Risk-based inspection: misconceptions vs realised benefits

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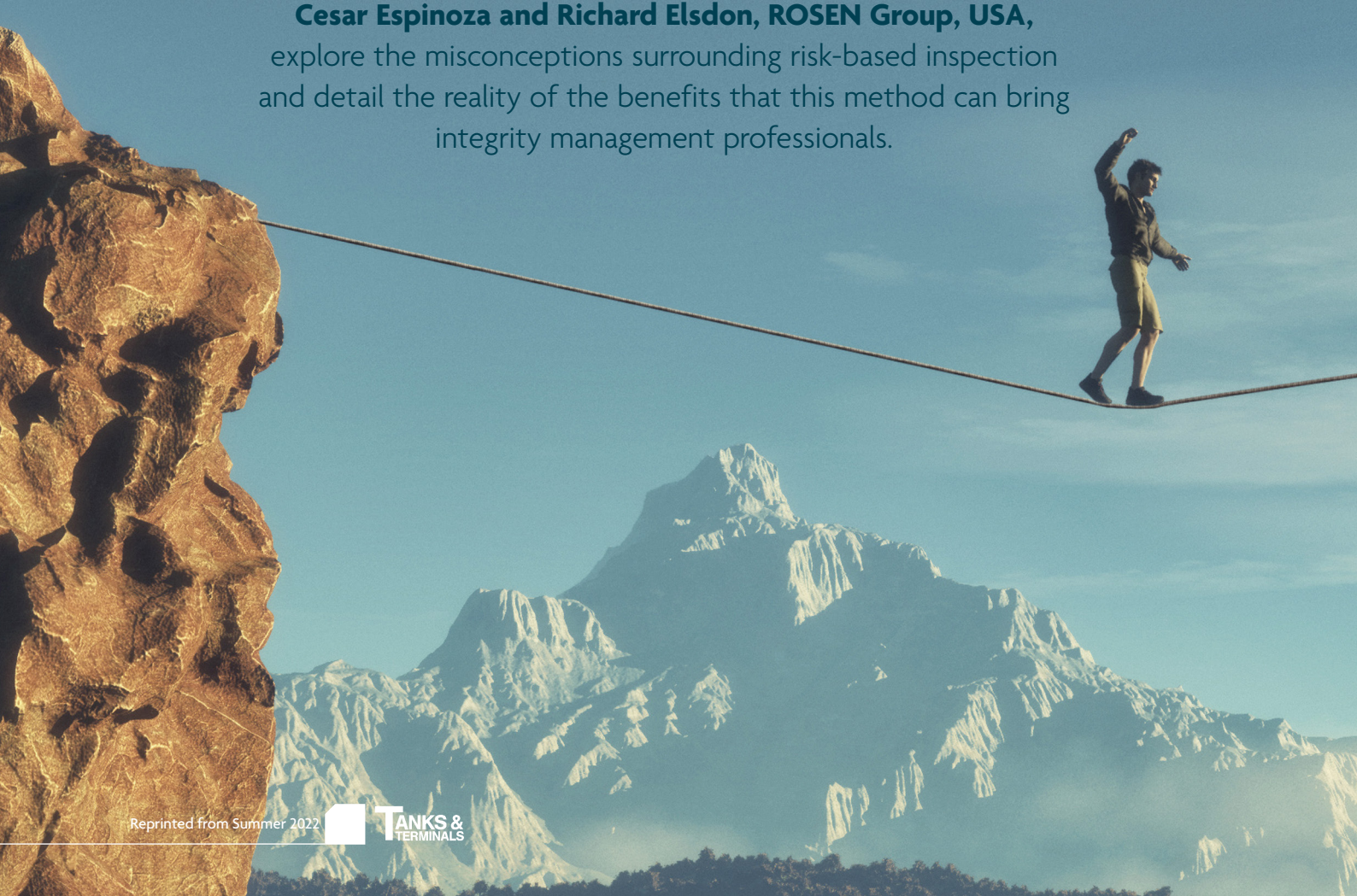
explore the misconceptions surrounding risk-based inspection and detail the reality of the benefits that this method can bring integrity management professionals.



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Since the introduction of the concept of risk-based inspection (RBI) to the petroleum refining and chemical industries in the early 1990s, integrity management (IM) professionals at operating sites around the world have been implementing this methodology with the intention of better identifying and understanding operational risk and where fixed equipment is in its lifecycle. It has taken almost three decades to achieve the level of maturity and recognition that the RBI methodology boasts today as a key element of an IM programme.

