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Ref	21802-MS-01	Project	AOWFL

Project: Babcock FORECAST Deployment

Client: Aberdeen Offshore Wind Farm Ltd

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1 Introduction

Babcock own and operate a floating LiDAR system based upon proven low motion buoy design which provides a stable platform to host wind resource and environmental data capture equipment. The complete system is collectively known as FORECAST and will be referred to as such throughout this document.

FORECAST is supplemented by a Waverider buoy which is deployed near to FORECAST location within the operating zone of the buoy.

This document details the methodology for shallow water deployment of FORECAST which will be subject to final selection of the marine contractor selected by Babcock to undertake the deployment.

FORECAST is made up of three main sections, allowing it to be disassembled and transported via road. Currently, the three sections are held at Rosyth, within Babcock's commercial port facility.

1.1 Scope

The deployment operation is divided into the following main stages

- Transport to Aberdeen port and assembly quayside
- Mooring installation
- Load-out from quayside Tow to site
- Connection to moorings
- Recovery & Decommissioning

2 FORECAST General Particulars

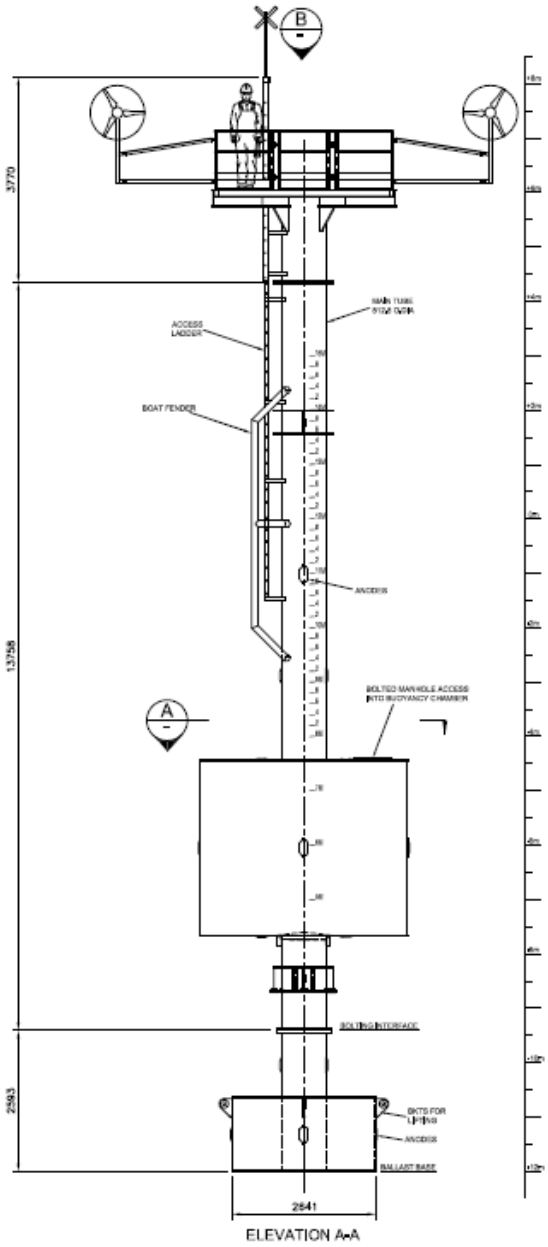
Main General Particulars
Length of Structure: 20m
Length Overall: 23.3m
Operating draft: 12m
Air draft: 11.3m
Platform dimensions: 3m x 3m
Diameter of buoyancy chamber: 3.8m
Total Assembly Weight: 49Te
Construction Material: High grade mild steel

Mooring Arrangement
3 Point mooring system with either clump weight or embedment anchors, according to seabed conditions.
Survivability: 1 in 100 year storm

Operational parameters
Operating temp range: -20º to +50ºC
Drift Radius: 10m
Operating water depths: 20m to 100m
Max Operating wave height: 4.25m
Yaw: +/- 30º

Major Equipment
Zephir Lidar – 300 series
Data Logger System
3D Sonic anemometer
Satellite Compass
12V Electrical power system
2 x 350W Turbine Generators
4 x LG 300W Solar PV Panels

Communications
GSM / GPRS
SatCom
Local Wi-Fi



ELEVATION A-A

3 Deployment

The deployment of the FORECAST system is dependent upon final assessment of the technical and commercial aspects of various deployment options that exist for this project. Some factors are subject to change based upon this final selection such as deployment quayside location, marine contractor and vessel selection. These factors affect the detailed methodology that will be employed to deploy and recover the system.

