OLYMPUS®

Your Vision, Our Future

Innovation in NDT™

PipeWIZARD®

Automated ultrasonic inspection of pipeline girth welds using phased arrays

- Fast scanning speed: 100 mm/s
- Weld-to-weld inspection time of less than four minutes for 36-inch pipe
- Very flexible for different pipe diameters, wall thicknesses, and weld profiles
- Low operating costs
- High reliability
- “One size fits all”
- Great for special scans

RD TECH®

PipeWIZARD®

Girth Weld Inspection System Overview

Gas pipelines are made of high-strength steel and operate at a significant percentage of yield strength. Pipes are girth-welded on site, typically using automated welding. Then, they are rapidly inspected, coated, and buried. Due to the demanding construction cycle, it is important that any defect in the welds be detected and analyzed very quickly.

Over the past several years, AUT (automated ultrasonic testing) has started to supplant radiography for gas pipeline weld inspection around the world. AUT offers better inspection detection and sizing, plus lower reject rates.

There are a number of specific constraints related to the construction cycle:

1. Time: Onshore, the inspection cycle (mount scanner, scan, return, remove scanner, drive to next weld) is under four minutes. Offshore, the time may only be two minutes, but moving is not required.

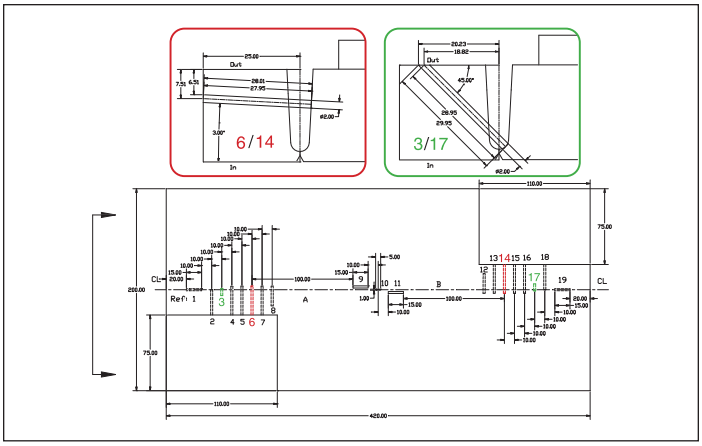
2. Data analysis: Data needs to be analyzed before moving to the next weld. This means characterizing the weld as accept/reject, almost in real time.

3. Data storage: It is essential to store the data during the inspection cycle for regulatory purposes.

All these specific constraints are addressed by AUT.

Codes

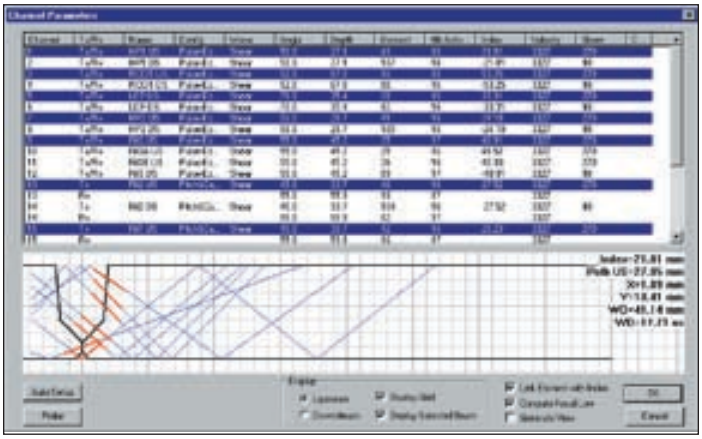
In 1998, the ASTM published ASTM E-1961-98. This code includes key features for automated ultrasonic testing of girth welds: zone discrimination, rapid data interpretation, specialized calibration blocks, setup procedures. E-1961 is targeted for the use of ECA (Engineering Critical Analysis). In 1999, the American Petroleum Institute published the 19th version of API 1104, which covered mechanized UT of girth welds as well as radiography.



