NDT SCOOP

INSPECTION MAGAZINE

by ndtcorner.com

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CAIRO EXPO 2025

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Q.3 EDITION 2024
NDT SCOOP Publication

ON THE COVER

RVI Infinity Innovation is a company based in Germany, they are dedicated on design, develop and manufacture remote visual inspection products and solutions for industrial confined space inspection and quality control of NDT.

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Training Venue : Free Zone 3 Block G, Attaka, Suez, Egypt
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info@deltaips.net k.ramadan@deltaips.net

Kuwait Office Salem Al Mubarak St,
Soud Al Mutairi Complex, M1 Floor, Office 21, Salmiya.
Mobile : 90078311 Tel :41113940
Kuwaitadmin@deltaips.net

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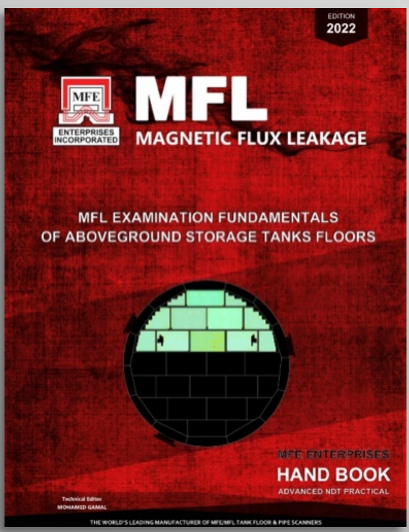

A Comprehensive MFL Operational Handbook

TANK FLOOR INSPECTION

www.mfeenterprises.com
www.mfeafrica.com

ABSTRACT

This Book is strongly providing a comprehensive guide to the MFL Tank Floor Examination.

Magnetic Flux Leakage (MFL) inspection is a method of non-destructive testing (NDT) used to detect and assess corrosion, pitting and wall loss in lined and unlined metallic storage tanks and pipelines. A powerful magnet is used to magnetize the steel. In areas where there is corrosion or missing metal, the magnetic field “leaks” from the steel. MFL tools use sensors placed between the poles of the magnet to pinpoint the leakage field.

MFL is a rapid and robust approach that continues to be widely used to detect corrosion defects in Tank Floors as it considered a large area within short time scales. Once a defect has been detected, the main failing of the MFL approach is its inability to size and classify. To improve sizing accuracy, defect needs to be quantified and followed up by prove up using UT thickness with A scan features.
MFL is a widely used to detect corrosion in above ground storage tank floors (ASTs) within the oil industry where tank floors are inspected periodically, the AST to be taken out-of-service and emptied. This makes maintenance times that much more expensive and calls for techniques that are both reliable and fast. MFL is widely used in the context because of its inherent speed.

MFL is accepted technology for locating defects on a tank floor. It is recommended by ASME Code and API 653. While MFL signals are often related to the volume of a defect, its depth is perhaps the most difficult to estimate and the most critical dimension since it indicates the closeness of a potential leak and if misinterpreted can lead to erroneous repair strategies with costly outcomes. Therefore, accurately determining the geometry of defects is pivotal if an optimum repair strategy is to be formulated.

Get your Printed MFL Handbook
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Sonatest

ULTRASONIC INSPECTION OF PIPELINE

Circumferential Butt welds

Sonatest

P I P E L I N E

What is Pipeline Circumferential?

Pipelines are an integral part of all industry processes in all sectors worldwide. Transporting liquids, gases, and solids through above ground, buried and subsea pipes, the condition of the pipework is essential to the safety and continued operation of the processes they are a part of.

A pipelines main vulnerability is located at the welded joints connecting sections of the line. The welding process introduces heat affected zones that lead to structural changes in the metal that weaken the part in the weld area, the fatigue resistance, is lowered and the overall strength and toughness can be affected.

Additional failure mechanisms can be introduced during service, these can include.

- Temperature fluctuations.
- Internal flow erosion.
- High pressure cycling.
- System vibration.
- Mechanical damage.
- External corrosion from the environment or water held in lagging.

METHODS OF MITIGATING THESE ISSUES ARE AVAILABLE BUT THE WELD SHOULD ALWAYS BE CONSIDERED A POINT OF WEAKNESS AND BE REGULARLY INSPECTED TO MONITOR ITS CONDITION.

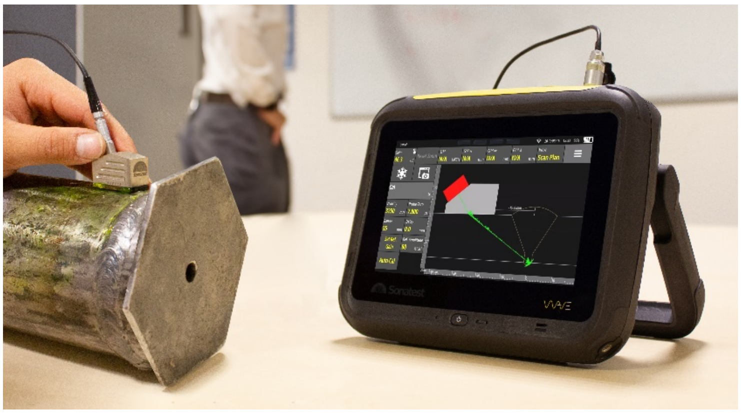
ULTRASONIC INSPECTION METHODS

Multiple inspection methods exist to assess pipeline welds, these include surface methods such as Visual, Magnetic Particle, Dye Penetrant and Eddy Current inspection, these only inform the inspector on the condition of the surface and slight subsurface of the weld. Full volumetric inspection requires Ultrasonic methods (UT) or Radiography (RAD).

UT has many advantages over RAD, the MAIN ONES being.

- UT produces no radiation hazard and can be carried out alongside other personnel; this is a safer process than radiography and means the site does not need to be cleared of workers for the inspection to take place.
- UT is sensitive to small defects, cracking defects and planar lack of fusion defects making it a great application for thinner pipework but is also applicable for thicker materials.

