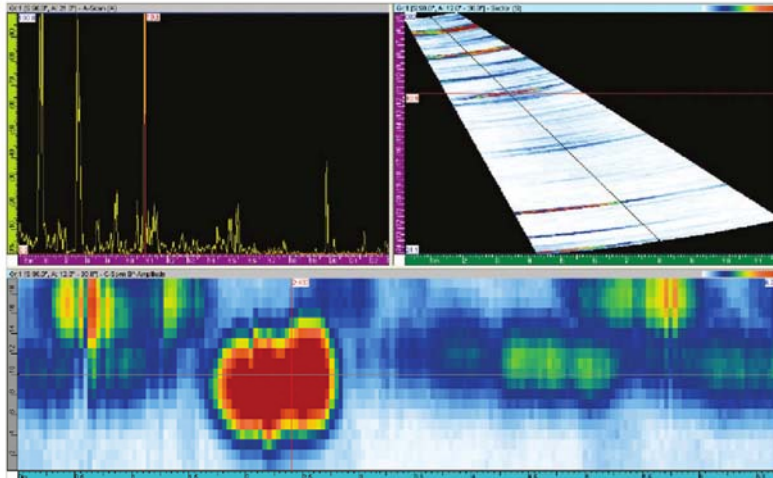


# TecScan Eases Train Axle Inspection

Train axles undergo high stress during service that calls for periodic verification of their integrity and checking for possible formation of cracks. The knowledge of the stress concentration on the axles allows operators to predict the location of occurrence of the cracks and to perform scheduled inspection in these specific areas. In most cases, the critical areas of an axle can be accessed from its ends by performing ultrasonic pulse-echo inspections at specific refraction angles.

ArcelorMittal is one of Canada's leading manufacturers of iron ore to steel markets around the world. Lévis Joseph, a project coordinator at the company's industrial site and railway plant in Port-Cartier, Québec, Canada, recently contacted SGS Canada in search of a solution to update their train axle inspection hardware with state-of-the-art nondestructive testing (NDT) equipment. It has been used as part of a scheduled maintenance and served to monitor crack growth at critical



This example of an A-Scan, S-Scan (sectorial) and C-Scan shows an artificial crack (notch) below a bearing; echoes corresponding to the bearing are visible besides the notch signal. The X and Y scales of the C-Scan view respectively correspond to the axle circumference and refraction angles of the beam. *Source: TecScan Systems*

locations within the axles. Following the request from ArcelorMittal, SGS Canada contacted TecScan Systems (Boucherville, Québec) to evaluate the performance of the existing hardware.

"When I first contacted SGS, our axle inspection head needed to be repaired or replaced and I wished to verify that the ultrasonic hardware was still reliable for this demanding application," says Joseph. "It consisted of multiple ultrasonic probes enclosed in a probe holder, each one aiming at different angles inside the axles. A rotation of the probe holder around the axle central axis allowed covering their entire circumference while monitoring the A-Scan for possible flaws."

The train axle inspection involves sending ultrasonic waves at the ends of the axles to detect cracks initiating at locations determined by the distribution and concentration of stress during service; this allows performing the inspection without having to completely disassemble the axles, which is both a labor intensive and time-consuming operation. One of the difficulties that needed to be overcome was the presence of large threaded holes at the shaft ends, which greatly decrease the usable area where ultrasounds can be launched into the material.

The study performed by TecScan first aimed at determining whether or not reliable crack detection could be achieved in an axle with the existing hardware, which proved to be abnormally noisy and required replacement. Because the mechanical probe holder needed to be redesigned, the possibility of including encoded scanning capabilities to the system also was evaluated. While this option could offer additional and more intuitive data presentation to the operators, it required replacing the

existing flaw detector with new hardware that supported encoded imaging.

"At first, the goal of the acoustic study was to redesign the inspection head and possibly replace our probes with new ones," says Joseph. "When TecScan showed us B-Scan images of the artificial cracks that they had acquired with their laboratory equipment, separating the flaw signals from the axle internal reflections became so easy that I thought this might be a better long-term solution for us."

After the decision was made to consider an encoded scanning head solution, the proper associated hardware needed to be selected. Following additional tests with different configurations, a manual scanner design combining phased array technology was proposed to ArcelorMittal.

This solution makes use of a linear array to inspect the inner structure of the axle by firing at multiple refracted angles through focusing, and C-Scan imaging to visualize the amplitude of the echoes returning from the critical areas of the axles. In addition, the design of the scanner was adapted to fit all axle dimensions tested by ArcelorMittal, therefore allowing them to use a single scanner for all of their inspections; previously, a different scanning head needed to be used for each axle diameter.

## BENEFITS

- The train axle inspection went from performing a different scan for each probe angle down to a single scan covering all requested angles at the same time.
- Data analysis went from single A-Scan data analysis to a combination of A, sectorial and C-Scan data presentation.
- The solution optimized inspection time while decreasing the chances of false calls and providing additional data for the axle's track record.



TecScan's Axle Inspection Scanner is designed to hold on to the train axle with the use of magnetic pads. *Source: TecScan Systems*

TecScan's Axle Inspection Scanner, a one axis rotational train axle scanner, was developed for this purpose. It was designed with an adjustable probe holder that maintains a phased array probe in contact with the axle end during the scan, as well as a centering device for proper probe positioning. The probe holder design, probe array selection and focal laws were determined and optimized to allow a full coverage of the axle circumference while avoiding interferences with the threaded holes at the axle end. In addition, low friction magnetic pads help to keep good contact with the axle during scanning, as well as secure the scanner on the axle end while the operator adjusts its ultrasonic parameters.

With TecScan's Axle Inspection Scanner solution, the inspection of train axles at the ArcelorMittal installations went from having to perform a different scan for each probe angle down to a single scan covering all requested angles at the same time. In addition, data analysis went from single A-Scan

data analysis to a combination of A, sectorial and C-Scan data presentation. Not only was the inspection time optimized with this solution, but it also decreased their chances of false calls while providing additional data for the axle's track record.

"TecScan's Axle Inspection tuned out to be ergonomic and well designed," says Joseph. "We expect our inspection productivity to increase and our false call rate to decrease with the scanned phased array solution. The false indications that came from the axle's internal structure and probes are now easier to identify with the sectorial scan display. The encoded, amplitude C-Scan images of the areas of interest are also a great addition since it will allow better monitoring of crack growth from sizing and variations of the echo amplitude."

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Reply 36

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