Pipeline integrity

Focus on pipeline ageing and third-party interference

In the spring issue of the CONCAWE *Review* we reported on COPEX 2006, the CONCAWE Oil Pipelines Operators Experience Exchange seminar that took place in Brussels at the end March of this year. This article focuses on the two main topics discussed at the Seminar and highlights the main conclusions and intended follow-up actions.

Repairing a damaged pipeline

Pipeline ageing

The bulk of the EU cross-country oil pipeline network was built in the 1960s. When CONCAWE started collecting performance data in 1971 the average age of the network was eight years. It was 34 years in 2004 (see Figure 1). There is no current plan for large-scale replacement of existing lines, and hence the average age of the existing network will continue to increase.

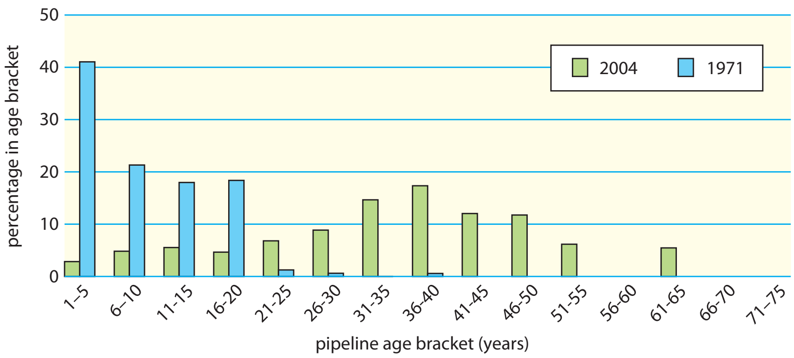
The question to ask is whether this matters or, more specifically, to what extent age affects the integrity of pipelines and/or other aspects of their operation.

There are two concerns associated with time: ageing/fatigue of the metal and welds (and consequent deterioration of the pipeline's structure and strength) and internal/external corrosion.

Metal deterioration is a slow process that depends on many factors related to quality of the original steel, design and operating conditions. Generally a steel pipeline operated within its original design window has a very long lifetime. It must also be pointed out that older lines were generally built with high safety margins in terms of e.g. wall thickness. From this point of view more modern lines designed in accordance with e.g. the API or national codes may be more vulnerable in the future. There must of course be a time limit but the general opinion is that we are still far from it in the case of oil pipelines. A parallel can be made with 19th century steel civil structures that are still being used and are still safe, often under conditions which exceed those for which they were originally designed.

The CONCAWE spill statistics provide some evidence that external/internal corrosion can be kept under control.

Figure 1 The age profile of the European cross-country pipeline network



In 1971 the average age of the European cross-country pipeline network was 8 years; in 2004 it was 34 years.

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Figure 2 Frequency of corrosion related spills for cold oil pipelines in the EU

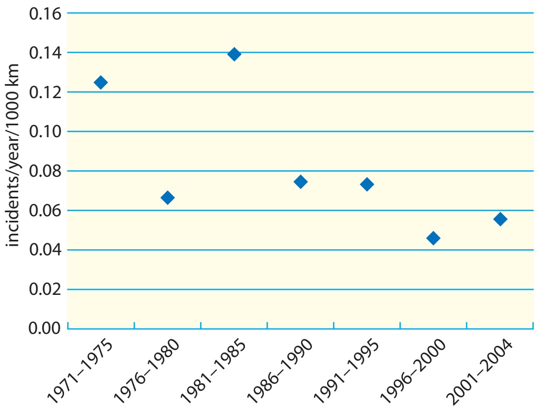


Figure 2 shows the frequency of corrosion-related spills over time for cold oil pipelines in the EU. There is clearly no increase with time and, if anything, the frequency has been on a downward trend over the years. We conclude that there is no direct correlation between age and corrosion-related failures. Indeed corrosion is usually the result of a specific set of conditions on a local line section and, if not well managed, can result in line failure within a relatively short time.

This favourable outcome is in part the result of continuous improvement in pipeline inspection and maintenance techniques which form an integral part of the pipeline integrity management system operated by the vast majority of all European pipeline operators.

Investigation techniques now routinely involve intelligence pigs which are becoming increasingly sophisticated in the range of data that can be collected and the portion of the pipeline surface that is effectively inspected. This is in addition to more traditional external and internal inspections of non-piggable sections, direct and indirect corrosion measurements and pressure tests (for obvious reasons this last method is certainly not preferred).

Excavating machinery can cause extensive damage to pipelines that does not always result in immediate failure.

Inspection data are used, together with historical operational data, for risk-based assessments by company and external experts to determine the need for repairs, preventive maintenance, passive and active corrosion mitigation (cathodic protection, corrosion inhibitors, etc.) and, where required, appropriate adaptation of operating conditions to take account of the state of the line.

All these activities have a cost but they are generally necessary on both new and older lines. There may come a time when signs of ageing on a line would increase the frequency of inspections and the instances of repairs, and force capacity reductions that would become unacceptable. In such a case replacement of a section of a line may have to be considered but this is viewed as an unlikely scenario.