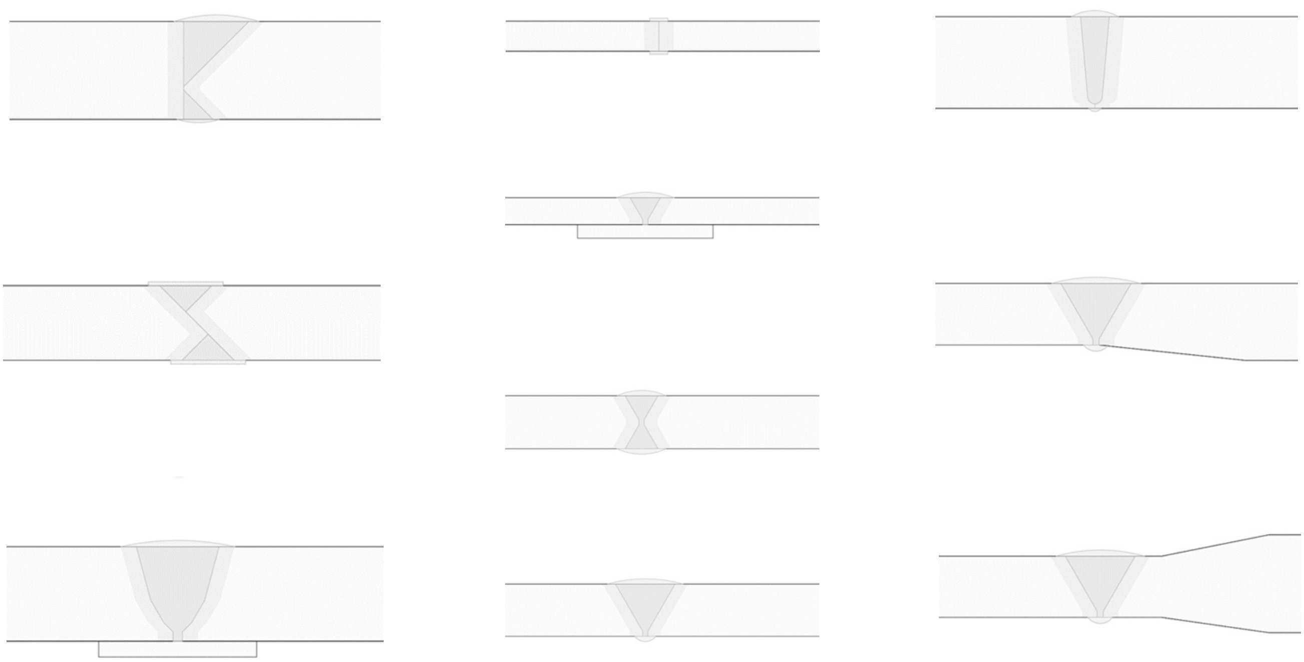
ULTRASONIC INSPECTION OF BUTT WELDS ON PIPE SECTIONS



Inspection Challenges of Circumferential Butt Welds

The most common circumferential weld geometry is pipe to pipe, both sides are the same material and same thickness, but this is not always the case, a pipe section can be welded to fittings such as bends, reducers, tees, and flanges which can be different thicknesses, made of cast materials and have attachments restricting access for inspection. All of these are points to consider when choosing the correct ultrasonic method for the inspection.

Examples of Butt weld configurations that can be encountered

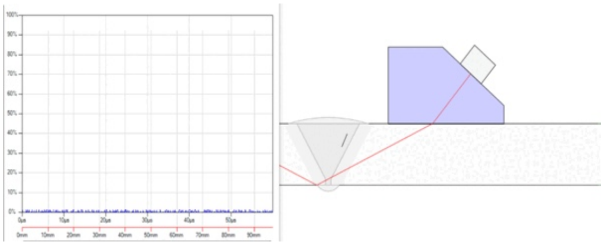


For further information or support, please contact the Sonatest Applications Team: applications@sonatest.com

Types Of ULTRASONIC INSPECTION

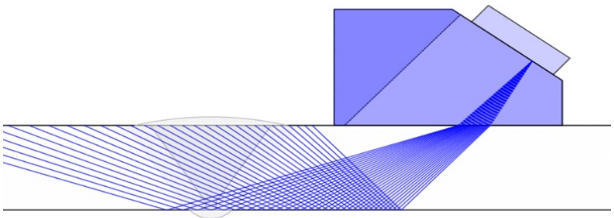
Conventional Ultrasonic (UT)

UT utilizes single or dual crystal transducers in single beam configurations to interrogate a weld. Transducers are set to produce specific known angles in the material (usually 0°, 45°, 60° and 70°, but other angles can be used) manual 'scanning' or movement of the transducer on the surface ensures coverage of the weld, return signals are interpreted by the inspector to detect and size defects.



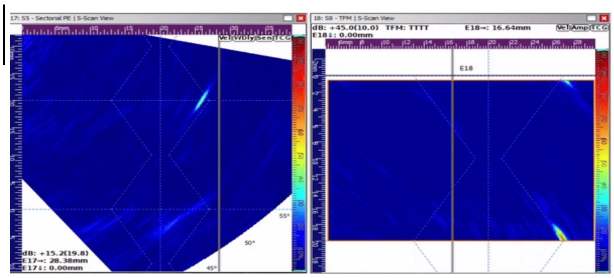
Phased Array (PA)

A PA inspection is carried out using a transducer containing multiple individual elements in an array. These elements are pulsed individually or in groups to create a beam that can be directed and focused depending on the requirements of the inspection. PA inspection can inspect full weld volumes in a single sweep or interrogate specific areas of a weld and produces a recorded data file with views that can be manipulated to aid interpretation.



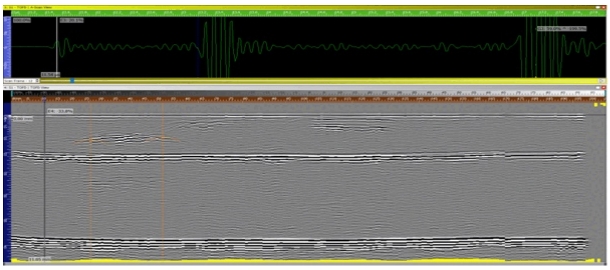
Full Matrix Capture / Total Focusing Method (FMC/TFM)

FMC is a form of data capture utilizing PA transducers, individual elements are pulsed, and A-Scan data is recorded by each of the remaining elements, this process is repeated for each element in turn creating a large set of data. TFM is a method of processing and displaying an FMC data set, an area of interest is chosen as a resolution set. FMC takes each pixel in this area and averages the total number of A-Scans for this pixel, creating a new A-Scan. As this is the average of 100s or 1000s of A-Scans, it reduces noise and is focused on this pixel. Repeating this for each pixel creates a view where the scan is focused at every pixel in the area.



Time of Flight Diffraction (TOFD)

TOFD utilizes two transducers set apart and facing each other in a 'pitch-catch' formation. One transducer sends a pulse into the material and the other transducer receives. Instead of using reflections from defects and displaying results as depth of reflection or beam path, TOFD detects 'tip diffraction signals' which are much weaker and displays results in time of flight. This gives a technique that has a high accuracy to defect depth and through wall height and is often used in the calculations for fracture mechanics.



WHAT SOLUTIONS can ULTRASOUNDS provide for pipelines?

ULTRASOUND COVERS MANY INSPECTIONS AREAS

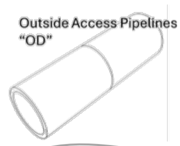
We will cover the two-outside diameter (OD) and inside diameter (ID) surface access situations where UT is commonly employed. The blog will not cover all pipeline inspection cases, but most current technologies are included.

Note: *Insulation on pipelines does not allow for the transmission of sound to the pipe below; this means for ultrasonic methods to be utilized, the insulation must be removed in the areas of interest. Alternatively, internal scanning methods such as pig crawlers can be used, or guided wave systems can be set at strategic points along the line, allowing for minimal insulation removal and screening of the pipe under the insulation.*

General PA-UT Methods

The following section contains the OD scenario and the ID examinations. For each case (where applicable), there is an example of conventional UT, PA Inspection, TFM or even a corrosion map rendering for much better visualisation. Beam Tool (Scan Plan) and CIVA Analysis (**Sonatest Compatible Advanced Analysis software**) were used to build this table below.