The options that exist are:

1. Deploying FORECAST directly from quayside to the deck of a vessel for transportation to site. Deployment of FORECAST from deck to the water utilising ships crane.
2. Vertical tow by a suitable vessel following a quayside lift into the water at a deployment location with suitable draft conditions.
3. Inclined tow by a suitable vessel(s) following a quayside lift into the water at a deployment location with shallow draft conditions.

The device may be deployed from Rosyth, Montrose or Aberdeen depending upon final contractor selection.

The following example methodology is given based upon option 3.

3.1 Transport and Assembly

The FORECAST structure is divided into three sections to enable transport by road. The sections are connected using bolted flanges with gaskets.

All FORECAST sections and the associated ground tackle (moorings) will be transported by road, from Babcock's commercial port located in Rosyth, to Aberdeen port. The three units are assembled quayside in the vertical position, ready for lift operation, into the water.

Quayside location within Aberdeen port is to be confirmed and will be subject to port availability at time of the deployment operation.

3.2 Three Point Mooring Installation

Step	Description
1.	Moorings assembled on quayside, Aberdeen Docks. Anchors located close to quay edge within safe lifting radius of vessel crane. The remainder of the mooring leg will be flaked to ensure sufficient slack during the anchor lifting operation.
2.	A tool box will be held to ensure all personnel are aware of the dangers associated with the load out. Particular attention will be paid to the dangers of heavy lifts and bights.
3.	The mooring anchor will be stropped in accordance with the lift plan.
4.	The anchor will be lifted by the vessels crane, swung over the quay and decked in a position close to the bow roller.

5.	A suitable bight of mooring line will be stropped using a webbing sling. The bight will be lifted and swung inboard on the vessel with proper attention being paid to the dangers of hanging lines.
6.	Once on-board, the mooring anchor and line will be lashed to a level commensurate with sea conditions expected during the transit to site.
7.	The vessel will transit to site, subject to the requirements of the Aberdeen Wind Farm site operation requirements.
8.	A tool box talk will be held to ensure all personnel are aware of the dangers associated with mooring deployment. Particular attention will be paid communications between bridge/ deck/ crane operator/ winch operator and to the danger of running lines and bights.
9.	The anchor winch line will be shackled into the end of the mooring line. The mooring line will be wound onto the anchor winch.
10.	The mooring anchor will be stropped using a sling with a minimum SWL of 20 tonnes.
11.	The vessel crane will be hooked to the anchor strop and sufficient tension taken to allow the safe unlashing of the anchor and mooring line.
12.	The vessel crane will take the anchor weight until it lifts from the deck. The crane will continue lifting until the anchor has sufficient height to clear the bow roller. Tag line will be rigged to prevent swinging.
13.	The anchor will be swung over the bow roller and lowered until the weight is taken by the anchor winch wire.
14.	The vessel crane hook will be released from the anchor strop and cleared.
15.	The vessel shall be manoeuvred until the bow roller is over the anchor landing position, accurately determined by the vessels on-board plotter.
16.	The anchor will be lowered to the seabed at the predetermined coordinates to enable FORECAST to enable FORECAST to operate at the installation coordinates. The position will be recorded by the vessel master and noted.
17.	As the vessel is manoeuvred astern, the mooring line will be paid out from the vessel winch.
18.	The temporary surface support buoy and pendant will be shackled into the tri-plate located at the end of the fibre riser.
19.	Once the bitter end is clear of the winch, a slip line will be rigged through the tri-

	plate / chain tail shackle.
20.	The winch wire will be disconnected, and the bitter end over-boarded on the slip line.
21.	The surface support buoy will be over-boarded and the mooring slipped.
22.	The mooring installation vessel would then transit to Aberdeen dock
23.	If deck space allows, all three anchors and their moorings will be transferred to the deck of the vessel for a single transit to the site location. If not Steps 3 to 23 will be repeated for each anchor mooring.

