GUIDED WAVE ULTRASONIC INSPECTION FOR ROAD CROSSING PIPELINES

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ABSTRACT

- **Guided Wave technology, also known as Long Range Ultrasonic Testing**

- **Is a rapid screening method to detect and measure (up to certain level) internal/external corrosion, pitting and any other metal loss.**

- **Guided wave technology is mainly introduced to find cross sectional variations but in recent times it is also used as a reliable tool in finding out corrosion of buried / insulated piping online. This paper will elaborate the technique in detail.**

INTRODUCTION

- **Corrosion is a major problem in petro chemical and refinery plant piping. Most of the pipelines are of high pressure, high temperature, buried or insulated.**

- **Inspection of buried pipelines with normal ultrasonic testing is not possible due to the lack of accessibility.**

- **Guided wave technology helps in accessing the condition of buried and insulated piping without excavating and removing the insulation.**

PRE INSPECTION

- **All the buried areas were measured and drawing was made.**
- **Visual inspection was conducted at all entry points.**
- **The test location (GUW dead zone= Approx.500mm from both side of the Ring) was inspected Using Manual Ultrasonic testing.**

INSPECTION

- All the Road crossings lines were inspected from both sides.
- Most of the road crossings were between 18 to 25 meter long.
- Guided wave Ultrasonics G3 Equipment was used to perform this inspection.
- All the Road crossings were inspected using two fittings due to Attenuation and DAC Placement.
- The Guided Wave inspection has been carried out by providing an overlap with the adjacent GUL Inspection. (that is from the other end)

GUIDED WAVE TECHNIQUE

- **Ultrasound inspection as a quality tool has become quite popular and effective in thickness measurement, flaw detection, and material characterization.**

- **The guided wave uses low frequency which propagates along the pipe wall as torsional mode and it is designed for rapid screening of long lengths of pipelines to detect external or internal corrosion.**

GUIDED WAVE TECHNIQUE cont.

- **This technique is primarily composed of three components, the transducer ring, the Wave maker G3 instrument and the laptop with Wavepro software .**

- **The pipe wall act as a guide for the ultrasonic wave to propagate down the length.**

CALIBRATION

The Equipment automatically samples three calibration signals with each data collection. This data allows various parameters, such as the true signal to ambient noise ratio to be determined. (Figure-03)