OUTSIDE "OD"



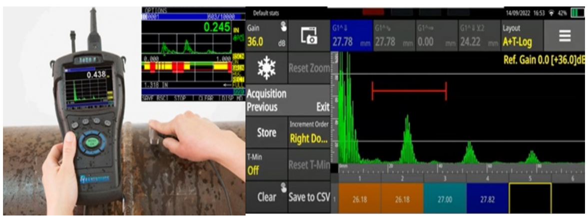
1- CORROSION MAPPING

Conventional UT	0° L-scan/TFM

Conventional UT

0° Manual UT
100% Manual Scanning of an Area

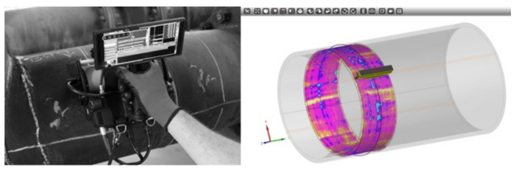
0° Manual UT
Spot Reading Grid Method



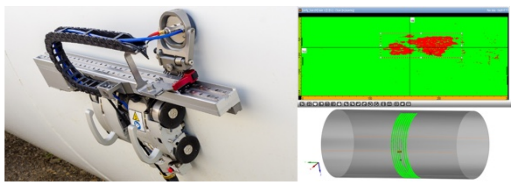
0° L-scan/TFM

Manual Inspection (Not Encoded) Scanning

Manual Example of a circumferential PA Scan corrosion survey that creates large C-scan data. The photo below is a 128E WP2 scenario.



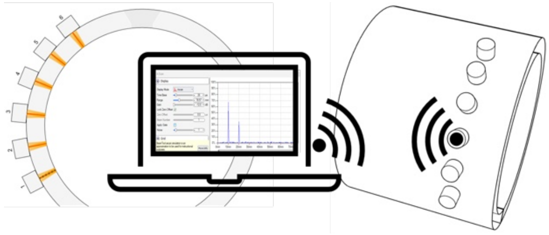
Example Automated/Semi-automated Scans: PA L-scan/UT/LL TFM Carried out with Crawler Scanners.



2- Constant Monitoring

(Belt / Single Point)

Single/Multiple Point(s) Constantly Being Monitored on Pipelines (Can Be Positioned Under Insulation)

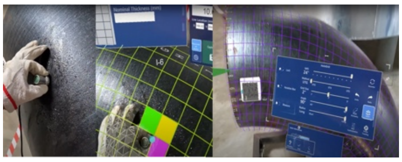


3- Elbow Mapping

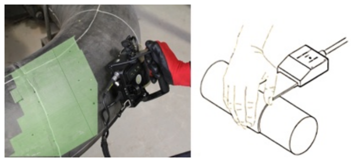
Flex Probe, Wheel Probe or Conventional UT

0° Manual UT
Spot Reading Grid

UT Automated Grid with
Augmented Reality (AR) Lens



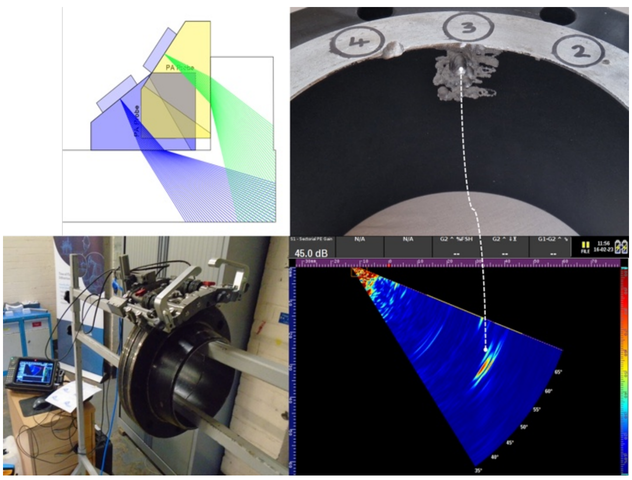
PA Using a Flexible/
Wheel Probe Array



5- Flange Face

Corrosion Inspection (Inner ROI)
In-service / Phased-Array

PA or TFM can be achieved around the flange. A bolt can reduce the region of interest access. The inspection procedure is always challenging and amended accordingly because there are many flange profiles in the field.

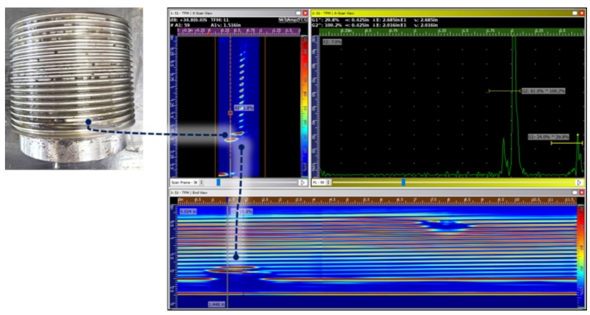


4- Flange (Bolts)

Corrosion Inspection
Phased-Array

PA and/or TFM Bolt Scanning

New Infallible Option: Slim Bolt Scanner (By a Valve or 2 Side-by-side Flanges). SONATEST Wide Bolt Scanner Offer Depending on the Bolt Size Requirement and Height Clearance.



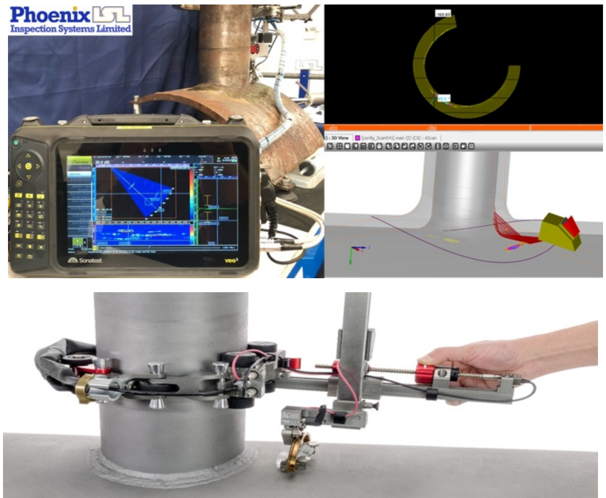
6- Nozzle Inspection

Conventional UT

A-Scan with an Imported Nozzle Geometry for a Reliable Flaw and Geometry Echo Location.

