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FOUR REALIZED BENEFITS OF A TRANSITION FROM A TIME-BASED TO A RISK-BASED INSPECTION APPROACH

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INTRODUCTION

Nearly five years ago, an oil and gas company with exploration and production activities began expanding its gas facilities to meet the rising demand of a growing industrial base in that region. Asset integrity of these facilities had historically been achieved through a time based inspection (TBI) approach. Although this approach had made it possible to keep operating assets in good condition over many years, its efficiency was affected by an increasing number of assets and facilities built to enhance production and counteract depletion of reservoirs. This led to high associated costs and resources needed to meet the requirements of the mechanical integrity program. Hence, the company felt the urgent need to optimize its inspection program.

Most operating companies are aware of Risk-Based Inspection (RBI). However, they still have reservations about transitioning from a TBI to an RBI approach. Throughout our careers, we have been involved in the implementation of RBI programs in several facilities, and in all cases have faced the counteracting human effects of the "resistance-to-change" behavior. This resistance to break the mold and try something relatively new, like the RBI methodology, is much stronger in vintage upstream oil and gas facilities. Using the very challenging, but successful, transition from a TBI to an RBI approach in the above mentioned upstream facility as a case study, we can outline the following four major realized benefits out of the RBI implementation:

1. Reduced Turnaround Exposure
2. Extended Inspection Intervals / Reduced Inspection Scope / Increased Availability
3. Increased Operational Awareness
4. Optimized Inspections and Maintenance Costs

REDUCED TURNAROUND EXPOSURE

Historically, the majority of the accidents in the oil and gas industry have occurred during turnarounds (TARs) or major maintenance activities. During these activities, 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, a significant amount of work is done at elevated heights, with heavy and special tools and/or equipment such as cranes and scaffolding being used, which further increases the risk of an incident.

In the case at hand, RBI implementation helped reduce turnaround durations. From a safety perspective, this result was a major benefit, as the duration for which personnel were now exposed to TAR conditions was significantly reduced.

Previously, on a TBI schedule—in which the scope essentially covered the intervention of every single piece of equipment and piping—the TAR duration for the gas treating units (GTUs) was approximately eight weeks, and the size of the maintenance and inspection crew was over 100 people. Considering 12 hour workdays (no night shifts), this resulted in about 67,000 hours of personnel exposure to TAR conditions.

With the RBI approach, a large number of unnecessary inspections were identified and removed from the TAR scope. Additionally, inspections with the ability to be completed online, at any time, were also removed from the scope. Therefore, TAR scope was considerably reduced to about 30% of the original scope, thus reducing the duration of the TAR and the number of personnel required. Considering the size of the facilities and the reduced scope of work, the duration of the TAR was now reduced to 15 days, and the number of personnel required to carry out the TAR was reduced to about 30-35 people. This resulted in a reduction of the total number of hours of exposure to TAR conditions to around 6,300 hours, thereby enabling realignment of inspection resources and personnel to areas needing the same.

EXTENDED INSPECTION INTERVALS / REDUCED INSPECTION SCOPE / INCREASED AVAILABILITY

As stated in Recommended Practice API-580, "The primary work products of the RBI assessment and management approach are plans that address ways to manage risks on an individual equipment level." In addition to risk reduction and an overall enhanced safety environment, RBI plans may result in cost reductions. RBI also helps to identify equipment that either does not require mitigation, or requires minimal inspection coverage, or some other form of mitigation because of the acceptable level of risk associated with its operation. Therefore, inspection and maintenance activities can be more cost-effective and provide sufficient room for efficient planning and scheduling. This results in a significant reduction in the number of inspections executed and the volume of the data collected. This focus on a smaller set of data should also result in more accurate information.

