

# HOW ADVANCED INSPECTION TECHNIQUES KEEP RAIL SYSTEMS RIGHT ON TRACK

EDDYFI TECHNOLOGIES KEEPS RAIL OPERATIONS ROLLING



WHITE PAPER



In today's fast-paced world, the rail industry demands exceptional safety, reliability, and efficiency. **Beyond Current** standards isn't just a goal—it's a necessity. The rail industry plays a critical role in global logistics, handling a significant portion of freight and providing an environmentally friendly alternative to other transport methods. As the demand for rail transportation grows, maintaining the integrity of rail systems is crucial. With the rise in rail freight and the need for reliable transport, robust inspection practices are essential for upholding safety and efficiency across the industry.



## ALL ABOARD FOR SAFETY

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The rail sector is critical to global transportation, driving economic growth and providing sustainable solutions for moving goods and people. In this dynamic landscape, maintaining the highest standards of safety, reliability, and efficiency is essential. As the demand for rail transportation increases, so does the need for robust inspection practices to ensure every component's integrity. Non-Destructive Testing (NDT) plays a vital role in this process, offering the precision and reliability needed to prevent failures, optimize maintenance, and keep these critical systems operating smoothly.

However, the industry faces several challenges in implementing NDT. The complex shapes and diverse materials of components like axles, wheels, and even railway tracks make thorough testing difficult. Inspections often occur in challenging environments, which can limit access and accuracy. The need for highly sensitive defect detection must be balanced with the demand for quick inspections to reduce downtime.

Eddyfi Technologies provides advanced inspection solutions specifically designed for the rail sector. These technologies are crucial for maintaining asset integrity, optimizing operational efficiency, and ensuring compliance with regulatory standards. Key inspection methods include Phased Array Ultrasonic Testing (PAUT), Eddy Current Array (ECA), and Alternating Current Field Measurement (ACFM®).

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**Most consumers think of trucks for logistics and deliveries, but the U.S. rail freight system accounts for approximately 16% of all shipments by weight. Rail freight is a more environmentally friendly option, emitting 75% less greenhouse gas than trucks. By 2035, rail freight tonnage is expected to grow by 22%, reaching 15.3 billion tons, and is projected to increase further to 16.9 billion tons by 2050. Railway tank cars transport a wide variety of essential products across industries such as agriculture, food and beverage, chemicals, plastics, and oil and gas.**

U.S. Department of Transportation, Federal Railroad Administration. (2010). *National Rail Plan Progress Report*. Retrieved from [https://railroads.dot.gov/sites/fra.dot.gov/files/fra\\_net/1336/NRP\\_Sept2010\\_WEB.pdf](https://railroads.dot.gov/sites/fra.dot.gov/files/fra_net/1336/NRP_Sept2010_WEB.pdf).

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## AN ARRAY OF POSSIBILITIES FOR BETTER RAIL INSPECTION

Eddy Current Array (ECA) is a fast and sensitive NDT method, ideal for detecting surface cracks even through coatings. Its ability to adapt to different shapes and rapidly collect data makes it essential for rail inspections. ECA technology is crucial in the rail industry, addressing the specific challenges of inspecting critical components such as wheels, axles, bogies, and welds, all of which require precision and reliability.

ECA technology has proven effective in a variety of rail industry applications:

**Axle Inspections:** ECA is instrumental in the inspection of axles, which often have complex geometries and are subject to significant loads. The ability of ECA to detect cracks in hard-to-reach areas, such as radii and cylindrical sections, makes it an ideal choice for this application. The technology's capability to detect defects through coatings also streamlines the inspection process, eliminating the need for coating removal and thereby reducing both time and costs.



Figure 1: Demonstrating ECA's detection capabilities and sensitivity, an axle body with artificial defects was painted to test inspection efficacy. The flexible ECA probe was used for inspection without altering configuration parameters, showcasing its ability to detect defects through the coating.



Figure 2: Inspection of the accessible part of the axle body using four successive scans with the Spyne™ probe.



**Wheel Inspections:** Train wheels are crucial components, as they are the sole contact point between the carriage and the rail. Factors like track debris, braking cycles, and moisture can cause cracking, with tight radii in wheels exacerbating these issues. Our I-Flex™ ECA probes, known for their flexibility and durability, are ideal for inspecting wheel surfaces and axle shafts.

