



WHITE PAPER · ASSET INTEGRITY INTELLIGENCE

Enhancing Risk-Based Inspection for Corrosion Under Insulation with **High-Density Digital Inspection Data**

How ARIX Technologies improves CUI inspection with a repeatable data source for stronger risk models, defensible decisions, and enterprise-wide integrity management.



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Enhancing Risk-Based Inspection for Corrosion Under Insulation

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ABSTRACT

Corrosion Under Insulation (CUI) is one of the process industries' most persistent integrity threats and one of the hardest to manage through conventional sample-based inspection. Risk-Based Inspection (RBI), guided by API RP 580 and 581, is a sound framework for allocating inspection resources by probability and consequence of failure – but for CUI, its performance is limited by the quantity, consistency, and representativeness of the evidence available to validate degradation assumptions and update Probability of Failure (PoF).

ARIX® Technologies' VENUS robotic platform removes that limitation: high-density Pulsed Eddy Current (PEC) and Real-Time Radiography (RTR) scanning, paired with georeferenced digital reporting, produces a far denser, more consistent inspection dataset – without scaffolding or insulation removal. This paper explains how that dataset strengthens existing RBI programs: sharper inspection targeting, more defensible risk decisions, and a consistent methodology across sites and portfolios. Robotics supplies the evidence RBI needs to become more accurate, repeatable, and economically scalable.

85–100%	7–15×	37–70%	10 mo → 39 d
of accessible surface examined in suitable applications	faster execution than strip-and-inspect campaigns	lower campaign cost, depending on scope	program duration at Petromax Refining

EXECUTIVE SUMMARY

RBI is the accepted framework for prioritizing mechanical integrity because it focuses resources where risk is highest. For CUI, however, that decision is often based on indirect risk factors and a small number of inspection locations – not because the RBI philosophy is flawed, but because scaffolding, insulation removal, inspection, disposal, and reinstatement have historically been costly and disruptive.

ARIX Technologies' central proposition is that the economics of CUI data collection have changed. Purpose-built robotic inspection can now generate high-density, spatially referenced datasets over 85–100% of the accessible pipe surface in suitable applications, while reducing scaffolding, insulation disturbance, duration, and cost. The value is not simply more coverage – it is lower uncertainty and a repeatable evidence base that improves the next RBI decision.

01 —



Augment RBI effectiveness

High-density robotic inspection gives RBI programs a denser, more consistent body of measured evidence, reducing reliance on sparse samples and generic assumptions.

02 —



Improve future segment targeting

Georeferenced findings convert into model inputs – damage extent, minimum remaining wall, corrosion-rate distributions, inspection effectiveness, confidence – that refine future circuit and segment prioritization.

03 —



Strengthen defensibility for regulators, auditors, and insurers

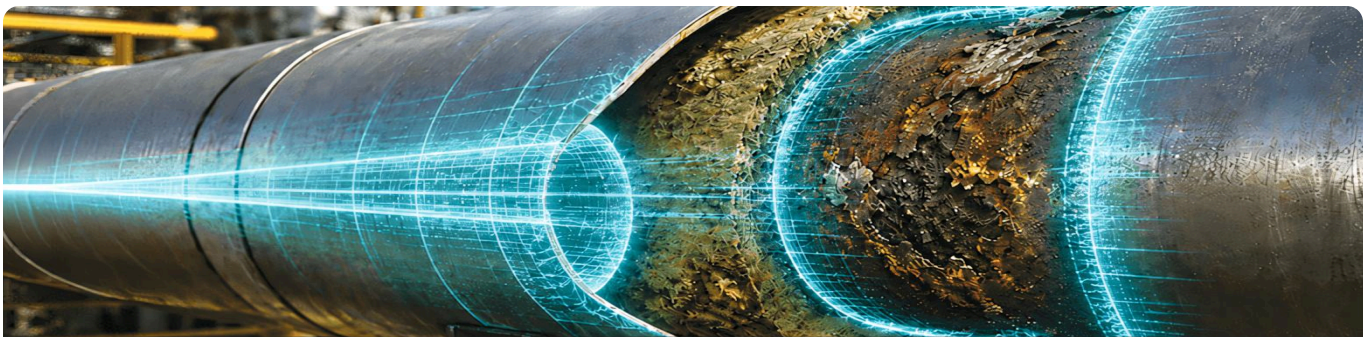
A documented chain – from scope and technology qualification through data acquisition, engineering review, model update, and inspection decision – gives risk-based interval and scope decisions a transparent, auditable basis.

04 —



Standardize a consistent enterprise methodology

Robotic execution, standardized scan plans, digital QA/QC, and common reporting make the methodology replicable across facilities, contractors, countries, and business units at lower lifecycle cost.



ARIX POINT OF VIEW

The next major improvement in CUI RBI will not come solely from a different risk algorithm. It will come from improving the quality, density, traceability, and repeatability of the inspection evidence on which every risk algorithm depends.



Why CUI RBI Is Fundamentally Data-Limited

1 RBI Is Only as Strong as the Evidence That Feeds It

Corrosion Under Insulation (CUI) is an external degradation mechanism driven by moisture, oxygen, contaminants, insulation design, coating performance, weatherproofing condition, process temperature, cycling, and local geometry. Carbon and low-alloy steels are most susceptible across the commonly cited 0–175 °C (32–350 °F) range, and austenitic stainless steels can also suffer chloride-induced stress-corrosion cracking under insulation. Because the damage is hidden, external cladding condition is an imperfect predictor of the metal beneath it.