Phased-Array

Sectorial and/or Linear Scan with B-Scan and C-Scan (End and Top Scan Views)

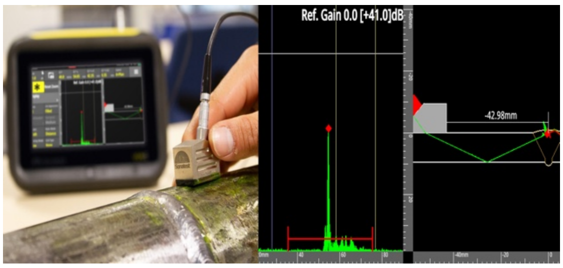


PA inspection with folded S-scan and rotated around the nozzle

7- Butt Welds

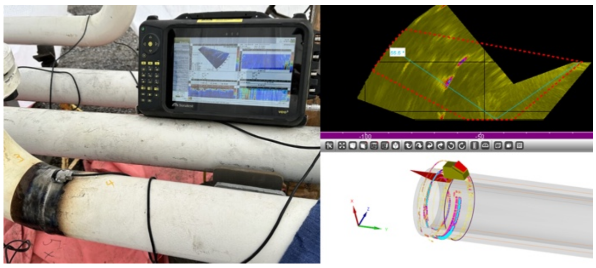
Conventional UT

A-Scan with an Interactive Scan Plan; A Live A-scan Is Displayed in the Butt Weld Geometry.



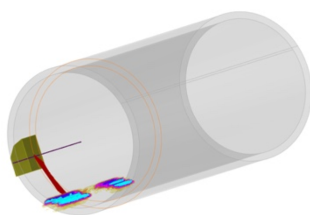
Phased-Array

Sectorial and/or Linear Scan. This Ultrasound Solution Can Run Both the PA S-scan and TFMI™ (TT+TTT+TTTT) in Parallel.



8- Special Cases

OD Surface Corrosion under Pipes Support: PA-CAT™ - Remaining Wall of External Piping Assessment, Underneath Saddle Supports on Vessels – PA Pitch-catch S-scan with Post-analysis Profile Extraction.



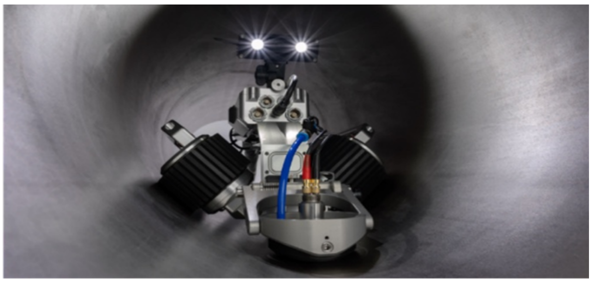
Internal Side "ID"

Internal Corrosion Mapping Inspection

UT or PA probe for medium/large diameters

Internal Scanners Better Suit Diameters Around 2 to 6 Inches. (TSIS Scanner Below)

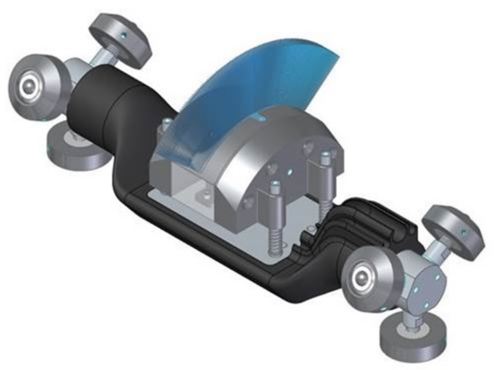
For phased array inspections, we recommend a linear array and a motorised crawler like the following Jireh TERAX crawler.

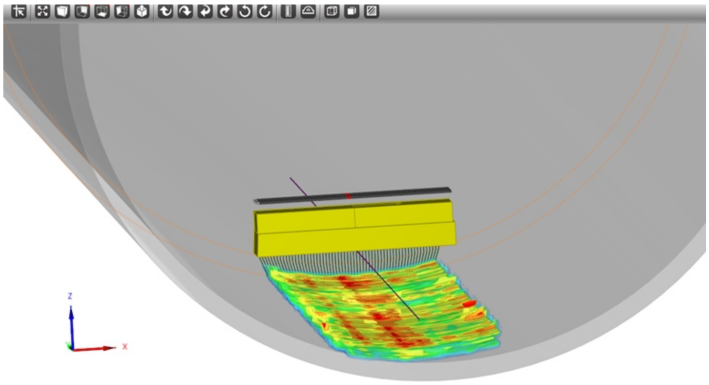


Internal Corrosion Mapping Inspection

Curved ID Linear Array

Special curved 19-inch AOD array design for ID inspection. Irrigation and encoder are included in that solution.





Pipeline Integrity Guide for NDT Specialists

Non-Destructive Testing

Most common methods

Introduction

This blog is the first article regarding a broad pipeline integrity SONATEST campaign as NDT insights. We will start with an overview of pipeline inspections. We will then develop more specific ultrasound content (blogs, solution notes, etc.) that is always related to pipeline assets. The goal is to provide NDT insights throughout this educational journey.

Pipeline Codes Driving its Integrity

The life cycle of pipelines should be monitored because they require critical quality control analysis. For example, there are pressure hazard factors to deal with, its intrinsic money asset value, the potential environmental accident consequences, and more to consider. Many standards regulate pipe structures to avoid disasters and hazards. The most known codes provide all the necessary requirements to achieve viable quality control. Among them are API, ASME, ASTM, and ISO.

There are also existing codes that cover distinctive cases, such as plastic pipe butt joints and austenitic steel lines and welds, high-pressure lines made of hardened steel, etc. Since you are now aware of the common regulations, let us check out the main non-destructive scenarios that can be applied to pipelines.

- **ASTM E213 – 22**: Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing
- **ASTM E1961 – 21**: Standard Practice for Mechanized Ultrasonic Testing of Girth Welds Using Zonal Discrimination with Focused Search Units
- **API STD-1104** Welding of Pipeline and Related Facilities
- **ISO 17635** – Non-destructive testing of welds – General rules for metallic materials
- **ISO 5817** – Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections

General NDT Methods for Pipeline Inspection

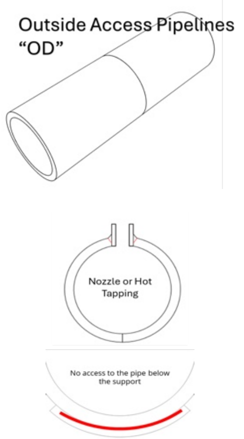
The next section contains two scenarios for inspection from the outside diameter surface (OD) and inspection from the inside diameter surface (ID). These locations get different inspection techniques separately because the defect characterization requirement may differ from time to time. For example, a full phased array mapping would not get the same remaining wall thickness data density and precision as a pulse eddy current mapping, even if both serve an adequate NDT evaluation approach.

Pipeline External Inspection Techniques:

- Automatic UT Corrosion Mapping
- Phased Array Ultrasound (Planned inspections or Constant Monitoring Systems)
- MFL Pipe Scan
- LRUT Guided wave.
- EMAT (Surface & Subsurface)
- Thermal Imaging
- UT grid with A Scan feature.
- Acoustic Emission

EXTRA CHALLENGES (Limited access & complex geometries):

- Flanges (bolt-in survey with limited access)
- Elbows (especially mitered elbows)
- Valves
- Reducers
- Dissimilar materials/layered pipes, Etc.

