Hywind Pilot Offshore Wind Farm

Contract No. 718523

Horizontal Directional Drilling

METHOD STATEMENT FOR ADDITIONAL WORKS TO CLEAN BORE & STABILISE SINK HOLES

Method Statement No. : MS-1553-718523-08-C0

Issue	Date	Description	Originator	Reviewed	Approved
C0	31.08.16	For Review & Approval	[redacted]	[redacted]	[redacted]
			J.M. Seamans: Managing Director	P. Monks: Project Engineer	J.M. Seamans: Managing Director

0.0 Method Statement Revision and Issue Statement

Issue	Description
C0	For Review & Approval

1.0 Introduction

The following Method Statement describes some additional works proposed at a drill site in Peterhead, Scotland aimed at stabilising settlement areas above a 24" drilled hole formed by horizontal directional drilling and the subsequent cleaning of the borehole so as to enable drilling operations to proceed as originally planned.

A 660 m long x 22-24" diameter hole has been drilled from a drill site within Barclay Park, Peterhead to the seabed some 300 m offshore. The hole starts and finishes at the existing ground level and drops at 10-15° initially before levelling out some 14-16 m below ground level. Once the drilled hole was completed it was intended for a string of plastic pipe to be pulled into the borehole and for the annulus to be grouted as it was pulled.

Unfortunately, due to unexpected ground conditions below the seabed, this installation process has been delayed and this has led to severe settlement over the first 20-25 m of the bore. These areas are contained within Barclay Park, but it is clear that material continues to be lost above the drill line in this area and this is causing concern regarding the potential for this to extend beyond Barclay Park as well as feeding large quantities of sand and gravel into the drilled hole thereby making it impossible to install the duct.

This method statement describes the means by which an attempt is to be made to stabilise this ground and clean the bore so as to enable the planned duct installation process to proceed. This involves several separate operations:

- Stage 1 – Run 20" casing into the rock section of the bore to provide additional temporary support to the roof of the bore to minimise further settlement while the drill string within the borehole is recovered.
- Stage 2 – Sealing the end of the borehole so as to enable the upper section of the hole to be flooded which will further improve stability and facilitate the stabilisation and hole-cleaning works.
- Stage 3 – Flooding the upper section of the bore and the settlement holes with grout so as to effectively form a stable roof to the drilled hole and prevent further settlement.
- Stage 4 – Cleaning the borehole by means of flushing with bentonite drill fluid as per standard drilling operations.

The 4 stages are described in the following sections.

2.0 Equipment, Personnel & HSE

The works will be undertaken by the land based drill spread located within the Barclay Park Drill Site and by the LMR Drill Crew. Additional equipment will be restricted to the use of an electric-arc welding set operated by a certified welder.

The following documents have been produced during project preparation and should be familiar to all personnel working on sites:

- Emergency Response Plan.
- Risk Assessments.
- Environmental Management Plan.
- Lifting Plans.
- Casing Installation RAMS, Document Ref. RAMS-1553-718523-PD-02-C0.

Copies of the above documents are posted in the Site Canteen.

Prior to work commencing, all LMR personnel will pass through an induction by the Client/Main Contractor relating to safety and a Toolbox Talk by the LMR Project Manager communicating the contents of the method statements and risk assessments. Prior to the induction, personnel training records and certification will be provided.

Appropriate PPE will be worn by all personnel, including visitors, as a minimum this will include:

- Hard hats.
- Safety Glasses (unless deemed by risk assessment to present a greater hazard if worn (e.g. when banking vehicles in the rain)).
- Fire Retardant coveralls.
- Safety Boots with ankle support (Rigger boots are not permitted).
- Hi-Vis long sleeve top.
- Gloves and Ear Protection as required by task specific risk assessments.
- Welding PPE as identified in RAMS-1553-718523-PD-02-C0
- Dust masks during grout mixing.

A stock of the above PPE will be maintained on site and issued to all personnel as appropriate.

The Project Manager will have overall responsibility for safety on site with a more detailed description of HSE responsibilities described in the Project Health and Safety Management Plan.

All personnel will be trained in and proficient at the activity they are undertaking. All plant operators will be CPCS accredited and will undertake recorded daily inspections of their machines (see sample sheet in Appendix A). All works will be carried out in a safe manner, using only certified equipment, and the work site maintained so that it functions safely and efficiently.

Work will be ongoing 7 days per week and scheduled on a 12 hr basis with the working day running from 0700 hrs to 1900 hrs.

At the start of every shift, the Project Manager will perform a Take-5 safety briefing addressing the work activities for that shift. The briefing will concentrate on communicating any actions that need to be completed that day and highlighting any factors on that day that might aggravate risks, such as inclement weather, co-ordination of onshore and offshore activities or unusually high levels of plant movements. All actions will also be recorded in the daily log.

