

C. Joseph and J. Kench, Prime Horizontal, the Netherlands, discusses pipe mapping systems that offer accuracy and precision.

MULTI-PURPOSE pipeline mapping



P rime Horizontal's GyroTrack is a versatile and unique multi-purpose utility line and pipeline mapping system. With a proven track record on virtually every continent, this multi-diameter system provides some of the most accurate results for pipeline surveying, especially for pipelines installed by horizontal directional drilling (HDD).

The GyroTrack survey tool measures its position along the length of the pipeline by the use of a built-in odometer. The rear and front centralisers consist of three cantilever sprung wheels, which are pressed simultaneously against the wall of the pipeline, effectively centralising the tool within the pipe.

Two of these wheels on the rear centraliser are fitted

radially with small magnets. The arms that hold the two wheels have electronic pick off sensors, which see a pulse from each magnet as it rotates past. The software calculates the distance travelled in the pipe, based on the known distance per magnetic pulse.

The reason for measurement on two wheels is that the signal from both wheels can be graphically analysed after the tool data has been downloaded. Should the trace from one of the wheels show points where there are different distances or speeds measured to that of the other wheel, this can indicate that the tool was either not centralised properly or that there was a problem with one of the wheels, possibly slipping during the survey run. In either case, such a scenario would indicate that the survey might be corrupted and the tool should be run again.

Using this method for measuring distance while pulling the tool through the pipe negates potential erroneous effects from stretch or bounce, which might be incurred by using the pulling rope to measure distance. When both wheels show a consistent measurement, the overall depth measured by the GyroTrack is then compared by the software to the physical distance calculated, based upon the fit between the entry and exit co-ordinates and the azimuth/elevation changes measured by the tool. A quality assurance scale factor is then given based on this comparison. This scale factor is compared to the specification of the tool to confirm that the survey taken falls within acceptable tolerances.

There have been occasions where the 'XYZ' of each end of the pipe is measured a week before the gyro survey is performed. During this time, it has been known for physical changes to be made to the pipe; extra sections might have been added to the pipe or even cut off from the end. These changes would be highlighted in the gyro survey as a scale factor error above the acceptable tolerance. The combination of wheels and magnets acting as odometers are an important part of the tool's quality assurance.

The unique system of interchangeable, centralising wheel units gives the GyroTrack an operational range of ID 90 mm (3.5 in.) to ID 1200 mm (48 in.). The system can be used with pipelines of any material, steel, concrete, HDPE, PE, PVC etc.

The GyroTrack tool, with its centralisation, may be pulled either by a hand operated wireline or a mechanical

winch. In certain cases, the tool may be pumped through the product line.

The rope utilised is a 4 mm nylon rope made up of double woven nylon and can withstand up to 500 kg (breaking strain). The tool itself can store up to 3 hrs of data based on battery life.

Since the GyroTrack does not rely on online communication, such as GPS or tethering, it is ideally suited for underground use, regardless of depth or terrain. Its high accuracy and easy handling features have made it the system of choice in utility pipeline infrastructures.

The process first starts with surveying the jobsite to determine the entry and exit points. Prerequisites include the pipe must be clean, free of obstacles and smooth on the inside. The presence of any sort of beading (which may occur due to welding of pipe joints) can affect the accuracy of the survey. If there is beading, it can be easily removed and then the GyroTrack survey can commence.

Two suitably qualified engineers, who pull the tool back and forth through the pipeline using the pre-installed rope on a mechanical winch, operate the survey tool. For crossings of longer than 400 m, electrically powered winches are utilised. If electrical winches are used, an electrical mains supply on both ends is required. The electrical winches have a remote control for speed, torque and an emergency stop, to ensure consistent speed control and providing safety to the operators who are in constant contact via radio.

The customer needs to supply the land survey coordinates of the pipe ends, measured on the top side of the pipe. Preferably, the required local co-ordinate system is provided to ensure the accuracy of readings that will be presented in the final GIS report, which gives a graphical representation of the pipe location as well as the XYZ co-ordinates of the pipe based on the given pipe end co-ordinates. These pipe end co-ordinates are not to be confused with the planned co-ordinates, as it happens often that the end pipe position can change once the pipe has been pulled into the hole.

When operating the GyroTrack system onsite, a winch unit is placed at each end of the pipeline to be surveyed. The pre-installed rope in the pipe is connected directly to one of the winches, which is then set into neutral, allowing the rope to be pulled into the pipeline.

On the other side, the GyroTrack tool is taken out of its case and assembled, using the corresponding wheels to the intended diameter. It is connected between the winch and the rope, placed into the end of the pipeline and activated.

The GyroTrack tool is now ready to be pulled at a constant and steady speed through the pipeline until it arrives at the other end. It should be pulled at between 1 - 2 m/sec. Care is taken that it does not exit the pipe at the other end but remains flush with the end of the pipe when coming to a stop. Once the GyroTrack tool has reached the other end, it is necessary to hold the tool



Figure 1. The GyroTrack tool positioned in a pipe.

stationary for up to 2 mins to calibrate the tool ready for the following run.