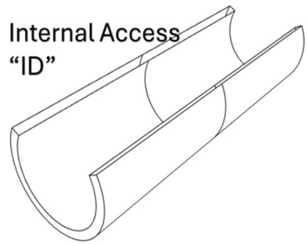


Pipeline Internal Inspection Techniques:

- Automated & Semi-Automated Phased Array Ultrasound & UT
- Visual Inspection using Remote Cameras (RVI)
- In-line Inspection with UT and MFL (Pigging)

EXTRA CHALLENGES

- Height clearance
- Scanners and crawlers' technologies investment (pigging)
- Inner surface conditions may affect crawling and NDT evaluation performance
- The overall setup requires reliable components of:
  - Remote controls (visual and signal acquisition)
  - Constant irrigation
  - Post-analysis software
  - Qualified NDT and crawler operators' teamwork

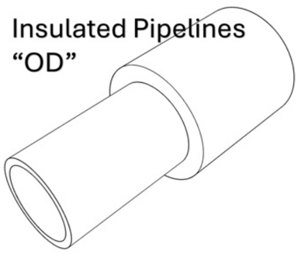


Pipeline Insulated Inspection Techniques:

- Pulsed Eddy Current Array
- Guided Wave (AKA LRUT)
- Radiography
- Permanent Monitoring Systems
- Acoustic Emission

EXTRA CHALLENGES

- Insulation is not ultrasound compatible
- Buried pipelines
  - Pipe configuration is sometimes unknown
- Small diameter pipeline configuration may not allow all ID crawlers
- Lower precision techniques may require further NDT assessments



Challenges for some locations and flaw characterisations

The previous tables contain only the typical challenges that an NDT service provider can face. Fortunately, there are many solutions to overcome most of the difficult aspects of pipeline inspections. Here are a few examples of when the NDT advances through the pipeline industry requirements.

- Small footprint PA probe → Low clearance access, single access weld on flanges.
- Rolling probes with Glycol under cold conditions → Clear off the water coupling freezing issues.
- EMAT probe → When water coupling is now allowed.
- Pulsed Eddy current mapping → Allows a full screening mapping without preparation. (Magnetic field penetrates through the insulation)
- The use of CAD overlay → to superimpose ultrasound images or RT shots to spot any dissimilarities.
- AI & smart post-analysis software tools → Some NDT data is hard to interpret (like TOFD, Acoustic emissions or LRUT data) The software will detect and flag anomalies. Software evaluation tools are also more precise.

What's Next?
Because we are engineering ultrasound solutions, the NDT piping solution focus will move on to PAUT, TFM, TOFD, etc. There are indeed many ultrasound techniques that gravitate around the pipeline asset. Each has pros and cons, but certainly, achieving reliable quality control that also fulfills a good practice standard.

Please contact applications@sonatest.com if you have any questions.

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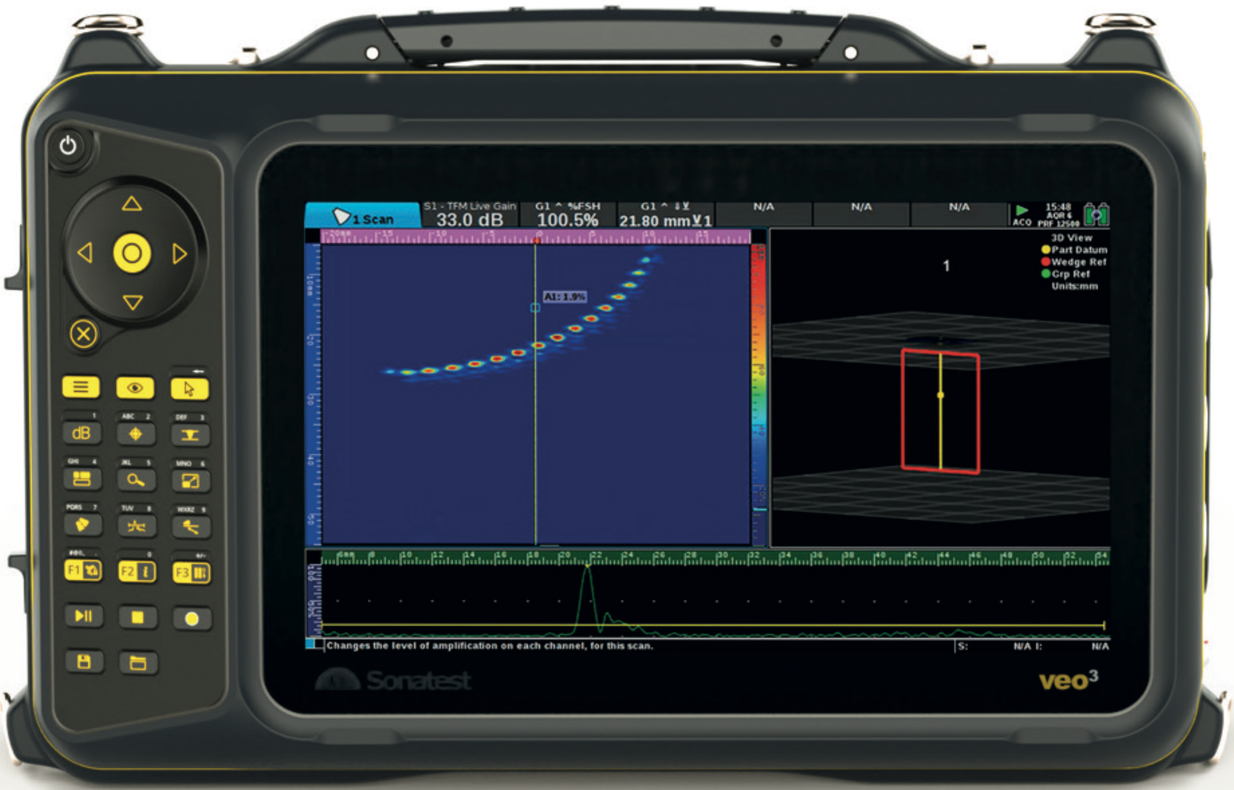