Recorded inspection of all excavations will be undertaken daily. The inspection will include the adequacy and suitability of fencing around the excavation, location and suitability of stop boards for reversing vehicles and the provision of suitable signage as defined in the appropriate Risk Assessments.

3.0 Procedures

Throughout Stages 1, 2 & 3, a regular watch on the settlement areas is maintained and operations stopped and procedures reviewed in the event of any significant further movement.

Stage 1 – Running Casing

- 42 m of 508 mm diameter (20") x 11 mm wall thickness casing is delivered to site in 4 no. sections.

- The pipes are progressively welded together to form a long casing pipe which is fed into the pre-existing 29 m x 24" casing pipe installed from the drill exit point down to the rockhead. The pipe is pushed through the 24" casing by the drilling rig as the casing is welded. The means by which the pipe is welded and installed is largely as per RAMS-1553-718523-PD-02-C0 with the exception that the pipe is slightly smaller (20" compared with 24") and the final target length for the string is greater (36-42 m instead of 29 m).

- The 24" casing is 29 m long and the intention is to run the 20" casing several metres beyond this and into the existing 24" diameter hole. The minimum target length is 36 m, while 40 m is preferred. The casing will be run until either the torque required to rotate the pipe exceeds 50 kNm or the push load exceeds 50 tonnes.

Stage 2 – Sealing the Borehole

- It is necessary to seal the end of the borehole to be able to effectively stabilise the settlement areas. There is currently a string of drill pipes running through the first 580 m of the drilled hole. This will not be moved until the 20" casing has been installed. The hole is partially filled with material that has dropped into the hole from the settlement areas and this material is hindering the extraction of the drill string.

- Once the casing has been installed and prior to sealing the borehole, it is necessary to continue efforts to reduce the effort required to recover the drill string back to the drill site. As such, the drill string will be pulled and rotated back along the drilled hole with the force applied to the drill string limited to 90 kNm torque and 100T pull. The recovery of the drill string will be continued to a point at which the length of string in the hole is less than 500 m and the rate of retraction has reduced to no more than 30 minutes per drill pipe. These limits are not absolutes and may be reviewed depending on ongoing progress and any further movement at the settlement areas. Any changes will be agreed with Head Office before implementation.

- Once the drill pipes have been withdrawn to the point in the hole where it is agreed that conditions are suitable, preparations will be made to mix and pump grout into the borehole through the drill string.

- The volume of grout that will be pumped will be 200 l/m of hole from the end of the drill string to the exit point in the seabed trench (640 m MD) plus an additional 5 m^3. For example, if the end of the drill pipe is at 490 m when grouting the volume pumped would be 0.2 x 150 (i.e. 640-490) + 5 = 35 m^3.

  The grout will be mixed in the mud mixing tanks and will be formed by adding bentonite to water in the tank to form a 35s viscosity drill fluid then by adding 800 kg/m^3 of cement to the tank. Once added and mixed, the batch will be pumped without delay. A small sample of the grout will be taken to help with assessing the strength of the grout within the borehole.

  This volume of grout should be sufficient to fill the full length of the bore from the end of the drill string to the exit point at the bottom of the trench in the seabed and potentially the lower parts of the trench. The exact level within the trench is impossible to determine due to uncertainty as to the volume of sand/gravel in the drilled hole and the geometry of the hole approaching the exit point. Nonetheless, with some 300 m^3 of excavation and some 35 m^3 of pumped volume, the volume pumped will only be a small fraction of the volume of the excavation and would be contained within the lower reaches of this.

- Following the mixing and pumping of the grout, the grout will be displaced from the drill string with bentonite with a volume of 15 l/m of drill string plus 5 m^3 pumped in total (e.g. for 490 m of pipe in the bore this equates to (0.015 x 490) + 5 = 12.4 m^3).

- As soon as the displacement fluid has been pumped, the drill string will be withdrawn for a minimum of 3 joints, but generally up to a point in the borehole where the end of the drill string is at an elevation above -16 m LAT.

- At that point, movement of the drill string is ceased until the grout sample has hardened to the consistency of frozen butter (typically 24-36 hrs from pumping). Once the sample has reached this consistency, drill fluid is pumped through the drill string with flow expected to return up to the drill site as was the case throughout drilling operations until the seabed was breached.

- With drill fluid returns re-established, the recovery of the drill string continues with the rheological qualities of the drill fluid improved as this becomes more thoroughly mixed with the water in the borehole. The full length of the drill string is pulled from the bore. If the flow of drill fluid back to the drill site has not been re-established, these grouting operations have to be repeated.

