Inspectioneering Journal

ASSET INTEGRITY INTELLIGENCE

What is in a Recommendation?

Kim Jenkins, *Operations Manager/Mechanical Integrity Specialist at MISTRAS Group*

VOLUME 31, ISSUE 3

MAY | JUNE 2025

Risk-Based Inspection and the Transformation of an Inspector

Kim Jenkins, *Operations Manager/Mechanical Integrity Specialist at MISTRAS Group*

In the petrochemical and refining industries, inspections have traditionally been governed by calendar-based intervals driven by prescriptive codes and standards. While this time-based approach has merits and has served industry for decades, it tends to focus on prescribed schedules without fully accounting for the varied risk profiles of different assets, process conditions, and operating environments. Over time, risk-based inspection (RBI) methodology has emerged as a more nuanced strategy—one that places greater emphasis on relative risk, enabling more efficient allocation of inspection resources and a deeper understanding of potential degradation mechanisms.

At the heart of this transformation is the inspector, whose role ranges from following fixed timelines to actively engaging with risk data. An inspector's perspective must shift from simply asking, "When is the next inspection?" to more comprehensive questions:

1. "Why" – Why is a particular inspection necessary?
2. "What" – What types of damage or degradation mechanisms are we looking for?
3. "Where" – Where is that damage most likely to occur?
4. "When" – When should inspections be performed based on risk rather than a static calendar?
5. "Who" – Who ultimately benefits from robust, timely inspections? The answer to "Who" is always broad: owner/users, employees, local communities, and the general public all rely on safe and reliable operations.

This article offers a refresher on how traditional calendar-based inspections compare to an RBI approach. It explores how this shift transforms the inspector's role, requiring new skill sets, continuous learning, and deeper collaboration in pursuit of improved safety and operational efficiency.

Calendar-Based Inspections

Historically, many facilities have used time-based schedules to plan inspections for pressure vessels, piping, and other critical equipment. This traditional time versus half-life philosophy directs the inspector to focus on time and/or the remaining life of pressure-containing components. However, that may not align with the actual risk each asset poses based on specific operating conditions.

Issues with the calendar-based inspection approach include:

- **Reliance on Prescriptive Intervals**: In a time-based setting, the prime driver for scheduling inspections is the elapsed time since the previous examination, typically to some sort of estimate of time to reach half-life to reach t-min or other criteria. Although this method does offer answers to the who, what, when, where, and why questions, it focuses heavily on the "When?" requirements, which can overlook unique process conditions. Certain equipment in benign service may not require frequent inspections, while equipment subject to highly corrosive or fluctuating operating parameters may need closer scrutiny sooner than code-defined intervals due to potential consequences, which were not considered, or considered with much differentiation, in prescriptive time-based programs.
- **Potential for Overlooked Damage Mechanisms**: Calendar-based inspections often focus on basic thickness measurements to manage corrosion and erosion. However, this approach can miss more nuanced or emerging damage mechanisms, such as high-temperature hydrogen attack (HTHA), stress corrosion cracking (SCC), or microbiologically influenced corrosion (MIC). Without the structured discipline of a formal risk assessment, these damage mechanisms may remain unidentified until they present a more substantial threat to equipment integrity. We want to find the damage before "it finds us."
- **Limited Formal Risk Assessment**: While knowledgeable inspectors typically apply professional judgment in the field, there is not always a mechanism to systematically capture or quantify this judgment in a time-based program. As a result, inspection scopes and intervals may not be optimized, and opportunities to reduce or reprioritize inspection activities are often missed, potentially increasing cost and risk.

Evolving Towards Risk-Based Inspection

Risk-based inspection represents a fundamental shift from "inspection by the calendar" to "inspection by risk," incorporating and evaluating several risk factors like operational environments, historical data, damage mechanisms validation, inspection history, and more.