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WAVE

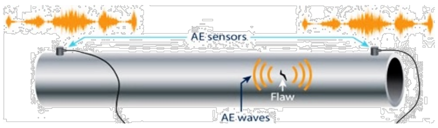
WAVE - Interactive Flaw Detector

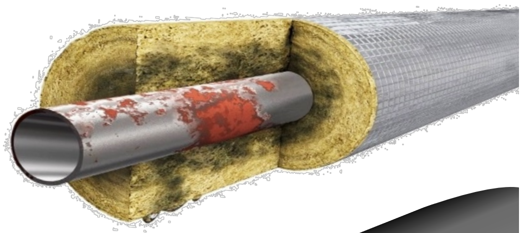
Inspect with Confidence

PIPELINE INTEGRITY

Non-Destructive Testing

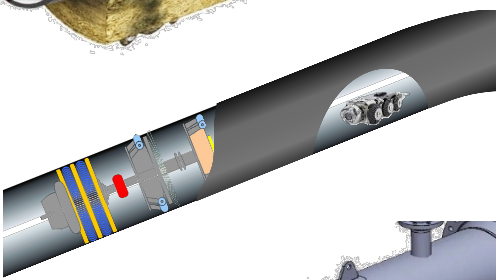
Most common methods





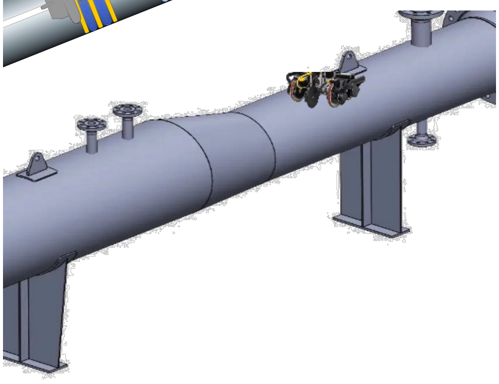
INSPECTION OVER INSULATION

- Pulsed Eddy Current
- LRUT Guided Wave
- Digital RT
- Acoustic Emission



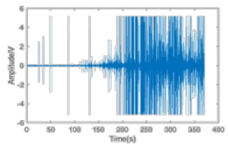
INTERNAL INSPECTION

- Automated & Semi-Automated Phased Array Ultrasound & UT
- Smart/Intelligent Pig
- Remote Visual Inspection (RVI)

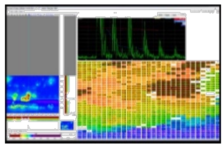


EXTERNAL INSPECTION

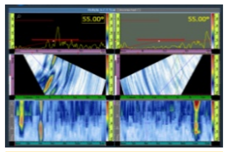
- Automatic UT Corrosion Mapping
- Phased Array Ultrasound (Planned inspections or Constant Monitoring Systems)
- MFL Pipe Scan
- LRUT Guided wave.
- EMAT (Surface & Subsurface)
- Thermal Imaging
- UT grid with A Scan feature.
- Acoustic Emission



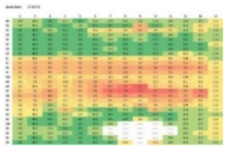
Acoustic Emission



AUT Scan



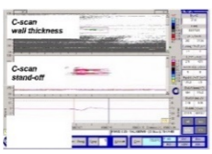
PAUT Scan



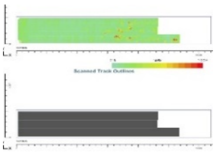
UT Grid Scan

Digital RT

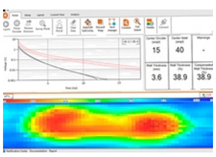
Thermal Imaging



Smart Pigging

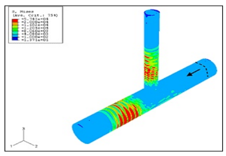


MFL Scan



ECT Scan

RVI Image



LRUT Test

Conventional NDT used for internal Inspection!

Most common methods are Visual Testing, Magnetic Particle Testing, Penetrant Testing, Ultrasonic Testing, Radiographic Testing and Eddy Current. In these tests, defects such as corrosion, cracks, decrease in wall thickness or gaps in internal structures are identified in ferritic and austenitic steels, aluminum alloys, nickel, copper and titanium alloys during production or usage. Non-destructive testing methods can change depending on the procedure, size, thickness, and structure of the material.

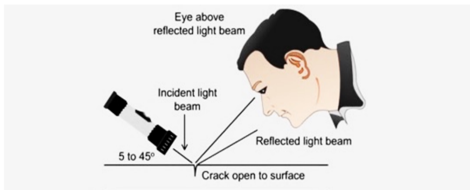
Visual Inspection.

VT is the fastest and cheapest method of Non-destructive testing. It's the first step of every inspection before any other Non-destructive test starts. When performing visual test with naked eye, equipment such as magnifying glass, light source, borescope, and mirror can also be used.

The condition of the surface is important to detect discontinuities such as cracks, porosities, and undercuts. Required cleanings must be finished before visual testing starts. surface cleaning is very important.

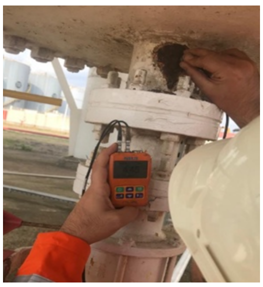
Visual Testing is perhaps the oldest and most widely used inspection technique. Often the eyes of the inspector are the only "equipment" used for the inspection. Visual İnspection is applicable to virtually any material, at any stage of manufacture, at any point in its service life. **To perform a successful direct visual examination, adequate lighting and good inspector eyesight is required.**

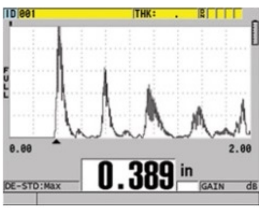
VT seems like an easy method, but it has its own inspection terms, and the experience of the staff is important. Test should be performed under enough light, minimum 500 lux, with an angle not lower than 30° and the distance between eye and the surface shouldn't be less than 300 mm.



Ultrasonic Testing

Wall Thickness & Metal Loses measurements using UT Thickness Gauges includes A-scan feature to able to detect corrosion failure and display reading in Digital & A-scan view.



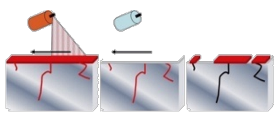


Magnetic Testing

MT is essentially a surface-type examination, although some imperfections just below the surface are detectable. This type of examination is limited to materials which can be magnetized (hence it is not appropriate for austenitic stainless steels). An area to be examined by magnetic particle examination can be completely examined or examined on a random sampling basis, as specified.

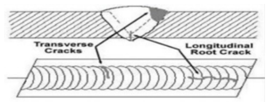
Penetrant Testing

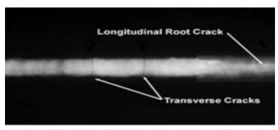
PT is a method to detect surface-connected defects. It is important to have a clean and smooth surface. After mechanical, chemical precleaning the surface must be dry and any dirt such as rust, oil, or paint should be cleaned from the surface as it will affect the process. The biggest advantage of this method is it has no restrictions about the material.

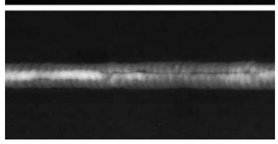


Radiography Testing

Random RT X-ray or gamma ray radiography may be used. The selection of the method should be dependent upon its adaptability to work being radiographed. When random radiography of welds is specified by the engineering design, it should be done on the number of welds designated. The engineering design shall specify the extent to which each examined weld should be radiographed. Random radiography may also be used for examination of piping components such as a valve or fitting to any extent specified by the engineering design.







Advanced NDT used for internal & external Inspection!

