbine	5 dagen	maa 6-2-17	vri 10-2-17	53
55		Transport turbine and blades to Kirkwall	1 dag	maa 13-2-17	maa 13-2-17	54;51
56		**Installation activities**	**50 dagen**	**maa 23-1-17**	**vri 31-3-17**	
57		Tool container and mooring lines of TFS to Kirkwall	5 dagen	maa 30-1-17	vri 3-2-17	
58		Get 20 foot containers	5 dagen	maa 30-1-17	maa 6-2-17	59
59		Get crane at Kirkwall	5 dagen	maa 23-1-17	maa 30-1-17	30GB+50%
60		Transport TFS to Kirkwall	5 dagen	maa 6-2-17	vri 10-2-17	41
61		Notice to Marniners (NtM)	1 dag	vri 10-2-17	vri 10-2-17	
62		**Onshore Eday sub station**	**30 dagen**	**maa 23-1-17**	**vri 3-3-17**	
63		Install electrical works at Eday	30 dagen	maa 23-1-17	vri 3-3-17	
64		**On shore works - Hatston pier**	**9 dagen**	**vri 10-2-17**	**woe 22-2-17**	
65		Install crane, fencing, portacabin	0.5 dagen	vri 10-2-17	vri 10-2-17	
66		Install 20 ft container for placing TFS	0.5 dagen	vri 10-2-17	vri 10-2-17	65
67		Pick-up middle section from trailer on placing holders	0.25 dagen	maa 13-2-17	maa 13-2-17	66
68		Connect bows	0.25 dagen	maa 13-2-17	maa 13-2-17	67
69		Hoist in 6.6kV transformer	0.25 dagen	maa 13-2-17	maa 13-2-17	68
70		Hoist assembled hull on high support (containers)	0.25 dagen	maa 13-2-17	maa 13-2-17	69



71		Connect strut	0.5 dagen	din 14-2-17	din 14-2-17	70
72		Attach turbine to strut	0.5 dagen	din 14-2-17	din 14-2-17	71
73		Outfit the internals of the TFS (electrical work)	4 dagen	woe 15-2-17	maa 20-2-17	72
74		Outfit the externals of the TFS (lights, railing)	2 dagen	woe 15-2-17	don 16-2-17	72
75		Prepare cable tail and fit to platform	0.5 dagen	din 21-2-17	din 21-2-17	73
76		Fit nylon mooring lines to TFS	0.5 dagen	vri 17-2-17	vri 17-2-17	74
77		With 2 cranes, hoist TFS into water	0.8 dagen	din 21-2-17	din 21-2-17	73
78		Moor TFS with fenders to Hatston pier	0.2 dagen	din 21-2-17	din 21-2-17	77
79		Clean up pier	1 dag	woe 22-2-17	woe 22-2-17	78
80		**Offshore activities**	**6 dagen**	**din 28-2-17**	**din 7-3-17**	**13**
81		**Prep works anchor and ground chain Hatston Pier**	**6 dagen**	**din 28-2-17**	**din 7-3-17**	
82		Mobilize multicat with anchor for anchor 1	0.5 dagen	din 28-2-17	din 28-2-17	49
83		Install anchor 1 at site	1 dag	din 28-2-17	woe 1-3-17	82
84		Mobilize multicat with anchor for anchor 2	0.5 dagen	woe 1-3-17	woe 1-3-17	83
85		Install anchor 2 at site	1 dag	don 2-3-17	don 2-3-17	84
86		Mobilize multicat with anchor for anchor 3	0.5 dagen	vri 3-3-17	vri 3-3-17	85
87		Install anchor 3 at site	1 dag	vri 3-3-17	maa 6-3-17	86
88		Mobilize multicat with anchor for anchor 4	0.5 dagen	maa 6-3-17	maa 6-3-17	87
89		Install anchor 4 at site	1 dag	din 7-3-17	din 7-3-17	88
90		**Electrical off shore**	**2 dagen**	**din 28-2-17**	**woe 1-3-17**	
91		Temporary mooring deployment	1 dag	din 28-2-17	din 28-2-17	
92		cable preparation works	1 dag	woe 1-3-17	woe 1-3-17	91
93		**Installation works TFS at berth 8**	**4 dagen**	**woe 22-2-17**	**maa 27-2-17**	
94		Transport TFS to berth	1 dag	woe 22-2-17	woe 22-2-17	78
95		Connect mooring lines between TFS and anchors + tensioning	1 dag	don 23-2-17	don 23-2-17	94
96		Pick up subsea cable and connect connector and tail cable	1.8 dagen	vri 24-2-17	maa 27-2-17	95
97		Connect tail cable to TFS	0.2 dagen	maa 27-2-17	maa 27-2-17	96
98		**Commissioning activities**	**11 dagen**	**vri 17-3-17**	**vri 31-3-17**	
99		On shore electronics	2 dagen	vri 17-3-17	maa 20-3-17	63
100		TFS functionality	2 dagen	din 21-3-17	woe 22-3-17	99
101		Turbine functionalty	1 dag	don 23-3-17	don 23-3-17	100
102		Communications	1 dag	vri 24-3-17	vri 24-3-17	101;97
103		Offgem commissioning	2 dagen	maa 27-3-17	din 28-3-17	102;20
104						
105		COD	1 dag	vri 31-3-17	vri 31-3-17