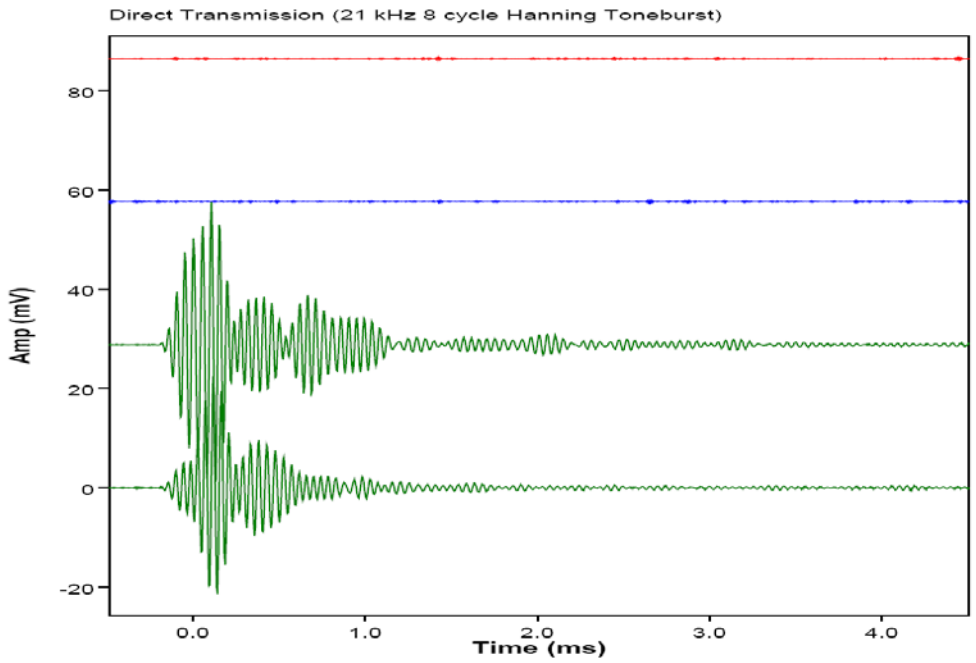


Figure 01

Green Signal (in figure 01): This is the signal as transmitted from one row to next row. It is used to measure how efficiently energy is coupled into the pipe.

Blue Line (in figure 01): This signal is used to determine the amount of error expected in the measurement related to signal size on the green trace.

Red Line (in figure 01): This signal is received by the transducer when the equipment is not transmitting and this represents the noise in the pipe that has been created by other sources.

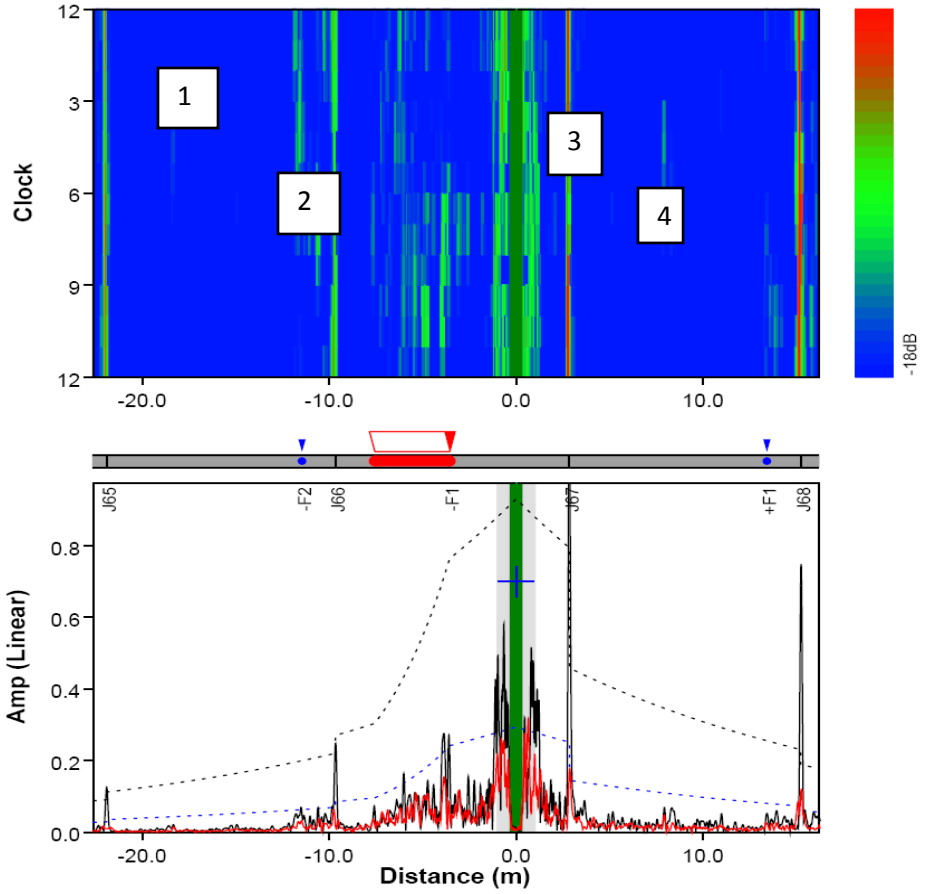
CALIBRATION Cont.

Figure 02

Figure 03

In the presence of a reflector with symmetric configuration such as a circumferential weld joint, the ultrasonic beam is also reflected symmetrically (provided a pure symmetric wave is excited at the transducers) and appears on the instrument screen as a black trace [see in Figure 02 (-f3/-f2)] The trace appears black and red in case of localized defect such as corrosion/pitting (Figure -03).