Despite this positive evolution, there are still several misconceptions that have led to misapplications of the methodology, an adverse reputation in some circles, and fruitless investments. Some of the early misconceptions have been properly addressed by the revision of the recommended practices and standard documents (such as API-581 and DNV-RP-G101) that have supported RBI implementations, but some of the original misconceptions are still present today. The expectation of cost reduction, a reduced number of inspections, an extension of inspection intervals and the perception that it only supports inspection management efforts are arguably the main misconceptions.

On the other side of the spectrum, multiple collateral benefits of implementing RBI that were not originally conceived at its creation have been realised. These have constituted important additions to the IM programme and general plant operations, as well as significant cultural and organisational changes that have transformed the industry for the better. Cost reallocation, reduced turnaround exposure, optimised inspection intervals and scopes, and increased operational awareness are a few examples of the side benefits of implementing RBI.

The purpose of this article is to review these misconceptions and portray how they contrast with the realised collateral benefits. A case study from a successful RBI implementation project will be used to better illustrate the intent of this article. This is the first in a series of articles covering multiple relevant topics and experiences collected by ROSEN during almost two decades of developing and implementing RBI programmes at numerous facilities across the globe.

Case study background

When a company began expanding its gas facilities to meet the rising demand of a growing regional industrial base, it ran into inspection schedules and expenditure issues. Historically, asset integrity at its facilities was maintained through a time-based inspection (TBI) approach. However, the increasing number of facilities built to enhance production and counteract depletion of reservoirs began to impact plant efficiency. Because a TBI scheme schedules inspections of virtually every single item on a site, it proved to be increasingly costly in terms of expenditures and resources for the company to meet its own inspection schedules without compromising safety.

This company felt it could optimise its inspection programme by introducing a RBI scheme. In focusing on threats and mitigation, RBI provides a better link between the mechanisms that lead to equipment failure (loss of containment) and the inspection approaches that will effectively reduce associated risks.

Misconceptions vs realised benefits

As mentioned in the introduction, the main purpose of this article is to contrast the initial misconceptions with the perceived benefits following an effective RBI implementation. Table 1 shows the main misconceptions next to their counterparts on the benefits side. In the following sections, these face-offs between misconceptions and benefits will be expanded and illustrated with actual experiences from the implementation of an RBI programme at the facility used as the case study for this article.

Cost reduction vs cost reallocation

Probably the most persistent misconception among some operators is that once an RBI programme is implemented, it will immediately save them money. In fact, in the short-term, the cost of acquiring and processing sufficiently detailed data to implement an effective RBI scheme can be high. However, it is reasonable to expect that inspection and maintenance costs will be reduced over the long-term. The major benefit of a successful RBI scheme is that it should optimise inspection and

maintenance costs while ensuring the reliability and functionality of the asset. It also justifies reducing or eliminating inspections of low-risk assets, where such inspection activities have little or no effect on the overall plant risk. The result is that inspection resources are applied where they are really needed, increasing the cost-effectiveness of inspection programmes.

Furthermore, RBI can provide a justification for eliminating unnecessary or inappropriate inspection techniques. For example, a risk assessment of a pressure vessel may show that intrusive inspections can be replaced by non-intrusive inspections (NII). Avoiding equipment shutdown, possibly by NII, provides another opportunity for managing inspection cost by not having to blind, open, clean and internally inspect items during downtime. Operators need to be aware that while there is a potential for the reduction of inspection costs through the utilisation of RBI, the focus must be on maintaining equipment integrity.

By implementing RBI, this company recognised maintenance cost reductions of over US$10.5 million in the 5 years after the implementation began – just as a result of extended run lengths. The savings on the inspection side were reallocated into inspector training to sustain the new working culture, procurement of new equipment, and exploration and acquisition of new technology and software for managing inspection data more efficiently.

Reduced number of inspections vs reduced turnaround exposure

Historically, a majority of accidents in the oil and gas industry occur during turnarounds (TAR) or major maintenance activities. This is because there are more people onsite, and most of them are engaged in non-standard operations, such as cleaning, flushing, welding and repairing equipment. In addition, there is a significant amount of working at heights and use of heavy tools and special equipment, such as cranes and scaffolding. All these factors contribute to an increased risk of a safety incident.

The TAR duration for this gas plant was approximately 8 weeks on a TBI scheme. With over 100 additional people onsite working 12-hour days, the exposure to turnaround conditions was around 67 000 hours. Implementing the RBI scheme reduced the TAR to about 30% of the original scope, significantly driving down TAR costs. Furthermore, from a safety perspective, the reduction in personnel numbers and overall exposure to an average of 6700 hours per unit resulted in a major safety benefit.