3.3 FORECAST Load out from Quayside

Step	Description
1.	FORECAST assembled on quayside at Aberdeen dock. FORECAST will be located close to quay edge within safe lifting radius of the quayside crane. The mooring leg chain tails will be shackled to the mooring lugs and lashed to the structure above the design waterline to allow connection to mooring lines at the site location.
2.	Towing vessel is manoeuvred alongside quay ready to take up FORECAST tow line.
3.	A tool box will be held to ensure all personnel are aware of the dangers associated with the load out. Particular attention will be paid to the dangers of heavy lifts.
4.	Using a suitable cherry picker, or suitably certified man riding basket, rig the Lidar to lift and readiness for towing once in the water. Towing line to be laid out to the towing vessel, on hand, quayside, with plenty of slack. Particular attention is to be given to ensure that the line does not interfere with the lift operation and hoist into the water. Pay particular attention to the clearance required by instrumentation. Rig tag lines assist control of inclined swinging.
5.	Rig structure with additional buoyancy bags to assist 60º incline when structure enters the water.
6.	Ensure all project personnel are aware that the heavy lift is about to commence. Standby vessel mooring lines.
7.	Take the weight on the quayside crane and lift slowly clear of the quay, allowing the structure to progressively incline to approx. 60º angle.
8.	Swing the buoy over the Quay edge, to the side of the attending towing vessel.
9.	Lower slowly until the buoyancy chamber is partly submerged. Continue to lower slowly until approximately 75% of the weight is transferred from hook by

	displacement structure (buoyancy).
10.	FORECAST will free float at the induced 60º angle, supported by the additional buoyancy aids to maintain the angle of heel in the water.
11.	Towing vessel to take up slack on tow line and temporarily hold FORECAST alongside vessel at the hip, fendered off and secured to ship side. Sufficient fenders are deployed and positioned to prevent damage occurring between vessel and FORECAST whilst secured at the hip.

3.4 FORECAST Tow to site

Once the Tow vessel reaches a safe operating distance outside Aberdeen harbour with sufficient depth of water to ensure buoy under keel clearance of at least 3m, FORECAST will be released from the ship side and manoeuvred astern of the vessel for commencement of towing to its deployment location.

The towing arrangement utilises the mooring chain tails rigged to the FORECAST for connection to the pre-deployed moorings, arrangement TBC. This may be part wire/ part fibre stretcher or all fibre.

Note: A towing analysis will be carried prior to the deployment operation to determine towing characteristics with buoyancy aids at the 60º angle and predict the anticipated loads.

Step	Description
1.	Vessel will tow FORECAST whilst secured on the hip, until a safe operating distance outside of Aberdeen harbour and sufficient depth of water.
2.	Ensure all personnel are aware of executing tow transition.
3.	FORECAST is released from the hip and manoeuvred astern of the vessel in the towing position, paying out the tow line. Once in the correct position and orientation the tow vessel then takes up the tow line slack, ready to commence tow to site location.
4.	The tow vessel (multicat) will proceed at slow speed (c 4kts) on a medium to short tow (c 40-60m)
5.	The tow route will be monitored and recorded by vessel master

3.5 FORECAST Mooring and Commissioning

The final part of the operation will be the connection of the buoy to the pre-laid three point mooring. The final 10m of the mooring legs consist of chain tails shackled into the lower lugs. These tails will be fitted whilst the buoy is on the quay and led to a lashing point above the design water line. This will enable the deck crew to make the mooring connection in way of the tri-plate.

Step	Description
1.	During the tow, a toolbox talk will be held as a final briefing for the mooring operation. Particular attention shall be paid to bridge/ deck communications and the dangers of lines under tension/ bights.
2.	Upon arrival on site, the multicat will shorten up the tow and bring the buoy alongside. Lines and fenders will be rigged to allow the buoy to be towed “on the hip”.
3.	It is important that the buoy is correctly aligned to ensure the mooring legs are attached in the correct sequence and FORECAST is in the correct orientation with the solar array facing south.
4.	The first surface support buoy will be grapnelled and brought inboard using the vessels *drum end / capstan.*
5.	The mooring line will be heaved inboard until there is sufficient slack to allow the line to be handled safely on deck.
6.	The mooring line shall be stoppered off inboard of the bow roller.
7.	The chain tail shall be led from the buoy, outboard of the vessel then inboard over the bow roller. It will be stoppered off just inboard of the roller.
8.	The surface support buoy will be unshackled from the tri-plate.
9.	The chain tail shall be shackled into the tri-plate. Split pins will be fitted and verified as secure.
10.	The sub-sea support buoy shall then be shackled into the tri-plate.
11.	A slip hook shall be attached to the crane wire and hooked over one of the links of the chain tail.
12.	The bight will be lifted clear of the deck with the crane and the weight taken off the