Industry studies consistently characterize CUI as a major maintenance and loss-of-containment concern, associating it with 40–60% of piping maintenance expenditure and, in some onshore operating environments, a substantial share of reported hydrocarbon leaks – figures that explain why CUI remains a priority for owner-operators, insurers, regulators, and standards bodies.

RBI provides the right organizing logic. API RP 580 establishes the principles of a risk-based program, while quantitative methodologies such as API RP 581 estimate PoF and Consequence of Failure (CoF) to prioritize inspection scope and timing. For CUI, that analysis typically weighs temperature, insulation and coating condition, environmental exposure, service history, inspection history, and inspection effectiveness.

Every RBI methodology – regardless of software platform, corporate procedure, or level of quantification – is only as good as its input data. Sparse evidence forces the model to lean on generic damage factors, broad corrosion-rate assumptions, subjective condition ratings, and the presumption that inspected locations are representative. Dense, repeatable evidence lets measured condition progressively replace those assumptions – the fundamental role of high-density robotic CUI inspection.

2 Why Traditional CUI Inspection Leaves Material Uncertainty

2.1 Localized Damage and Sampling Bias

Traditional CUI programs concentrate inspection at sampling locations believed most susceptible: supports, shoes, low points, dead legs, cladding penetrations, damaged jacketing, terminations, and known water-ingress points. This sampling approach assumes that the inspected locations are statistically representative of the circuit's worst-case condition. CUI, however, is notoriously localized and driven by micro-environments. A circuit can pass every RBI-selected inspection location and still harbor through-wall pits only a few feet away. Full-coverage robotic data eliminates this sampling uncertainty and gives the RBI model a more complete picture of the actual condition.

2.2 Model Uncertainty and Systematic Under-Prediction

A 2021 study by Corrosie Labs compared multiple published and in-house RBI tools against measured CUI wall-loss datasets concluded that “all (complex and simple) CUI risk-based inspection planning tools reviewed contained flaws that would severely limit their effectiveness.” Notably, API 581 was shown to under-predict marine CUI wall loss and corrosion rates, especially above ~70 °C. When RBI models are calibrated or adjusted using sparse historical samples, these biases persist. Dense robotic thickness maps provide the ground-truth data needed to recalibrate temperature, coating, and environment factors, improving future PoF estimates for the entire population of circuits.

2.3 Dynamic and Intermittent Service

CUI susceptibility is not always captured by a single normal operating temperature. Intermittent operation, start-stop duty, standby periods, steam-out, heat tracing, seasonal change, and temperature cycling can leave a line within a corrosion-active range for long periods even when its nominal operating condition appears less susceptible – and high-temperature exposure can degrade a coating that later meets moisture during lower-temperature operation.

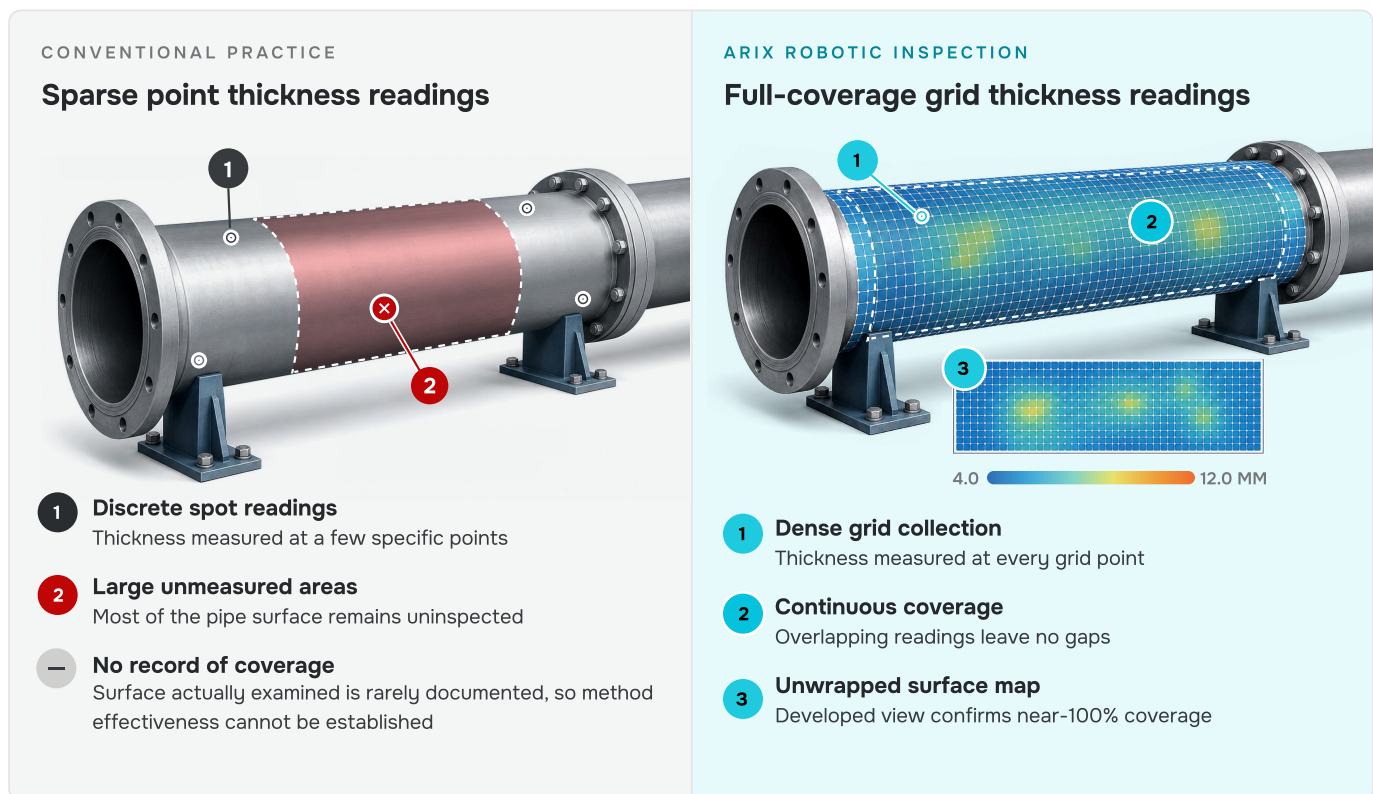
Full-coverage inspections detect the resulting damage regardless of whether the original risk model correctly anticipated the cyclic aggravating factor, giving operators the opportunity to update RBI assumptions and inspection plans.

