SAIBA ENGINEERING

GUIDED WAVE TESTING

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EST. 1999

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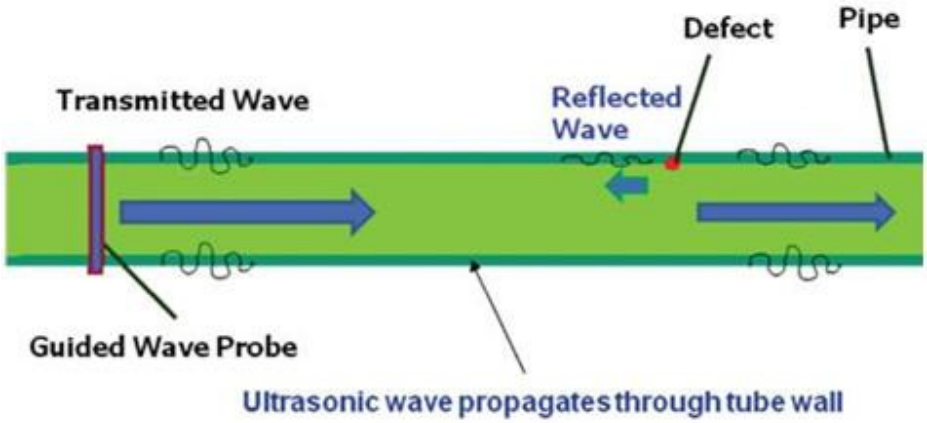
WHAT IS GUIDED WAVE TESTING?



WHY GUIDED WAVE TESTING?

STATUTORY REQUIREMENTS IN TERMS OF THE ACT STATED BELOW:

OCCUPATIONAL HEALTH AND SAFETY ACT, 1993 : PRESSURE EQUIPMENT REGULATIONS: SECTION 11(e)

"All piping and pipelines to be inspected and tested in accordance with the relevant in-service health and safety standard: Provided that where the health and safety standard does not prescribe in-service inspections and test intervals, such intervals shall be determined by a risk-based inspection applying sound engineering practice: Provided further that such inspection and test for Category II equipment and higher as categorized in terms of SANS 347 shall be performed by a competent person referred to in regulation 1 of the General Machinery Regulations, 1988."

PIPELINE CORROSION MONITORING

The probe continuously covers the whole circumference (360°) of pipe so that generated guided wave has a short dead zone and minimizes flexural mode generation.
Thus probe allows inspection of up to 500 feet in each direction in aboveground painted pipes of good condition with defect detection sensitivity for defects that have an area of approximately 2-3% of the total pipe wall cross section. Furthermore, the inexpensive probes are most often permanently installed to pipeline at difficult-to-access location to facilitate long-term pipeline monitoring.

- **Piping systems in oil, gas, and petrochemical facilities**
- **Offshore piping systems/risers**
- **Power generation piping systems**
- **Road crossings/levee penetrations**
- **Elevated or complex piping systems with limited clearance**
- **Buried pipelines**

PIPELINE CORROSION MONITORING

As an example of pipeline inspection, a cased pipeline outside diameter of 10¾ inch (273mm) and 0.843 inch (22mm) wall under a highway was tested as shown in the photograph. The pipeline was bent (via a 15° mitre joint) and then crossed another road in a casing. The lengths of cased section under the highway and the other road were about 253 and 53 feet (93m), respectively. The probes were set up 10.2 feet (3.2m) from the closer end of highway casing pipe, and the line was inspected using 32-kHz, torsional guided wave.

The test data was analysed and reported using data analysis and reporting software. The software calculates the wave velocity, attenuation, and the equivalent percentage reflection to find detected signals and indicate their location and severity. The percentage reflections of defects and geometric features are roughly proportional to their cross-sectional area relative to the pipe wall. The table summarized the geometric features and defects found from the data. No defect bigger than 2% cross-sectional area was found in this test, and the pipeline was determined to be in good condition.

