

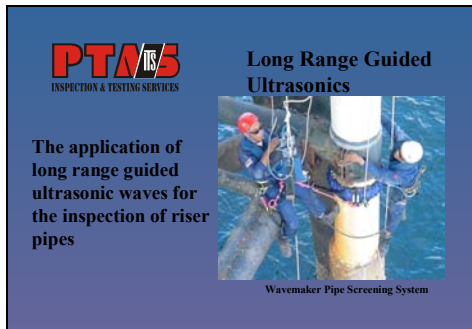
THE APPLICATION OF LONG RANGE GUIDED ULTRASONICS FOR THE INSPECTION OF RISER PIPES

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Abstract: Corrosion and other defects that reduce the cross-sectional area of pipes cause major problems in the oil, chemical and the other industries. Most standard NDT methods measure the remaining pipe wall accurately, but over a small area so it is almost always uneconomic to inspect 100% of the pipe. In practice a pragmatic approach is usually adopted where the wall thickness at a number of points is measured and this information is used to determine the fitness for purpose of the pipe. However, this approach generally requires unrestricted access to the outer surface of the pipe and this is not possible, if the pipe is insulated, has protective coatings or is buried. This means that even external corrosion cannot be seen so that accurate measurements of the remaining wall can be made at the correct location on the pipe. Ultrasonic guided wave inspection using the Wavemaker Pipe Screening System (WPSS) offers a novel solution to many such inspection problems. Guided waves can be excited from easy to access locations on the pipe and will propagate many metres along the pipe, the returning echoes indicating the presence of corrosion or other pipe features. PTAS-ITS now use the WPSS routinely in Brunei and Indonesia; this paper discusses our operational experience in proving the technique to our client and presents recent inspection results on riser pipes inspected in Indonesia.

Introduction: This paper discusses our operational experience in proving the technique to our client and presents recent inspection results on riser pipes inspected in Indonesia.

Slide
1



The slide features the PTAS-ITS logo (INSPECTION & TESTING SERVICES) in the top left. The main title is "Long Range Guided Ultrasonics". Below the title is a photograph of two workers in blue safety gear and hard hats working on a large vertical pipe. The caption below the photo reads "Wavemaker Pipe Screening System". The main text on the slide is "The application of long range guided ultrasonic waves for the inspection of riser pipes".

Guided Ultrasonics makes the Wavemaker pipe screening system. It is important to understand from the beginning that this is a screening tool. It is not a magic solution to all inspection problems. What it does do is provide a method of rapidly determining where there are problem areas on a pipe.

Slide
2




The slide has a title box at the top that says "What is Long Range UT (LRUT)?". Below the title is a photograph of a large pipe with a ring attached to it. The text on the slide explains the LRUT process: "In LRUT an array of ultrasonic transducer elements are fitted around the pipe. Instead of scanning the region directly below or near to the transducers, guided waves travel down the length of the pipe. This allows 10's of meters to be inspected from a single location. In this picture you can see a ring attached to a section of EPDM wrapped 30" diameter pipe. From this single location low frequency guided waves are transmitted in both directions along the length of the pipe screening difficult to access areas remotely." The slide also includes the PTAS-ITS logo and the text "16 WCNDT Canada Sept. 2004 Page 2".

What is long range UT : Instead of scanning the region directly below or near to the transducers, guided waves travel down the length of the pipe. This allows 10's of meters to be inspected from a single location. In this picture you can see a ring attached to a section of EPDM wrapped pipe. From this single location waves are sent in each direction.

Slide
3

How Does It Work?

- To perform the test, a ring is placed around the pipe. No couplant is needed as the transducers dry couple on to the pipe.
- The surface of the pipe does not usually need to be prepared. Any loose flaking paint or corrosion needs to be scraped off of the pipe, but otherwise, no preparation is necessary.
- The technique works by looking for reflections from changes in cross section of the pipe. These reflections are collected and analyzed. Potential problem areas are identified and can be investigated using another technique to determine area and severity. In this picture the area of test is the straight piece of pipe after the bend under the EPDM wrap




PTAC
16 WNDT Canada Sept. 2004 Page 3

To actually perform the test, a ring of transducers is placed around the pipe. No couplant is needed. The transducers dry couple on to the pipe. The surface of the pipe usually does not need to be prepared. Any loose flaking paint or corrosion needs to be scraped off of the pipe, but otherwise, no preparation is necessary. In this picture the area of test is the straight piece of pipe after the bend under the EPDM wrap.

