

Memo

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GMS Geotechnics – GMS2016-029

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Subject **Recommended geotechnical and geophysical survey near FPS - Hywind Scotland**

1 Background

Based on the Hywind floating turbine (FWT) barrier assessment, Ref. /1/, it is found out that the FPS (Forties Pipeline System), operated by BP needs to be protected from a free drifting scenario of the Hywind FWT. The proposed protection method involves a rock installation as high as 2m. The seabed condition and detail soil information at the foreseen locations is not documented, but competent over consolidated soil is expected. In order to better understand the ground condition and optimize any protection design work, additional seabed and soil data are required.

DNV's impact probability assessment, ref. /2/, highlights that there are two particular sectors along the FPS route, near Hywind, where the FPS lies in the assessed minimum and maximum water depths. The study concludes that impact is possible if the natural barriers fail to protect the stop the drifting FWT.

The purpose of this document is to provide a scope of work for seabed surveys intended to document soil and seabed conditions. Company plans to perform a geological/geotechnical desktop study to better understand the geological setting in the area. Furthermore, Company will perform in-situ investigations including geophysical survey with sub-bottom profiling and a geotechnical site survey with cone penetration tests (CPT) or gravity coring in order to establish relevant soil strength parameters for design of rock berms and to document soil strength in shallow water area.

2 Location

Hywind floating offshore wind farm is located in North sea, approximately 25 km east of Peterhead, Scotland. The location of the wind park is in near proximity of the BP operated Forties pipeline system (FPS), which passes south of the site, See Figure 2-1 below.