2.4 Weak Feedback from Inspection Results

An inspection program's value depends not only on finding damage but on learning from both positive and negative findings. In many organizations, spot readings, photographs, and work-pack records stay fragmented across contractor reports, inspection databases, spreadsheets, and maintenance systems, and 'no damage found' are often recorded without enough detail to establish the surface actually examined or the method's effectiveness.

Sparse data makes robust Bayesian updating difficult. Continuous robotic datasets – georeferenced thickness maps linked to process conditions – create the foundation for true learning systems in which every campaign measurably improves the accuracy of the next risk ranking.

High-density data does not eliminate engineering uncertainty; it makes uncertainty more visible, measurable, and manageable.



3 What Industry Failures Reveal About the Data Gap

Historical CUI events show the residual risk that remains when a risk model operates with incomplete service information, limited inspection coverage, or weak transfer of learning between comparable assets. Three cases are particularly relevant.

3.1 Hot-Oil Line – Intermittent Service (2014)

Ifezue et al. documented severe CUI on 2-inch hot-oil lines at an onshore natural-gas processing plant. The lines operated only periodically at temperatures up to approximately 240 °C and spent most of each month idle at ambient temperature. The system had been categorized as low CUI risk because its normal operating temperature was above a conventional susceptibility threshold. In practice, coating degradation during high-temperature excursions, prolonged ambient exposure, and water ingress produced severe chain pitting, reducing wall thickness from approximately 4 mm to 1 mm.

The lesson is not that temperature should be removed from RBI, but that a static temperature assumption did not represent the actual degradation cycle. High-density inspection would have provided direct evidence of the resulting wall loss and a stronger basis for updating the risk model across other circuits with comparable intermittent duty.

3.2 Dow Chemical LHC Plant – Limited-Sampling Inspection (2008)

The 2008 failure of an 8-inch carbon-steel hydrocarbon regeneration line at Dow's LHC plant in Freeport, Texas illustrates the limits of narrowly scoped inspection access. The line alternated between elevated-temperature regeneration service and long standby periods; a small pinhole leak preceded a major line failure during isolation and depressurization, with a reported financial impact of approximately USD 18.7 million.

The prior inspection had removed only a small insulation plug at an elbow – too little to adequately examine the wider CUI-susceptible area. Similar damage had already occurred on a parallel train and at other company locations, but that experience was never fully translated into the inspected scope. A high-density strategy would not depend on selecting one perfect plug location; it would examine the accessible circuit systematically and produce a digital record comparable across similar services.

3.3 Broader Industry Patterns

- **2006 Petrochemical Plant Fire (~USD 50 million):** A CUI-induced leak led to a fire that destroyed approximately half of a processing unit. Higher-coverage inspection data would have increased the probability of detection before the event.
- **Geary (2013) Refinery Hydrocarbon Line Failure:** Metallurgical analysis of a carbon-steel refinery hydrocarbon line that failed due to CUI, reinforcing that visual cladding condition and limited NDT sampling are unreliable predictors of remaining wall thickness.
- **Early-life severe CUI (5–10 year service) and unexpected high-temperature CUI in “dry” locations:**

Industry datasets (Watt et al., 2021 and operator reports) document multiple instances of severe wall loss or leaks on circuits that generic RBI factors under-ranked. Full- coverage measurements would have identified the damage early and provided calibration data to improve the underlying models for the rest of the plant.

ARIX's position is that the industry response should be to improve the data available to validate and update risk-based prioritization.