Table 1. Misconceptions vs realised benefits of implementing an RBI programme

Misconception	Realised benefit
Cost reduction	Cost reallocation
Reduced number of inspections	Reduced turnaround exposure
Extension of intervals	Optimised intervals and scopes
Only supports inspection management	Increased operational awareness

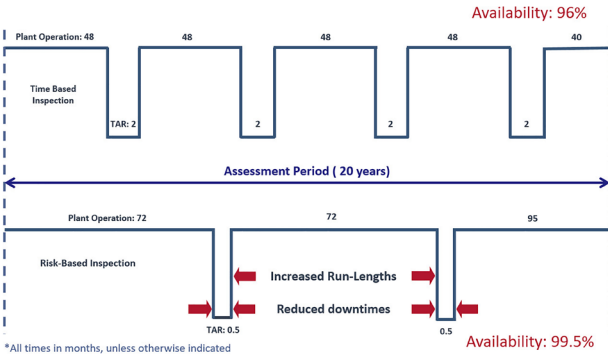

Figure 1. Sample facility timeline run with TBI and RBI approaches; RBI achieves better asset availabilty.

Extension of intervals vs optimised intervals and scopes

In focusing on risks and their mitigation, RBI provides a better linkage between the mechanisms that lead to equipment failure (loss of containment) and the inspection approaches that will effectively reduce associated risks. In any operating facility, a relatively large percentage of the risk is usually associated with a small percentage of the equipment. Adopting an RBI methodology to plan inspection activities enables the inspection/maintenance department to provide a higher level of coverage of high-risk items and expend an appropriate amount of effort on lower-risk equipment.

Another beneficial side effect of RBI implementation is a significant improvement of asset availability. Availability is the probability of a piece of equipment being available to perform a determined function in a determined period of time. Safely extending the run length of a facility and reducing its downtime due to turnaround directly increases the plant's/asset's availability. Figure 1 compares how TBI and RBI each affect asset availability across a timeline.

There were 43 gas processing facilities spread out over a large area and, in order to ensure coverage of the local energy demand, no more than three of these facilities could be shut down simultaneously. The operator was struggling to complete the 11 turnarounds per year necessary to achieve compliance within the 4-year inspection cycle. RBI implementation, fortunately, served to justify an extension of the inspection interval from 4 to 6 years, as well as a reduction in the inspection scope (more NII and elimination of unnecessary inspections and those that do not add value). The average duration of a turnaround dropped from an 8-week schedule to 15 days. This allowed the operator to rearrange its turnaround planning, resulting in a more relaxed and optimised schedule.

Only supports inspection management vs increased operational awareness

RBI significantly increases safety while supporting the organisation at different levels. A common myth is that RBI is only implemented as a way to achieve cost savings and cut inspection budgets. In reality, it supports and enhances the performance and knowledge of several departments in an organisation, including process engineers, HSE personnel and even finance staff.

Because of the continuous interaction with corrosion and inspection engineers during the RBI implementation, along with regular discussions about the effects of operating conditions on equipment damage susceptibility, operational staff started to

hold themselves accountable for verifying that the facility/equipment is being operated within the integrity operating windows (IOWs). They realised that they are responsible for providing data on process upsets that feed the RBI programme. They are also responsible for verifying that equipment repairs, replacements or additions are included in the equipment condition data supplied by the equipment inspector. It became a regular practice that operational staff informed corrosion and materials engineers about an excursion of any of the IOWs. They also understood that they needed to seek approval/advice before making any significant process adjustments.

During the inspection and failure history review stage of the RBI implementation, several instances were identified where recurrent failures had been repeatedly repaired without ever considering the root cause. In some cases, costly metallurgy upgrades were performed to try and eliminate repetitive failures. Unsurprisingly, these were unsuccessful. The following case illustrates where a repetitive failure was found to be related to operations rather than being caused by a materials issue or damage mechanism.

The main equipment in the glycol regeneration process is the glycol reboiler. This piece of equipment consists of a firetube that is inserted into a shell. Operations were not controlling the glycol level inside the reboiler, as it was not considered critical for the operation of the unit. Due to an unstable glycol level, solids accumulated in part of the top section of the firetube, eventually forming a thick insulating layer that left the top half of the firetube without cooling. This, in turn, created localised overheated areas, leading to recurrent failures in this component due to creep. A new IOW was incorporated to mitigate this failure. Thus, thanks to operations' awareness of the cause of the failure, it has not occurred again.

