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1. INTRODUCTION

1.1.1 Project Description

Fugro and Aberdeen Offshore Windfarm Limited (AOWFL) are planning to conduct a geotechnical investigation at the Aberdeen Offshore Windfarm location.

The primary objectives of the geotechnical investigation are:

- Increase understanding of the shallow soils and lateral variability across the base of the foundation; and;
- Inform detailed design of foundations.

The base case for the geotechnical campaign is presented in table 1.1 below, it is based upon performing three deep push CPTUs to refusal (assumed to be around 25m below seabed) at each foundation location, of which one at each location shall be with a seismic cone.

In addition, three boreholes with near-continuous sampling to rockhead are envisaged. However, it is understood that some coring will be required.

Table 1.1: Scope of Work

Number of Locations	Seabed CPTU	Seismic CPTU	Borehole	CPTU Dissipation tests
11	2 per location	1 per location	3 in total	2 per location
Total:	22	11	3	22

As per AOWFL's requirements it is Fugro's intention to perform the deep push CPTUs first; followed by boreholes afterwards (including where it is required to extend the deep push CPTUs).

1.2 Methodology

1.2.1 Mobilisation

The geotechnical equipment required to complete the scope of work will be transported to the selected mobilisation port, Den Helder. The operating/project personnel and client representatives will join the vessel in port. During mobilisation in port the equipment will be subject to functionality tests prior to departure to site, inclusive of a Differential Global Positioning System (DGPS) check and full wet test deployment of the relevant seabed equipment, we would also complete a calibration or verification of the Ultra Short Base Line (USBL) acoustic positioning system if deemed necessary. All operations will be conducted in accordance with the operating procedures of the equipment spread. A full and

detailed kick-off meeting will take place involving all relevant parties including client, vessel management, party chief, and discipline/shift supervisors. We would then sail to the first location.

1.2.2 Water Depth Determination

Water depth would be measured at each investigation location and reduced to Lowest Astronomical Tide (LAT). Water depth measurements would be performed using a vessel-mounted echo sounder and the drill string lowered onto the clamps in the seabed frame. A sound velocity probe will be used for the purpose of the computation of the speed of sound in water. A temperature/salinity profile shall be taken at the commencement of the work and at intervals as required, for the purpose of computation of the speed of sound in water.

A sector scanning sonar may be deployed prior to lowering the seabed frame to determine that the site is clear to land the seabed frame, in particular if further UXO mitigation is needed at site.

1.2.3 Seabed CPT Operations

The Bucentaur will commence the offshore works mobilised with the Fugro Seacalf® 20 T to carry out the 3 x 11 seabed CPTs down to refusal.

The unit will be mobilised into the deployment position within the vessel's moonpool, where it will be handled by the heavy load winches. 10 cm^2 and 15 cm^2 PCPT cones will be provided to allow selection of the optimum cone type for the soil conditions encountered.

Once mobilised, the equipment will be subject to functionality tests prior to departure to site, inclusive of a DGPS and DP interface check. All operations will be conducted in accordance with the operational procedures of the equipment spread.

The vessel will transit to site, and upon arrival set up over the site of the initial PCPT test on Dynamic Positioning (DP).

The vessel will hold station on the site of the initial test by use of DP, and the seabed unit lowered to the seabed. Once on the seabed, the depth and inclination of the unit will be recorded, and the test commenced. The unit would drive the cone into the seabed at the standard rate of 2 cm/second.

PCPT data, including qc, fs and u2, total thrust and inclination shall be continuously recorded and displayed within the control cabin. The tests shall continue to the required terminal depth, or until refusal as defined by total thrust equalling nominal reaction provided, cone end reaching 80% of cone capacity, friction reaching 15% of cone axial capacity, string deviation over 10 degrees between tip and seabed, rod deviation greater than 3 degrees over a 1 metre length or where further penetration may result in equipment damage (subject to explanation and discussion with the onboard representative). Where directed by the onboard representative the cone penetration will cease.

Upon completion of the test the sounding rods will be retracted and the seabed frame recovered to the moonpool, where the seabed frame will be held on the cursor latches within the moonpool.

Once secured in the moonpool, the vessel will transit to the next test site and the process repeated, until the scope of work is concluded.

Operations will be conducted on a continuous basis, 24 hours per day, and 7 days per week.

Data will be processed aboard and draft field results issued to the onboard representative on a daily basis within 24 hours of each test completion, and/or uploaded to an FTP site, for general review. The data will be downloaded to Fugro offices ashore for reprocessing and issue in factual and interpreted reports in accordance with the specification, and direction from the Employer.

Once the vessel has completed the Seabed CPT scope of work it will transit to port for conversion into Downhole mode, transit back to site and commence drilling operations.

