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CASE STUDY

February 2026

Transforming Risk Based Inspection Through Widescale Deployment of WAND

INTRODUCTION

As asset integrity management evolves in the digital age, industries are seeking solutions that deliver more accurate, efficient, and cost-effective wall thickness measurements. Risk-Based Inspection (RBI) relies heavily on reliable thickness data to assess remaining life and determine inspection intervals. This case study examines how the widescale deployment of Inductosense's Wireless and Non-Destructive (WAND) technology is optimising RBI by reducing inspection costs, enhancing safety, improving data fidelity, and supporting predictive maintenance strategies

RBI frameworks:
RBI frameworks prioritize inspection activities based on the likelihood and consequences of equipment failure. This relationship can be summarized by the following equation:

$$Im[year]=Rf*Lr[year] \quad [1]$$

Where Im is the maximum inspection interval, Rf is the risk factor, and Lr is the estimated remnant life.

Rf is the risk factor, which can be derived from the probability and impact table below.

Probability	Extreme	0.5	0.3	0.2	0.1
	High	0.7	0.5	0.3	0.2
	Medium	0.8	0.7	0.5	0.3
	Low	0.9	0.8	0.7	0.5
Impact		Low	Medium	High	Extreme

Table 1: Risk factor table, the numbers in the table are for example purposes only and may vary from site to site.

Lr is the estimated remnant life, and for systems dominated by wall thickness this is typically calculated using the following equation:

$$Lr(year)=(tc[mm]-ta[mm])rc[mm/year]/[2]$$

Where *tc* is the current wall thickness, *ta* is the minimum allowable wall thickness and *rc* is the corrosion rate. Clearly, the accuracy of the corrosion rate estimation has a significant impact on the remnant life and, consequently, inspection interval.

A large downstream plant may have over 100,000 corrosion monitoring locations (CMLs), where wall thickness is typically measured using manual ultrasonic testing (MUT). These measurements are costly and prone to significant human error, often leading to challenges in interpreting results such as estimating corrosion rates. This can result in either over-inspection or under-inspection. As a result often conservative estimates must be used which will raise the overall inspection cost.

Permanently installed ultrasonic sensors have long been available as an alternative to MUT, providing a means for more accurate corrosion rate prediction and therefore efficient inspection plans. Today, these sensors are becoming more cost-competitive, enabling large-scale deployment across sites.

Inductosense's WAND technology represents a breakthrough in wall thickness monitoring. It enables rapid, repeatable ultrasonic measurements via battery-free, cost-effective sensors that are permanently installed on assets at scale. This paper discusses how WAND supports the evolution of RBI programs into more data-driven, efficient, and safer systems and presents field deployment results to support this.

Traditional Inspection Strategy:

RBI prioritises equipment and inspection resources based on the likelihood and consequences of equipment failure as discussed in the previous section.

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For example, figure.1 shows an example of inspection frequency versus corrosion severity, assuming that the risk factor, current wall thickness and minimum allowable wall thickness are the same. Essentially how often inspections must be performed as a function of rc in Equation 2. The percentages refer to what fraction of the CML's on a typical asset fall into each of these categories.

