NEWS

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EXCAVATING NEAR PIPELINES
THE HUMAN FACTOR
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By Richard Roels, Senior Consultant for DNV GL and Dr Mike Acton, Principal Consultant for DNV GL

The protection of natural gas pipelines from unintentional gas releases is a key priority for pipeline companies. The consequences of an involuntary gas release from a pipeline can be severe. Fortunately, unintentional gas releases are rare. In the last 40 years, there has been a downward trend as demonstrated by European Gas pipeline Incident data Group (EGIG) statistics.

EGIG statistics also show that 48 per cent of the unintentional releases that do happen are caused by third party interference, in the form of excavation works near the pipeline. Such excavation work is recognised as one of the major threats to pipeline integrity and the safety of those in the surrounding area. For this reason, pipeline companies go to considerable lengths to prevent damage. Physical protection installed above the pipeline, such as concrete slabbing, is one such method. Visual indications, such as marker tape, can also be installed to draw attention to the presence of a pipeline.

A joint industry project (JIP) looking at pipeline protection was established in 2006, managed by DNV GL on behalf of 12 pipeline operators from a number of countries in Europe and North America. The JIP sought to update participants’ third-party damage probability failure models; improve the accuracy of risk assessments and improve recommendations for effective preventative maintenance practices for excavating around pipelines. The JIP covered a number of important topics such as: mechanical protection specifications, a review of incidents/near misses, lateral encroachment, optimal slab design and human factors.

One of the objectives of the human factors work, delivered by DNV GL’s psychologists, was to get a better understanding of the factors influencing drivers’ behaviour and to try to quantify it more accurately. The findings from the human factors work fed into the production of the fault tree. However, in exploring the factors that influence operator behaviour, the project gained a broader understanding of what the main factors are. The following narrative explains the methodology and results of the study.

METHODOLOGY

Getting a detailed understanding of the factors influencing machine drivers’ behaviour meant choosing an appropriate design and method for the project. The approach had to overcome a number of challenges; obtaining quantifiable and consistent information about driver behaviour from nine countries, in seven languages, while being genuinely representative of ‘real world’ behaviour. The wider project had already developed the fault tree with...
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Their reaction when they encounter the barrier. These exercises can provide a realistic simulation of the excavation task, although the driver may modify their behaviour being aware that he/she is participating in a study. Even if they are not told of the exact purpose, their behaviour will change simply because of the situation. These studies do provide a good opportunity to obtain rich and detailed data, but are expensive to conduct and reflect the behaviour of just a handful of drivers.

The decision was taken to use a questionnaire, which had to be rigorous, and so was based on an analysis of machine operators’ tasks. The questionnaire contained a number of different situations and participants were asked to rate what they believed would happen according to defined response scales. The scales provided the basis for quantification. To control the risk of drivers providing desirable or idealised responses, a number of measures were implemented. As well as rating their own behaviours, participants were asked to rate those of fellow machine drivers which tended to produce fewer ‘good practice’ responses. No names or company details were recorded and the questionnaire stated that responses would be grouped for analysis, all of which helped to secure candid and frank feedback.

The questionnaire was translated, distributed and collected by participating companies with responses from 282 machine drivers. The results indicated that most drivers had experience of operating different sized excavators and 18 per cent had experience in using other machines such as drilling machines, soil stabilisers and chain trenchers. Detailed analysis was undertaken by DNV GL’s psychologists with the findings contributing to a number of areas of the project. The following summarises some of the headline findings.

SAFE SYSTEM FOR EXCAVATION WORK

Most reputable operators appreciate the importance of setting up a safe system of work to control the risk of pipeline damage. Central to this is being trained in the procedures used to govern safe working. Feedback from drivers indicated that there were procedures covering topics such as: checking the site for buried pipelines, digging of trial holes and taking action after hitting a pipeline/protection material. It may be of some concern that while these procedures exist, between 22 per cent and 29 per cent of drivers indicated that they had not been trained in them.