Stage 3 – Grouting Upper Section of Bore & Settlement Holes

Stages 1 & 2 are necessary and unavoidable to enable the process of stabilising the borehole and the settlement areas to begin. This process involves the filling of the upper section of the bore and the sink holes (partially) with grout. The process to achieve this are as follows:

- Steel rings formed from 15 mm plate will be prepared and welded to the ends of the 26” and 24” casings and the outer walls of the 24” and 20” casings so as to seal the gaps between these and prevent grout from flowing up between the casings rather than into

the settlement areas as well as secure the 20" casing to the better anchored 24" and 26" pipes.

- An open string of drill pipes (6 no.) will be run through the 20" casing and into the borehole. A 'sealing-sub' will be added to the drill string which will have a round plate welded to it which, when pushed against the end of the 20" casing, will be welded in position so as seal the end of the casing. Either the sealing plate or the 20" casing will have been prepared with a 1" BSP or similar bleed-off valve.

- Grout will be prepared in the mixing tanks is an identical fashion as that described in the Stage 2 operations and with the same recipe (800 kg/m^3 of cement in 35s bentonite) and with the bleed-off valve open the grout will be slowly pumped through the drill string. Flow is likely to be through the valve rather than into the settlement areas and the valve will be incrementally closed so as to increase the pressure in the borehole and force the grout into the settlement areas.

  If no grout flows into the settlement areas, the process will be discontinued once either the pressure in the casing pipe reaches 1 bar or 30 m^3 of grout has been pumped (whichever comes first). In such an event, further grout is pumped directly into the settlement areas from above with the grout being pumped through PE pipes directly into the settlement areas. The grout in such circumstances may be either prepared in the mixing tank or be delivered to site in ready-mix form.

- On completion of the grout pumping, the sealing sub is cut free from the 20" casing and the drill string is withdrawn from the casing and set aside. The 20" casing is then withdrawn from the 24" casing and similarly set-aside. No works can then be undertaken until the grout sample taken at the time of pumping has hardened to a frozen butter or chalk-like texture indicating that this should have sufficient strength to be self-supporting once a the drilled hole has been re-established. At this point in time, the settlement areas should have been effectively stabilised.

Stage 4

Stage 4 is the process of re-establishing the drilled hole so as to facilitate the final stages of drilling works and the pullback of the cable duct. The pre-existing hole at this stage consists of the original 22-24" diameter hole with the last 100-200 m of hole plugged with grout, variable volumes of sand and gravel (from the settlement areas) and bentonite predominately filling the central section of the bore and grout filling the 24" casing and the upper sections of the drilled hole within the granite.

The hole will be largely returned to its original condition by way of running a 22" tri-cone bit back through the hole with this mounted on the end of a string of drill pipes (i.e. no mud-motor and no need for steering control). The bit can be expected to follow the route of the pre-existing bore as the grout will be much weaker than the granite and it can be expected that drilling rates of 10-15 mins per drill pipe can be achieved through the grouted sections. Bentonite drill fluid will be pumped throughout this process with this carrying sand and drilled cement grout back to the drill site where it can be separated by the recycling plant. Some additional treatment of the drill fluid is likely with Sodium Bicarbonate added to treat cement contamination and maintain an appropriate pH value.

It is difficult to predict exactly when drill fluid returns to the drill site will be lost as the drill bit approaches the exit point. It is possible that the grout will have sealed the loss zone that led to the premature loss of drill fluid returns during the original drilling process and will enable returns to be kept right until punch-out. Bentonite will be pumped until punch-out with the weight-on-bit and pumping rate being reduced while drilling the final 20 m of the bore so as to try to minimise any potential disruption of any unstable formation that might be present. Once the drill bit has exited, the seabed operations would return to those previously discussed with a trip-out for the pullback BHA and subsequent pullback of the duct into the drilled hole.

APPENDIX A

Sample Daily Inspection Sheet

LMR Drilling UK Ltd			
	Contract No.		7
	Rig Site*	Pipe Site*	

*Delete as applicable

Excavator Inspection Sheet

Description of Rig	Date & Time of Inspection		Name of Person Carrying Out Inspection	Position of Person Carrying Out Inspection	Signed
	Date	Time			

Inspection & Maintenance Criteria	Details of any defects or potential health and safety issues	Can work continue under safe conditions?	Defects reported to?	Actions to be taken
General set up				
Safety switches				
Emergency stops				
Main hydraulics				
Condition of hydraulic hoses				
Security pins and bolts				
Bucket				
Forks				
Oil leaks				
Last service				
Next service				
Engine oil level				
Hydraulic oil level				
Checked for winter work?				
Spare oil filter and fuel on site				
Other findings				