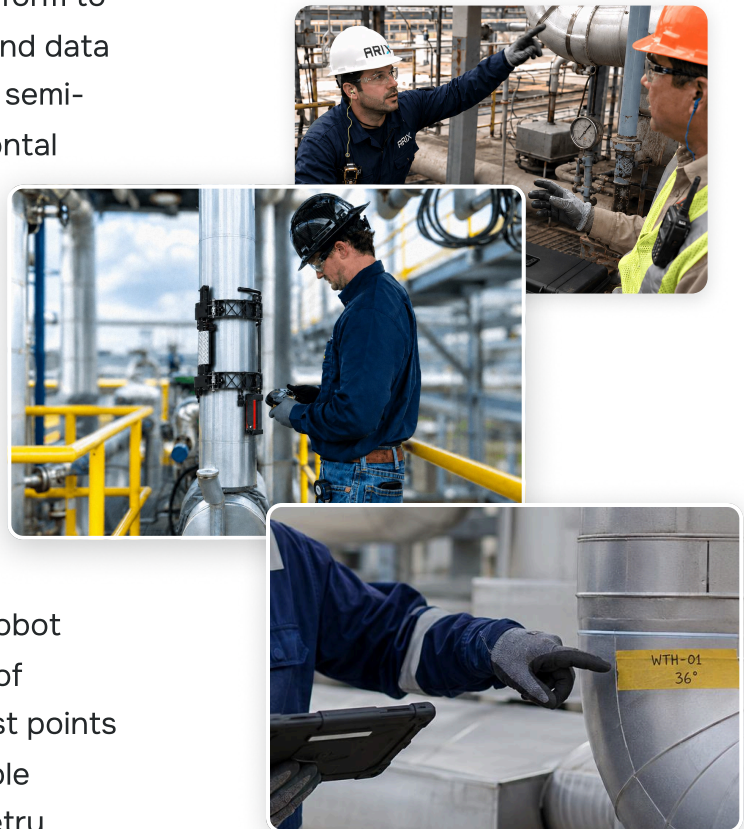
ARIX High-Density Robotic Inspection as a New RBI Data Source

4 The ARIX Inspection Model

A PROVEN PROCESS

ARIX Technologies developed the VENUS platform to address the access, coverage, consistency, and data limitations of insulated-piping inspection. The semi-autonomous crawler traverses suitable horizontal and vertical pipe configurations without magnetic adhesion, extensive scaffolding, or routine insulation removal, combining high-resolution visual inspection with Pulsed Eddy Current (PEC) and, where required, Real-Time Radiography (RTR) to identify and characterize potential wall-loss through insulation.

The strategic distinction is not simply that a robot replaces a technician: ARIX changes the unit of inspection from a small number of isolated test points to a structured digital scan, creating repeatable information linked to physical location, geometry, inspection method, scan date, operating context, and subsequent engineering disposition.



4.1 From Raw Scan Data to RBI-Ready Evidence

RBI software should not be expected to ingest every raw robotic signal directly; effective integration requires a governed engineering workflow that converts inspection data into decision-quality attributes, which may include:

- Minimum measured or estimated remaining wall within the qualified inspection envelope.
- Damage distribution across a circuit or defined segment.
- Corrosion-rate estimates or distributions where a valid time-separated baseline exists.
- Required confirmatory examination, repair, fitness-for-service assessment, or monitoring action.
- Location, length, circumferential extent, and severity of indications.
- Comparison with nominal thickness, previous inspection results, and applicable retirement thickness.
- Inspection effectiveness, confidence, inaccessible areas, and method limitations.

This distinction matters for credibility: robotic data is not a substitute for engineering judgment. It expands and improves the evidence available to qualified personnel, who remain responsible for interpreting indications, applying applicable codes, and approving changes to risk rankings or inspection intervals.

4.2 What High-Density and Near-Full Coverage Mean

In suitable commercial deployments, ARIX reports structured grid scanning over approximately 85–100% of the accessible pipe circumference and length of interest. ‘Near-full coverage’ should be understood as coverage of the accessible surface within the qualified application envelope.

Pipe diameter, bends, branches, supports, insulation system, jacketing profile, damaged cladding, clearance, surface condition, process constraints, and site access can all limit crawler movement or inspection quality, and PEC and RTR have their own defined detection and sizing capabilities. A defensible program documents these limitations and uses complementary methods – manual PEC or RTR inspections, targeted insulation removal, ultrasonic testing, conventional radiography, or direct visual examination – wherever the robot cannot access an area or an indication needs confirmation.

4.3 Commercial Performance Benchmarks

ARIX commercial deployments show that higher inspection density does not require higher total campaign cost – the principal economic advantage comes from reducing access construction, insulation disturbance, craft interfaces, and elapsed duration. Reported deployments range from 7–15 times faster execution and 37–70% lower cost than comparable conventional strip-and-inspect campaigns, depending on geometry, site conditions, and scope.

METRIC	TRADITIONAL SAMPLE-BASED APPROACH	ARIX HIGH-DENSITY ROBOTIC APPROACH
Accessible surface examined	Typically, selected windows, strips, or point locations	Structured grid; reported 85–100% of accessible surface in suitable applications
Access requirement	Scaffolding, rope access, insulation removal, or combinations	Near-zero scaffolding for reachable configurations; no routine insulation removal
Data product	Spot readings, photographs, and local observations	Georeferenced PEC/RTR/visual dataset, video, scan metadata, and digital mapping
Spatial continuity	Low to moderate	High across the defined scan scope
Repeatability	Strongly dependent on work pack, access, and individual execution	Standard scan grid, procedures, QA/QC, and digital reporting
Campaign duration	Often months for multi-unit programs	Days to weeks in cited campaigns
RBI value	Confirms selected locations	Supports model validation, segment reprioritization, and digital baseline creation

Table 1. Comparative characteristics. Ranges are based on ARIX commercial case studies and are application dependent.

In one cited engagement, ARIX completed a comprehensive grid scan of 325 linear feet of insulated piping – 1,625 total scanned feet counting circumferential paths – in under two days, versus a conventional estimate of approximately 26 days and more than USD 90,000 in scaffolding and labor; the robotic campaign cost roughly 30% of the conventional alternative. At Petromax Refining, the inspection program shrank from approximately ten months to 39 days, with 85% or greater coverage, 37–63% cost reduction, and near-elimination of scaffolding.