STEAM GENERATOR TUBE INSPECTION

The field trials of steam generator tube inspection with guided wave testing system were conducted at an operating plant in Texas. The guided-wave testing was conducted on horizontal re-heater. Tubes in one of the steam generators at the plant. The outer diameter of the tube was 2M inches. The overall horizontal length of the re-heater tube was approximately 40 feet. Each tube line was made of five different materials (SA-210 A-1, SA-213 T-11, SA-213 T-22, SA-213 T-9, and SA-213 TP-304H), with thicknesses ranging from 0.148 to 0.300 inch.

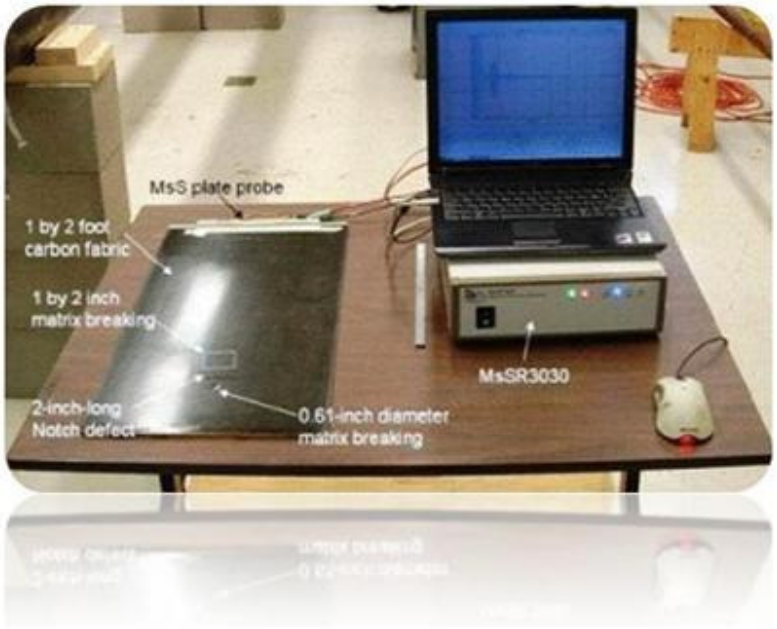
Each line also contained three U-bends and two or more 90° bends.

Buried stub angle inspection

Stub angles are used to anchor and stabilize the lattice tower. The concern of the lattice tower is that its buried portion could be heavily corroded, and it would not be easily detectable from above ground. When the corrosion of these stub angles progresses to unsafe levels, the tower structure could catastrophically fail.

MONITORING OF MATRIX BREAKING IN COMPOSITE MATERIALS

Ultrasonic guided wave propagation in composite materials has been investigated theoretically and experimentally for many years. It was found that symmetric (S0) Lamb wave has much lower attenuation than asymmetric (A0) Lamb wave in composite material. Much research was performed to make a transducer generate SO-mode wave. However, the piezoelectric and PVDF transducers can efficiently generate AO-mode wave in composite, but they are not good for generating S0 Lamb wave.