	stoppers.
13.	The bight will be lowered into the water until the weight is taken by the subsea buoy. The slip hook would then be recovered inboard.
14.	Once the first two legs are secure, one member of Babcock project team to board the buoy from the multicat using the access ladder.
15.	Carry out equipment commissioning. Recover person from buoy ladder to deck.
16.	Recover last chain tail to deck and stopper off.
17.	Let go buoy lines and manoeuvre vessel clear.
18.	Manoeuvre vessel towards last surface support buoy.
19.	Vessel Master to confirm and record FORECAST positional coordinates.
20.	Multicat transit back to Aberdeen port.

3.6 Deploy Waverider Buoy

The Waverider buoy is deployed after FORECAST is deployed, to reduce any risk of collision during the operation.

The Waverider buoy has a single mooring line attached to a clump weight (500Kg) made up from scrap anchor chain, gathered up creating a clump weight.

The Waverider buoy is deployed in the southerly position centrally between two of the three FORECAST anchor moorings within the zone. (See diagram in section 6)

4 Recovery & Decommissioning

Upon completion of the wind resource campaign, FORECAST and all of the associated equipment will be completely removed from the deployment site. The recovery and decommissioning operation is essentially the reverse of the Deployment method.

The first part of the operation will be disconnection of the buoy from the three moorings. The top 10m of the mooring legs consist of chain tails shackled into the lower lugs and to a triplate with a mid-water buoy and the rest of the mooring. The chain tails will be disconnected from the tri-plate and secured back to the buoy. The rest of the mooring can be surface buoyed off, to allow for recovery after the buoy has been completed transit to port.

4.1 Recovery Waverider buoy

The Waverider buoy has a single mooring line with clump anchor. It will be recovered with boathook and hauled on-board. The mooring line is continued to be hauled in using the dolly on the end of the winch until the clump anchor (500Kg of bunched chain) is recovered.

The Waverider buoy is recovered prior to recovery of FORECAST moorings to maximise manoeuvring area and mitigate any risk of collision during the operation.

4.2 FORECAST Removal from moorings

Step	Description
1.	A toolbox talk will be held as a final briefing for the recovery operation. Particular attention shall be paid to bridge/ deck communications and the dangers of lines under tension/ bights.
2.	Upon arrival on site, the Babcock project crew will board FORECAST via the access ladder and shut down the system ready for removal.
3.	Upon completion of shut down, the Babcock team will disembark FORECAST. The multicat will prepare a grapnel for mooring recovery. The grapnel will be rigged over the bow roller and on to the main winch.
4.	The first mooring chain will be grappled by the vessel going astern and brought inboard using the vessels winch. This operation is to be closely monitored to prevent damage to assets.
5.	The mooring chain will be heaved inboard until the mid-water buoy and triplate is on deck and sufficient slack to allow the line to be handled safely is on deck.
6.	The mooring chain and nylon rope shall be stoppered off inboard of the bow roller.

7.	The tri plate will be disconnected.
8.	A surface marker buoy with recovery line will be connected to the hard eye of the rope leading to the anchor.
9.	The surface marker buoy with the rest of the mooring will be released.
10.	Vessel moves alongside the buoy with the mooring chain to the corresponding pad eye for the mooring.
11.	Mooring chain to be secured with a shackle to the pad eye on buoy allowing no slack chain below the bottom of the buoy in the water.
12.	Repeat steps 3 – 11 for moorings 2 and 3.
13.	Vessel to secure buoy to side to allow towing/set up towing bridle. The towing bridal will be set up as per drawing and original tow out to location.