Slide
4

What Can It do?

- Can be performed without taking the pipe out of service
- Can be performed at elevated temperatures up to 120°C
- Can be performed under coatings, Ground, Concrete, Cladding, Bitumen, Ethylene Propylene Diene Monomer (EPDM) etc
- It is sensitive to corrosion anywhere on the circumference of the pipe
- It is equally sensitive to both internal and external corrosion
- The entire volume of the pipe is inspected (within the diagnostic length of a test). Not only spot locations
- Pulse echo type operation provides information on feature position and approximate size
- Sophisticated analysis aids interpretation of results

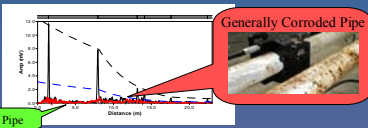


PTAC
16 WNDT Canada Sept. 2004 Page 4

The inspection can be performed without taking the pipe out of service. The entire volume of the pipe is inspected. It does not sample at only spot locations, it is sensitive to corrosion anywhere on the circumference. It is equally sensitive to both internal and external corrosion. The technique works by looking for reflections from changes in cross section of the pipe. Long ranges of pipe can be screened from a single location.

Slide
5

Factors affecting the results: General Condition of Pipe



Clean Pipe

Generally Corroded Pipe

The propagating guided waves reflect from all changes in cross section no matter how small. The reflections from small amounts of corrosion appear as a 'noise' floor on the trace. For example in the trace above, the pipe section on the left is a clean pipe, but the section on the left is generally corroded like the pipe shown on the bottom right.

PTAC
16 WNDT Canada Sept. 2004 Page 5

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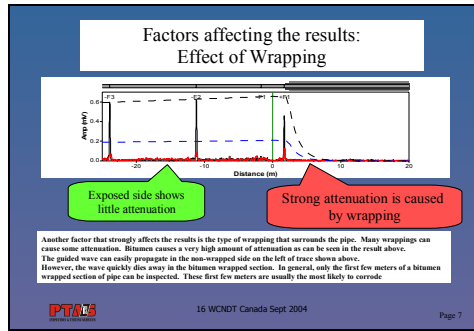
Factors affecting the results: Type of defect

- More difficult
 - Single isolated pit
 - Smooth gradual defects
 - Axial cracks
 - Small pits in welds
- Easier
 - A cluster of pits
 - Sharp corrosion
 - Circumferential cracks
 - Large cracks in welds

PTAC
16 WNDT Canada Sept. 2004 Page 6

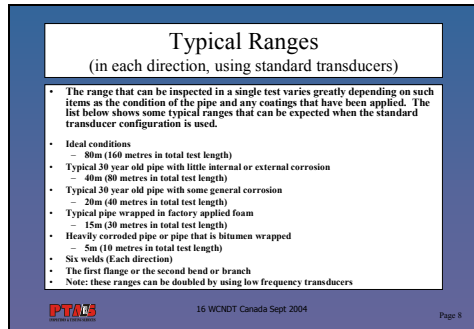
Factors affecting the results – Type of defect.

Slide
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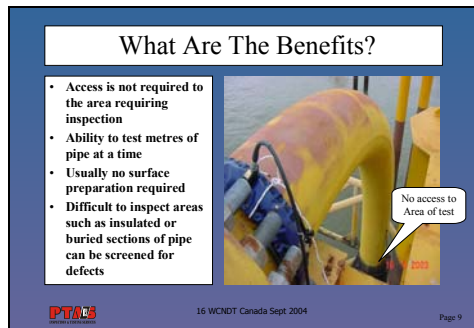
The type of wrapping that surrounds the pipe strongly affects the results. Bitumen causes a very high amount of attenuation as can be seen in the result above. The guided wave can easily propagate in the non-wrapped side. However, the wave quickly dies away in the bitumen wrapped section. Usually only the first few meters of a bitumen wrapped section can be inspected. These first few meters are usually the most likely to corrode.

