What are they missing?

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Significant insights into risk are routinely missed when certain risk assessment methodologies are used. This article examines some fundamental differences between QRA techniques in terms of how they catch – and potentially miss – important evidence.

There are still alternative risk assessment methodologies available to the pipeline industry. These alternatives are by no means equivalent. Some suffer from serious general limitations, while others miss subtle but essential aspects of risk.

Regarding the former, most US operators should now recognise the waning days of our older relative, scoring and indexing risk assessment systems. While still technically 'allowable' by US regulations, their inappropriateness for impact management project purposes has been demonstrated and communicated for more than 15 years now.

This includes the public criticism of such methodologies by US regulators Pipeline and Hazardous Materials Safety Administration for more than eight years now. So, the reasons to migrate away from such approaches are well documented.

Let's therefore examine some of the more subtle differences among even the better methodologies – quantitative risk assessment (QRA) techniques. For instance, what gets missed when an otherwise good QRA does not make appropriate use of all available evidence?

Take, for example, two important categories of risk evidence: inspection and monitoring results versus chemistry-based estimates of corrosion rates.

Say there are internal corrosion coupons measuring corrosion rates at various locations along a pipeline. This is direct inspection/monitoring data. However, if this is the only corrosion rate evidence being used, how does one answer questions such as: What occurs between these locations? What about pipelines without any coupons?

Here is where a parallel path of evidence should take over – an estimate of the corrosion rate based on probable chemical and hydraulic characteristics at each location. Without this chemistry-based evidence, the blind spots in the inspection and monitoring data cannot be addressed. Furthermore, a coupon is measuring the mitigated corrosion rate. How bad could corrosion be if the mitigation fails? Again, chemistry-based knowledge is needed.

Other examples: how do you compare a pipeline with an inline inspection (ILI) to one without ILI? A full risk assessment needs to capture three possibilities: 1) ILI with anomalies found; 2) ILI with no anomalies found; and 3) no ILI performed. These are distinctly different risk scenarios.

What if there are corrosion coupon results showing corrosion rates of zero but ILI findings of metal loss? That is, what if one piece of evidence suggests no corrosion, while the other indicates corrosion is active or has at least happened in the past. How do you resolve the conflicting evidence?

All of these are directly answered and traceable in a properly built risk assessment. On the other end of the spectrum, a weaker risk assessment may ignore most, or all, of these evidences, relying instead on historical statistics or generalisations or, even worse, some kind of relative scoring scheme.

Interplay among the three key elements – exposure, mitigation and resistance – is the key to proper risk assessment, as has been detailed in several previous articles. Omitting this interplay really misses the underlying understanding of the probability of failure (PoF) and, without that understanding, we can't manage the risk efficiently.

A failure to recognise this critical aspect of estimating PoF can cripple even an otherwise good QRA.

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QRA

Even among the more robust risk assessment techniques, generally referred to as QRA, there's a need for a new categorisation. Yes, we certainly do need to differentiate among QRA techniques because the underlying fundamentals are not equivalent. You can arrive at a quantification of risk in at least two general ways: statistics-centric QRA versus engineered QRA.

The former has been around for decades. Developed by statisticians it, of course, makes often exclusive use of historical failure rates. Engineered QRA (or physics based QRA), the newer version of QRA, is based on fundamentals of science and engineering, using historical data in a more limited way. Here's how they differ.

Statistics-centric QRA

Statistics-centric QRAs are mostly based on generic historical incident rates derived from all-inclusive databases that:

- use multiple populations with multiple diameters, ages, cover depths, wall thickness, activity levels, corrosion rates, coatings, inspection protocols, etc.
- sometimes include attempted adjustments to these generic rates using factors inserted by various means (e.g. Bayesian techniques).

The biggest limitation in a statistics-centric QRA approach is that hundreds of potentially important factors can't be considered unless exceptionally detailed databases are available, which there are not. This technique is generally not designed to accommodate evidence such as the examples above and, hence, can miss many important aspects.

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Engineered QRA

Engineered QRAs are location specific analyses based on fundamentals of science/engineering and use:

- segment specific characteristics
- segment specific history
  - probable past damages
  - probable future damages
- site specific characteristics (those that potentially influence PoF and consequence of failure).

Unlike a statistics-centric QRA, this approach is designed to receive and utilise all evidence.

QRA and probability

Not all differences in QRAs require new categories, though. Recent guidance documentation[1] makes an additional distinction involving the 'probabilistic' aspect of QRA assessments. That additional categorisation creates confusion. Afterall, the universe and everything in it is of a probabilistic nature, at least from the perspective of mankind's current knowledge. All QRAs must therefore consider this in their quantifications.

So, rather than a different class of QRA, probabilistic considerations are a necessary part of all QRAs (and, really, all other types of risk assessments).

Common ways to accommodate the probabilistic aspects of our world in a QRA include either: 1) using distributions, rather than point estimates, for each input, or 2) picking two or more values to represent underlying distributions (a P50/P90+ approach).

SUMMARY

The conclusion here is that serious differences exist among risk assessment methodologies, even among those considered a single class, such as QRA. Practitioners must recognise strengths and limitations beyond simple categorisations. **P**

[1] *Pipeline risk modelling overview of methods and tools for improved implementation, PHMSA, May 2018*