Oil pipelines in Europe are indeed becoming older but this is not seen as a serious problem for the foreseeable future. Pipeline operators fully integrate this factor in the pipeline integrity management system.

Third-party interference

Pipelines run for long distances across rural and urban areas, crossing roads, railways and rivers. By their very nature they are less controllable by the operator than industrial sites and are therefore open to interference by third parties. Not surprisingly this has always been an important cause of incidents and near misses whereas, over the years, other causes of pipeline failure have progressively been brought under control through improved inspection and maintenance systems and generally improved pipeline integrity management systems.

Figure 3 shows the frequency of spills for five groups of causes. All frequencies have steadily decreased over the years but third-party interference has been at best static in the past 15 years. It is now by far the most important cause of spills from European oil pipelines, representing more than 50% of all spills in the past 5 years.

It must be noted that this is an issue not only for oil pipelines but also for all other buried infrastructure such as other pipelines and underground cables, for which similar statistics apply.

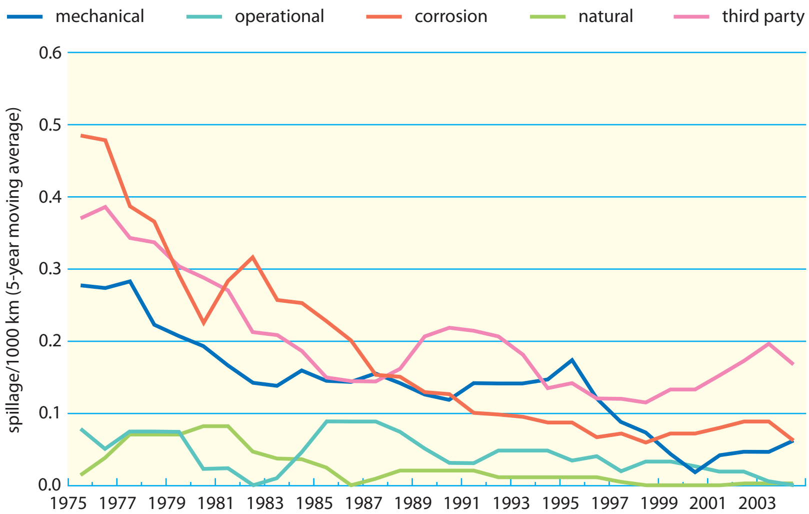
Interference by third parties can take many forms, including attempted theft, although most cases are linked to excavation activities by either farmers and landowners or civil works contractors. Freak incidents also occur as illustrated by a recent case where an electric pylon fell and punctured a pipeline. In many cases damage is done to the pipeline by some form of machinery without resulting in an immediate leak. Failure occurs later (sometimes years later) through metal fatigue or as a result of a minor operational upset such as a pressure surge.

Pipeline operators have been well aware of this problem for many years. It is, however, a multi-stakeholder issue that has proven to be a 'difficult nut to crack'.

Operators have a number of options at their disposal to protect the lines and limit the consequences of incidents. Passive protection of a pipeline in particularly risky areas can include greater burial depths and concrete covers. Warning strips running above the pipeline are also commonly used. Active protection involves surveillance by air patrol, CCTV, car and foot patrols. In addition various mitigation systems can be installed such as leak detection and location systems, and remotely operated isolation valves.

However useful all these may be, they will not serve to prevent all incidents. Involvement of the other stakeholders, particularly regulating and permitting authorities and civil contractors, is essential. A number of countries or provinces have put 'one-call' systems in place to ensure proper and centralised communication between those whose job it is to excavate, and operators of pipelines and other buried infrastructure. The Dutch KLIC system and the ALIZ scheme in operation in North Rhine Westphalia are examples of such systems. In a recent UK project a database of 'infringements' (i.e. including near-misses, undeclared work, etc.) was collected. This showed that some companies (often large utilities) are the most repeated offenders, and it provided an objective tool to confront such companies

Figure 3 Frequency of pipeline spills for five groups of causes



The frequency of spills for all five groups of causes has decreased steadily over the years. The most important cause of spills is third-party interference which represents more than 50 per cent of all spills in the past five years.

and trigger corrective action. These systems are effective up to a point but still have to rely on minimum discipline by those who are about to dig. The problem is compounded by the fact that civil works often involve several layers of contractors and sub-contractors, making communication between the pipeline operator and the man holding the pickaxe particularly difficult.

It is essential that authorities are involved to provide an official framework for such 'one-call' systems and a certain level of regulation and enforcement. No amount of legislation will, however, definitely solve the problem. Overly complex and prescriptive regulatory systems could even be counter-productive. The onus must be on communication and training, the lack thereof being at the root of most incidents. Here too, operators have an important role to play in keeping regular contact with land owners, farmers and all contractors who are likely to be involved in excavation activities near a pipeline.

Members of the CONCAWE Oil Pipelines Management Group are fully aware of their responsibilities in this matter and have decided to take a leading role towards improvement. A working group has been formed and is currently working on the definition of operator's best practices and the development of recommendations and guidelines for operators, authorities and potential third parties.