1.2.4 Drilling Operations

Drilling would be performed using soil boring equipment through a centre moon pool using a top drive power swivel. The equipment includes a fixed derrick rig, mud mixing and pumping unit, as well as other tools and accessories required to carry out the survey. A heave motion compensator is fitted to the power swivel to ensure the drill bit maintains a uniform pressure on the base of the borehole during drilling operations. An ample supply of drilling mud will be provided and a spare string of drill pipe, sufficient spare parts and other supplies required to avoid delays will be available.

The work is to be performed in drilling and coring mode using API pipe and seawater or drilling mud. A selection of drill and coring bits shall be supplied to cope with the expected range of possible soil conditions. As a minimum this shall include drag bits and roller bits.

The seabed frame would be provided with a re-entry guide to enable the drill bit to be changed during drilling. The seabed frame would also be fitted with a pipe clamp to immobilise the drill string in order to minimise soil disturbance during sampling and testing.

Upon completion of a borehole, the pipe will be withdrawn, and the seabed frame lifted into the moon pool. If boreholes are located close together, then it may be possible to pull the drill pipe clear of the seafloor and raise the seabed frame off the seafloor and move the vessel without recovering all equipment back to deck.

Operations will be conducted on a continuous basis, 24 hours per day, and 7 days per week.

1.2.5 Sampling

Depending on the in situ soil characteristics the most appropriate sampler would be chosen. Sampling would be performed using either a thin walled wireline push-sampler with or without a stationary piston (WIP or PISTON sampler), a thick walled wireline push-sampler (also WIP sampler) or a split spoon hammer sampler. Sampling and testing would be performed from the bottom of a vertically-stabilised drill string. This provides optimum protection against buckling of tools and drill string. It also makes it possible to accurately control and monitor the penetration of the sampling tube or sensor into the soil below the bottom of the borehole. Most of the equipment utilises a hydraulic jacking system that is operated down hole via an electro-hydraulic umbilical cable, which allows the measured data to be

displayed at the surface as the test proceeds. Down hole instrumentation is available to check tool position, proper latch-in, total applied thrust and penetration of sensor or sampling tube into the soil. Digital data transmission is used with this equipment.

A range of thin walled and thick walled Shelby tubes would be provided. These are to be without core catchers for cohesive sediments and with a range of core catchers for non-cohesive soils. For very dense granular soils, thin walled push sample tubes shall be supplied with catchers in order to improve recovery. Push sample tubes shall be of 63 mm – 76 mm OD (outside diameter). Tubes of 50 mm OD shall also be provided and available for use in very dense granular soils where 63 mm – 76 mm OD tubes have been unable to achieve the necessary recovery.

1.2.6 Downhole Piezocone Penetration Testing (PCPT)

In-situ PCPTs would be performed using the Fugro WISON® MKIII system consisting of a wireline down hole jacking unit with a 3 metre stroke (dependent on cone size) and a thrust capacity of 90 kN.

After the borehole has been advanced to the required test level it is cleaned by mud flushing and if there is a centre insert plug in the drill bit it is retrieved. The WISON® is lowered by its electro-hydraulic umbilical to the bottom of the drill pipe, where it seats just behind the drill bit and latches under its own weight. The test sequence is then activated from a surface control cabin and the cone penetrometer is hydraulically pushed into the soil at a constant rate of 2 cm/s. Throughout the test, the measurements of cone resistance, sleeve friction and pore pressure, if measured, are displayed graphically in the control cabin. These data are simultaneously recorded by computer. This facilitates detailed data processing, interpretation and presentation both offshore and onshore. Upon reaching the maximum achievable stroke of either 1.5 or 3 metres (depending on which cones are used), or the limiting thrust capacity of 90 kN, the test is terminated and the system depressurised. The drill string is lifted to extract the cone and test rod out of the ground and the WISON® unit is retrieved; the complete operation having taken 10 to 15 minutes.

Depending on soil conditions either a 10 cm^2 or 5 cm^2 cone would be utilised with a 3 m or 1.5 m stroke respectively.

1.2.7 Offshore Laboratory Testing

All recovered samples will be processed in the offshore laboratory, where the specified laboratory testing will be conducted, and the remaining core and materials will be preserved and sealed for onward shipment to the onshore laboratory in accordance with the specification. All testing and preservation will be undertaken based on British Standards BS 1377 and BS 5930, as appropriate, and in compliance with NORSOK GR-001.

Preliminary borehole logs and test data will be available for delivery to the onboard representative, and/or uploaded to an FTP site within 48 hrs of completion of the borehole, though in normal circumstances this can ordinarily be achieved within 24 hours. A draft laboratory testing schedule will be presented to the onboard client representative before completion of the fieldwork.

All samples and data will dispatched to Fugro's Wallingford laboratory and office for further laboratory testing, and factual and interpretative reporting.