

LMR Drilling UK Ltd.

So long Solent



Solent Gas Transits

LMR Drilling UK Ltd. has recently completed the installation of 2 no. 324 mm dia. steel pipelines which were installed through separate holes some 50 m below the bed of the Solent using the Horizontal Directional Drilling (HDD) technique. Each crossing, at 3,930 m length is believed to be some 20% longer than any previously completed using HDD. Despite the significant challenges the crossings presented, the project was completed on schedule and budget and to the great satisfaction of all concerned.



Aerial View of Drilled Crossing showing Drill Alignment & Pipe Stringing Site

Project Brief

The existing gas supply pipelines to the Isle of Wight, owned and operated by Southern Gas Networks (SGN) had been installed in the 1960s using traditional marine trenching techniques. Periodic exposure of sections of the pipeline due to the strong currents in the Solent required ongoing remedial work and this, together with land stability issues at the landfall location on the island, led SGN to investigate options for replacing these pipelines.

With a strong preference to have the pipelines buried at depth below the Solent to eradicate the risk of damage from anchor drags, erosion, etc. and reduce the environmental impact of construction, SGN investigated the potential for installing the replacement lines using trenchless techniques.

At almost 4,000 m in length the crossing was significantly longer than any that had previously been achieved by HDD. However, when compared with the cost of tunnelling (the only realistic alternative), HDD proved to be very attractive. As such, SGN sought opinions from leading HDD Contractors as to the viability of undertaking the crossings using HDD and to better understand the risks and potential risk-mitigation measures. The consensus was that HDDs of such lengths, while well beyond current limits, were not impossible. An excellent understanding of the ground conditions was identified as a key factor.

Geology

As part of the pre-construction evaluation of the Project, SGN had commissioned a detailed study of the geology under the Solent. Land-based boreholes in the vicinity of the crossing route provided data on which a ground model was constructed and presented a relatively simple geological sequence of consolidated sediments dipping gently towards the Isle of Wight. These sediments could be broadly separated into an upper sequence of cohesive clays and silts overlaying the non-cohesive soils of the Becton Sand Formation.

To undertake a more detailed assessment of the geology would have required a number of marine boreholes which presented both environmental and consenting challenges. As an alternative, the innovative solution of undertaking a trial drill was proposed. This would not only provide information regarding the ground conditions below the Solent, but would also provide the drilling contractor with real data on which an assessment of the viability of the crossing could be made with greater confidence.

Phase 1

With the difference in the cost of marine boreholes and undertaking a trial-drill relatively small and with SGN understanding the benefits that the trial-drill data would provide, the decision was taken to proceed in two phases with Phase 2

to be awarded subject to a positive conclusion from the Phase 1 operations.

The project was ultimately tendered on this basis and in 2008 a contract was awarded to LMR to undertake the Phase 1 works. The aims of the trial-drill included:

- Assessment of the ground conditions below the Solent, the drillability of the formations and the reliability of the ground model.
- Obtaining detailed, real data from which the forces required to execute the Phase 2 works could be reliably extrapolated.
- The optimisation of drill fluid and recycling plant design.
- The finalisation of the pipeline specification.
- Providing the data to enable a price for the Phase 2 works to be agreed.

Ultimately, the trial-drill had to convince both the Contractor and the Client that installing the pipes over such a distance using HDD was realistic and achievable.

The trial drill consisted of a 17½" diameter pilot hole drilled from a drill site located at Lepe, Hampshire, some 200 m inland from the northern shoreline of the Solent. Construction of the drill-site commenced in October 2008 and pilot drilling commenced shortly thereafter.

The trial drill continued until February 2009 with a total of 1,450 m drilled. This provided some excellent data on which to assess the forces required to drill the much longer holes necessary in Phase 2. The results of the trial drill and LMR's conclusions were presented in a detailed report. The conclusion was installation by HDD was viable and that the best route would be some 40 - 60 m below the bed of the Solent.

Phase 2 - Introduction

Based on the trial-drill data, it was concluded that it would be possible to drill 20" diameter pilot bores and, therefore, to install 2 no. 12" pipes rather than 3 no. 10" pipes as had originally been envisaged.

