Use of Long Range Guided Wave Ultrasonics for Fitness for Service Determination of Pipelines

PUBLISHABLE SUMMARY

19239

Background

Long range inspection using guided ultrasonic waves is a relatively new and exciting inspection technique for the detection of corrosion in pipes and pipelines. The current state-of-the-art is able to screen tens of metres of pipe from a single test location and is particularly advantageous for the examination of inaccessible pipe lengths, such as cased road crossings, from adjacent areas. However, It is principally a detection tool, with minimal useful information being given about the severity of the flaws found.

There is, as yet, relatively limited experience with its use and limited data are available to validate performance. Test procedures are not yet standardised.

Recent advancements in this technology within TWI's Core Research Programme have shown that it is possible to use the output from the guided wave test to determine the size of flaws detected, so that such information may be input to standard methods of determining fitness for continued service.

This is a vital step forward, as it is clear from feedback from the pipeline industry that the primary concern of operators in both the USA and Europe is the need to meet regulatory requirements. The regulators require that the information derived from inspections is sufficient to allow fitness-for-service (FFS) procedures such as in ASME B31G, or similar alternatives, to be used safely, or that the integrity assessment is at least equivalent to performing a hydrotest.

The aim of this project was to extend the capabilities of the sizing technique to a greater range of pipe sizes (up to 20 inch diameter) and to test it against a database of real pipeline flaws. The predictions of fitness-for-service using data from the guided wave tests and from the real flaw database were compared to determine the validity of using the guided wave test data as an input to the analysis.

TWI Ltd, Granta Park, Great Abington, Cambridge CB21 6AL, UK. Tel: +44 (0)1223 899000

Use of Long Range Guided Wave Ultrasonics for Fitness for Service Determination of Pipelines

Objectives

- Integrate flaw sizing inspections with procedures for determination of pipeline fitness-for-service.
- Determine the link between guided wave responses and flaw size.
- Extend the flaw sizing method to cover a wider range of pipe diameters.
- Establish the accuracy of these assessments through validation tests.

Project Outcome

A flaw sizing procedure was developed for the assessment of individual features in straight pipe. The procedure allows the through wall extent of 'non-narrow' flaws (currently <60°) to be measured. Experimental validation and enhancement to the technique has been carried out and the conclusions from the work are summarised as follows:

- The technique has been shown to work experimentally for a range of pipe diameters and flaw sizes and shapes. All features detected were correctly identified as either 'narrow' or 'non-narrow' flaws. As per the flaw sizing procedure developed, estimations for the dimensions of the flaws classed as 'non-narrow' were made. The through wall extent was found to be within 1.1mm of the actual value and the circumferential extent was found to be within 28° of the actual value.
- Fitness-for-service assessments have been carried out using ASME B31G. Using the experimental data gathered, it has been shown that the revised MAOP calculated from experimentally measured flaw sizes is within 13% of the actual value. Moreover, the revised MAOP from the experimentally measured values is well within the revised MAOP for an example where the axial extent is known indicating that the procedure used is conservative.
- Estimates have been made based on the ApplusRTD laser profilometry database for the most severe flaw that could be undetected by the guided wave flaw sizing procedure. The reduction in MAOP operating pressure for these flaws was just 5%. This indicates that the flaw sizing procedure could be used conservatively as a direct input to a fitness-for-service assessment.
- A refinement to the flaw depth sizing procedure has been tested in a 24" schedule 40 pipe. It was shown that it was possible to determine the circumferential extent to within three degrees and the through wall extent to within 1.1mm using this technique.

Benefits

- Validated techniques for the examination of difficult to inspect areas, including cased crossings, which enable standard methods of determining fitness-for-service to be applied without further intervention.
- Potential to save up to 80% on inspection costs which were around £160,000 ($300,000) per km of pipeline at the time of the project.
- Evidence to support the use of this technology for presentation to regulatory bodies and standards organisations.

Participants

The Sponsor Group Comprised:

- EPRI
- Shell
- Pipeline Research Council International

Use of Long Range Guided Wave Ultrasonics for Fitness for Service Determination of Pipelines

Scope of Work

The work carried out comprised the following:

- A set of 41 flaw clusters was extracted from the ApplusRTD laser profilometry database and analysed.
- Flaw sizing capability was assessed using finite element modelling for a range of pipe sizes (2 to 36inch) and a variety of flaw shapes.
- Practical procedures for flaw sizing tests using long range guided waves were developed.
- Experimental guided wave measurements were carried out on a range of pipe sizes (6 to 24 inch).
- Fitness for Service (FFS) assessments were carried out on the set of experimentally measured flaws.

Price and Duration

The project had a duration of 2 years and a budget of £299,000. The fee for additional companies buying back into the project results is £50,000.

Further Information

For further information on how a Joint Industry Project (JIP) runs please visit:

http://www.twi.co.uk/services/research-and-consultancy/joint-industry-projects/

JIP Co-ordinator: Tracey Stocks

Ref: 19239/2/14

Email: jip@twi.co.uk

Project Leader: Peter Mudge

Email: peter.mudge@twi.co.uk