Due to the nature of its business, size, and production field development, the discussed facility was struggling with the planning and execution of the TAR schedule every year. There were 43 GTUs spread out in an area of 30 square miles, and no more than three of these facilities could be shut down simultaneously in order to cover the local energy demands. With the previous TBI schedule

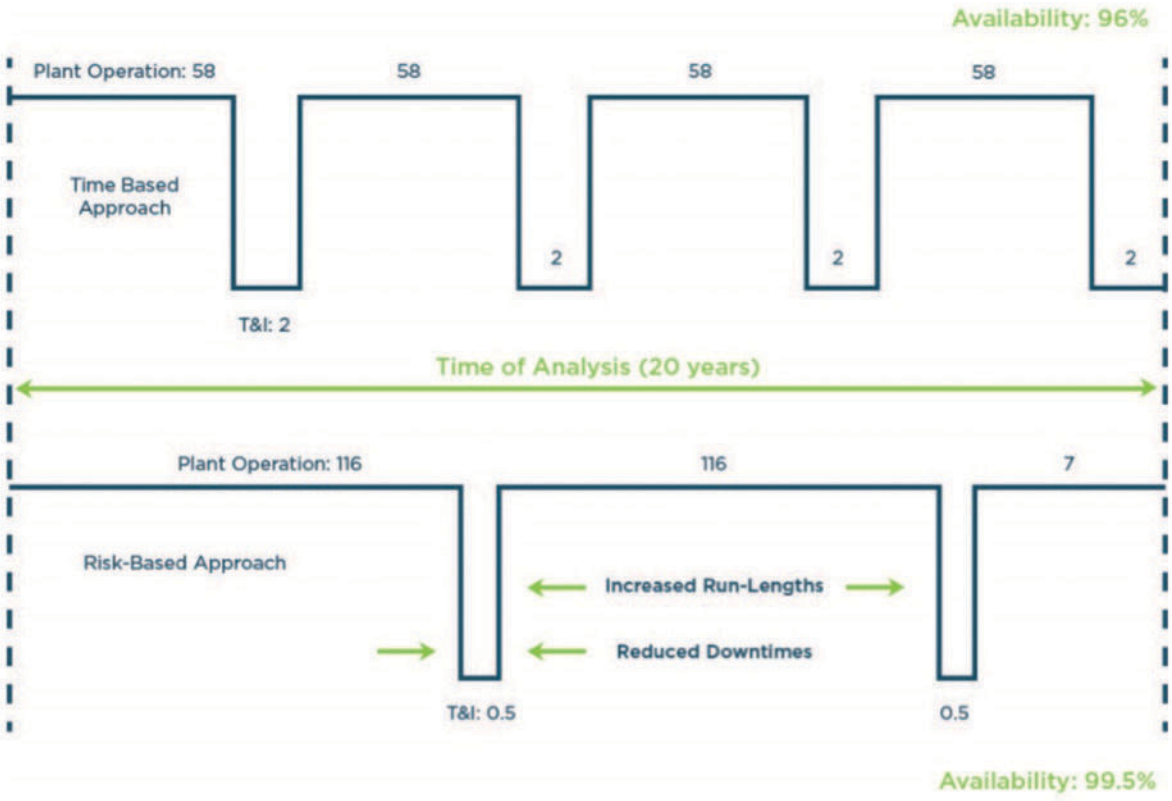

Figure 1. Example of a facility timeline run with both TBI and RBI approaches. Increased asset availability is achieved with RBI.

and TAR scope, it had been very tight to complete around 11 TARs per year, in order to have all the plants in compliance within the four year TAR schedule. After the RBI implementation, we were able to justify extending the inspection interval from four to six years, as well as reducing the inspection scope so that the TAR duration is now 15 days, rather than the approximate 8 weeks, based on the earlier TBI approach. This enabled the company to rearrange their TAR planning to a more relaxed and optimized schedule.

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 on the high-risk items and an appropriate effort on lower risk equipment.

A significant improvement in an asset's availability is another positive effect of RBI implementation. Availability is the probability of a piece of equipment to be available to perform a desired function in a determined period of time. Safely extending the run-length of a facility and reducing its downtime due to a TAR will directly increase the plant/assets' availability. **Figure 1** compares how both TBI and RBI affect asset availability across a timeline.

INCREASED OPERATIONAL AWARENESS

RBI significantly increases safety and supports the organization at different levels. A common myth is that RBI is only implemented as a way to support cost savings and inspection budgets. In reality, it supports and enhances the performance of several departments in the organization in many ways. For example, equipping operators, process engineers, HSE personnel, and even finance staff, with sound knowledge and awareness of the above mentioned points can prove extremely beneficial for an oil and gas company.