Slide
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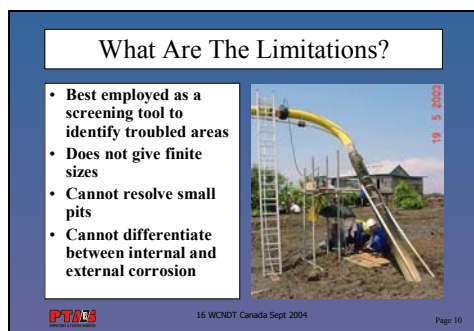
The range that will be inspected in a single test varies greatly depending on such items as the condition of the pipe and any coatings that have been applied. The slide above shows some typical ranges that can be expected when the standard transducer configuration is used. If the low frequency transducers are used, these ranges can normally be doubled (or more).

Slide
9



Access is not required to the area requiring inspection, it has the ability to test many metres of the riser at one time. Usually no surface preparation is required. Difficult to inspect areas such as splash zone or buried sections of the riser can be inspected.

Slide
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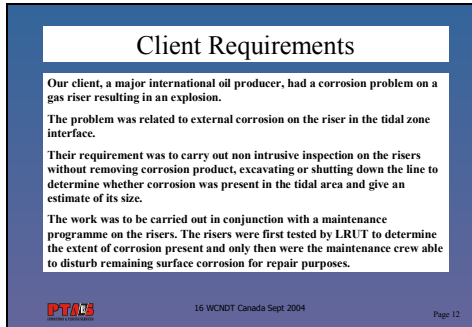
LRUT can be best employed as a screening tool that is used to identify trouble areas. Once these trouble areas have been identified they can be targeted using other methods of examination. This allows for 100 percent coverage at a fraction of the price of many other methods.

Slide
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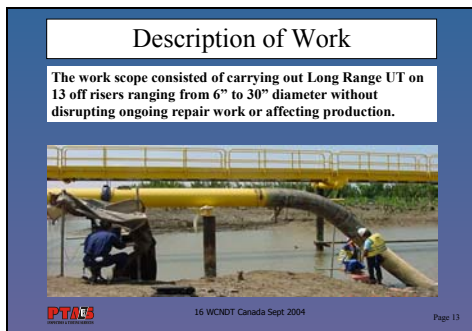
This slide is typical of the working conditions; this is in the tidal zone of a river estuary. For larger diameter pipes, an inflatable belt system is used. The system allows for a light flexible application of the technique to large diameter pipes. The normal range of inflatable rings is from 6 to 24 inches in diameter. (Larger pipes can be inspected, but on large pipes only large corrosion patches can be found.)

Slide
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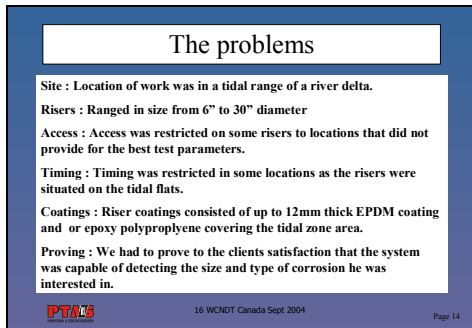
The work was to be carried out in conjunction with a maintenance programme on the risers. The risers were first tested by LRUT then only were the maintenance crew able to disturb remaining surface coatings for repair purposes.

Slide
13



This slide shows another typical location of the worksite. The job entailed carrying out LRUT on 13 risers from 6 to 30 inch diameter in the splash and ground entrance area.

Slide
14

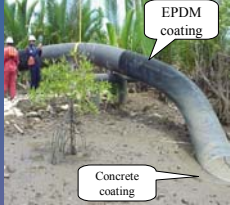


The Client was interested in detecting corrosion equivalent to 5 % change in cross sectional area.

Slide 15

Proving the system

Our client was concerned that the guided waves would not be able to penetrate the EPDM coating to the area of interest, which was the tidal zone of the riser. This area could be up to 8 metres away from the start of the wrapping. We had to prove to the client that the system had the capability to detect a 5% loss of CSA defect as far away as possible from the ring location.