C scan Image



In figure 04

Number -1 shows a defect in between 6 to 1 o'clock position

In figure 04

Number -2 shows a defect in between 6 to 9 o'clock position

In figure 04

Number -3 shows a simple support at 5 to 6 o'clock position

In figure 04

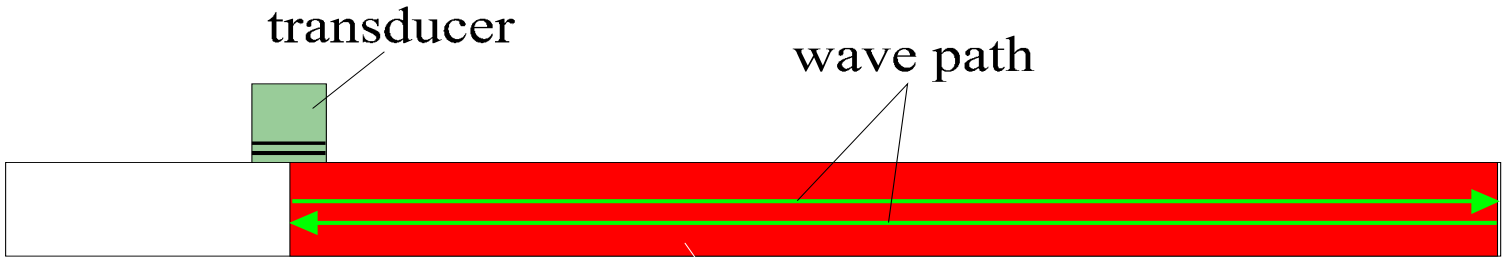
Number -4 shows a defect in between 9 to 11 o'clock position

Figure 04

CONVECTIONAL Vs LONG RANGE INSPECTION

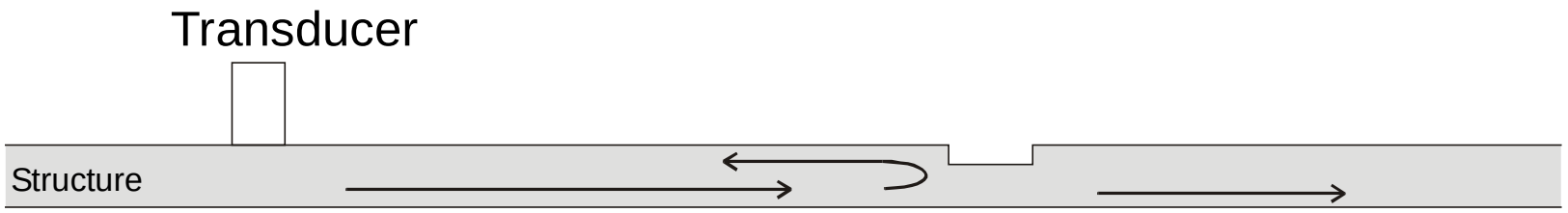
Conventional Inspection

Long Range Inspection



REFLECTION

The change in cross section due to thickness loss, weld profile, welded/normal supports and pipe features will cause reflection of GW. The reflection is detected by the transducer and sent to the computer.



Schematic of wave Behavior in the presence of a wall loss

PIPE INSPECTION UNDER INSULATION

- **Using Guided Waves, a probe can be applied to the pipe at a single location and several meters of the pipe can be inspected. The insulation is only removed where the ring is applied.**

- **Tuning the element spacing and the excitation frequency permits selection of the appropriate Guided Wave Mode for inspection of the particular pipe geometry.**

INSPECTION RANGE

- **Inspection Range:**

  In Normal condition 150 meter pipe can be tested in both directions from a single test point. Typically for above ground piping 60 meter and buried piping 12-15 meters.

