HP Special Focus | Maintenance, Reliability and Inspection

Common challenges in risk-based inspection for piping: Insights from experience

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Risk-based inspection (RBI) for piping systems has been a hot topic at recent industry meetings. While many operators have implemented piping RBI in the past, the results have not always been realistic. Lately, more scrutiny has been given to RBI methodology for piping and work process details. The authors' company's experience in this area has revealed several recurring issues that can significantly impact the effectiveness of a piping RBI program. This article will identify the top five common problems and concerns related to RBI assessments for piping, along with some thoughts on how to address these issues.

#1: Poor circuitization. One of the most prevalent issues in piping RBI is poor circuitization. Circuits are often too large and not well-defined around identified damage mechanisms (DMs). The key to effective circuitization is ensuring that piping components with common DMs and expected corrosion rates are grouped. This approach leads to a more concise and targeted inspection strategy, reducing the risk of overlooking critical areas.

Conversely, circuits can also be broken down too granularly. Circuitization that prescribes triggers for breaking circuits—such as between every equipment item, increases in pressure or temperature, or circuit length—can also lead to a lack of focus on common DMs. Too many circuits can lead to unnecessary data collection and increase management time.

Small bore piping/components within a circuit may result in non-conservative inspection intervals, depending on the methodology used to analyze the probability or likelihood of failure.

- **How to improve circuitization:** Focus on the least common denominator when defining circuits. Ensure that each circuit represents a group of components with similar DMs and expected damage morphology. While updating circuitization is time-intensive, appropriate circuit breaks are crucial to developing an effective inspection strategy, whether using RBI or not. When there is a mix of small bore piping/components within a circuit, consider establishing a sub-circuit for these components or plan to continue inspecting them specifically on the percentage of remaining life basis vs. risk only.

#2: Lack of a specific inspection strategy for DMs. Another common issue is the lack of a specific, targeted inspection strategy for individual DMs. Even when DM reviews (DMRs) are completed, it is rare to see a corresponding adjustment in condition monitoring locations (CMLs) to better identify damage in the most likely areas. This step requires detailed review at the ISO/field level, not just at the piping and instrumentation diagram (P&ID) level.

- **Recommendation:** Develop a detailed inspection strategy document that allows inspectors to create a comprehensive program. Establish a strategy where CMLs are aligned to focus on areas where damage is most likely to occur, ensuring RBI can be appropriately applied to the circuit. The strategy should address appropriate inspection techniques for the DMs and the scope of the inspection, considering the likelihood of the degree of localized behavior.

#3: No formal data analysis or adjustment to inspection strategy. Many companies tend to "feed the beast" and generate the next inspection due date without formally analyzing the collected data. This approach can lead to missed opportunities to improve the inspection strategy. Periodic data review and/or implementing triggers—such as comparison to an estimated corrosion rate or significant changes in corrosion data trends—can help ensure the effectiveness of an inspection strategy. Additional triggers should include changes/exceedances on integrity operating windows and other process changes documented by management of changes (MoCs).

- **Suggested approach:** Identify key metrics upfront, such as expected corrosion rates and locations, and set triggers that require a deeper analysis when these metrics deviate from expectations. This proactive approach can minimize the time needed to maintain the RBI program while ensuring it remains accurate and effective.

#4: Poor ultrasonic testing (UT) data management practices. UT data management is another area that can significantly impact piping RBI. Common issues include failing to review data, ignoring growths, or deleting suspect or "bad" data without re-inspecting or validating the locations in the field. These poor data management practices can lead to errors in the RBI assessment.

- **Best practices:** Establish rigorous data management protocols, including regular reviews of UT data, prompt re-inspection of suspect areas and validation of questionable data in the field. This ensures that all data is reliable, and that the RBI program is based on accurate information. Key data parameters to track include significant changes in the corrosion rate, the coefficient of data variation or any standard deviation of the circuit data,: these can be indicators of a process change or the degree of localized corrosion behavior.

#5: No consideration for RBI methodology limitations. Finally, many RBI programs fail to account for the limitations of the specific RBI methodology being applied. Calculations are handled differently by commonly used RBI software programs. A lack of understanding how these calculations are designed can lead to overly conservative or (worse) non-conservative results. For example, grouping

small-bore piping with larger diameter piping in an RBI analysis can produce non-conservative results for the smaller diameter components.

- **To avoid this pitfall:** Gain a deep understanding of the chosen RBI methodology calculations and their limitations before adjusting your program. Be aware of how inspection credits, circuit groups and assumptions affect the results, and make adjustments to ensure any analysis remains accurate and reliable.

Takeaway. Addressing these common problems in RBI assessments for piping requires attention to detail, a proactive approach to data management and a thorough understanding of the methodologies' limitations. With a focus on improving circuitization, aligning inspection strategies with damage mechanisms, conducting formal data analysis, managing UT data effectively and understanding RBI methodology limitations, companies can significantly enhance the effectiveness of their RBI programs and reduce the risk of unexpected failures in piping systems. **HP**

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