PTACS
16 WCNDDT Canada Sept. 2004
Page 15

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Slide 16

The Test Riser

A 20" diameter by 25.4mm thick test riser was made available for proving the technique. This riser had 12metres of EPDM coating on the pipe and 3.1metres of epoxy fiberglass coating on the bend. The object of the testing was to determine if a 5% loss of cross sectional area on the elbow could be reliably detected through the coating from the other end of the pipe.



PTACS
16 WCNDDT Canada Sept. 2004
Page 16

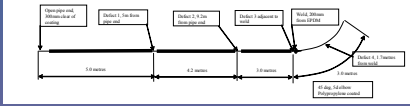
We were supplied with a redundant test riser to prove the system to the client. We were able to introduce artificial defects into the riser at various locations.

Slide 17

The Defects

4 defects were introduced into the riser at a variety of locations

- 1: 100mm x 300mm x 11mm deep = 9% change in CSA
- 2: 100mm x 300mm x 11mm deep = 9% change in CSA
- 3: 50mm x 300mm x 11mm deep = 9% change in CSA
- 4: 100mm x 100mm x 6mm deep = 2% change in CSA




PTACS
16 WCNDDT Canada Sept. 2004
Page 17

4 defects were introduced by grinding, ranging from 2% to 9% change in CSA.

Slide 18

Scanning the Riser

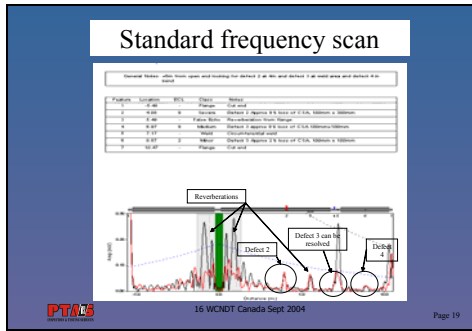
Testing using standard frequency transducers at 35mm spacing resulted in better than expected results. The best results were obtained from a frequency of approximately 26 to 30kHz and an excitation signal of 8 to 10 cycles Hamming. This resulted in the reliable detection of an artificial defect in the outside of the elbow 100mm square by 6mm deep equating to a 2% loss of cross sectional area, from a location 13 metres away, through an EPDM coating length of 11.5m and 1.5m of Epoxy fiberglass. The next slide shows the results achieved from the location at defect 1



PTACS
16 WCNDDT Canada Sept. 2004
Page 18

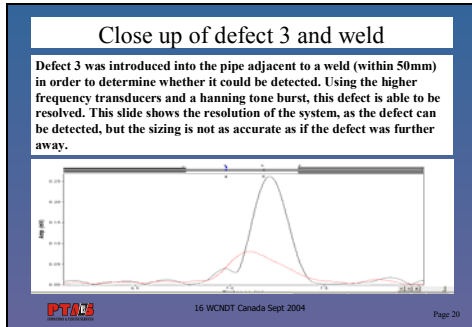
The riser was scanned from a variety of locations whilst the defects were being introduced utilising both low frequency and standard probes. The testing was stopped when we were able to prove to the client that we were able to consistently record defect 4 located in the outside of the elbow and equivalent to a change in CSA to 2% through more than 11metres of EPDM coating.

Slide
19



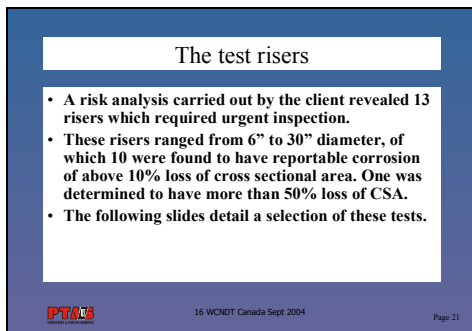
This slide shows the results of one of the final scans. The location of test is adjacent to defect 1. All the other defects can be clearly seen even defect 4 which is equivalent to a 2% change in CSA and defect 3 which is only 50mm to a weld.