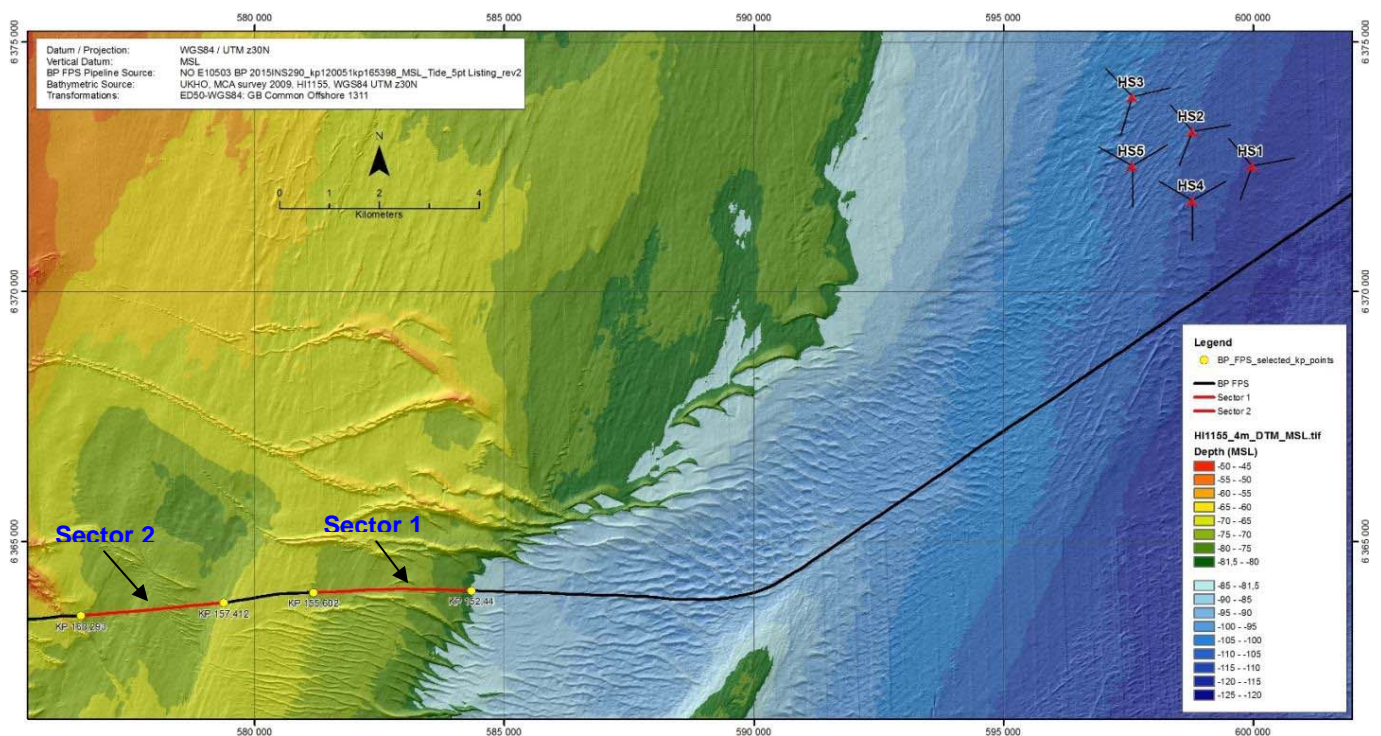


Figure 2-1 Bathymetric map of Hywind- Scotland wind park and FPS

3 Seabed Condition

The seabed condition at Hywind FWT farm is dominated by sand wave features with a gradient of 1 to 4 degrees and crest heights 1.5 to 2.0m. From the bathymetric data, there appear to be ridges composed of competent material just north and North West of the FPS route near sectors 1 and 2, see figure 2-1. From the geotechnical studies of the wind farm area and cable route, Ref. /3/, and borehole samples obtained from British Geological Survey (BGS), Ref. /4/, A very thin layer of fine Holocene sedimentary sand is reported at seabed, followed the Wee Bankie formation which mainly consists of glacial till with shear strength typically in excess of 100 kPa. As the seabed approaches land and the water depth reduces, larger areas of glacial till and bedrock becomes exposed on the seabed.

4 Scope of Work

A seabed survey, consisting of both geotechnical and geophysical investigations, parallel to the FPS route, in the sectors where there is a probability of impact is planned. The survey is aimed to provide detailed seabed and sub-surface soil information, which is required to determine a realistic pipeline-soil-rock berm interaction and mitigation protection designs.

