

CASE STUDY

Cost-effective pipeline girth weld AUT for Brazil

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The expansion of the Brazilian Samarco Mineração S.A. mining production facility required the construction of a second iron ore slurry pipeline. This upgrade interconnects the facilities of Samarco in Mina do Germano, Minas Gerais, with Ponta Ubu in Espirito Santo. The project involves 340.6 km of 16" and 57.8 km of 14" steel pipe, and includes several new pumping, pressure measuring, and valve stations. At full production capacity the new pipeline will convey 16.5 million tons per year, in addition to the current 13.5 million tons per year.

In early April 2006, Eclipse Scientific Pipeline AUT Group and Materials Research Institute were contracted by NDT Do Brasil to act as project start-up consultants for the client's impending entry into the pipeline girth weld inspection market. NDT Do Brasil's advanced ultrasonic inspection team has been actively performing AUT with phased array and TOFD techniques for many years, and it was decided that the time had arrived to break into the growing and very competitive pipeline girth weld inspection market. Project start-up consultants were engaged to assist with technical details.

The primary roles of the project start-up consultants are to:

- Provide unbiased technical support for the client.
- Develop procedures and techniques.
- Design calibration blocks.
- Conduct training of project personnel.
- Perform system qualifications and validation.
- Conduct Probability of Detection (POD) and sizing accuracy studies.

The Samarco pipeline project is somewhat unique – at 398 km it is the world's longest iron ore slurry transport system. The rugged terrain and stringent engineering requires the use of ten different pipe wall thicknesses. The material thicknesses range from 7.9 mm to 17.5 mm. The joints are manually welded single V bevel configuration. Although the geometry posed little problem for the use of zonal discrimination, the variable root gap offset, and the disparity of wall thicknesses posed certain technical challenges. Of particular concern was the potential of excess internal root reinforcement. Due to the thin wall

of the pipe, multiple skips were required to optimise the zonal targets. For the 7.9 mm wall thickness it was determined that a single fill target along with volumetric, cap and root notches would provide satisfactory zonal coverage.

Having already built an extensive AUT portfolio for the company, and being accomplished at the implementation of new technology, NDT Do Brasil owner Fábio Fraga Moreira decided to invest in AGR Technology Design's Focus-Scan phased array instrument for this task. The selection of an inspection system is one crucial component in the process of securing a successful project outcome. This system was configured with a 16/128 PA pulser/receiver and included integrated TOFD, strip-chart and B-scan displays. With their knowledge of field conditions and available resources, a reliable scanner was built with off-the-shelf components. The resultant CRC-based scanner proved to be both robust and lightweight and included



Figure 1. Route of iron ore slurry pipeline from the mine site to the shipping port

a pair of 64-element 5 MHz PA transducers, dedicated TOFD probes and an Eclipse MPE encoder.

An excellent TOFD display was achieved on the 7.9 mm wall pipe, greatly enhancing defect verification and geometric characterisation. The intrinsic versatility of the software allows for a reverse scan of the weld while maintaining the original circumferential location values. This effect aids the evaluation and comparison of forward and reverse scans for system validation. The analysis software is available to perform off-line auditing, third party review or remote data interpretation.

Acknowledging the production



Figure 2. Typical terrain of the Samarco pipeline right of way



Figure 3. Primary AUT inspection rig equipped for difficult terrain

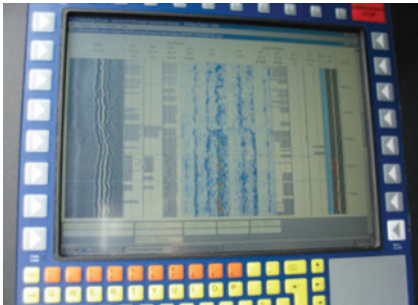


Figure 4. Scan of 7.9 mm x 16" pipe girth weld

requirements and the noted technical complications, the NDT Do Brasil design team developed several innovative and elegant solutions. A few of the more noteworthy accomplishments included:

- ❑ the design and implementation of a quick-change calibration block carrier system;
- ❑ installation of a couplant tank capable of supplying water for the entire production shift;
- ❑ integrated battery and inverter power supply for all electrical supply demands;
- ❑ custom installation of all data acquisition hardware within the truck cab, allowing the system operator to drive and scan without leaving the driver's seat;
- ❑ system capable of scanning 7.9 mm to 17.5 mm W/T without change of phased array probe offset spacing.

The experienced AUT crew was provided with a 50 hour zonal discrimination training course which covered in detail the fundamental principles of this inspection technique. Course material included:

- ❑ General and zonal AUT theory.
- ❑ TOFD set-up, sizing and limitations.
- ❑ Weld scan data (strip chart) interpretation.
- ❑ Defect characterisation, sizing, and overtrace considerations.
- ❑ Calibration block design and utilisation.
- ❑ Pipeline construction theory.
- ❑ Data acquisition and analysis software familiarity.
- ❑ Hands-on band placement and scanner set-up.

Further system familiarity and on the job training was accomplished on site, with the ongoing support of an Eclipse Pipeline AUT Group Supervisor.

After the completion of the validation welds, the system was deployed to the right-of-way for field trials. Within several days the newly trained AUT inspection crew was scanning 100 welds per shift, despite the impediments of a very muddy terrain. A flexible AUT procedure was developed to apply a technique for each wall thickness required by the project scope. The operators were tasked with daily system checks ensuring continuous data quality, and results were delivered rapidly to facilitate continuous feedback to the 'front end' welding crew.

The implementation of the AGR Technology Design Focus-Scan phased array instrument and software as a platform for zonal discrimination AUT of pipeline girth welds proved to be a cost-effective solution for this project application. While providing the requisite AUT weld inspection service every consideration was made to minimise the environmental impact on this sensitive area.

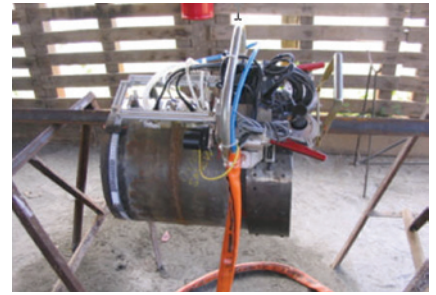


Figure 5. CRC-based scanning rig on 16" calibration block



Figure 6. AGR Technology Design Focus-Scan phased array instrument mounted in the vehicle



Figure 7. Inspections were carried out in difficult terrain and under arduous conditions

Acknowledgements

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A picture of the AGR Technology Design Focus-Scan mounted onboard the vehicle (similar to Figure 6) appeared on the front cover of *Insight* February 2007.



Figure 8. Scanner mounted on the cal block