Slide
20



Defect 3 was introduced into the pipe adjacent to a weld (within 50mm) in order to determine whether it could be detected. This slide shows the resolution of the system, as the defect can be resolved but the sizing is not as accurate as if the defect was further away.

Slide
21



A risk analysis carried out by the client revealed 13 risers, which required urgent inspection.

Slide
22



This riser was located offshore, in shallow water.

Slide
23

8" riser details

- This riser was 8" diameter by 20mm thick. It was located on an offshore installation in shallow water.
- The coating consisted of EPDM wrap.
- No significant corrosion was detected within a 14m test range

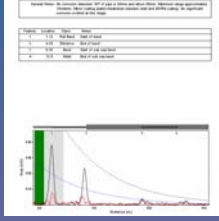
PT&S
16 WCNDDT Canada Sept. 2004 Page 23

This section is included as a comparison between a riser in good condition compared to the following 1 in poor condition.

Slide
24

8" riser report

This scan shows clean pipe with no significant corrosion present. The double echos at positions 3 and 4 are due to the difference in distance between the inside and outside radius of the swept bends from the ring position.




Position	Distance (m)	Signal Intensity
1	0.0	Low
2	1.0	Low
3	2.0	High
4	3.0	High
5	4.0	Low
6	5.0	Low

PT&S
16 WCNDDT Canada Sept. 2004 Page 24

The scan shows clean pipe with no significant corrosion present. The double echos at positions 3 and 4 are due to the difference in distance between the inside and outside radius of the swept bends from the ring position.

Slide
25

6" riser location



PT&S
16 WCNDDT Canada Sept. 2004 Page 25

This slide shows the ring location and the vertical section of the riser.

Slide
26

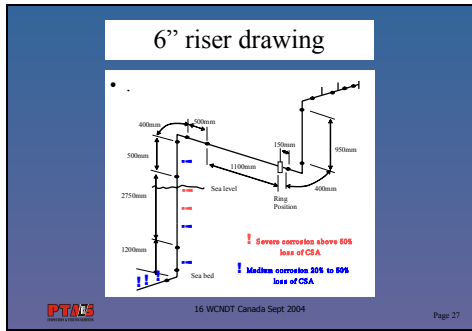
6" riser details

- This riser was 6" diameter by 18mm thick. It was located on an offshore installation in shallow water.
- The bitumen type coating was severely broken down in the splash zone area. External corrosion could be seen visually on this riser but due to the heavy corrosion products the remaining thickness could not be assessed.
- Corrosion was detected up to 50% wall loss within a 10 metre test range. This test range was limited by the extent and severity of the corrosion present.

PT&S
16 WCNDDT Canada Sept. 2004 Page 26

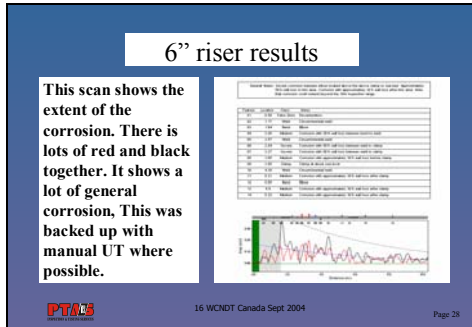
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Slide
27



Shows a drawing of the layout of the riser with corrosion detected beyond the lower riser bend.

Slide
28



This scan shows the extent of the corrosion. There is lots of red and black together. It shows a lot of general corrosion, which was backed up with manual UT carried out by a diver. A good correlation was achieved between the results of the LRUT and the manual scanning.

Slide
29



This slide shows another 30" riser location. We are shooting towards the ground from this ring location. It is typical of the working conditions in this area and is located at a river crossing and had a combination of coatings, Bitumen where it entered the ground and EPDM/Concrete where it entered the water.

Slide
30

Conclusion

Long range UT has proven to be a useful tool in the inspection of offshore risers, enabling the pipeline reliability engineers to predict remaining life span and direct maintenance costs, where appropriate, without the requirement for costly pipeline shutdown and pigging operations.

PT&S
16 WCNDT Canada Sept. 2004
Page 33

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