Calibration block containing flat-bottom holes (FBH) and other reference reflectors (ASTM 1997).

All PipeWIZARD® products comply with ASTM E-1961, and by inference, with API 1104. As well, PipeWIZARD complies with DNV2000 OS-F101 which is the offshore AUT code. In some circumstances, company specifications may override the codes, typically by asking for improved sizing or better resolution.

Advantages and Key Features of AUT



Ray-tracing tool showing zone discrimination of a CRC-Evans-type weld profile.

AUT is replacing radiography for pipeline girth weld inspections worldwide. The advantages of conventional AUT are clear:

1. No ra diation hazard.
2. Better process control of welding, giving lower reject rates.
3. Larger defect acceptance using ECA, also giving lower reject rates.
4. Faster inspections.
5. Rapid and reliable data interpretation from special output display.
6. Overall, onshore mechanized ultrasonics offer a better inspection solution with lower reject rates than radiography.
7. Phased arrays offer major advantages over conventional AUT.

Advantages of Phased Arrays for Girth Weld Inspections

- Smaller and lighter probe pans with potentially reduced cutback (down to 2 in.).
- One PipeWIZARD® can scan pipes ranging in diameter from 2 in. to 56 in. while only changing the band, setup file, and wedge.
- The standard PipeWIZARD can scan pipe walls from 6 mm to 50 mm (0.25 in. to 2 in.).
- Increased number of zones for better detection and vertical sizing.
- Scan time is reduced by several seconds due to the narrower probe pan.
- Any weld profile, pipe diameter, or wall thickness can be accommodated by recalling the appropriate setup files.
- Arrays can be programmed to perform real coupling checks using the back wall.
- Setup wizard enables automatic setups.
- Special applications (see next page).

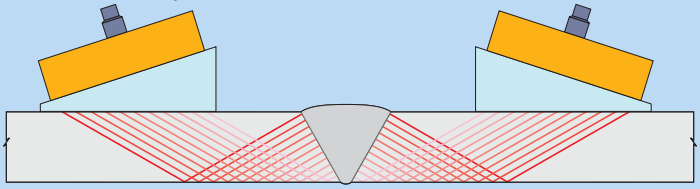
Near Real-Time Output Display

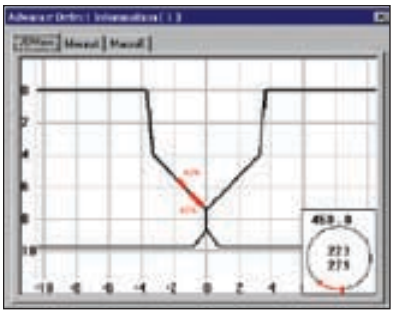
- Scrolling display is designed for rapid interpretation and analysis by operator.
- Weld is “opened out” to display upstream and downstream sides.
- Each zone is displayed as a twin-gate strip chart, with amplitude and time of flight (TOF).
- B-scans display and characterize porosity of root and cap regions.
- The optional TOFD display improves misoriented defect detection as well as defect sizing.
- Colored strip charts on the right side of the screen show coupling status.
- Up to 128 channels are possible.

What Are Phased Arrays?