4.3 Transit to Port and Lift Out

Step	Description
1.	The multicat will proceed at slow speed (c 4kts) on a medium to short tow (c 40-60m) to port.
2.	Upon entering Aberdeen port, the multicat will shorten up the tow and bring the buoy alongside. Lines and fenders will be rigged to allow the buoy to be towed “on the hip”.
3.	Riggers are to board FORECAST wearing the correct PPE, when the buoy is in a secure and stable position. The lifting gear is secured to lifting point on FORECAST as per lift plan to enable a single point lift
4.	Whilst at the hip, using one of the three mooring tails attached to FORECAST, the vessel crane induces a heel, in a controlled manner with additional lines to the vessel. The vessel provisions adequate fendering to prevent damage to vessel and buoy.
5.	As FORECAST reaches the 60º angle, buoyancy aids are attached to FORECAST to assist in retaining the angle of heel during free floating, prior to lift out of the water.
6.	The vessel continues transit into Aberdeen port to the nominated quayside location.
7.	Prior to commencing the lift, the multicat will lie alongside the quayside and pass the towline using a heaving line.

8.	The quayside crane, after carrying out all necessary tool-box talks will prepare for lifting.
9.	FORECAST is connected to the crane hook. Pay particular attention to the clearance required by instrumentation.
10.	Ensure all project personnel are aware that the heavy lift is about to commence. Lift supervisor to confirm the lift can proceed.
11.	The vessel is to move off and hold at a safe distance, remaining on standby.
12.	Take the weight on the quayside crane and lift slowly clear of the water. Due to marine growth the buoy could be slightly heavier than expected.
13.	As FORECAST is clear of the water, it will adopt a more upright angle, near to 3º. FORECAST is slewed and hoisted quayside. Full control of the load must be maintained at all times, if this is not possible the operation will be stopped.
14.	Lower slowly until the ballast chamber is in contact with dunnage, quayside. Continue to lower slowly until approximately 75% of the weight is transferred from hook to quay. When landing the buoy be aware of marine growth on the bottom of the ballast chamber.
15.	Rig securing lines from quayside anchor points to FORECAST pad eyes and tension.
16.	Once the buoy is secured, the vessel can stand down and commence recovery of the three point mooring system.

4.4 FORECAST Disassembly

FORECAST is progressively disassembled into three separate section, whilst secured in the vertical position quayside. Working from the top down, first removing the platform and then centre section by unbolting the flange connections.

Depending on the level of marine growth, FORECAST may have to be pressure washed down prior to disassembly.

Each section is hoisted onto transport lorries for road transport back to Rosyth Dockyard

4.5 Three Point Mooring Recovery

Step	Description
1.	Deck prepared for mooring and anchor handling.
2.	Vessel to transit to site. A task toolbox talks to be given including the dangers of anchor handling operations.
3.	Surface buoy for mooring recovered with boathook and hauled on-board.
4.	Mooring rope to be hauled on board using the dolly on the end of the winch. The vessel is to use thrust to keep the tension of the mooring rope to a minimum.
5.	When the mooring chain is on deck, this is to be stoppered off and the mooring rope can be disconnected, the working wire of the winch is to be connected to the chain.
6.	Winch is used to recover mooring chain. During the recovery the anchor will be lifted from the seabed. Vessel is to hold station above the anchor position until the anchor is at the bow roller.
7.	Preventer wires would be rigged from vessel pad eyes to the anchor shackle.
8.	A suitable strop is rigged through the anchor shackle and the crane hook connected there in.
9.	The weight is taken by the crane, and the preventers let go.
10.	The anchor is recovered to deck and stowed. The mooring chain can be wound off the winch and stowed.
11.	Repeat steps 2 to 6 for moorings 2 and 3
12.	Transit to Aberdeen port for demobilisation.

5 Waverider buoy

FORECAST will be supplemented by a Waverider buoy to record metocean data at the site location. The Waverider buoy will be deployed within the designated 100m radius operation exclusion zone, centred about FORECAST location.

