Life cycle risk – an HDD example

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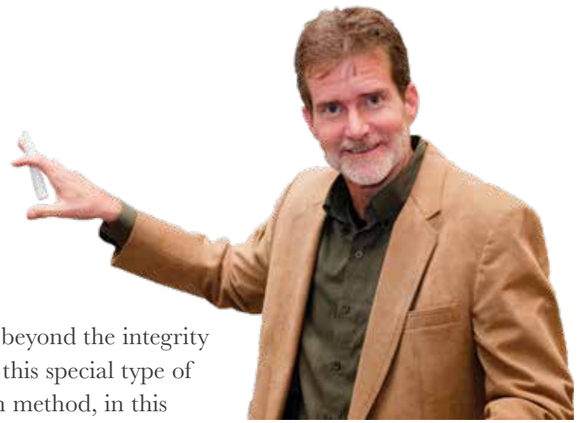

Life cycle risk assessment is an interesting topic in and beyond the integrity management field. This article features a discussion of this special type of risk assessment applied to a certain pipeline installation method, in this case, HDD installation.

In previous articles, we've discussed some non-regulatory integrity management program applications of pipeline risk assessment, including due diligence, portfolio management, strategic risk planning, and more. In this article, let's examine a risk assessment application slightly expanded from a conventional operational risk assessment.

LIFE CYCLE RISK ASSESSMENT

A life cycle risk assessment can generate risk estimates for, in our case, two phases of an asset's life. Each phase requires a definition of the 'failure' for which risk is being assessed.

One failure is defined as any significant issue arising during installation that results in significantly more costs than anticipated: installation risk. The other is defined as a leak or rupture of an operating pipeline segment: operational risk.

Both risks are monetised, as regular readers will recognise our preferred way to measure risk: risk is expressed in terms of potential dollars lost.

Each failure definition generates consequence scenarios. Consequences, or costs, associated with failures as defined above are estimated under two main categories as:

- potential receptor damages during long-term operations
- losses to owner/operator during installation, including scenarios involving damages that are not detected during the installation phase.

There is overlap since all receptor damage scenarios generate consequences to owner/operator and some of the installation scenarios may eventually contribute to receptor damages (via leak or rupture scenarios during operation).

RISKS DURING HDD

Life cycle risk assessment can be an important aspect of ownership for certain types of pipeline segments. For instance, consider a segment installed using horizontal directional drilling (HDD). Despite its many benefits, there are also some interesting risk implications of long-term ownership.

A pipeline installed using HDD has risks unique from its conventionally installed neighbouring segments. Many of the differences in risk are directly related to the installation itself and appear in both probability of failure (PoF) and consequence of failure (CoF) aspects of risk.

PoF issues

Installation:

- precise location of neighbouring pipelines/utilities
- contractor methods to be used
- potential for hydraulic fracture.

Operations:

- increased depth reduces certain threats
- inability to perform certain mitigations
- possible installation weaknesses.

CoF issues

- inability to repair HDD crossings – i.e. higher frequencies of replacements if defects occur during operations of if neighbouring facilities are contacted
- high replacement costs of HDD crossings.

The differences in risk will impact costs of ownership and should be considered. If assessing a yet-to-be-installed segment, pre-installation uncertainty will play a role. A risk assessment may have to make assumptions around installation

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issues pending final regulatory approval and installation contractor choices.

For example, a regulator and/or installer must make choices related to the specifics of how the installation and quality assurance will be performed.

These choices are made in the context of incomplete knowledge of subsurface conditions; incomplete since, despite normal geotechnical investigations, much will still be unknown.

There are unique perils associated with an HDD installation. Unlike the conventional installations, when even minor contact is made with a deeply buried neighbouring asset, consequences can be dramatic, such as the cost of replacing the neighbouring asset.

Similarly, HDD may place pipe and welds under stresses that would not occur in conventional installation, perhaps introducing weaknesses manifesting as contributors to future failures.

Of course, there are mitigation measures available to at least partially offset any increased failure potential. But, consistent with good risk assessment practice, a mitigated threat is never as 'safe' as a non-existent threat.

This in no way suggests that HDD installations are not valuable. A non-HDD installation through the same area could be prohibitively expensive, requiring sometimes impractical reroutes, but understanding the cost/benefits of all options allows optimum decision making.

RISK ASSESSMENT FRAMEWORK

A framework for HDD installation risk assessment could use failure scenarios that fall into three general categories of loss (additional and unplanned costs):

- redrill HDD – a full or partial redrilling is required but does not require a full reinstallation of pipe
- reinstall the HDD – installation errors are so severe that a full reinstallation is required
- other installation incidents – unanticipated actions are required, including scenarios where obstacles, errors or inefficiencies are encountered that do not require redrill or reinstall but nonetheless generate additional costs.

Installation errors and failures involve numerous potential scenarios, each with varying probabilities and consequences. Many have potential for either design phase or execution phase errors, both within the installation process.

Cost exceedances including time delays, rework and others are the most common consequences associated with an installation failure. Some examples of rework are conducting additional soil investigations, redesign and rebore, among others. Property damages, legal costs and increased regulatory requirements are also potential consequences.

As noted, both types of risk – installation and operational – are efficiently expressed in units of $/year. A significant change in risk is anticipated at the point where the installed pipeline segment is placed into hydrocarbon transportation service – this is seen in the profile of risk versus time.

RISK ESTIMATES

Preliminary risk estimates will often appear high for HDD installations compared to conventional installations. The higher risks will likely be due to the issues previously noted, especially the increased CoF costs.

In a recent assessment, preliminary estimates of installation risk showed expected losses were about 7 per cent per installation. This means that an installation cost of US$329 per metre actually carries a cost of US$351 per metre.

Total life cycle risk is the sum of installation risk and operations risk. Both are measured in terms of expected loss, which is a function of PoF and CoF expressed in monetary units.

Annualising the installation risk (over, say, 30 years) and combining with the operational risks per year allows comparisons with other pipeline segments. Recall that these 'annualised potential losses' are a measure of risk and should be viewed as being additive to costs of installation, operation and maintenance.

Operational risks – after installation, while transporting product – may also be higher for HDD segments, for reasons linked to those differentiating installation risks. An operational risk assessment must take care to include all failure modes.

For instance, a focus solely on rupture incidents usually results in very low failure frequencies for many threats. Analyses may show that the external corrosion rupture frequency carries extremely low incidence rates when the focus is solely on rupture, ignoring leak potential.

This may cause an important aspect to be missed: the expensive proposition that the HDD installation must be replaced, even if damage would be repairable in most other segments. Rupture is not a reasonable sole basis for risk assessments on pipelines installed by HDD.

MANAGING RISK

Once risk estimates are finalised, many opportunities exist to reduce PoF risk in both installation and operational risk, should risks be deemed unacceptable. There are fewer opportunities to reduce CoF risk in HDD installations.

With monetised risks being estimated, a cost–benefit value can be generated for each potential risk reduction measure. As long as the cost of a measure is not 'grossly disproportionate' to the risk reduction benefit it generates, the measure should be considered to be a strong candidate for implementation.

This may ultimately lead a decision maker to employ more inspection or quality assurance mechanisms during installation. Similarly, more monitoring or protective measures may be appropriate during its operational life cycle, given the inability to repair.

A life cycle risk assessment provides understanding and context, giving decision makers critical information for improving risk management in all of the asset's life phases. **P**