**Bogie Inspections:** For bogies, particularly those made from aluminum, ECA probes can inspect welds and other critical components for cracks and flaws. While Ultrasonic Testing (UT) is standard for subsurface defects, ECA provides a quicker solution in the field. Eddyfi Technologies ECA technology detects Lack of Fusion (LoF) and Lack of Penetration (LoP) up to eight millimeters (0.32 inches) below the surface, reducing inspection time. For complex bogie geometries and braking unit slots, our adaptable probes ensure thorough and efficient detection of cracks and corrosion.

**Weld Inspections:** ECA technology is used to inspect welds in rail carriages and other structures. For fillet welds, ECA sensors can be adapted with custom probe bodies for specific geometries. Eddyfi Technologies also provides smaller, custom probes for detecting submillimeter cracks in limited access areas. Additionally, the Sharck™ ECA probe can inspect carbon steel carriages, identifying and sizing cracks in weld crowns and toes.

These ECA solutions are compatible with Eddyfi Technologies' Reddy® and Ectane® instruments, allowing for portable and efficient rail inspections. Whether it's detecting cracks in tight spaces or inspecting large surfaces quickly, ECA is a powerful tool for maintaining the safety and reliability of the rail industry.



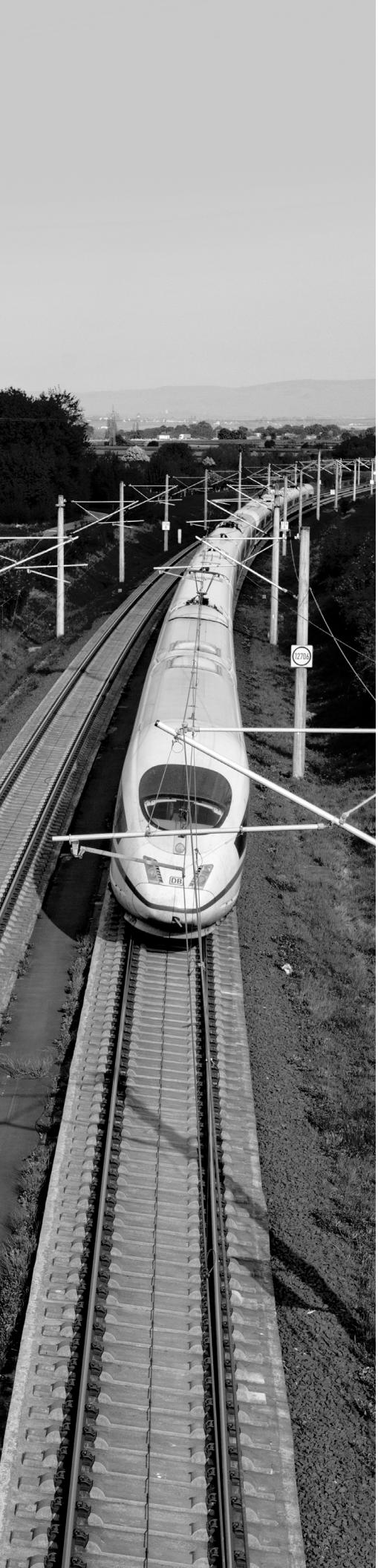
Figure 3: Best portable electromagnetic NDT system for rapid crack detections and corrosion assessment.

Packaged with the latest technology, Reddy and its embedded data analysis software offer the most intuitive user experience, which includes real-time C-scans, a modern, rugged, and large multi-touch interface, as well as many other features that enable fast, high PoD surface inspections.



Figure 4: The most advance surface array and tube inspection test instrument.

With a complete overhaul of the assembly, the Ectane 3 incorporates the latest electronic components available on the market in a more rugged platform than ever before. Building on the foundation laid by its predecessor for more than a decade, the IP65-certified Ectane 3 is the device you can count on to withstand even the harshest field environments.



## KEEPING RAIL INSPECTIONS ON THE RIGHT TRACK WITH PHASED ARRAY ULTRASONIC TESTING

**Phased Array Ultrasonic Testing** (PAUT) is a versatile and powerful inspection method that uses multiple ultrasonic elements to focus and steer the sound beam. This capability allows for detailed inspection of complex geometries and large components, making it ideal for rail industry applications.

**Axle Inspections:** Solid axles are challenging to inspect due to their accessibility and complex shapes. Eddyfi Technologies simplifies this process with a solution that detects corrosion and cracks, particularly at the crack initiation stage, without removing the axle from the bogie. Our phased array solution uses a unique probe and scanner that provide clear images overlaid on a true view of the axle's geometry from a DXF file. This allows for quick, accurate flaw detection and consistent results. The scanner, easily installed with a central pin locator and magnet, lets operators cover the entire axle surface by simply rotating it, without needing to hold the probe.