Conclusion

Operators sometimes fail to appreciate that there is a significant change in managerial responsibility when implementing an RBI programme, in part due to the historical misconceptions associated with the RBI methodology. A TBI is a prescriptive exercise where the major responsibility of the owner is to ensure that they have identified and inspected all items in their facility. Compliance is confirmed by checking a box. In an RBI scheme, the responsibility for demonstrating compliance switches to safety case holders, who must convince regulators that their facilities are being operated in a safe manner and at a risk level acceptable to employees and the public.

After about two decades of executing multiple RBI implementation projects across the globe at different facilities, the acquired experience is that – whether shifting from TBI to RBI or relaunching an RBI programme after failed attempts – the process inevitably presents challenges. Nevertheless, it is worth pursuing because it comes with an opportunity to deliver significant benefits for companies.

An effective RBI programme not only brings safety benefits through risk reduction, it can also trigger a cultural change in how employees engage with a company's IM scheme. The potential financial benefits of a successful RBI scheme allow for investments or cost reallocation to be aimed at improving integrity processes and developing employee skills. T&T

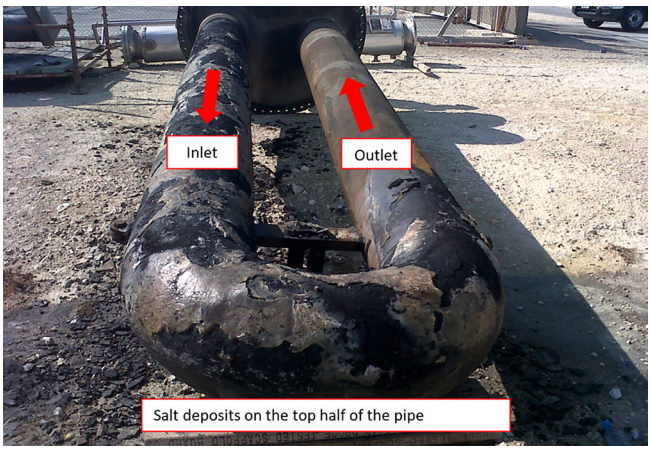

Figure 2. Increased number of facilities can have serious impact on managing vital inspection schedules.

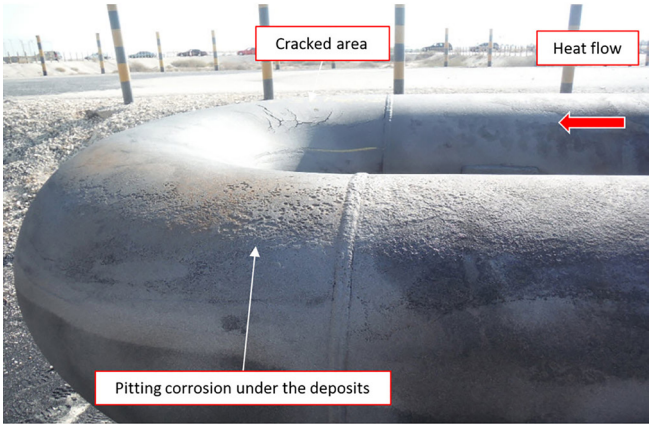

Figure 3. Continuous interaction with corrosion and inspection engineers during the RBI implementation allows for optimised integrity across multiple departments and operational processes.

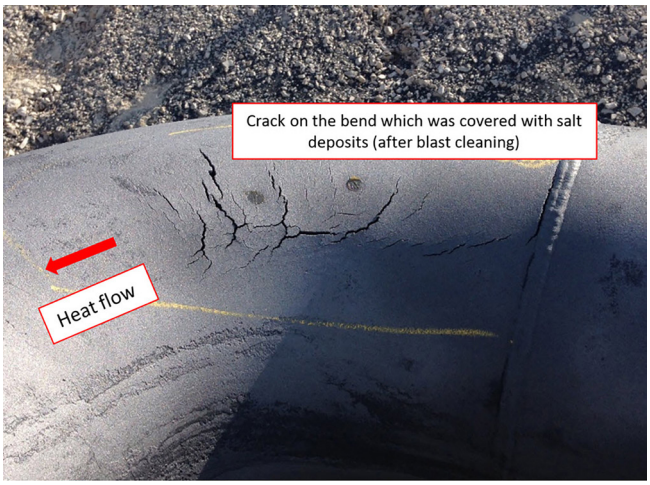

Figure 4. An effective RBI programme not only brings safety benefits through risk reduction, it can also trigger a cultural change in how employees engage with a company's integrity management scheme.