A number of questions were asked about preparations for excavation work at the worksite and, in general, feedback suggests some room for improvement. For example, 29 per cent indicated that necessary permits are not always obtained, 41 per cent do not always receive a toolbox talk/pre-job meeting and 56 per cent do not use pipeline detectors for every job. While there may be legitimate explanations for some of these findings, it does appear that even before any excavation work occurs, there are some inherent weaknesses in systems that aim to ensure pipeline protection.

INFORMATION PROVIDED TO DRIVERS

Drivers’ behaviour appears to be strongly influenced by the amount of information they are given about a pipeline, with greater levels of caution being exercised where the exact location is unknown and they are informed that there is no physical barrier. Clearly it is not realistic or practical to withhold information about pipeline location on the basis that it will make drivers excavate with extra caution. This underlines the importance of drivers having accurate information about a pipeline. However, if there are discrepancies in the information provided, these need to be identified and acted on. For example, if drawings indicate one route for the pipeline and markers indicate another, there is a chance...
that one source could be incorrectly disregarded. The worst-case could see a driver excavating above a pipeline that they genuinely believe is in a different location and so, when their machine comes into contact with the pipeline (or protective measure), the driver may actively attempt to break/remove the item. It is important to encourage drivers and supervisors to both look for potentially inconsistent information and to believe both are correct, until they can verify otherwise.

DIGGING
Machine drivers need to be able to differentiate between measures to protect pipelines (or pipelines themselves) and other similar materials such as rock or foundations of a previously demolished building. Feedback indicated that drivers encounter obstacles that could be mistaken for protection measures quite infrequently and around 20 per cent of respondents indicated it was ‘difficult’ or ‘not possible’ to differentiate protective measures from other buried items such as bedrock. PE slabs are used as an alternative to concrete slabbing and are typically yellow in colour; this can help enable drivers to differentiate it, as a protective measure, from other buried materials. The findings underline the importance of the need for protective measures to provide a strong indication to drivers as to the presence of a pipeline, as well as actually protecting the pipe itself. As well as relying on visual cues, drivers may also detect a change in sound or machine behaviour that indicates the presence of a protective measure.

The range of machine drivers’ actions in response to striking unknown objects was also examined, and 87 per cent indicated that they would stop using their machines. Around 70 per cent indicated that they would definitely inform their supervisor of an object, dig underneath it, remove it, or attempt to break through it, with their machine.

FACTORS AFFECTING EXCAVATION WORK
Any excavation work can be made more difficult by the pressure of ‘performance shaping factors’ such as poor weather and time pressures. Nineteen such factors were included on the questionnaire and machine drivers indicated the top five most influential factors, shown in rank order in Figure 1.

The negative impact of factors, such as darkness or lack of instruction is not difficult to imagine. Fatigue can increase the chance that a driver has of making mistakes and violating procedures. The value of this information is when the factors are taken in combination to create scenarios that show how incidents can happen. The following fictitious example illustrates this: An inexperienced machine driver, working with a heavy excavator, did not have a pre-job meeting and is excavating in an area where he believes there is no pipeline, because an out-of-date drawing was supplied. He is nearing the end of his shift, light is failing and he is starting to tire, but wants to get the job done. He then strikes a concrete slab but he cannot see the marker tape because it is getting dark. He wonders what it is, excavates to find the edges of the slab and removes it, before continuing to excavate when the bucket strikes the pipeline...

Most companies appreciate such issues and are implementing measures to manage such challenges through improvements in, for example: competence, training, contractor checks, fatigue management, procedures, and on-site supervision.

ROUND UP AND FUTURE DIRECTION
The findings of the study produced valuable information to quantify the human error rate in this type of activity. The study also highlighted many useful insights into operator behaviour and areas where potential improvements in training and risk mitigation could be made.

Round up and future direction

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