Figure 5: Phased array ultrasonic solution with a unique probe and scanner ensures consistent, reliable results for train axle inspections.

**Weld Inspections:** The Mantis™ and Gekko® portable PAUT instruments provide high-resolution imaging and real-time analysis, significantly improving the reliability and speed of weld inspections. PAUT's ability to detect defects in weld heat-affected zones (HAZ) is particularly beneficial for rail maintenance, ensuring that any potential failures are identified and addressed promptly.

**Bogie Inspections:** For high-speed trains like Japan's Shinkansen, PAUT is used to inspect bogie frames for fatigue cracks. The system's ability to penetrate thick materials and detect subsurface defects ensures that any potential structural issues are identified early.

At Eddyfi Technologies, we eliminate the guesswork from phased array ultrasonic testing. Our expert team has crafted dedicated packages for both common and niche inspection applications, addressing the unique demands of your role as an NDT inspector with comprehensive, turnkey solutions.

## CRACKING THE SURFACE: ACFM® FOR RAIL INSPECTIONS

***“The established Eddyfi solution is comprised of the Amigo™ 2 ACFM instrument with powerful embedded software and purpose-built probes. Inspecting a complete tank car with ACFM takes approximately two hours, saving asset owners millions at the end of the year.”***

**Charles Tremblay**  
Product Manager

Alternating Current Field Measurement (ACFM®) was initially developed for the oil and gas industry to detect and size surface-breaking cracks with minimal surface preparation. Over time, it has become widely adopted across various industries as an effective alternative to traditional magnetic particle and dye penetrant inspections. Eddyfi Technologies' ACFM solutions are designed for versatility, allowing them to be applied to a wide range of components, from large structural elements to smaller machinery parts.

**Rail Inspection:** ACFM is proven to detect Rolling Contact Fatigue (RCF) cracks in rail surfaces with a high probability of detection. The method's ability to provide clear, high-resolution data quickly makes it an essential tool for ongoing rail maintenance.

**Tank Railcar Inspection:** ACFM is used to inspect critical welds in tank railcars, particularly in areas subjected to high stress. The technique's ability to inspect rough, coated surfaces without requiring coating removal is a significant advantage, reducing inspection time and costs.

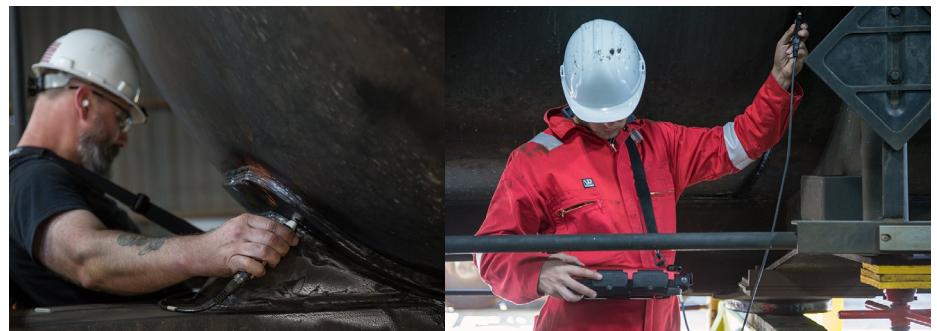


Figure 6: Sensu 2 ACFM probes with the Amigo 2 for rail tank car weld inspection.

**Bridge Inspections:** ACFM is also utilized in infrastructure inspections, such as bridges, where it can detect and measure cracks in support structures. This is crucial for preventing failures that could lead to severe consequences, such as train collisions.



Figure 7: Amigo2 is engineered around an advanced signal acquisition and processing system that offers smoother, higher resolution indications that increase the detectability of small defects.

**The powerful data acquisition system behind our ACFM technology is the Amigo2, a self-contained unit incorporating electronics, multi-touch display and storage in a rugged enclosure. Thanks to the Amigo2's fast electronics, which facilitate rapid inspection scans with the largest array probes, a comprehensive train axle inspection can be completed within a few minutes.**



## STIKING TO PRECISION: REMOTE VISUAL INSPECTION FOR CONFINED SPACE ENTRY APPLICATIONS

In the rail industry, Federal Railroad Administration (FRA) regulations mandate that every rail or tank car be inspected before leaving an industrial facility, terminal, or yard. Historically, these inspections—especially for tank cars transporting liquids and gases—have been manual, depending heavily on the expertise of inspection personnel. This process is labor-intensive, subjective, and lacks comprehensive record-keeping unless repairs are needed, leading to a reactive maintenance approach.