Broadly speaking, there is a continuum of potentially API 580-acceptable RBI approaches—from **qualitative**, to **semi-quantitative** to **quantitative**—may help shift the time-based focus toward prioritizing inspection activities based on probability of failure (POF) and consequence of failure (COF) established at consequence gates. The quantitative approaches rely more on hard, numerical facts and statistics, while the semi-quantitative approach blends integrity data with subject matter expertise/opinion and experience. Where qualitative studies require the least amount of actual data and tend to calculate based on ranges and opinion.

Figure 1. Risk Matrix Chart showing the risk level associated POF and COF.

Benefits of the RBI approach include:

- Targeted Inspection Planning: In an RBI framework, the "Where" and "What" are informed by a structured analysis of potential damage mechanisms. This allows inspectors to concentrate on the most critical locations—welds prone to stress corrosion cracking, nozzles susceptible to erosion, or areas vulnerable to corrosion under insulation. Instead of uniformly checking thickness or other parameters across an entire vessel, inspectors focus on high-risk regions with a good understanding of what to expect and where to inspect, improving the likelihood of detecting early signs of damage.
- Consequence Gates and Risk Thresholds: Equipment items are evaluated for POF and COF. The result is a calculated risk profile that categorizes equipment into tiers: high, medium, or low risk. Assets with high-risk rankings (due to especially severe consequences or higher degradation rates) are subject to more frequent or more detailed inspection activities. In contrast, low-risk items may be assigned extended intervals. This approach optimizes resources and can reduce unnecessary inspections, simultaneously lowering costs and enhancing safety.
- Integration of Data and Expertise: Effective RBI programs utilize both algorithmic logic and calculations and insights from subject matter experts (SMEs). Quantitative data—such as corrosion rates, material properties, operating practices and design margins—are supplemented by qualitative factors like inspector experience, process anomalies, and prior turnaround discoveries. Semi-quantitative methods, in particular, rely on this fusion of field knowledge and numeric data to derive the most accurate possible risk assessment.

Regardless of which individual approach is used, a risk-based approach helps operators more effectively assess operating risks, assign inspection locations, and make more informed inspection and maintenance decisions compared to traditional time-based methods.

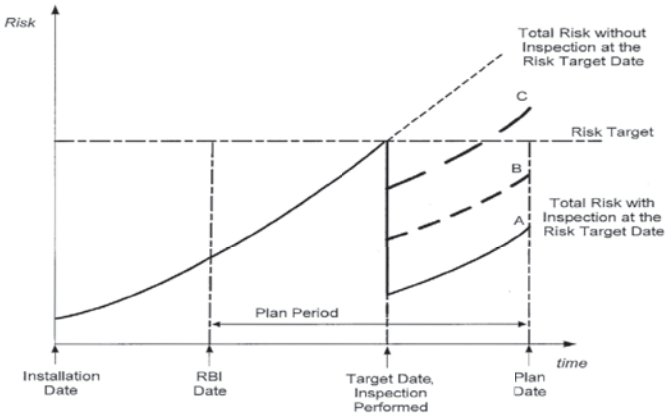

Figure 2. RBI Inspection Frequency Basis.

The Transformation of an Inspector

Transitioning to an RBI program fundamentally changes the inspector's role. Instead of a strict reliance on fixed time-based schedules, inspectors are becoming central to translating risk assessments into actionable inspection plans. This requires new competencies and a broader view of overall asset integrity, typically as part of a more collaborative decision-making process specific to inspection planning and execution than is the norm in a time-based approach.

The inspector's new role is now strategically valuable, because they are essential in implementing and managing an inspection program that prioritizes safety, resource allocation, compliance, enhanced decision-making, and the implementation of continuous improvements in the facility.