These examples show a practical, budget-neutral path to substantially more CUI data than traditional sampling allowed.



WHY THIS MATTERS FOR RBI

Because the same budget now buys an order of magnitude more measurement, coverage stops being a cost decision and becomes a data-quality decision – which is where RBI has always needed the help.

From Inspection Data to Closed-Loop, Defensible RBI

5 Sharper RBI Inputs

ARIX does not propose scanning every insulated line at every interval, nor replacing risk-based planning with robotic inspection. What changes is that, once a circuit is selected, a robotic campaign produces a much richer condition dataset than conventional sampling, so the next RBI cycle is based on improved evidence.

5.1 Higher-Confidence Probability of Failure Inputs

CUI PoF calculations often combine generic damage factors with inspection-effectiveness adjustments. High-density inspection provides direct evidence of whether damage is present, how it is distributed, and where the worst areas are – evidence engineering review can use to challenge assumed corrosion rates, revise damage extent, validate coating or environmental factors, and select a more appropriate inspection-effectiveness category under the owner's RBI methodology.

This does not make PoF exact – material properties, measurement error, future moisture ingress, operating changes, and inaccessible areas remain uncertain – but a larger share of that uncertainty is now informed by measured condition rather than untested assumptions.

5.2 Better Identification of Future Segments to Inspect

A high-density baseline creates a spatial record of where damage was, and was not, found within the examined scope. Combined with process temperature, insulation design, coating system, age, climate, geometry, and service history, the dataset can reveal recurring damage patterns, so future inspection plans can target segments that share those characteristics rather than simply repeat past inspection locations.

At the circuit level, results may justify elevating previously medium-ranked segments, deprioritizing consistently sound configurations, or redrawing circuit boundaries where degradation behavior differs materially. At the site or enterprise level, normalized data can reveal that a particular insulation detail, support design, coating generation, or intermittent-service pattern is more predictive than the generic assumptions originally used.

6 Closed-Loop Learning and Digital Asset Memory

6.1 Closed-Loop and Bayesian Updating

The term ‘Bayesian updating’ is often used loosely in RBI discussions; in practical terms, it means new inspection evidence changes the confidence assigned to prior assumptions. A high-density dataset is especially useful here because it contains both findings and examined areas with no relevant indication – and those negative results only become meaningful once the organization can demonstrate the scope and effectiveness of the examination.

A rigorous closed-loop process therefore includes data normalization, quality checks, engineering interpretation, documentation of inaccessible areas, confirmation of significant indications, and a controlled update to the RBI record – a traceable learning cycle in which each campaign improves the evidence available for the next risk ranking.

A closed-loop inspection cycle, with RBI as the decision engine

Each cycle feeds the next risk ranking - RBI remains the decision engine;
ARIX improves the evidence that drives the decision.