To improve inspection efficiency and reduce human intervention, the STIK™ system offers a modern solution. This advanced remote visual inspection (RVI) system incorporates Eddyfi Technologies' Spectrum™ 120 high-definition pan, tilt, zoom (PTZ) camera, providing superior data collection capabilities. The STIK is a portable, turnkey system designed to assess the condition of railcar assets after discharge and cleaning.

The STIK enables full 360-degree internal inspections of tanks, evaluating liners, welds, fasteners, and potential defects. It helps identify cracks, worn areas, delamination, chemical degradation, and residual liquid in double-walled tanks. Real-time monitoring of critical components, such as drain valves and seals, as well as any obstructions or malfunctions, is also possible with the STIK.

By utilizing the STIK, inspections become more efficient and less hazardous, providing precise and comprehensive data that supports preventive and condition-based maintenance. This proactive approach ensures timely interventions, improving railcar safety and operational reliability.



Figure 8: The STIK performing remote visual inspection inside tank cars.

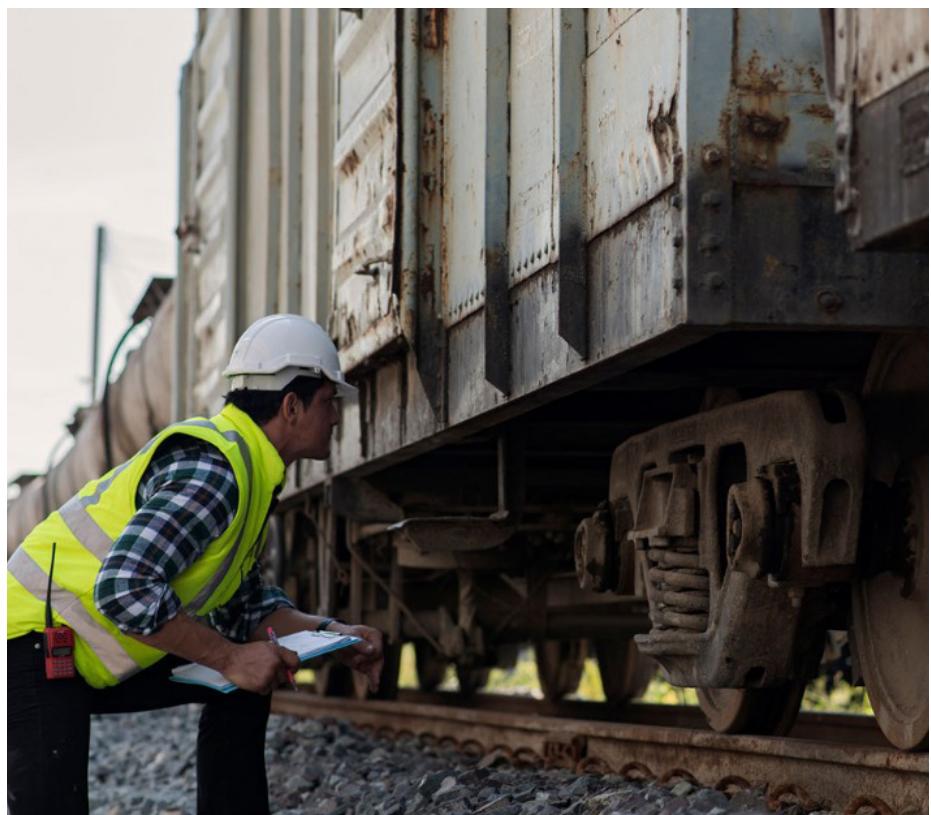
## ADVANCED INSPECTION SOLUTIONS FOR A SAFER, MORE EFFICIENT RAIL INDUSTRY

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As rail assets continue to serve as a vital component of global transportation, ensuring their safety, reliability, and efficiency is more important than ever. Eddyfi Technologies stands at the forefront of this mission, providing cutting-edge NDT solutions tailored to the unique challenges of the rail industry. From axles and welds to bogies and rail surfaces, our advanced inspection techniques, including PAUT, ECA, and ACFM, deliver the precision and reliability needed to keep rail systems operating smoothly and safely.

With the ability to detect defects early, minimize downtime, and enhance overall maintenance practices, Eddyfi Technologies' solutions not only meet but exceed industry standards. By adopting these advanced inspection methods, rail operators can ensure the integrity of their assets, prevent costly failures, and maintain the highest levels of safety and performance. Trust Eddyfi Technologies to keep your rail systems on the right track, today and into the future.

**Eddyfi Technologies has experience delivering advanced NDT solutions for the rail sector. Bring us your specific requirements and we'll offer the optimal solution.**





Beyond current

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