The below provides an example for the type of Waverider buoy that will be deployed

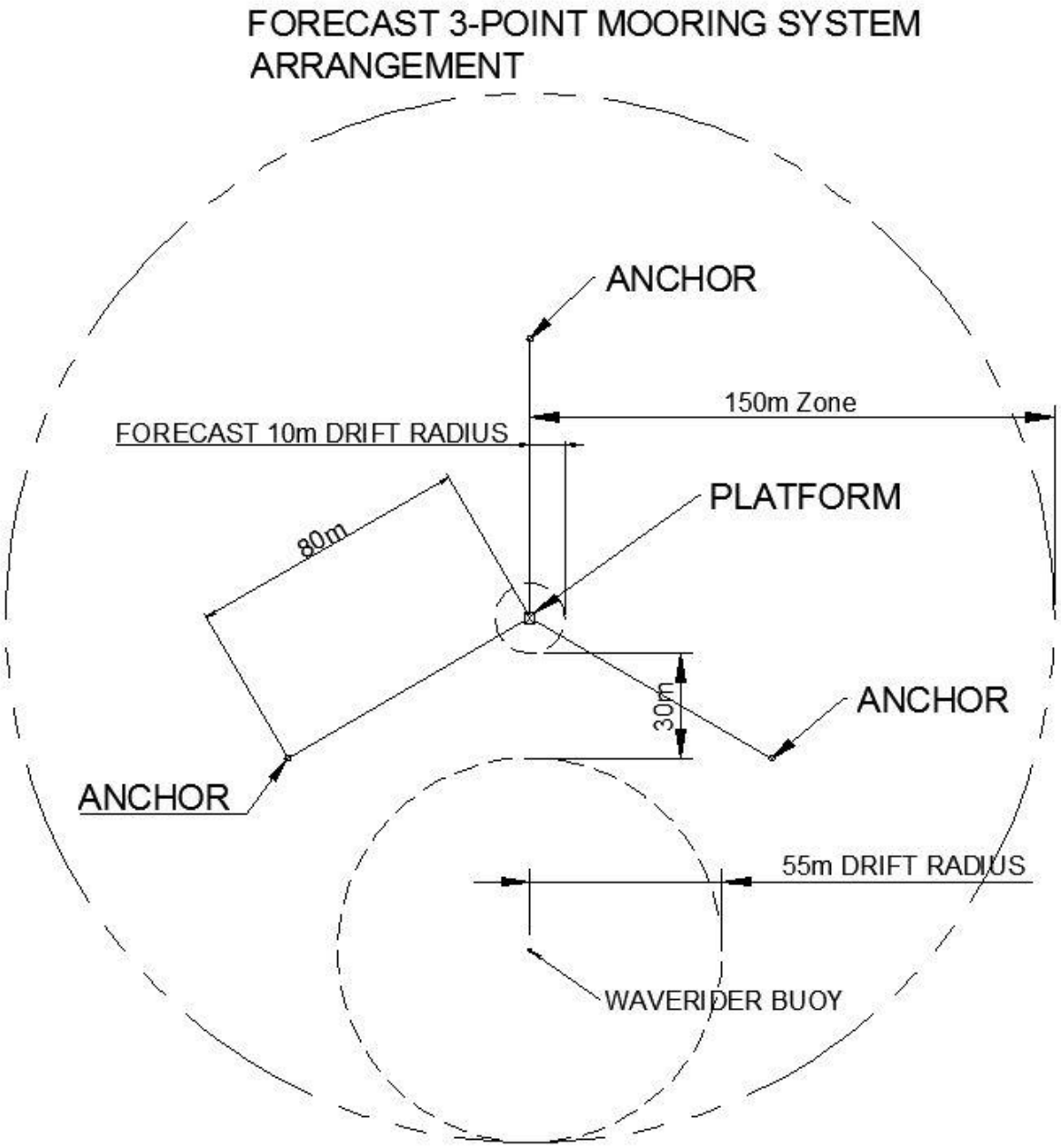
Directional Waverider DWR4/ACM

- wave motion sensor based on a stabilised platform, accelerometers, and magnetic compass
- **measures wave height** for wave periods of 1 to 30 seconds, accuracy 0.5 % of measured value
- **measures wave direction**
- **measures surface current**
- **measures water temperature**
- GPS for buoy monitoring and tracking through HF link
- internal logger
- power switch
- LED flash antenna
- 0.9 m diameter spherical hull of AISI 316 including eccentric mooring eye
- optional Cunifer hull, warranted not to corrode
- 1.3 years battery life (30 batteries)
- HF transmitter range 50 km over sea
- optional **Iridium SBD module** for ocean wide coverage and unlimited range
- optional Iridium Internet module
- optional **Argos module** for ocean wide coverage and unlimited range
- optional **Solar Panel system**
- optional hull painting

The Waverider buoy has a single point mooring system.