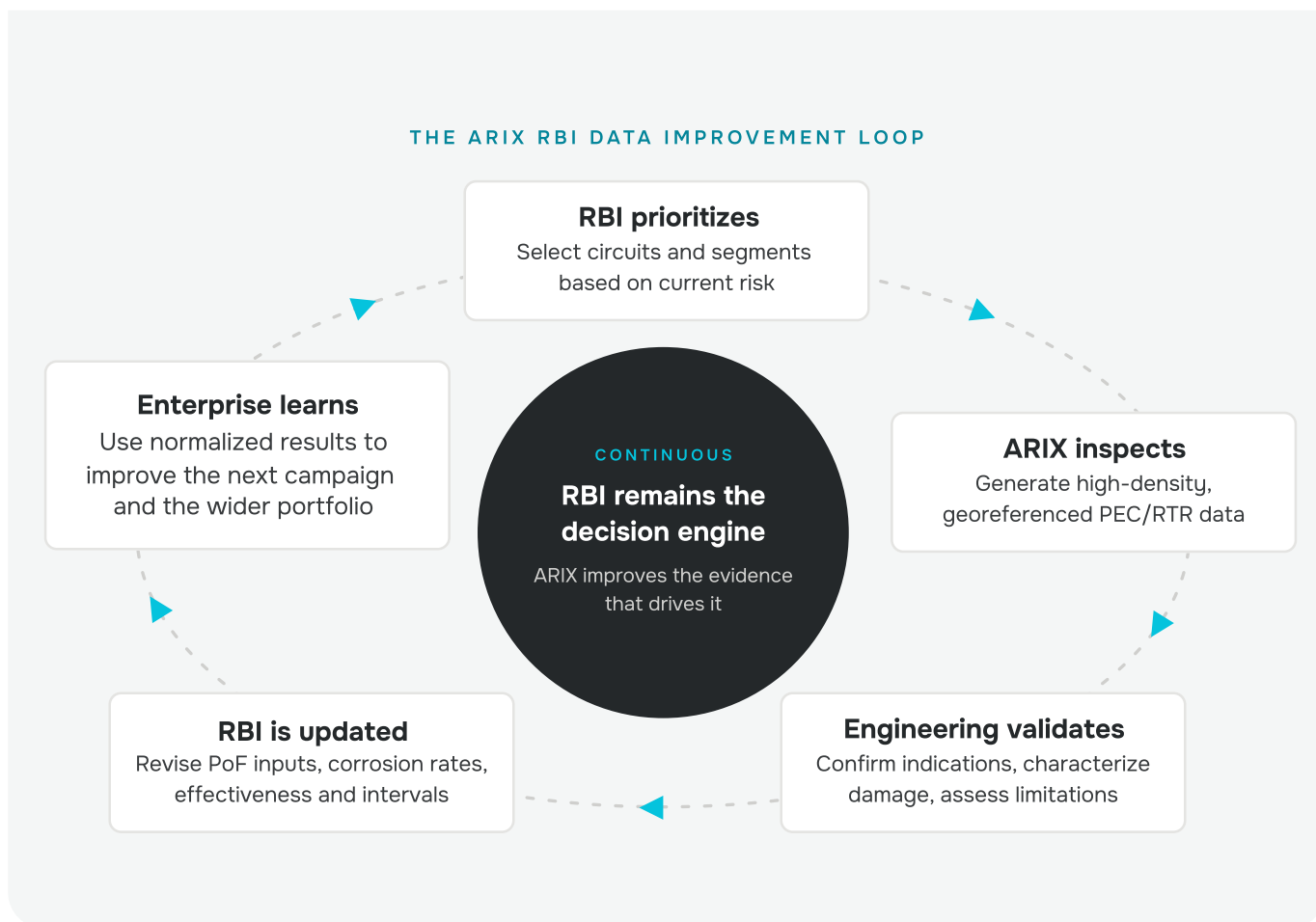


Figure 2. ARIX high-density inspection creates a closed-loop improvement process while RBI remains the decision engine.

6.2 Digital Asset Memory and Advanced Analytics

The first high-density campaign establishes a digital baseline. A repeat campaign, performed with comparable scan geometry and data conventions, can track change over time and support more defensible corrosion-rate estimates – and over several cycles, the organization develops a digital asset memory rather than a collection of disconnected inspection reports.

This is also the prerequisite for credible AI-assisted integrity management: machine-learning models cannot compensate for inconsistent, poorly located, or selectively recorded inspection data. ARIX's contribution is a standardized evidence layer on which pattern recognition, forecasting, and portfolio analytics can be built.

7 More Accurate Remaining-Life and Fitness-for-Service Decisions

Remaining-life calculations and API 579 fitness-for-service assessments are highly sensitive to the location and characterization of the governing defect, which a sparse inspection program may miss entirely. High-density inspection increases the probability that the critical location is identified within the examined scope and enables targeted confirmatory measurements where higher-accuracy sizing is required.

This supports two equally important outcomes: identifying repairs that are genuinely necessary and avoiding unnecessary insulation removal or replacement where the evidence supports continued service. The economic value therefore comes from both risk reduction and more selective maintenance.

8 Defensible RBI for Regulators, Auditors, and Insurers

Regulators generally expect an owner-operator to show that inspection scope and intervals are technically justified, implemented through competent procedures, and supported by records – they do not typically mandate one specific CUI technology. The regulatory value of robotic inspection therefore lies not in the word ‘robotic,’ but in the strength of the evidence and governance around its use.

Where an operator uses RBI to prioritize scope, extend an interval, or support continued operation, a defensible methodology must show a transparent chain of reasoning. High-density robotic inspection strengthens that chain when the program includes the six controls set out on the following page.

SIX CONTROLS THAT MAKE ROBOTIC CUI EVIDENCE DEFENSIBLE

01 Defined scope The asset, circuit boundaries, accessible surface, excluded areas, and intended RBI use are documented before execution.	02 Technology qualification The PEC/RTR procedure, calibration, detection and sizing capabilities, insulation envelope, geometry limitations, and personnel competence are defined and controlled.
03 Traceable data Every result is linked to a location, date, method, scan plan, quality status, and source file, with retained raw and interpreted data as required by the owner.	04 Engineering disposition Significant indications are reviewed by qualified personnel and confirmed by complementary NDT or insulation removal where necessary.
05 Controlled RBI update Changes to corrosion rate, PoF, inspection effectiveness, circuit ranking, or interval are documented with the evidence and assumptions that support them.	06 Transparent limitations Inaccessible areas, uncertain readings, out-of-envelope conditions, and unexamined components are not hidden inside an overall coverage percentage; they are recorded and managed.

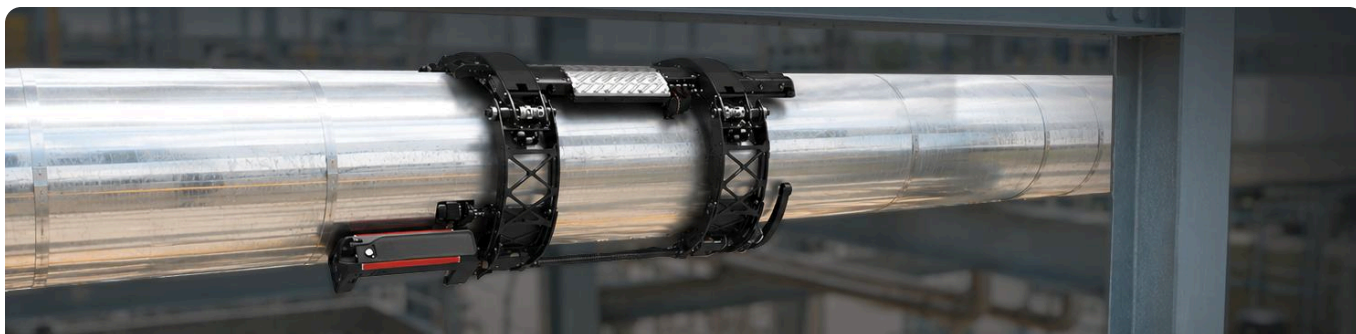
This governance is what makes the methodology defensible: a regulator or auditor should be able to reconstruct why a circuit was selected, what was inspected, what the technology could and could not establish, how results were interpreted, and how the evidence changed the integrity decision. ARIX's digital inspection model suits that requirement because the record is structured and reproducible rather than dependent on isolated field notes.