Most common methods are Phased Array UT, Automatic UT Corrosion Mapping, Acoustic Emission, Pulsed Eddy Current, Short Range guided wave. In these tests, you will have a permanent record and digital report for corrosion assessment. Defects such as corrosion, cracks, decrease in wall thickness or gaps in internal structures are identified in ferritic and austenitic steels, aluminum alloys, nickel, copper and titanium alloys during production or usage. Non-destructive testing methods can change depending on the procedure, size, thickness, and structure of the object need to inspect.

Ultrasonic Thickness Grids Measurement

UT Grid scan with spot digital reading & A-scan.

An ultrasonic thickness gauge works by precisely measuring how long it takes for a sound pulse that has been generated by a small probe called an ultrasonic transducer to travel through a test piece and reflect from the inside surface or far wall. From this measurement, the thickness of the test piece is calculated and displayed on a digital screen. The portability of the testing equipment allows for on-site inspection and results are instant. If a problem has been detected by the technique, additional non-destructive testing methods can be used to further investigate the findings.

Manual point thickness measurements using conventional ultrasound (UT) is a widely used technique for monitoring corrosion in many infrastructure applications. Depending upon the nature of the corrosion (e.g., localized, versus generalized and pitting), an inspector typically records the minimum thickness reading within a small area (usually 1 in.2). This however can lead to inconclusive inspection data due to minimal coverage of large areas, operator variability, lack of pitting or localized corrosion detection, and inadequate data reporting and analysis.

Automatic UT Mapping

Ultrasonic technique using powered scanners.

AUT is using mechanical scanners with magnetic wheels to only adhere purposes to locate inherent defects within a given material. AUT is the term used to describe corrosion mapping inspections, pulse-echo weld inspection, Phased Array and Time of Flight Diffraction.

Typical Automated Corrosion mapping systems can inspect 20-30 sq. meters per standard workday. The benefit of using the automated imaging systems allows a picture (C-Scan Image) quickly identifies any significant reduction in wall thickness. These automated corrosion mapping scans can then be superimposed into development drawings of equipment and accurately indicate location of problem regions. The images on this page show some significant problems detected from field inspections.

Automated Corrosion Mapping Ultrasonic scans of materials, uses a range of colors to represent the thickness range of part being inspected, typically blue colors are used to represent nominal wall thickness with orange and red colors used to indicate significant wall reduction.

Mapping of pipelines for follow up of Smart Pig surveys and Long-Range UT (LRUT) programs allows accurate assessment of localized areas of concern. Due to the speed of modern systems considerable coverage can be completed daily. If you have a critical system and you require 100% coverage for process reliability, then this is the solution you require.

Phased Array UT

Inspect large surface areas quickly with high resolution.

Inspect large surface areas quickly with high resolution. Typically, a thickness reading is performed every 1 mm2, which represents 500 more sample points than conventional ultrasound. This high resolution makes it possible to detect small, localized indications, such as corrosion pits, and it enables the operator to profile the shape of the corroded area.

Intuitive and affordable phased array instruments are now commercially available. These devices are easy to setup so users can record and archive data for further analysis. Easy-to-read images make interpreting acquisition data straightforward. The data can then be used to perform corrosion assessments according to ASME B31G and other applicable standards.

Multiplexing, sometimes called an electronic or linear scan, is used to perform corrosion monitoring. The sensor consists of a long-phased array probe, 25 –100 mm (1 – 4 in.) with between 32 and 128 elements. A small group of elements, defined as the active aperture, is activated to generate an ultrasonic beam propagating normal to the interface. This group of elements is then indexed using electronic multiplexing, creating a true physical movement of the ultrasonic beam under the array with an index as small as 1 mm (0.040”). The electronic indexing is performed so fast that a 4-inch (100 mm) line length is covered by the ultrasonic beams in milliseconds. The travel time of these beams is used to determine the component’s thickness at each acquisition point.

Pulsed Eddy Current

Inspection over Insulation to determine the condition of pipes and monitor corrosion.

PEC technology does not require direct contact with a test object nor specific surface cleaning, making inspection fast and easy even at high temperatures and on offshore wells. Inspections can be conducted, and corrosion can be monitored during operation to allow for planned maintenance and repairs to be scheduled and carried out at times optimal for your business.

Pulsed Eddy Current readings conducted many times at the same location can be reliably reproduced regardless of casing, coatings, or insulation. PEC technology provides results with a plus/minus 10% accuracy for corrosion detection and a plus/minus 0.2% accuracy rate for corrosion monitoring. Moreover, Pulsed Eddy Current inspections can be successfully and easily carried out at temperatures ranging from -100° C to 500° C (-150°F to 932°F).

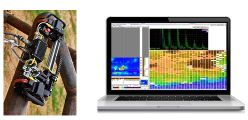
Pulsed Eddy Current technology is based on electromagnetics and provides average wall thickness values over the probe footprint area. It measures and compares the percentage variation in average wall thickness throughout an object. Pulsed Eddy Current can be effectively applied for corrosion detection and monitoring on pipes and vessels made of carbon steel or low-alloy steel without contacting the steel surface itself. PEC technology allows measurements to be made through insulation, concrete, or corrosion barriers.

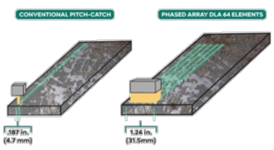
Acoustic Emission

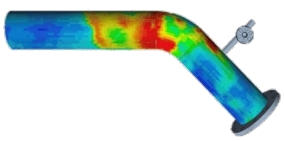
When a material with defects is subjected to mechanical stress or load, it releases energy. This energy travels in the shape of high-frequency stress waves. These waves or fluctuations are obtained with the utilization of sensors which in turn transforms the energy into voltage. This voltage is electronically overstated with the utilization of timing circuits and later refined as acoustic emission signal data.

AE refers to the generation of transient elastic waves produced by a sudden redistribution of stress in a material. When a structure is subject to an external stimulus (change in pressure, load, or temperature), localized sources trigger the release of energy, in the form of stress waves, which propagate to the surface and are recorded by sensors. With the right equipment and setup, motions on the order of picometers (10 – 12 m) can be identified. Sources of AE vary from natural events like earthquakes and rock bursts melting, twining, and phase transformations in metals. In composites, matrix cracking and fiber breakage and debonding contribute to acoustic emissions. AE’s have also been measured and recorded in polymers, wood, and concrete, among other materials.