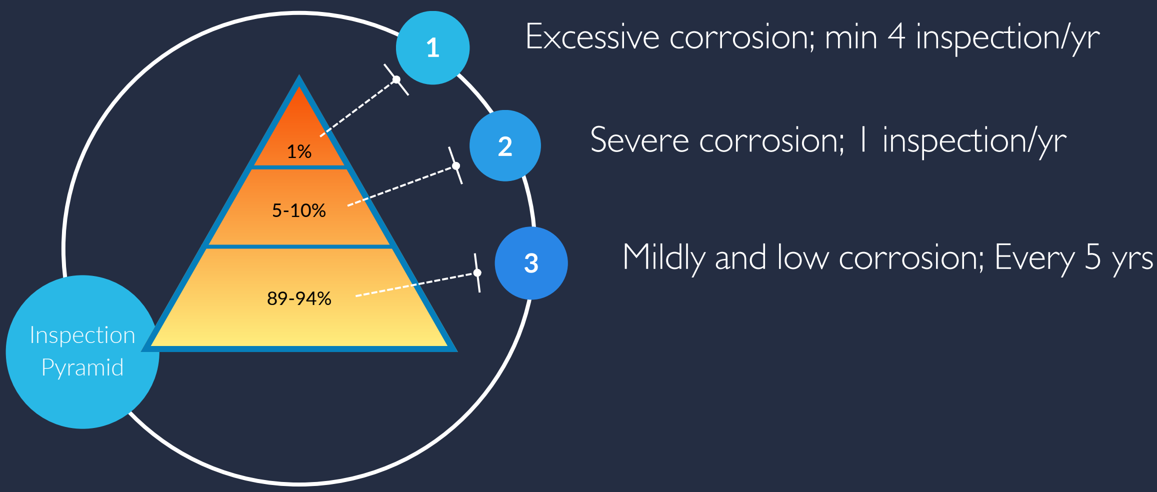

Figure 1: Inspection frequency against the corrosion severity

This approach optimises resource allocation, improves efficiency, and ensures that inspection intensity matches risk level. Due to inspection frequency requirements and to optimise inspection costs, different inspection methods are commonly applied to different tiers.

Tier 1: Online monitoring

The online monitoring hardware can be expensive but then the cost of each measurement is dramatically lower than MUT.

Tier 2: Robotics inspections

The hardware for robotic inspection (such as drone based UT) can be expensive so the cost per measurement is higher than online monitoring but lower than MUT.

Tier 3: Manual ultrasonic testing

The inspection hardware is low cost, but MUT requires a highly skilled inspector which is expensive.

This effect is normally coupled with the accessibility challenges and their associated costs as shown in the figure. 2. A similar inspection tier approach can be applied to these accessibility challenges. Areas that are hard to reach typically costing much more to inspect but making up a much smaller percentage of the total CML's. It is worth noting that even accessible locations have significant measurement costs in current systems, due to staff costs, site access requirements and significant health and safety obstacles.

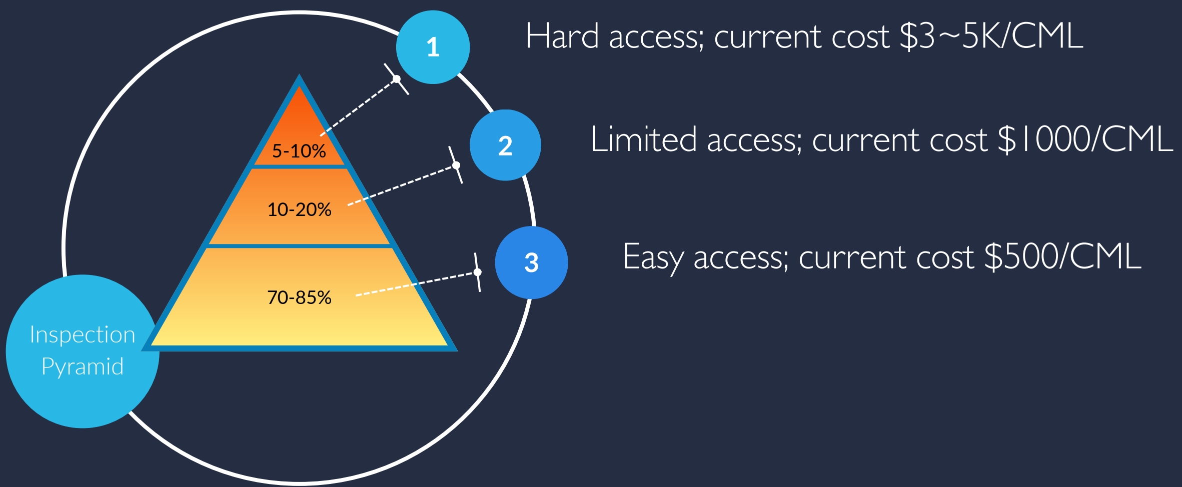

Figure 2: Inspection access cost

A significant challenge for this inspection strategy is data discrepancy resulting in poor remaining life estimation. This is due to the following discrete processes:

· Inconsistencies in monitoring location continuity between different inspection methods, repeat manual measurements are not in the exact same location and if a permanent system is installed to replace a manual one, the location will not be exactly the same.

· Variations in calibration parameters, such as velocity used for thickness calculations, across different inspection methods.

· Differences in thickness calculation approaches adopted by various methods.
Additionally, the data type and formatting also pose significant challenges for end users in combining, analyzing and adapting these inspection measurements for structural integrity assessments. Thus a need for a common, cost-effective method to cover all CML's severities and locations would be beneficial.