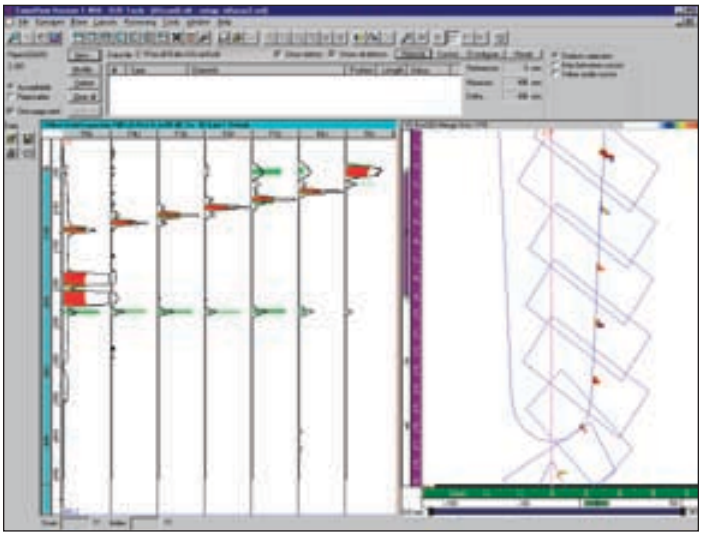
Phased arrays use electronic beam forming to generate and receive ultrasound. Each element in the array is individually pulsed and delayed to create a wide range of beam angles and focal distances.

A series of focal laws is developed, which enables weld scanning in a manner similar to conventional ultrasonics, but with only two arrays and with much greater flexibility. Setups are performed by loading a file, not by adjusting transducer positions. Electronic scanning permits customized weld inspections, including multiangle time-of-flight diffraction, advanced imaging, and detailed inspections.

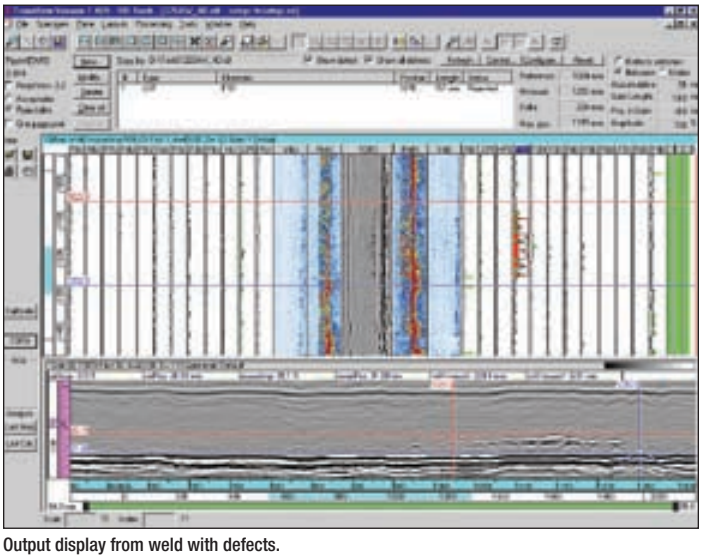




Automatic interpretation software.



Zone discrimination of a J-bevel type weld profile in a 19.1-mm calibration block.



Output display from weld with defects.

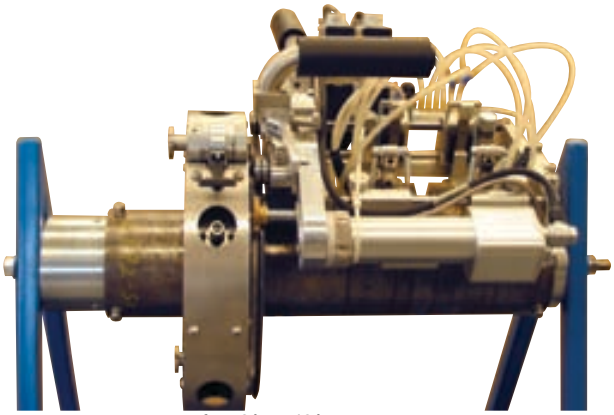
Defect Analysis

- Amplitude data is color-coded to alert the operator when a signal crosses the rejection threshold.
- Defects can be rapidly sized by counting the number of zones where the signal is detected.
- Defect length can be measured directly from screen.
- Defect location in the weld can be determined from the time-of-flight information (colored bar).
- Characterization is performed using amplitude, zones, and TOF data from the appropriate zone(s) and TOFD.