6 Mooring installation arrangement

The below diagram illustrates the mooring arrangement and the relationship between the three point mooring system and FORECAST, located at the centre of the zone. It also shows the location for the Waverider buoy.

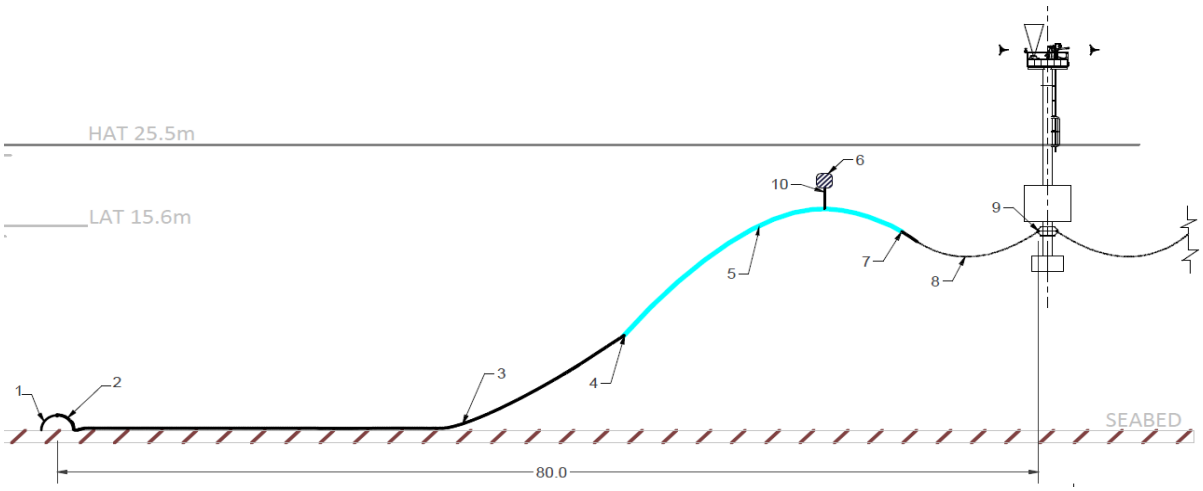


6.1 Three point mooring system

The mooring consists of 3 x chain / fibre / chain legs, each of which is attached to stockless anchors weighing 17 tonnes.

The last 10m of each mooring leg will consist of chain tails secured to the buoy mooring lugs pre-attached and towed to site with the buoy. The mooring system also requires a sub-sea buoy attached to the connection between the fibre riser and chain tail. This will be fitted during the buoy mooring operation.

The composition of each mooring leg required to be pre-installed will be as follows;



Component	Length	Weight
Stockless anchor	N/A	17.5 tonnes
Ground chain	55m	700 kgs
Fibre Riser	30m	52 kgs
Associated shackles	N/A	TBC
Temporary surface support buoy	Circa 2m diameter with light	TBC

6.2 Installation coordinates

FORECAST - 57º13.509'N : 1º59.895W

Waverider Buoy - 57º13.47396'N : 1º59.895W

Note: The Waverider buoy is located 65m directly south of FORECAST, central between the moorings as illustrated on the previous page.

6.3 Vessel Selection

The following information provides details of the typical vessel that will be used in the deployment of FORECAST and the Waverider buoy. Final vessel selection will be subject to

vessel availability and contractor selection, however the below vessel information is considered typical for the vessel required to undertake the deployment operation.

Example Vessel: Whalsa Lass

General Particulars:

General

Type of vessel	: Damen Multicat®2611
Builder	: Damen Shipyards Hardinxveld
	: Yard No. 571661
Basic Functions	: Anchor handling, dredger service, supply, Towing, hose handling, survey, ship assist
Classification	: Bureau Veritas ✠Hull•MACH Tug
	: Unrestricted Navigation
	: Nat. Authorities
	: MCA workboat Category 1
	: 150 miles from shore

Dimensions

Length o.a.	: 26.00m
Beam	: 11.50m
Depth at sides	: 3.50m
Draught aft	: 2.25m
Displacement	: 515 ton (m)
Free deck space	: 160m^2
Deck Loading	: 10t/m^2

Whalsa Lass

A full specification sheet is provided separate to this method statement as a reference.