Then the tool is pulled back through the pipe to its starting point, again without it exiting the pipe at the other end. It will also remain flush and be held stationary for up to 2 mins again. Generally this process is repeated twice to give a reading of up to four individual surveys. This is the minimum number of surveys that the operators perform, as it ensures a high level of accuracy for the survey.

The preliminary calculation is carried out using known co-ordinates, enabling the operators to ensure that the minimum four runs are within tolerance of each other. Once this is achieved, the survey is completed. The average accuracy can be increased by the growing number of runs through the pipe in both directions.

Once all the equipment is packed away, the data is downloaded and sent back to the office for analysis and inclusion into a GIS report, which is provided to the final client. The data is first analysed at onsite to confirm the accuracy and reliability of the data.

The GIS report provides the customer with a visual representation of the position of the pipe and other relevant data (XYZ location, bend radius etc.) in a 'pdf' format. Also submitted to the client are comma-separated values (csv) file, as well as a 'dwg' file for easy exporting to open platform formats for seamless integration into common GIS platforms such as AutoCAD, Excel, MicroStation, ARCGIS etc.

The XYZ positions are provided for every metre along the length of the pipe and the bend radius are provided

in 30 m intervals as standard (as this is the standard HDD measure for bend radius) though this is fully adjustable to suit any other intervals, which might be required.

Case studies

Below is a selection of projects that Prime Horizontal has completed. The first being a survey performed in the United Arab Emirates (UAE).

Dubai desert

The drilling contractor had an interesting challenge for the GyroTrack team. They had already utilised Prime Horizontal's steering services to perform a difficult drill through what turned out to be a fractured and ferrous formation. The jobsite was located a few hours from Dubai in a mountainous desert region.

The conditions were extremely hot and dry. The crossing was 725 m in length.

The contractor's concern was that the product pipe was pre-lined with concrete, so there was the risk that if a bend was too tight in the crossing, the concrete might crack or get damaged when pulling it through the reamed hole.



Figure 2. Data collection: the GyroTrack tool in the pipe



Figure 3. GyroTrack report cover page.

The interesting challenge for the GyroTrack team of engineers was to survey the drill string in order to gain an accurate bend radius measurement. The drill string has a varying internal diameter due to the upsets at the drill pipe connections and the GyroTrack tool is designed to accurately measure the inside of a smooth pipe with no welds or obstacles. This created a new technical challenge for our engineers. The GyroTrack team modified the centralisers to enable the tool to pass through a varying internal diameter without getting stuck or producing corrupted data. For an accurate survey, the magnetic wheels need to be constantly touching the inside of the drill string as the wheels capture the data.

The ID varied from 110 - 140 mm. Correctly sized wheel units were chosen and attached to the tool's newly modified centralisers. A test was performed to check how smoothly the tool set up would pass through the constantly changing internal diameters.

Once this test had been completed successfully using this new set up of the GyroTrack tool, the engineers surveyed the inside of the drill string. The speed at which the tool passed through the drill string was slightly slower than usual, allowing the centralisers to pass freely through the changes in internal diameter without damaging the tool.

Six individual runs were performed, the data was processed onsite and the quality assurance checks were made. Once the data had been finalised by the office based GIS specialist, the final report was produced and delivered to the contractor.

The client was then in a position to start the reaming of their pilot hole, knowing that their product pipe would not be damaged when being pulled through the reamed hole. Performing a GyroTrack survey through a drill string was a first for Prime Horizontal.

The Netherlands

The second case study is an extended reach survey job, which was 1100 m long in the south of the Netherlands.

The product pipe was made of steel in readiness to be a new gas line. The product pipe was a 168 mm OD steel gas pipe with ID of 150 mm. The two GyroTrack engineers performed a site induction before access to site was possible.

Once onsite, and with the internal diameter measured by our engineers and confirmed as 150 mm, the tool was set up with the appropriately sized centralisers and wheel units. The compass position of entry and exit were confirmed and the GyroTrack survey was carried out.

Four individual runs were performed, the first from the entry side (East) and second to the exit side (West). Once the tool had been calibrated at the end of pipe, it was then taken out, turned around to face forward and the second run was performed from exit side to entry side, this process was repeated for all four runs to collect the necessary data.

Data was processed onsite and the relevant quality assurance checks were made. The confirmed length of the crossing was 1120 m, and the accuracy over this distance was considered of a high quality for a crossing of this length. Prime's GIS specialist was sent the survey data and a final report produced and sent to the client.

The customer required the GyroTrack survey and accurate XYZ co-ordinates in their final report, because their next task was to drill alongside the existing pipeline. Knowledge of the location of the first pipe within a specified safe distance was essential for their progression on this particular project.

Prime Horizontal offers this service worldwide using the field proven GyroTrack platform. Companies may use GyroTrack for mapping their product lines after using Prime Horizontal to drill the initial HDD pilot hole or they could use GyroTrack to map existing pipeline and utility lines. 



Figure 4. Onsite data analysis.