OVERVIEW OF WAND TECHNOLOGY

The Wireless and Non-Destructive (WAND) system from Inductosense was initially developed by Dr. Chenghuan Zhong, Prof. Anthony Croxford and Prof. Paul Wilcox at the University of Bristol. The system uses inductive coupling to excite a wireless, battery-free ultrasonic sensor. The sensor is permanently bonded to the structure as illustrated in Fig.3(a). The inductive coupling is achieved using a three-coil network. One coil, termed the transducer coil, is connected to the piezoelectric transducer. The other two coils, called the transmitting and receiving coils, are contained within the WAND data collector and are connected to the outputs and inputs of the ultrasonic instrumentation as illustrated in Fig. 3(b). When the WAND data collector is held in close proximity to the sensor, electrical signals are transferred between the three coils and ultrasonic measurements are recorded from the sensors.

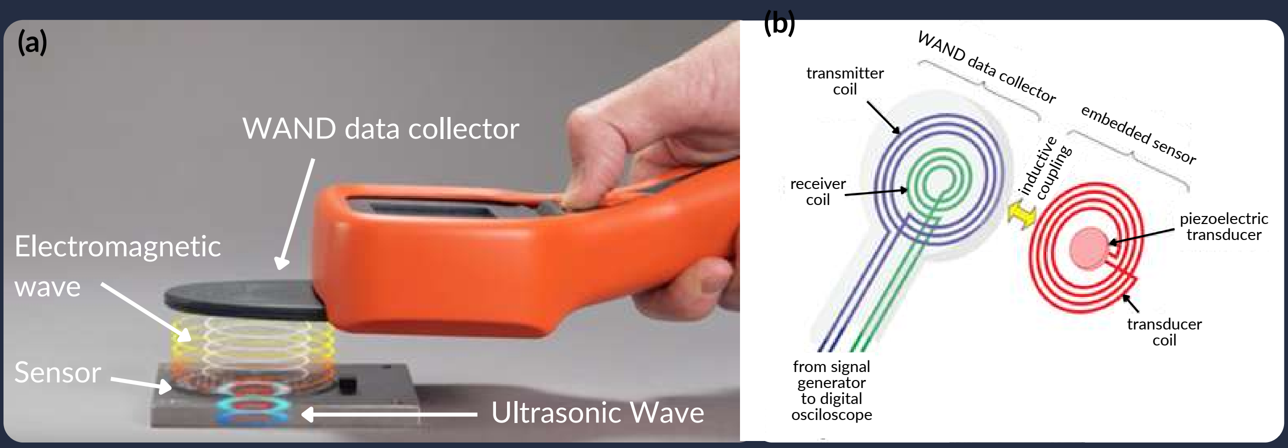

Figure 3: (a) Operation of WAND system, and (b) details of the inductive coupling between the WAND data collector and ultrasonic thickness sensor

Compared to conventional manual ultrasonic testing, the system enables fast contactless measurements (each reading taking a fraction of a second), with a separation distance between the WAND data collector and sensor of up to 5cm.. In addition the system does not required a skilled operator to use it.

There are different methods for collecting the data from the sensors: (i) a handheld data collector (HDC) as shown in figure 3 (ii) a remote data collector (RDC) – which automatically collects the measurements a pre-determined intervals which can then be downloaded bia Bluetooth 5.0 at up to 200m (iii) online data collection – using the RDC and a gateway to transfer the data to the cloud-based software automatically (iv) robotic data collection – a module that is integrated with robotic platforms such as a UAV. Operators can adopt a similar inspection strategy using the WAND solution, to that discussed earlier, as illustrated in figure 4.