Complete zone discrimination can be performed with two 60-element arrays, one on each side of the weld. Time-of-flight diffraction (TOFD) and other scans can be performed using the same arrays, or dedicated probes. The probe pan has been designed to accommodate the additional probes required to perform transverse inspections. Additional sizing techniques can be used, such as TOFD or amplitude weighted techniques.

Welds to Inspect

• Joint type	Circumferential weld
• Pipeline diameter	2 in. to 56 in.
• Thickness	6 mm to 50 mm (options for thicker pipes)
• Weld design	CRC-Evans, J-bevel, others (including manual welds)



Ring-type scanner covers a range from 2 in. to 16 in.

Calibration

The calibration block is complex: it contains reflectors to simulate defects expected in the field. For a CRC-Evans profile:

- Notches used for root and cap
- Angled FBHs used for LCP, fills, and hot passes

- Vertical through-wall holes used for positioning

Ultrasonic Zone Discrimination

- The weld is divided into zones, each 1 mm to 3 mm deep, for root, LCP, fills, and hot passes.
- Welds are inspected from both upstream and downstream sides for 100% coverage.
- Each weld zone is inspected in pulse-echo or tandem modes.
- The beam overlap from zone to zone is minimal.
- Reflectors detected in a single zone can be accurately sized as 2 mm or less.
- Twin gates are used for each channel for amplitude and time-of-flight.

Typical Defects to Be Detected

- Lack of fusion (surface or subsurface)
- Incomplete penetration
- Centerline solidificatio
- Cap and fill porosity
- Hi-low
- Misfire
- Burn through
- Root porosity
- Root undercut

Special Applications

- Thick pipes
- Small-diameter pipes
- Cladding
- Seamless pipes
- Tendons
- Risers
- Double jointing
- Challenging weld profiles

In-Service Applications

PipeWIZARD® has been used in a number of onshore and offshore applications and has completed over 200,000 welds and scans to date. The largest applications have been the Blue Stream project with Saipem, for which 65,000 welds and 130,000 scans were performed and the 4000-km Chinese WEPP project. For Blue Stream, PipeWIZARD ran for several months with no downtime. PipeWIZARD has operated flawlessly in hot and cold climates, in humid, salty, and dry conditions.

Onshore • Offshore • Around the World






Company	Location	Length	Bevel	Comments
Canspec/OIS	Canada	~300 km	CRC	Both PA and conventional
Fernas	Turkey	300 km	J-type	Onshore
Saipem	Congo	63 km	J-type	Offshore S-lay
Saipem	Angola	22 km	J-type	Offshore S-lay
Saipem	Ivory Coast	19 km	J-type	Offshore S-lay
OIS	Scotland	4 km	J-type	Onshore spool base
OIS	China	60 km	V-type	Onshore
Saipem	Black Sea	640 km	Presto and Passo J-types	Offshore J-lay
Saipem	Turkey	640 km	Passo & subarc	Onshore double jointing station
OIS	UK	80 km	CRC	Onshore
OIS	USA	8 km		Onshore catenary risers
Canspec	Canada	10 km	CRC	Onshore construction
OIS	North Sea	35 km	J-type	Offshore pipelay
Solus	Gulf of Mexico	70 welds	Manual V welds	Offshore risers
WEPP	China	4000 km	CFPCC	Onshore
COOEC	China Sea	105 km		Offshore
COOEC	China Sea	3 km		Offshore
Oceaneering OIS	United Kingdom	70 km	CRC	Transco
Saipem	Libya, China, Ecuador	178 km	Various	Offshore



PipeWIZARD® Delivers

- Real-time display and data analysis
- Automatic data recording
- TOFD scans for improved detection and sizing
- Accurate defect sizing to the depth of one zone (1 mm to 3 mm) or better using TOFD
- Precise measurement of defect length
- Defect location in weld fusion line or centerline
- Correct defect characterization
- Special scans for specific defects: B-scans for porosity and tandem probes for centerline cracking
- Optional top, side, and end views, or alternative displays