Summery for KNPC Buried/Sleeved Road crossing Inspection

- **Recently KNPC Inspected approximately 355 Buried/sleeved Road crossing Pipelines in their Shuaiba facilities. The entire pipeline was inspected Using G3 equipment.**

- **Sleeved Road crossing - 311 NO.**
- **Buried (with sand) - 44 NO.**
- **Cat-01 Defect (50 to 100%) - 09 NO.**
- **Cat-02 Defect (25 to 49%) - 24 NO.**
- **Minor Indication (No further action Required) - 31 NO.**

Typical Arrangement of Guided wave System

Photographs
(Showing G3 Guided Ultrasonic Equipment)

ADVANTAGES

- **Guided wave technology allows for 100% inspection**

- **The guided wave technology enables pipe inspection to be carried out without intrusive interventions, or lengthy shutdowns, while the remedial work is being carried out. It further allows for inspections at elevated temperatures without taking the pipe out of service.**

ADVANTAGES Contd.

- **The system is cost-effective in difficult to access locations such as sleeved road crossings, corrosion under insulation, wall penetrations, pipe racks, and rope access. It also allows for the inspection of different materials such as ferritic stainless steel, super duplex, aluminium, and titanium.**

ADVANTAGES Contd.

- In several cases, sections of pipe work within petrochemical plants are located several meters above the ground, where they cross roadways or other pipe racks. These sections of pipe are more difficult and costly to inspect using conventional techniques, as temporary scaffolding is required to gain access to them.

LIMITATIONS

- **The technology is screening for changes in cross-sectional area. Minimum required changes in this area is 5% to 10% depending on pipe conditions.**
- **Large branches and welded supports are seen as large defects, there by obscuring any smaller anomalies nearby.**
- **Effects of coating / wraps on signal range.**
- **Pipe temperature constraints.**
- **The region of wall loss must represent at least 5% of total shaded are to be detectable by the Guided Wave Technique**

CASE STUDIES

- **The focal points of these case studies are road crossings.**

CASE-01

- **The inspection results of 10”x9.5mm buried line without sleeve and no evidence of wall loss has been found during the inspection.**

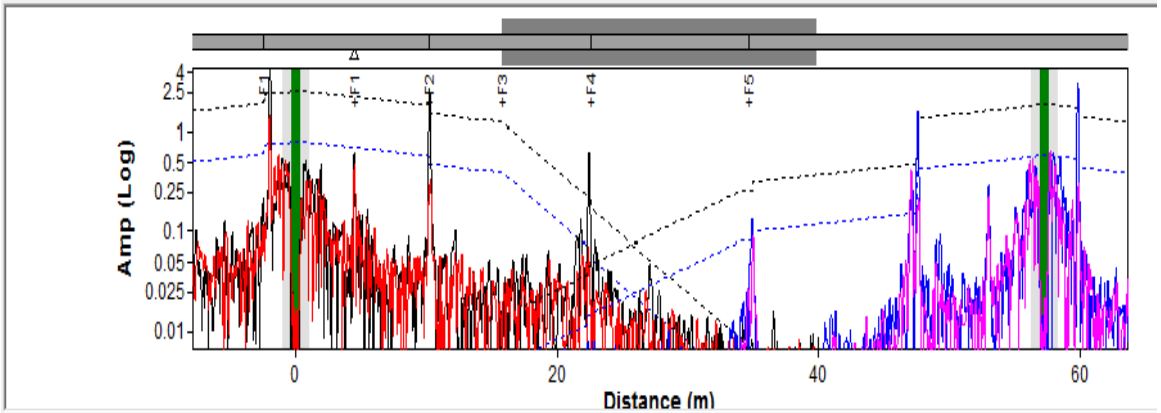
CASE-02

- **The inspection results of 10”x9.5 mm buried line with sleeve, during the GW inspection several severe indications were found and hence the line was isolated and visually inspected after excavation. (The results of GW Inspection were being confirmed by excavation)**

CASE STUDY 1

TP-01- dyke42. good wrapping coating, no indications, very good overlap. this under ground is ok with out sleeve.