9 Enterprise Standardization: From Site Campaigns to Portfolio Learning

Large operators often have strong corporate RBI standards but inconsistent CUI execution at site level: scaffolding availability, contractor capability, turnaround timing, local budgets, and reporting conventions can produce different inspection density and confidence across nominally similar assets, leaving the enterprise risk model populated by data of uneven quality.

ARIX offers a practical mechanism to standardize the evidence-generation process. A corporate deployment can define a common scan grid, technology qualification envelope, naming convention, location-referencing system, QA/QC process, reporting template, data schema, and escalation criteria – then replicate that same method across refineries, petrochemical plants, terminals, gas-processing assets, and power facilities.

The enterprise value is larger than the sum of individual inspections. Normalized datasets let an operator compare damage prevalence by climate, insulation type, coating system, age, support detail, process temperature, and service pattern, and translate lessons from one site into inspection priorities at another – before a leak or failure occurs.



ENTERPRISE LEARNING OPPORTUNITY

A standardized ARIX program can convert millions of measurements from separate campaigns into a corporate CUI knowledge base – one that can improve future RBI assumptions across the entire asset portfolio, not only on the circuits already inspected.

Economics, Implementation, and Industry Direction

10 The Economics of Better Evidence

The direct economic case for robotic CUI inspection is compelling because conventional access and insulation work often dominate campaign cost – scaffolding alone can account for 50–70% of traditional campaign cost, and ARIX cites examples of 99% scaffolding reduction. But the most important business case is not the price of the inspection; it is the lifecycle value created by a better integrity decision.

10.1 Direct Campaign Economics

Robotic inspection can reduce or eliminate large portions of scaffolding, insulation removal, disposal, reinstatement, painting repair, craft coordination, and permit duration, while shortening how long operating areas stay congested by access structures and lowering personnel exposure to work at height and around process equipment.

10.2 Uncertainty Economics

Better data changes future expenditure in ways not visible in the initial inspection quote. A more reliable PoF estimate can prevent unnecessary broad inspection, focus insulation removal on confirmed areas, support a justified re-inspection interval, prioritize repair before failure, and reduce the probability of an unplanned outage – benefits that play out over multiple budget cycles and belong in the investment case.

The causal chain is straightforward: higher measurement density improves understanding of actual condition; improved condition knowledge strengthens PoF and remaining-life decisions; better decisions improve the allocation of inspection and maintenance resources; and better allocation lowers lifecycle cost while reducing residual risk. Robotic inspection does not drive residual risk to zero, but it can materially reduce the risk associated with unexamined or poorly characterized accessible surface.

VALUE DRIVER	TRADITIONAL BASELINE	ARIX REPORTED RANGE	RBI / LIFECYCLE EFFECT
Direct inspection cost	100% baseline	30–63% of baseline	More inspection data within the same budget
Data reuse	Limited local records	Structured digital baseline	Supports re-inspection, model updates, and portfolio analytics
Maintenance selectivity	Broad strip or reactive work	Targeted confirmation and repair	Avoid unnecessary insulation disturbance and focus resources

Table 2. Economic and RBI value drivers. Reported ranges are drawn from the cited ARIX case studies and are not universal guarantees.

11 Recommended Implementation Path

Successful integration should be managed as an RBI data-improvement program, not as a stand-alone robotics demonstration. ARIX recommends a phased approach.

PHASE 1

Select a decision-relevant pilot

Use the existing RBI ranking to select circuits where the data gap matters most: high consequence, uncertain PoF, intermittent service, repeated insulation damage, high access cost, or conflicting inspection history. Define the decision the campaign is meant to support – confirming condition, reprioritizing segments, or establishing a baseline.

PHASE 2

Establish a qualified digital baseline

Agree the robotic procedure, scan density, coverage definition, data-location convention, confirmation criteria, inaccessible-area treatment, and reporting output, then execute the inspection and retain both interpreted results and underlying source data per the owner's record policy.

PHASE 3

Integrate results into RBI

Bring together the ARIX inspection team, corrosion/materials engineering, inspection authority, RBI owner, and maintenance planning to translate results into the fields required by the existing RBI methodology, and document any change to PoF assumptions, inspection effectiveness, risk ranking, circuit segmentation, re-inspection interval, or repair priority.

PHASE 4

Standardize and scale

Once technical and economic value is demonstrated, define an enterprise standard work process: standardized scan plans, QA/QC, data taxonomy, reporting, integration interfaces, performance metrics, and governance. Use the expanded dataset to identify comparable circuits across the portfolio and prioritize the next wave of campaigns.

12 Implications for Industry Practice and Standards

RBI standards and owner-user procedures have historically classified inspection effectiveness around the methods and coverage that were economically feasible at the time. High-density robotic inspection creates an opportunity to revisit how effectiveness is demonstrated for CUI – but the classification should not be awarded automatically because a robot was used. It should reflect qualified capability, actual accessible coverage, data quality, location traceability, and confirmation practice.

