Phased Array Ultrasonic Testing (PAUT)

Phased Array Ultrasonic Testing has become a recognised and trusted method of volumetric inspection, with typical applications being weld inspection and corrosion mapping. PAUT techniques reduce inspection time over conventional ultrasonic by simultaneously collecting multiple angle ultrasonic data in a single pass scan from either side of the weld. By ensuring accurate scan plans and specifically designed techniques, construction defects are readily detected, sized, and sentenced accordingly.

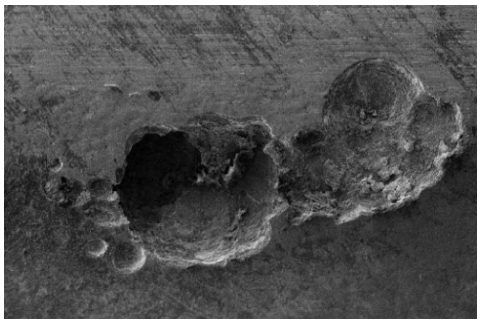
General Advantages of PAUT

- Fast and efficient
- Higher probability of detection
- Consistency & repeatable
- Data storage / recorded results
- Flexibility / not hazardous

Applications of PAUT

- Corrosion Mapping – *page 1*
- Weld Inspection – *page 2*
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- Bolt Inspection – *page 3*
- Small Bore Pipe – *page 3*

Corrosion Mapping: The high sensitivity of the phased array beam enables detection of reflected and/or diffracted signals which support in-depth defect characterization by imaging the true morphology of the damage mechanisms. Color-coded C-scan displays enable rapid data interpretation by clearly identify material losses and potential far surface damage.



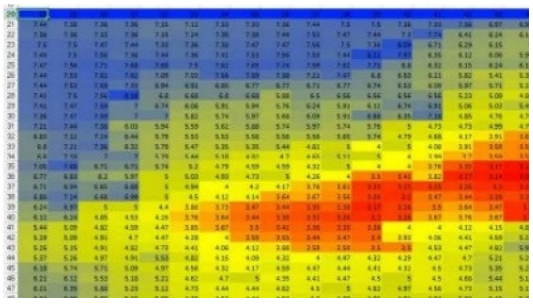
Microbial Induced Corrosion (MIC) within pipe

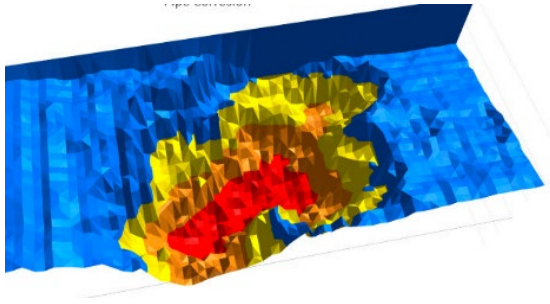
Defect locations can be recorded down to the millimetre to be monitored or for future repair reducing shutdown/maintenance times.

Features such as automatically listing the position of a pit and showing average thickness, minimum thickness, and the proportion of an area under a predefined thickness threshold can easily be implemented using third-party software. The .CSV file format is compatible with a variety of NDT programs as well as pipeline burst pressure calculators.



PAUT corrosion mapping equipment used for pipes & bends



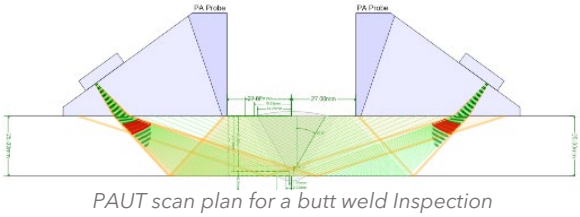


PAUT corrosion mapping data exported to .CSV Excel software with conditional formatting in 3D to display corrosion

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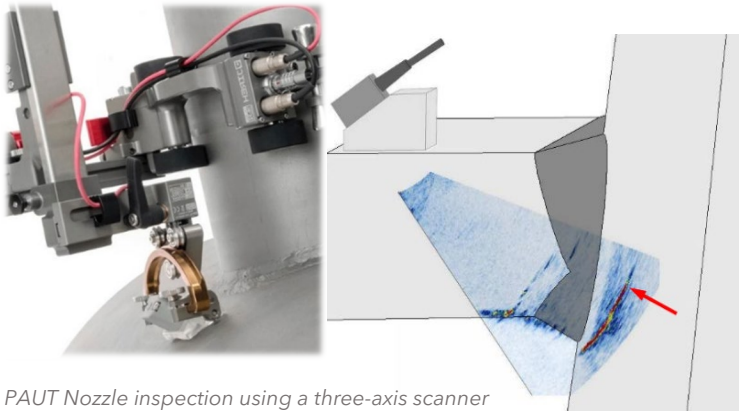
Weld Inspection: Failures of welds may lead to a loss of containment or other major consequences to the fitness-for-purpose of assets. PAUT reduces inspection time by simultaneously collecting multiple angle ultrasonic data in a single pass scan from either side of the weld.

Typical inspection rates are between 15-20 butts per shift. By ensuring accurate scan plans and specifically designed techniques, construction defects are readily detected, sized, and sentenced accordingly. Sophisticated analysis software enables experienced operators to interrogate welds from multiple orientations.



