Avoiding third-party interference with efficient and accurate depth of cover calculations

A key means of diminishing pipeline incidents due to third-party interference is the sufficient depth of cover. A ***UK Onshore Pipeline Operators Association*** *report from 2015 states that 20% of all product loss incurred between 1962 and 2014 was caused by external interference (Haswell, McConnell 2015). However, precise measurements of these values can be hard to come by, especially for the entire length of a buried pipeline. In a research project in cooperation with* ***National Grid Gas Transmission****, the* ***ROSEN Group*** *has begun validating a two-element approach combining specialized in-line inspection tools and ground elevation data. These calculations can be made to an accuracy of ±0.15 m root mean square error.*

Cause of the damage A major cause of damage to buried pipelines is third-party interference. Responsible for the damage is not material failure or equipment malfunction but human involvement, such as construction. Pipeline depth of cover can change due to shrinkage of soils or natural erosion, human activity, or failure of anti-buoyancy systems. Apart from routine surveillance, maintaining a minimum depth of cover is a solution of mitigation against third-party interference. Current techniques available for measuring depth of cover require significant effort to produce a detailed survey for an entire pipeline.

Testing the ground The Network Innovation Allowance scheme, which is provided by the UK gas regulator **OFGEM**, funded the project. Conducted in partnership with National Grid Gas Transmission, it demonstrated a new methodology to identify reduced depth of cover over an entire pipeline that considers ground elevation data and high-resolution data from an inertial measurement unit (IMU).

Prior to the in-line inspection of the 36”, 43 km natural gas pipeline, above-ground markers (AGM) were deployed at a nominal interval of 500 meters between markers. AGMs are devices placed directly over the buried pipeline ensuring that the in-line inspection tool provides accurate geographical data. The smaller the distance between each marker, the more accurate the results. At each AGM, the pipeline position was recorded using a high-accuracy GPS system and a pipe and cable locator. Following deployment of the AGMs, the in-line inspection was completed and inertial measurement unit (IMU) results were processed by the ROSEN data analysis team, resulting in an accurate pipe centerline. These units contain gyroscopes and accelerometers and are used to calculate the position of the inspection device. The IMU data is linked to known reference locations along a pipeline route to provide an accurate pipe centerline as a series of X, Y, and Z coordinates.

Two-element approach Ground-elevation data collected using light detection and ranging (LiDAR) techniques was combined with the accurate pipe centerline to calculate the depth of cover for the whole pipeline. The remote sensing method LiDAR uses laser light to measure distance to a target and is commonly utilized to map terrain and surface objects. This way, a great amount of highly accurate data can be collected, allowing large areas to be surveyed efficiently. To conclude the project and authenticate the results, ROSEN engineers undertook pipe depth and in-field GPS measurements, which demonstrated a depth of cover accuracy of ±0.15 m root mean square error.

The research project has shown that the methodology can accurately conduct depth of cover measurement. This has enabled National Grid Gas Transmission to review the entire pipeline and identify locations not meeting the minimum requirements. These locations may have an increased likelihood of damage occurring from third parties; therefore, National Grid Gas Transmission can implement mitigation measures. Previously, pipeline technicians would have been performing time-consuming survey activities in the field. The new methodology allows accurate estimates of depth of cover to be delivered as an additional service alongside a traditional in-line inspection.

REFERENCES

Haswell, J. V., McConnell, R. A. *UKOPA Pipeline Product Loss Incidents and Faults Report (1962-2014).* UKOPA/15/003, December 2015.