PipeWIZARD®: System Specifications

System Description

- Downsized probe pan containing two linear arrays
- Mechanized drive clamping onto welding band
- Large umbilical cable connecting probes, encoder, power, and couplant lines to instrumentation
- Instrumentation console including computer, pulsers, and motor drive
- Couplant containers, pump, and reclamation unit

Probe Pan

Probe pan contains two linear arrays.
Extra modules are available for transverse or TOFD inspections.
Couplant is pumped water or water-methanol in cold climates.
Lifting lever permits rapid rotation and minimizes possible damage.
Encoder running on welding band gives circumferential position.

Instrumentation

The instrumentation consists of:
Motor drive unit
Tomoscan FOCUS™ 32:128 phased-array unit
Industrial computer
Specific PipeWIZARD® software running on Microsoft® Windows NT® for data acquisition, analysis, and reporting
Automatic marking of indications exceeding rejection threshold to assist the operator
Inspection reports and list of defects adapted to client requirements
Automatic data saving to two separate media in real time

PipeWIZARD® Scanner

Pipe diameter	50 mm to 1424 mm (2 in. to 56 in.)
Pipe wall thickness	6 mm to 50 mm (0.25 in. to 2 in.) (Additional transducers may be required.)
Array	Two linear 7.5-MHz, 60-element
Scan speed	100 mm/s (4 in./s)
Scanner size	250 mm (L), 120 mm (W), 75 mm (H)
Scanner weight	2 kg (4.4 lb)
Additional probe pan slots	Extra slots for four conventional transducer pairs for transverse defects or additional scans
Weld profile	All common welds: CRC-Evans, J-bevel, manual, V, double V, X, etc. (any profile in principle)
Probe pan weight	18 kg (39.7 lb) (typical)

Umbilical

Length	Typically 25 m (80 ft)
Diameter	Armored cable 5 cm (2 in.) in diameter
Contents	128 ultrasonic cables, one motor drive cable, one encoder cable, and waterline for coupling

Ultrasonics

Method	Multichannel zone discrimination or custom scans as specified
Zone size	Less than 1 mm is possible using increased number of zones. (Maximum number of zones is 32 per view, and four views are available for a total of 128 zones.) ASTM E-1961 zone size is typically 1 mm to 3 mm.
Setup	Automatic with file loading
Automated setup	From CAD file of weld profile or from predefined weld profile and appropriate parameters
Display	1. Conventional twin-gate strip chart display; or 2. Increased number of zones for improved defect sizing; or 3. Multiple B-scans for improved defect characterization; or 4. Customized combination of displays. Coupling and circumferential position channels included, TOFD recommended.
Calibration and codes	ASTM E-1961, API 1104, DNV2000-OS-F101, or custom specifications
Additional modules	For transverse defects, thick walls, and customized scans

Phased Arrays

Instrumentation	Standard Tomoscan FOCUS™ 32:128 unit (32 simultaneous pulsers, 128 channels)	
Bandwidth	1 MHz to 20 MHz	
Maximum pulsing rate	20 kHz PRF	
Pulser delay	Adjustable from 0 µs to 25 µs in 2-ns increments	
Pulse output	Amplitude from 50 V to 200 V, width from 20 ns to 500 ns	
Receiver delay	Adjustable from 0 µs to 25 µs in 2-ns increments	
Receiver DAC	Up to 30 dB/µs on each element slope before summing	
Input filters	Four user-selectable ranges:	
	None 500 kHz to 5 MHz	2 MHz to 10 MHz 5 MHz to 15 MHz
Input impedance	50 W	
Inspection mode	Pulse-echo, pitch-and-catch (programmable)	
Dynamic range	56 dB/channel	
Computer interface	Both RS-232 and Ethernet™ standards	
Focal law storage	Up to 1024 different laws	
Power requirement	85 V to 265 V, 47 Hz to 63 Hz	
Operating temperature	0°C to 50°C	

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