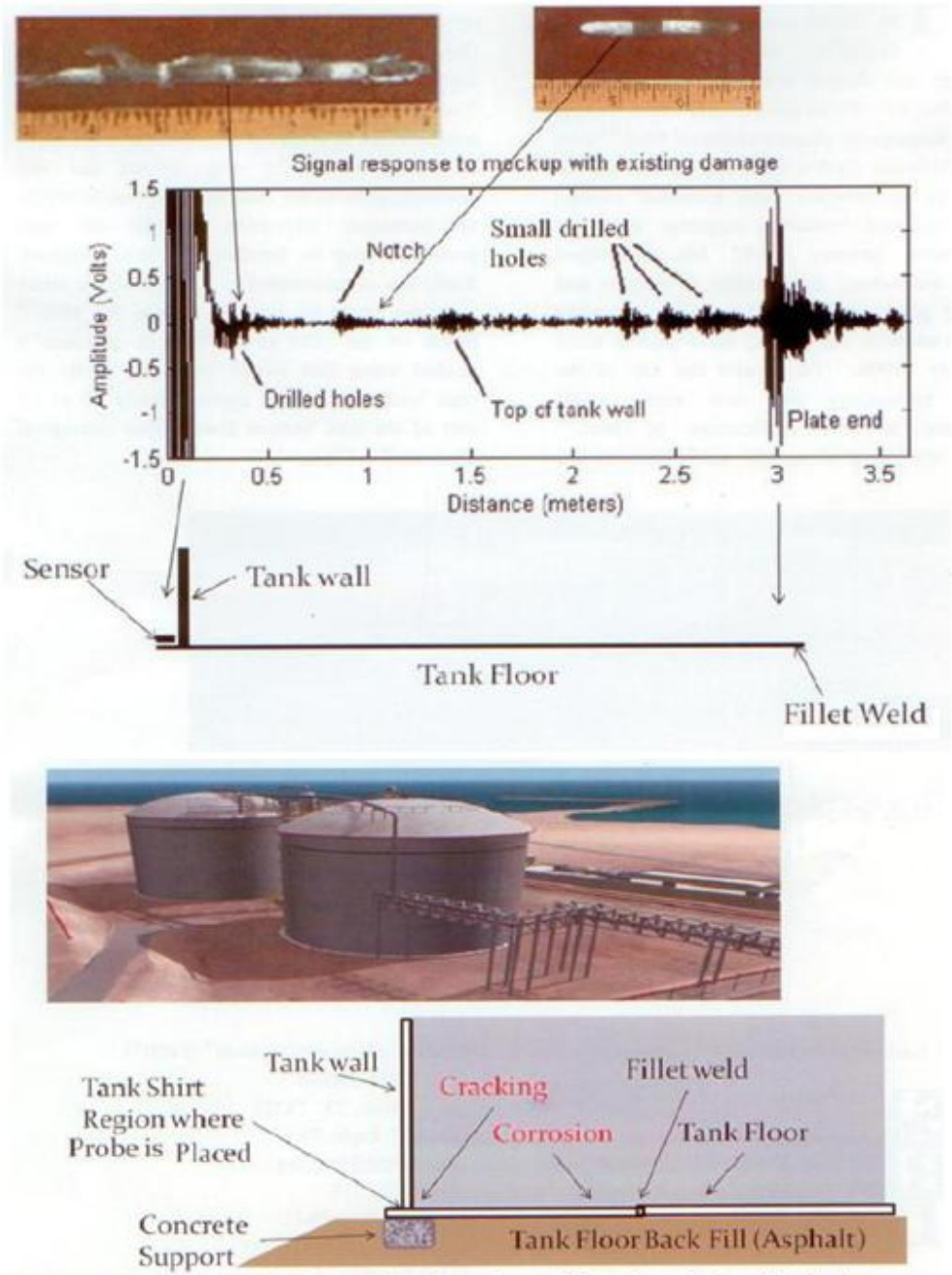


Figure 1. Illustration of the Tank Bottom Floor Inspection and Where the probe is positioned using shear couplant to generate the guided wave that propagates approximately 10 to 12 feet into the tank floor to detect corrosion

SPHERE LEG TESTING

- **Guided wave technology has been successfully utilized to inspect sphere legs without the need for scaffolding or removal of all lagging.**

ADVANTAGES OF GUIDED WAVE TESTING

- The total cross-sectional wall of the pipe is inspected.
- Ability to detect corrosion wall loss and cracks in aboveground, buried, and insulated pipe.
- Sensitivity can be as good as 2% loss of cross-section in ideal conditions (but is set at 5% or 10 % for buried pipeline or at long distance).
- Signal-to-noise ratio of better than 50 dB is obtained with epoxy-bonded probe on site.
- The generated signal with Probe is 50 dB (300 times) higher than the coherent noise of unwanted modes.
- Probes can be epoxy-bonded to pipeline for periodic inspection and monitoring.
- Probes can be permanently installed to pipeline at difficult-to-access location for long-term pipe monitoring.
- A pipe of up to 300 °C surface temperature can be tested without taking it out of service.
- Pulse-echo operation provides information on anomaly location and severity.
- Pitch-catch operation provides information on general corrosion of high-attenuation pipeline
- Sophisticated analysis software reduces false calls and helps making inspection report.
- Phase of signal is used to differentiate defects from geometric feature if the S/N ratio of signal is high.
- Small clearance between pipes is required - about 12 mm for monitoring and 25 mm for dry coupling.
- Narrow insulation removal along the circumference of pipe - about 60 mm for monitoring and inspection.

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