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IWEX | Inverse Wavefield Extrapolation

IWEX (Inverse Wavefield Extrapolation) is a full matrix capture (FMC) technique using ultrasonic (UT) inspection, in which individual A-scans are recorded for each element of an array transducer and processed in a manner similar to seismic processing and medical imaging. Advances in computer hardware and software are enabling these techniques to be implemented in real time in the field.

THE Applus+ SOLUTION

IWEX improves the ability to image flaws to determine if they are defects or benign. IWEX is a full matrix capture (FMC) technique, a new class of UT inspection technique that captures the full waveform (A-scan) for all combinations of firing each element in an array and acquiring the A-scans on each and every element of the array.

The term "Mode" indicates how many sound reflections the system uses to create the image of the flaw. **Where other FMC techniques generate a single mode at a time, up to three modes, IWEX can simultaneously generate up to 24 different modes to detect and image flaws of any orientation**, from parallel to perpendicular to the inspection surface by processing the 16,384 A-scans generated by the two 64-element array probes.

This is an improvement on phased array, which can often only "see" flaw tips and corners, where IWEX can image the flaw surface. The IWEX image can be viewed as a 2D cross-section or as a 3D image, allowing the user to get a better view of the flaw. This ability to "see" the flaw more clearly enables the user to distinguish between defect types and to discriminate certain benign flaws from others that can grow and lead to failure.

Better sizing and discrimination also allow users to qualify ILI tools and determine errors in ILI tool runs. Knowing the error in an ILI measurement can assist in engineering critical assessments to predict the probability of failure for specific types of pipeline defects.

The IWEX technology was developed in cooperation with Delft University of Technology and a first patent was granted in 2005. In addition, dedicated electronics hardware for parallel processing was developed in-house and patented in 2012, enabling real-time processing of the FMC data into 24 different IWEX modes. Recent developments include Phase Coherence Imaging (PCI) with an optimized algorithm that enables creating PCI images in parallel to the IWEX images without impact on the testing speed. Our proprietary PCI approach was patented in 2026.

Capability	Phased Array UT	ToFD	IWEX (Applus+)
Imaging modes per acquisition	1 mode at a time	1 mode	Up to 24 simultaneous
Full flaw surface imaging	Tips and corners only	Partial	Full flaw surface
3D volumetric imaging	Limited	2D only	2D and 3D
ILI tool qualification	Less-than-satisfactory	Limited	Precision qualification
Defect discrimination (benign vs. critical)	Limited	Limited	High discrimination
Phase Coherence Imaging (PCI)	Not possible	Not possible	Aid imaging for flaws

Target customers

IWEX is of great significance for the global energy industry. **Primary applications have been developed for inspecting girth welds, seam welds such as electric resistance weld (ERW) and flash weld (FW) seams**, and axial flaws in the pipe body, such as stress corrosion cracking.

In addition, the technique has been used to inspect the root of fillet welds for type B sleeves and welds in pressure vessels such as power plants and fuel-storage tanks.

IWEX is a next-generation UT-inspection technique. The previous state-of-the-art technique was Phased Array UT, which has been used for ILI tool validation, verification, and qualification, but with less-than-satisfactory results. IWEX should provide a method capable of qualifying ILI tools with sufficient accuracy.

Key customer benefits

IWEX helps Applus+ clients more confidently **predict the probability of failure for specific types of defects and, therefore, make informed decisions about the prioritization of repair and maintenance work**. Its enhanced sizing and discrimination also allow the client to leave certain flaws in place without a field repair. Ultimately, this all adds up to cost savings, reduced downtime, and enhanced productivity.