PAUT scan plan for a butt weld Inspection

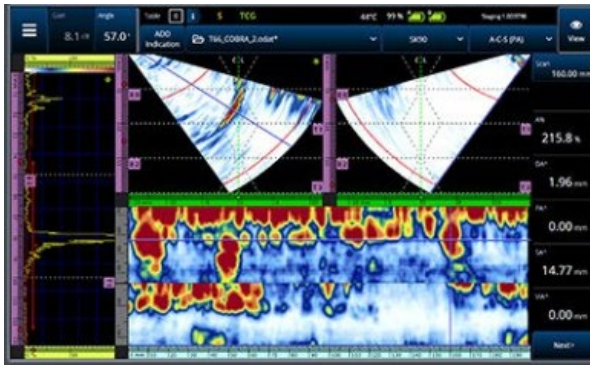
Combining phased array with non-orientation/non-amplitude reliant techniques Time of Flight Diffraction (ToFD) inspection with a phased array survey enables the interrogation of complex weld bevels or inaccessible fusion faces in the case of pipe-to-fitting joints.



PAUT Nozzle inspection using a three-axis scanner

T-joints and similar weld geometries have always presented a challenge for ultrasonic testing, but there is now a way to validate that coverage is adequate and to reduce the adverse effects of this configuration.

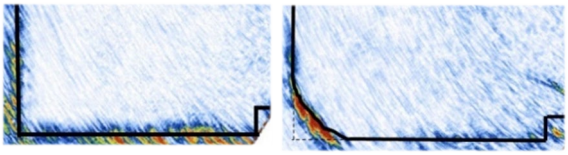
- Weld flaws such as lack of fusion, slag inclusions, porosity, inside diameter / outside diameter (I.D./O.D.) cracks, centreline cracks and incomplete penetration
- Erosion or corrosion – pitting, material loss and root erosion
- Inherent discontinuities in forged or casting materials such as laminations, forging bursts, cold shuts, hot tears and inclusions
- Environmentally or process induced damage such as MIC, HIC, thermal fatigue cracking, caustic cracking and stress corrosion cracking



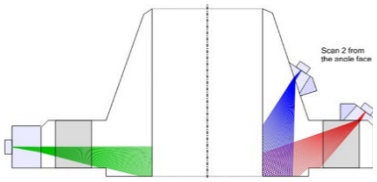
Typical PAUT raw data image from a weld inspection

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Flange Face Inspection: is used to detect crevice corrosion between sealing surfaces and gasket material. The weld neck and body material can also be measured for material loss using PAUT. A total of 3 scan positions can be carried out depending on the flange configuration giving enough data to confirm the condition of the flange. This method of inspection makes for a reliable screening process while keeping production online.



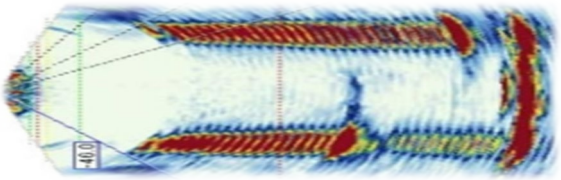
Data from Flange Face Inspection
Left Image: no corrosion Right Image: corner loss



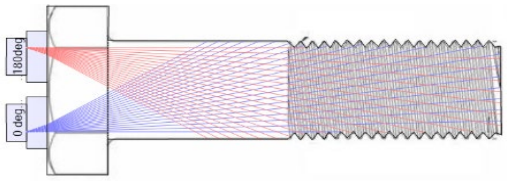


Left: scan plan of flange Inspection.
Right: Crevice corrosion detected with PAUT which was later repaired

Bolt Inspection utilises a scanner with a phased array probe that is attached to the head or end of a bolt. The bolt is then flooded with ultrasound and by means of a sectoral scan, defects are visualised without disassembling the bolt/nut.



Data collected from PAUT damaged bolt.

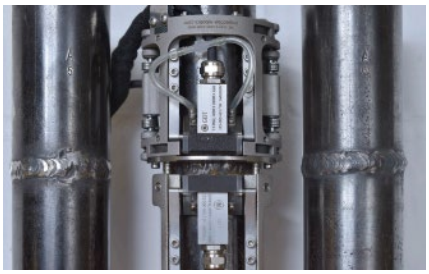


Scan plan of PAUT bolt Inspection.

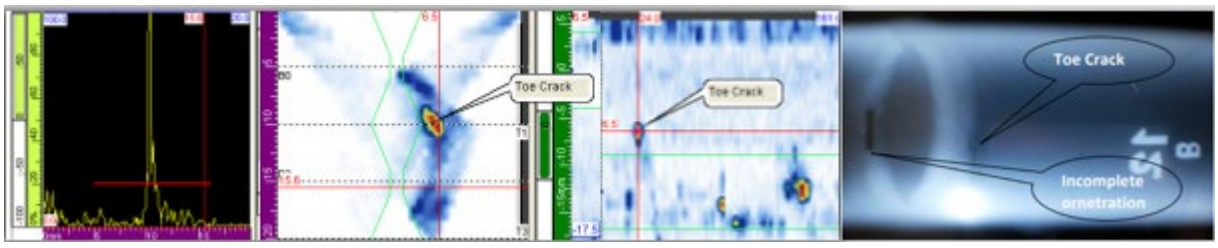
Any corrosion-related degradation of the thread can be observed, as well as the shaft of the bolt. Indications will be visible when they are shaped as linear indications between the toes of the thread.

Small Bore Pipework previously most small diameter pipe welds were radiographed for defects. However, radiography has significant limitations: safety and licensing issues, disruption to work schedules, chemical wastes, film storage, and poor detection of planar defects.

PAUT enables inspection of thin walled piping by providing semi-automated data collection. The low-profile scanner is specifically designed for use on small bore piping where minimal clearance is a limitation.



PAUT small bore pipe scanner



Data comparison from PAUT & RT on detecting defects showing the Lack of penetration and Toe crack