Due to the length of the crossing, it was necessary to complete the pilot drill for each pipeline in two sections, each drilled from opposite sides of the Solent. As such, drill sites were established at Gurnard, Isle of Wight and at Lepe, Hampshire. LMR's 250 tonne and 350 tonne drill rigs, capable of producing 3000kN and 3500kN push/pull force and 120kNm and

180kNm of torque respectively were mobilised to Gurnard and Lepe.



Lepe Drill Site

Phase 2 – Drilling Operations

Drilling Operations began in early October 2010 with 20" diameter pilot drills being drilled simultaneously from the two drill sites. The drilling assemblies consisted of 20" tri-cone drill bits mounted on 11¼" mud motors. Magnetic steering tools were housed within non-mag collars behind the motors and the remainder of the drill string was formed from specialist oilfield drill pipes.

Steering control was maintained using the data from the magnetic steering tools augmented by secondary Paratrack® data. The magnetic steering tool measures the orientation of the drill string as the drill progresses allowing a plot of the position of the drill bit to be maintained. The Paratrack® system provides additional, independent data allowing the primary survey to be fine-tuned.

Paratrack® operates by passing a weak current through a surveyed cable installed above the drill line with the resultant magnetic field being detected by the steering tool housed in the drill string. The software can then calculate the position of the drill-bit based on the orientation and strength of the magnetic field. With a majority of the crossing below the Solent waterway, cables were installed on the seabed for approximately 50% of the crossing so as to enhance steering accuracy.

The pilot holes drilled from either drill site were extended until reaching the 'intercept area'. This refers to the point at which the holes drilled from either end of the crossing were brought together many tens of metres below the seabed, thus producing a single, 20" diameter hole running between the two sites.



Gurnard Drill Site

Each intercept was achieved by first bringing the pilot holes alongside each other and verifying the relative position of the holes. The intercept geometry was then planned out based on this data and the intercept procedures adjusted to reflect the actual survey data. For both pipelines, the pilot bore drilled from Lepe was steered into that drilled from Gurnard.

Once the intercept had been successfully completed, the geometry of the intercept was verified to ensure compliance with minimum radius criteria for the pipeline. Once confirmed, the pilot string was withdrawn from the Lepe pilot bore as the Gurnard string was extended through to Lepe in readiness for the pipeline pullback.

Phase 2 – Pipeline Construction

Whilst the drilling operations were underway, the pipeline sections for each of the drilled holes were strung. Due to space constraints, LMR had each 4 km pipeline fabricated in three lengths of 750 m, 750 m & 2,500 m. The fabrication of the strings was undertaken simultaneously with the drilling operations. The schedule was tight and all operations had to be managed carefully to ensure that the pipe strings were ready in time for the pullback operations.

The pipe strings were set-up on roller conveyors in advance of the pullback. An over-bend was designed for an entry angle of 14° using rollers on raised foundations prior to pullback of the pipeline. Pipeline and overbend construction was completed as the Gurnard drill string emerged at the Lepe entry point in perfect timing for the subsequent pullback operations.

Phase 2 – Pipe Pullback & Testing

The first pipeline was installed on a continuous, 24 hr/day basis, between 9th & 13th December 2010 using the 250 tonne drill rig at the Gurnard site. Pullback was stopped twice to complete tie-in welds between the strings and the whole operation was completed over a 56 hour period. Pull loads remained less than 80 tonnes throughout the pullback operation testament to the integrity of the hole, the geometry through the intercept, the pipeline design criteria and the competence of the engineering of the crossing.

The pipeline construction and drilling operations were repeated in early 2011 with drilling operations for the second drill commencing on 27th January and with the pipeline pullback being completed with similar installation loads on 11th March.

Both pipelines have subsequently been successfully hydrotested and the integrity of the 800µm thick fusion-bonded epoxy coating proven to be excellent.

Summary

It was clear that the close co-operation between the Client, Southern Gas Networks, and Principal Contractor, LMR Drilling UK Ltd, in the planning and execution of the works and the innovative strategy of undertaking a trial-drill were instrumental in quantifying the risks at an early stage, providing confidence that the crossing was viable and the data to optimise the engineering of each of the crossings. The coastline around the Solent was left untouched, shipping lanes remained open and the impact on local communities was kept to a minimum.

Despite the extreme length of the crossings, the drilling works were completed within budget and within programme, a satisfactory result for all concerned. Ultimately the success of the crossings has moved the boundaries and expectations for installation of drilled crossings for future projects.



Pipe String Overbend at Lepe Drill Site

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