In the project discussed, the RBI framework brought about increased knowledge and cooperation. As a result of the continuous interaction between corrosion and inspection engineers, and regular discussions on the effects of operating conditions on equipment damage susceptibilities, operations personnel started to hold themselves accountable for verifying that the facility/equipment was being operated within the appropriate process operating windows. They realized and acknowledged that they were responsible for providing data on process upsets that would feed the RBI program. They were also responsible for verifying that equipment repairs/replacements/additions had been included in the equipment condition data supplied by the equipment inspector. It became a regular practice that operators informed corrosion and materials engineers about excursions of any of the Integrity Operating Windows (IOWs), as well as consulting these groups prior to making any significant process adjustments.

During the Inspection and Failure History review stage of the RBI implementation several instances were found where recurrent failures were repaired over and over without a closer look at the

Figure 2. Photos showing creep damage on the firetube of the Glycol Reboiler.

root-cause. In some cases, costly metallurgy upgrades had been done in order to eliminate repetitive failures, but with unsuccessful outcomes. The following illustration provides an example of one instance where a repetitive failure was found to be operations related, and not strictly related to damage mechanism/materials.

The main equipment in the Glycol Regeneration process is the Glycol Reboiler. This piece of equipment consists of a firetube that is inserted in a shell. Operations was not controlling the glycol level inside the reboiler, as it was not considered critical for running the equipment. The glycol level was not stable, thereby promoting solids accumulation on part of the top section of the firetube. The continuous deposition of solids on the top half of the firetube resulted in the formation of a thick layer that served as an insulating material, leaving that part of the firetube with no cooling. This generated localized overheated areas, which led to recurrent failures in this component due to creep. Initially, it was surprising for operations that the corrosion modeling did not call out creep as a damage mechanism for this component. A new IOW was incorporated to mitigate this risk, and as a result of the increased operational awareness, this failure has not occurred anymore. **Figure 2** shows photos of the creep damage on the firetube.

OPTIMIZED INSPECTION AND MAINTENANCE COSTS

Cost reduction is definitely not the primary objective of RBI implementation, but RBI certainly has the potential to generate collateral effects of cost optimization—or what many people in the industry call cost reallocation. An RBI program provides the justification to eliminate ineffective, unnecessary, or inappropriate inspection techniques. Intrusive inspections are substituted with online or non-intrusive inspections that do not require equipment shutdown. RBI also provides a basis for reduction or elimination of inspection activities in low risk assets where such actions have little or no effect on the associated risks. And lastly, a combination of more effective, infrequent inspections may be used in lieu of less effective, frequent inspections. This results in inspection resources being applied where they are really needed, and hence, an increase in the inspection cost-effectiveness.

Another opportunity to manage inspection costs is by identifying items in the inspection plan that can be executed in a non-intrusive, on-stream fashion. If the non-intrusive inspection provides sufficient risk mitigation, there is a potential for a net savings based on not having to blind, open, clean, and internally inspect during downtime. If the item considered is the main driver for bringing an operational unit down, non-intrusive inspection may contribute to increased uptime of the unit. The user should recognize that while there is a potential for the reduction of inspection costs through the utilization of RBI, increased equipment integrity and inspection cost optimization should always remain the primary focus.

In the discussed case study, run lengths were extended for GTUs and Oil Producing and Treating Facilities (OPTFs) without compromising safety and asset integrity. By implementing RBI, the company recognized maintenance reductions of over 10.5 MM USD in the first five years after the implementation was started. On the inspection side, beyond actual savings, there was significant cost reallocation. This resulted in investments of the budgetary resources being made on inspectors' training, procurement of new equipment, and exploration and acquisition of new technology and software for managing inspection data more proficiently.

CONCLUSION

Rather than provide a typical conclusion, we would like to go beyond simply summarizing the content of this article. A well implemented and consciously developed RBI program brings an endless list of benefits for an organization from various angles and perspectives: it promotes cultural change, generates confidence in the workers, allows companies to invest in enhancing processes, increases employees' skill sets and quality of life by enabling safer facility operations, and it helps people across the company do their jobs better. Truly the list goes on and on, and we are strong proponents of RBI due to the extensive value it provides. ■

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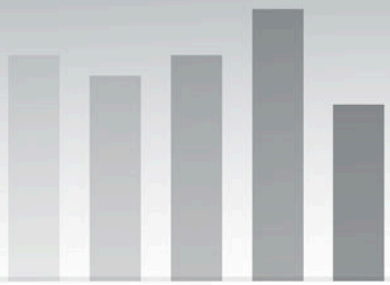

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