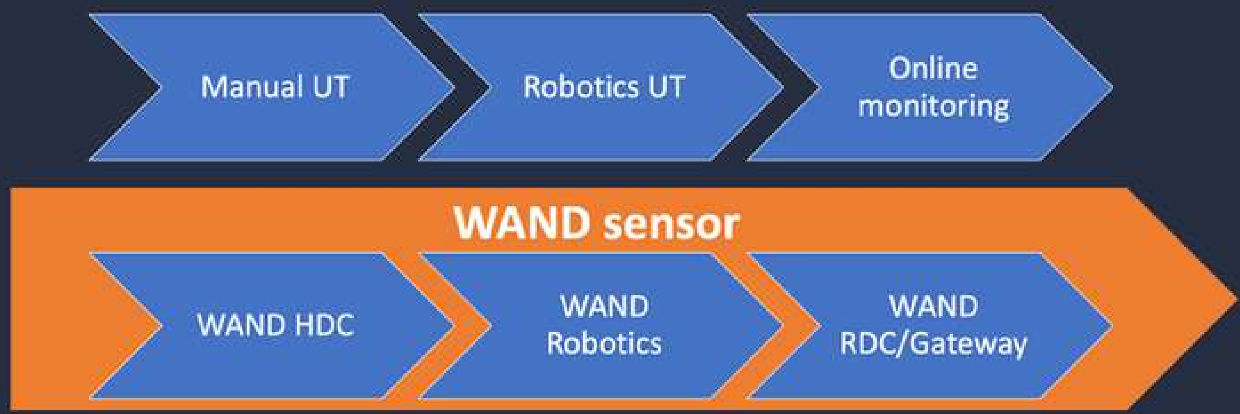

Figure 4: Comparison between the traditional inspection methods and WAND system

Compared to traditional inspection strategies, the WAND inspection strategy offers cost benefits at each tier over the long term while overcoming data discrepancy challenges. The are acquired from the same location each time and the processing is consistent. Indeed if processing methodologies are improved then these can be applied retrospectively as the data from each location where there is a sensor is stored (in contrast to MUT).

SYSTEM IMPLEMENTATION

This approach is being demonstrated globally across multiple sites with tens of thousands of sensors deployed. An example of how one site is using the WAND system, with thousands of sensors deployed, is described below.

For structures which have insulation, the Inductosense ECHO accessory is used. This works on the same principle of inductive coupling and allows the measurement location to be extended to an accessible place on the outside of the insulation (as shown in figure 5). A wall thickness measurement of the underlying structure can then be acquired without removing the insulation.

Figure 5: Structure with ECHO fitted

Tier I CMLs

With sensors deployed across the CMLs, Tier I targets are currently monitored using the RDC, as shown in figure 6. This enables data to be captured at whatever measurement frequency is desired and can be reconfigured at any time. A sample of the data collected by an RDC is presented in figure 7. Daily measurements were taken over a 2 month period, revealing an average corrosion rate of 3.1 mm/year. This allows immediate action to be taken based on the short-term corrosion rate.

Before the RDC was deployed, monthly manual ultrasonic testing was conducted, which required insulation removal and reinstallation. A return on investment of the RDC installation was achieved within a period of less than three months.

Figure 6: Structure with RDC fitted

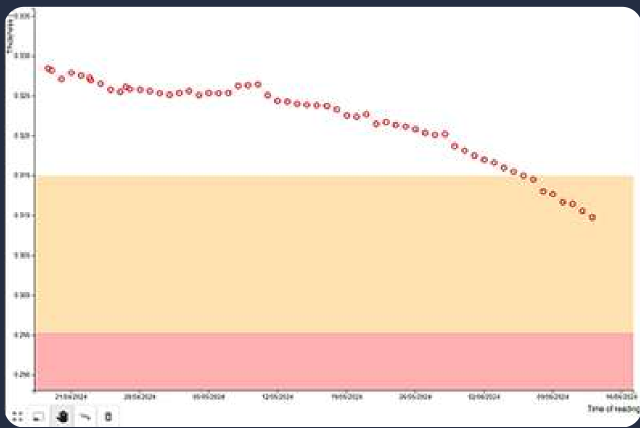

Figure 7: Thickness loss trend line over 2 months

Tier 2/3 CMLs

Tier 2/3 CMLs are currently monitored with HDCs with accessories such as the REACH – an extendable probe that allows measurements to be acquired from sensors at height (shown in the figure 8).

Figure 9 shows an example of a thickness plot from a CML with both MUT and using the WAND HDC. These two measurements were taken from at the same location, and clearly show the nature of the MUT challenge, which does not allow accurate trending. In the inspection cost, such as scaffolding in hard-to-access locations can be significantly reduced.

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Figure 8: Thickness measurement taken with HDC and REACH

Figure 9: Transition from Manual UT measurements to the WAND Solution

Inductosense is currently trialling robotic solutions for Tier 2/3 CMLs. The data collector has been integrated with various robotic platforms, such as drones and ATEX robots.

RBI AND INSPECTION PROGRAMMES IMPACT

Having described the potential benefits of the WAND solution we will now show the implications of the different methodologies to the outlined RBI inspection approach.