ARIX encourages owner-operators, inspection bodies, and standards committees to develop clearer guidance for incorporating high-density digital CUI data into PoF calculations and inspection-effectiveness categories. Shared, anonymized datasets could also improve the empirical basis of future CUI models by comparing predicted susceptibility with observed damage distributions across climates, insulation systems, operating regimes, and asset ages.

The industry should also distinguish between data acquisition and integrity decision-making: robotics can dramatically improve the former, but qualified engineering, applicable codes, fitness-for-service methods, and owner-user governance remain essential to the latter. Thought leadership here requires both ambition about the value of new data and discipline about the limits of the technology.

13 Conclusion

Risk-Based Inspection remains the correct framework for prioritizing CUI inspection resources. The opportunity now is to remove one of its most persistent constraints: sparse, inconsistent, and expensive inspection evidence. ARIX Technologies' high-density robotic approach changes the economics and quality of that evidence by examining substantially more accessible surface, recording results digitally, and applying a repeatable methodology that scales across an enterprise.

The implications extend well beyond inspection productivity. A denser, more consistent dataset can strengthen PoF inputs, identify future segments more intelligently, support remaining-life and fitness-for-service decisions, create an auditable basis for regulatory review, and enable comparable implementation across multiple sites. Repeated campaigns build a digital asset memory and a foundation for enterprise learning that isolated inspection windows cannot provide.



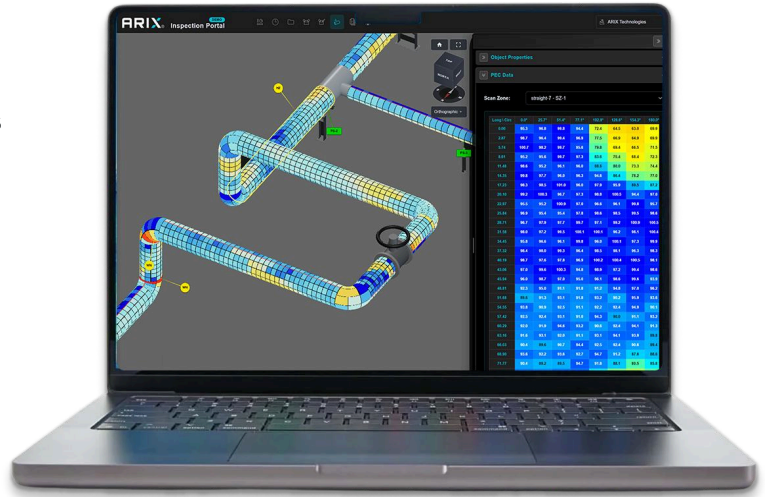
ARIX LEADERSHIP POSITION

RBI determines where risk should be managed. ARIX provides the high-density inspection evidence that allows the risk decision to be made with greater confidence, defended more transparently, and repeated consistently across the enterprise.

The next evolution of CUI RBI will not be defined solely by a different algorithm – it will be defined by better evidence. By combining robotics, qualified NDT, digital traceability, and a closed-loop integration process, ARIX is positioned to lead that evolution, helping operators move from assumption-heavy, sample-based CUI management toward evidence-driven mechanical integrity at scale.

ABOUT ARIX TECHNOLOGIES

ARIX Technologies develops and deploys robotic inspection solutions purpose-built for CUI and related mechanical integrity challenges in the energy and process industries. The VENUS platform combines robotic access, qualified NDT, and digital analytics to deliver high-density inspection data without routine scaffolding or insulation removal – helping operators strengthen existing RBI and mechanical integrity programs through better evidence, faster execution, and enterprise-scale consistency. Headquarters are in Houston, Texas.



ARIX INSPECTION PORTAL

BOOK A FIELD WALK

To discuss how high-density CUI data could strengthen your RBI program, schedule a site walkthrough with our team. You define what to inspect and where to focus; we scope the program around your priorities.

arix-tech.com/contact | (936) 463-1977

1. ExxonMobil industry studies cited in multiple industry sources; CUI is commonly reported to account for 40-60% of piping maintenance costs.
2. Petroleum Safety Authority Norway / Havtil. Maintenance management - corrosion under insulation (CUI). Reports cited in the source paper associate CUI with a substantial share of onshore hydrocarbon leaks.
3. Watt, C. et al. (2021). Using industry data to compare performance of different risk-based methods for the management of CUI. Corrosie Labs / industry paper.
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7. Cao, Q. et al. (2022). A Review of Corrosion under Insulation: A Critical Issue in the Oil and Gas Industry. Metals, 12(4), 561.
8. API Recommended Practice 580 and API Recommended Practice 581, applicable editions.
9. NACE / AMPP SP0198 and API 570 Piping Inspection Code, applicable editions.
10. ARIX Technologies commercial case studies, including Petromax Refining and multi-client grid-scan campaigns.
11. ARIX Technologies technical literature and webinars on the VENUS robotic platform combining PEC, RTR, visual inspection, and digital data reporting.
12. Industry reviews and conference papers from Inspectioneering and AMPP/NACE on the limitations of sparse CUI sampling and the use of higher-density inspection data.

Disclaimer: This white paper is intended for informational and educational purposes. Inspection programs should be developed and approved in accordance with applicable laws, codes, standards, owner-user procedures, technology qualification requirements, and qualified engineering judgment. Performance ranges are drawn from published material and ARIX commercial deployments; actual results vary with pipe geometry, insulation system, access, process conditions, and project scope. © ARIX® Technologies 2026. All rights reserved.