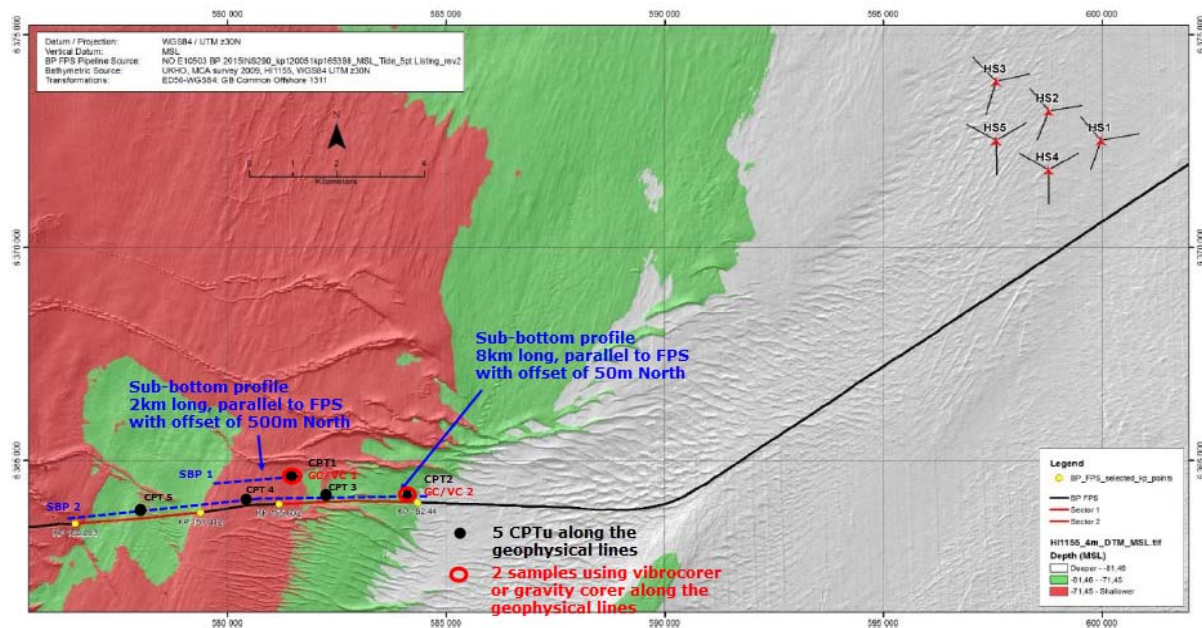


Figure 4-1 Planned CPT locations and SBP lines

4.1 Geophysical survey Scope of work

In conjunction with the planned intrusive, CPT, tests, it is planned to survey two sub-bottom profile lines approximately 1,5 km and 8 km running parallel to the FPS, as shown in figure 4-1. The extents and route corridor coordinates are listed in Table 4-2 below. The sub-bottom data will be processed and interpreted together with the CPT data.

In addition, it is a requirement to have UXO survey before the CPT tests. If the full UXO survey cannot be provided then Gariometer survey in a box of 15mx15m at each CPT location should be conducted.

Line ID	Easting [m] **	Northing [m] **
SBP 1	584446,39	6364285,19
	580838,17	6364228,69
	580592,45	6364217,01
	577293,18	6363839,32
	576593,59	6363780,19
SBP 2	581408,74	6364251,57
	579948,13	6364103,71

** The coordinates are approximate values

Table 4-1 Line coordinates for the SBP lines

4.2 Geotechnical Scope of work

A minimum of 5 CPTs (cone penetration test) along a line running parallel to the FPS route are identified. The locations are selected tentatively in such a way that detail and representative soil parameter in the identified sectors will be captured. Besides, in order to supplement the CPTs 2 Gravity coring or Vibro-coring sampling locations are envisaged.

All the CPT and sampling locations are planned along a line where seismic sub-bottom profiling is conducted; hence, the need for the sampling could be adjusted, minimized/increased, based on the sub-bottom profile data.

Location ID	Target penetration [m]	Easting [m] **	Northing [m] **
CPT 01	6.0	581408,74	6364251,57
VC/GC 01 *	3.0	581408,74	6364251,57
CPT 02	6.0	584446,39	6364285,19
VC/GC 02 *	3.0	584446,39	6364285,19
CPT 03	6.0	580838,17	6364228,69
CPT 04	6.0	580592,45	6364217,01
CPT 05	6.0	577293,18	6363839,32

* VC/GC = Vibrocoring or Gravity coring

** The coordinates are approximate values

Table 4-2 Planned geotechnical investigation (CPT / VC / GC) locations

5 Schedule

Owing to the small scope and assuming that, both the geotechnical and geophysical survey are to be mobilized from a survey vessel, the following time plane is deemed sufficient:

Activity	Duration [days]
Mobilization	1
Field operation (CPT + SBP)	1
Demobilization	0,5
Total	2,5

Table 5-1 Durations for the planned activities

References

1. BP (2016): "Hywind floating wind turbine barrier assessment", Doc. No.: J000586-00-PL-TEN-003, Rev. A
2. DNV (2015): "Assessment of the Probability of mooring line failure and the implication for the Forties Pipeline System", Doc. No.: 1ROF5JZ-13, Rev. 05
3. GEO (2014): "Hywind Scotland soil investigation 2014. North Sea. British sector. Anchoring of floating wind turbines and cable routes", Report 03, Rev. 02, dated 28.08.2014.
4. British Geological Survey (BGS). Public domain Geindex Offshore database, http://mapapps2.bgs.ac.uk/geindex_offshore/home.html. Borehole samples, BGS activity ID:1988271, 1951579 and 2012086