Corrosion Rate Prediction

Figure 11 statistically compares MUT data with data collected by the RDC system. The 95% confidence interval for the corrosion rate is dramatically reduced with the WAND system, consequently leading to much more accurate predictions of the estimated remaining life and inspection intervals. It is worth noting that in this case the data for each method was captured over a similar timeframe, so the enhanced accuracy is purely a result of more reliable data. This effect will only become more pronounced as data is captured over a protracted period. This high accuracy thickness data has been seamlessly integrated with the end-user asset management solution through APIs, enabling risk assessment and inspection scope generation for inspections and measurements, all while maintaining access to the original data.

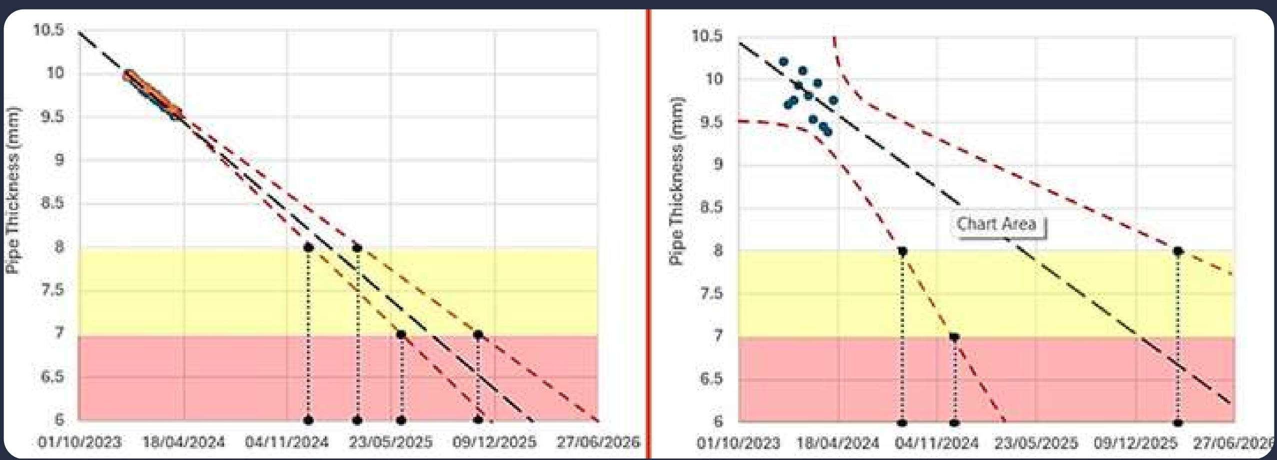

Figure 11: Thickness measurements over time with WAND (left) vs. Manual UT (right) show how improved data accuracy and increased measurement frequency improves maintenance planning accuracy.

Cost Reduction

Scaffolding, rope access, insulation removal, and extensive, skilled, manpower for manual ultrasonic testing contribute significantly to the overall inspection budgets. WAND enables a 60–90% reduction in these ancillary costs, especially when the sensors are installed as part of the existing inspection cycle. WAND helps RBI to lower cost, reduce risk, and prioritize effort where it matters most.

Safety Improvements
WAND can reduce personnel exposure to hazardous environments, for example with the use of the RDC to collect data from a sensor at height or with the HDC to acquire measurements quickly without removing insulation. This aligns with ALARP (As Low As Reasonably Practicable) to manage safety and integrity risks in a way that balances risk reduction with practical effort and cost.

CHALLENGES

While the benefits of WAND technology are compelling, widescale adoption requires consideration of:

- Where to place the sensors: Optimisation based on corrosion circuits, CMLs, and historical data.

- Installation planning: Best executed as part of the current inspection cycle (eg install a sensor at the point when the next inspection is due) to reduce additional access costs.

- Training and change management: Equipping inspection teams with skills and confidence to adopt new workflows.

CONCLUSION

Inductosense's WAND technology represents a shift in how thickness data is collected and used within RBI programs. By delivering repeatable, fast, and accurate measurements, it directly supports the pillars of RBI: accurate risk assessment, cost-effective inspection, and proactive integrity management. Widescale deployment, with thousands of sensors per asset, enables a new level of efficiency and insight, unlocking the potential for real-time risk assessment and fully digitalized integrity programs. In addition the technology is well suited to reconfiguring inspection approaches based on the on plant reality. For instance if a region of a plant shows increased corrosion rate a RDC may be substituted for a HDC seamlessly to increase measurement frequency while retaining continuity of data.

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