P	Feature	Locati...	ECL	Length	M	Wall	Extent	Class	Notes
P	+F1	4.48	-	0		-	25	Support	
P	+F2	10.21	-	0		-	90	Weld	
P	+F3	15.76	-	24		-	19	Earth	
P	+F4	22.53	-	0		-	100	Weld	
P	+F5	34.63	-	0		-	70	Weld	
P	-F1	-2.39	-	0		-	45	Weld	

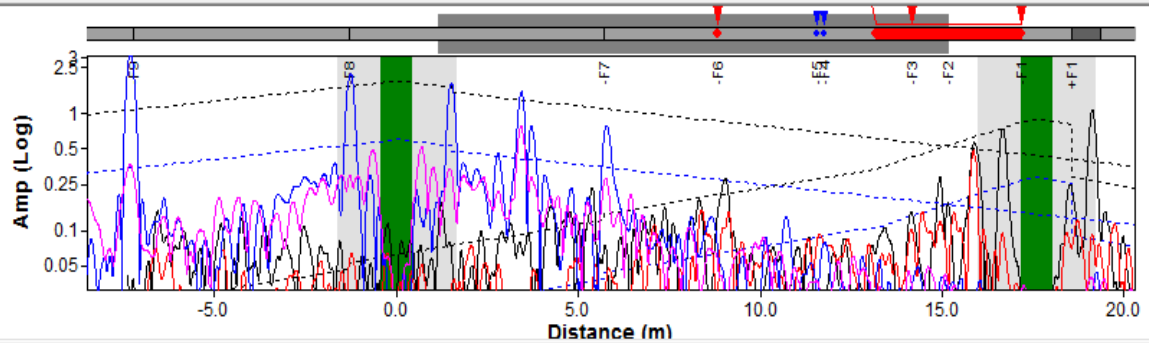


CASE STUDY 2

Pipe: 34-105A	Tested: 15 Feb 2009 12:09	Coating:
Site: KNPC SHU	Tested by: Jimmy Chackappan[INTREX]	Contents:
Location: dyke-75 +1.5m to weld	Client: KNPC/SHUAIBA	Supports:
Size: 10 inch	Procedure: GU 1.1	Corrosion:
GPS: 29°2.0573'N, 48°8.6992'E	DACs: Call=7%, Weld=23%	

2 test cover 100% of the weld area. major indication observed. scan from east side of the dyke. this test location made the varification after remove the sand (loose desert sand)from bottom side of the entry point(both side) and found so many locations external pittings. Photo attached.

P	Feature	Locati...	ECL	Length	M	Wall	Extent	Class	Notes
P	-F1	17.19	1	4		-	30	Severe	Localized external pittings near the test point 1.9m to entry, most of the area local severe local defects...
P	-F2	15.14	-	14		-	60	Sleeve	
P	-F3	14.19	8	0		-	30	Severe	Localized external pitting, same issue. wall loss measure 4.9mm
P	-F4	11.75	2	0		-	0	Medium	Not varified but ECL 09%, wall loss approx. 30-40%
P	-F5	11.55	3	0		-	0	Medium	Not varified but ECL 09%, wall loss approx. 30-40%
P	-F6	8.81	19	0		-	70	Severe	Not varified but ECL 14%, wall loss approx. 50-60%
P	-F7	5.7	-	0		-	50	Weld	
P	+F1	18.56	-	0		-	70	1D Bend	
P	-F8	-1.31	-	0		-	0	Weld	
P	-F9	-7.21	-	0		-	50	Weld	



CASE STUDY – 02 (PICTURE)

Severe external corrosion observed just outside the sleeve as well as inside the sleeve area. Minimum thickness measured was 5.6mm of original 9.5mm

CONCLUSION

- **Guided wave inspection potentially enables a buried / insulated pipe line to be tested from a single transducer position, so avoiding the time-consuming excavation required for conventional ultrasonic .**

- **The findings were confirmed after excavation and found reliable.**