This new strategic function requires an evolution in the required skills and approach. In addition to having a thorough understanding of risk assessment methodologies, POF and COF, and basic principles of evaluating risk categories, inspectors need

to have a mindset transition to the RBI approach, which can be achieved through:

- Required Training and Education: Inspectors must grasp core concepts outlined in API 580 and API 581, including how to identify relevant risk drivers and damage mechanisms. Training programs and certifications in risk-based methodologies are increasingly common and are critical for this transformation to succeed. Continuous learning is essential as RBI technologies, recommended practices, internal owner/operator policies and procedures, and even software evolve.
- Data Validation and Management: Accurate, up-to-date data lies at the heart of an RBI system. RBI-oriented inspectors must be adept at validating the quality and consistency of field findings, ensuring that any anomalies or unexpected readings trigger a closer review. A small data error in wall thickness or operating temperature can skew POF calculations, affecting the overall integrity plan. This data improves asset management and helps decision-makers prioritize investments in inspections, maintenance, and possible upgrades based on the equipment criticality.
- Detailed Inspection Test Plans (ITPs): RBI demands greater specificity in inspection test plans, outlining exact inspection methods, precise locations, and the anticipated effectiveness of each technique. Clarity in the scope of work (SOW) optimizes field time and ensures inspectors know precisely what they are looking for. Identifying potential damages and focusing on high-risk assets, inspectors using RBI approaches proactively reduce risks and improve the reliability of the asset being inspected. This leads to fewer unexpected outages, correct utilization of resources, and more consistent operations of the facility. Reviewing, assessing, and updating the inspection plan with new data and operational changes empowers the inspector to cultivate a culture of continuous improvement within the facility.
- Technical Reporting and Proficiency: Thorough and precise documentation is critical for maintaining an effective RBI cycle, as reliance on historical inspection data is even more critical than in time-based approaches. Whenever findings deviate from anticipated results, inspectors should detail these observations with clarity and specificity.
- Technical Proficiency in Fundamental RBI Calculations and Software: While engineers and risk analysts often handle the bulk of the numeric modeling, inspectors who grasp these core principles and understand how to use RBI software platforms can better validate the data inputs they collect. This enables them to interpret how specific damage mechanisms and changing process conditions could alter POF/COF values and the overall inspection strategy and improve the effectiveness and accuracy of the predictions.

Key Takeaways

Transitioning from purely calendar-based inspections to a risk-based methodology represents a transformative opportunity for both facilities and the inspectors themselves. By integrating risk calculations into every stage of the inspection planning process, the answers to the key questions become:

1. "**Why** do we perform this type of inspection?"
   – To reduce uncertainties and risks associated the probability and consequence of failure. The value of this type of inspection contributes to cost savings by reducing unnecessary inspections, prevents downtime associated with unplanned outages, and improves the overall safety and reliability of the assets within the facility.
2. "**What** are we looking for?"
   – Expected damages associated with the assets based on damage evaluations and thresholds.
3. "**Where** should we anticipate finding damage?
   – Known areas of vulnerability based on expected damages.
4. "**When** should this inspection be performed again?"
   – Determined by the assessment, evaluation, risk criteria and risk calculations of the asset.
5. "**Who** are we protecting?"
   – Same as above: Industry owners/users, each other, family, friends, and the public. All should and need to feel safe at and away from the workplace.

Embracing these principles enables inspectors to become catalysts for positive change, transforming not only their own career paths but also the overall approach to industrial safety and reliability. ■

For more information on this subject or the author, please email us at inquiries@inspectioneering.com.

CONTRIBUTING AUTHOR

Kim Jenkins

Mrs. Jenkins has 25+ years of experience in the petrochemical industry, where she has served in many roles, including NDE Level II technician, API Inspector, Lead Inspector, NDE Co-Ordinator, Turnaround Planning, Project Manager, and managing mechanical integrity teams to name a few. She currently serves as the Operations Manager/Mechanical Integrity Specialist within the Engineering group for MISTRAS Group, which utilizes and applies the knowledge and resources from MISTRAS Group which includes Engineering Services, PCMS® Software, Risk-Based Inspection (RBI), Fitness for Service (FFS), NDT solutions, web-based customer reporting, data management, and archiving.