Need more, read Edition# 3







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Digital Welding Solutions

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موزع معتمد لشركة إيساب العالميه

Challenges Affecting Our Industry

- Low Productivity
- Cost Control
- Quality & Traceability
- Access to Competence

Management on welding

- PRODUCTIVITY
- CONSUMPTION
- WELD SESSIONS
- DOCUMENTATION

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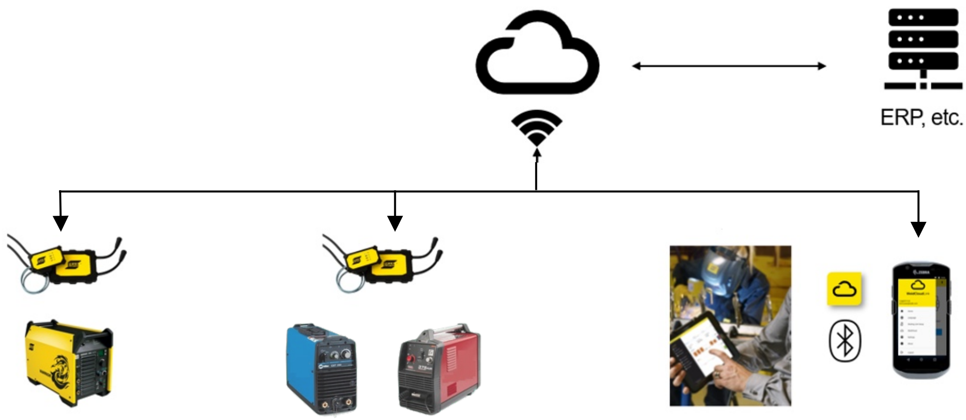
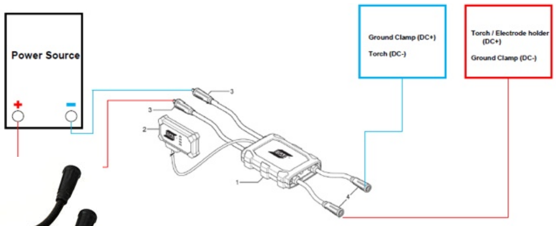
Simplicity Insight Control

Universal collection of welding and cutting software applications that connects data, machinery, and processes to...

Unlock your shop's true potential

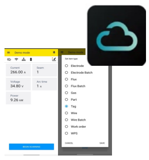


WELDCLOUD Universal Connector



Data Collected to INDUSUITE

- **Manual inputs "Universal connector" :**
  - ❑ Voltage.
  - ❑ Current.
  - ❑ Power.
  - ❑ Arc ON – time.
- **Manual inputs "WELDCLOUD Link" :**
  - ❑ Gas type.
  - ❑ Parts
  - ❑ Wire.
  - ❑ Work Order.
  - ❑ WPS.
  - ❑ Welders
  - ❑ etc.,



- **Automatically calculated by INDUSUITE :**
  - ❑ Heat input
  - ❑ Net deposition rate.
  - ❑ Filler material consumption.

WELDCLOUD Applications:

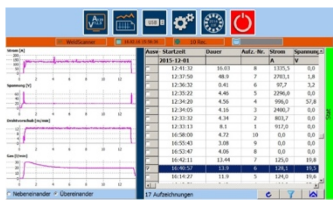
- Notes
- Productivity
- Fleet
- Assembly

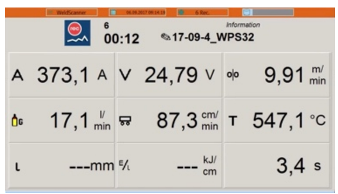
HKS - Weld Scanner

Designed and produced by **HKS Prozesstechnik in Germany**

- Multipurpose measuring device, usable as:
  - ❑ Voltage.
  - ❑ Current.
  - ❑ Arc time.
  - ❑ Heat Input.
  - ❑ Gas flow
- **Data export through USB.**
- **Touch screen with curve progression that shows all welding parameters.**

WeldScanner
Multi-talented recording device





Gas Flow Sensor

Voltage Sensors

Travel Speed Sensor

Wire Sensors

Contact ESAB EGYPT for more info.: info@esabegypt.com

MFE AFRICA is providing all service to the Middle East and Africa region.

We sell MFL Tank Floor Scanners by MFE Enterprises, since 1994, a U.S. based firm with more than 25 years of solid presence in the market. MFE manufactures Non-Destructive Testing (NDT) and Magnetic Flux Leakage (MFL) inspection equipment. It's manufactures and sells specialized storage tank and pipeline MFL inspection tools to ensure fast and efficient identification of defects in facility assets. Using modern MFL detection technology, MFE Enterprises offers the very best in storage tank and pipeline inspection equipment. Our mission has never changed: We provide educational information to the NDT community about MFL technology and the advantages of deploying our MFL Scanners for FAST and ACCURATE inspection of your plant assets. We have sold scanners around the world to NDT service specialists.

MFE AFRICA

Sales

MFE manufactures Non-Destructive Testing (NDT) and Magnetic Flux Leakage (MFL) inspection equipment. It's manufactures and sells specialized storage tank and pipeline MFL inspection tools to ensure fast and efficient identification of defects in facility assets. Using modern MFL detection technology.

Rental

We serve a variety of industries with our NDT, RVI and Environmental inspection equipment. Our tools and accessories help ensure safety in the workplace while maintaining equipment integrity! and protecting our clients' bottom line. We offer a large inventory of equipment from top manufacturers.

Calibration

NDT Electronics provide our clients with outstanding calibration and repair services in the field on Nondestructive Testing at an affordable price with a turnaround time unmatched in this industry. In 2016, NDT Electronics has joined the MFE Family, a family company since 1994.

Read more about MFE and our latest inspection systems!

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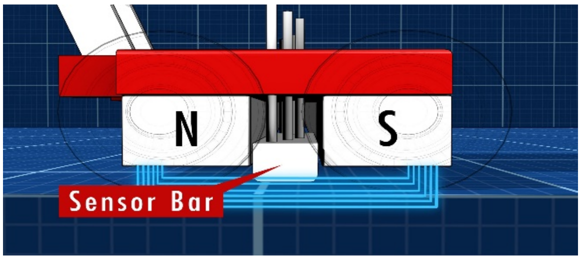
MAGNETIC FLUX LEAKAGE EXAMINATION

WHAT is MFL?

Magnetic Flux Leakage (MFL) Examination is a method of non-destructive testing (NDT) for a ferromagnetic material; began to be widely used from the beginning of the 50s in the twentieth century and is the most popular methods of tank floor, pipeline, and tubular inspection. It is a qualitative test used to detect and assess corrosion, pitting and wall loss in lined and unlined metallic storage tanks and pipelines. A powerful magnet is used to magnetize the steel in areas where there is corrosion or missing metal, the magnetic field "leaks" from the steel. MFL tools use sensors placed between the poles of the magnet to pinpoint the leakage field. MFL is a rapid and robust approach that continues to be widely used to detect corrosion defects in Tank Floors as it considered a large area within short time scales. Once a defect has been detected, the main failing of the MFL approach is its inability to size and classify. To Verify and improve sizing accuracy, defect needs to be quantified and followed up by prove up using UT thickness with A scan features.



MEASURING METHODS & SENSORS:

1. **Electromagnetic induction method**. Based on Faraday's law of induction Coil, it is one of the most basic magnetic measurement methods.
2. **Magnetic resistance effect method**. This method utilizes the changing characteristics of material resistances under magnetic fields.
3. **Hall Effect method**. The electromotive force is generated by the electric current in the magnetic field. The change of the magnetic field intensity can be obtained by measuring the electromotive force.
4. **Magnetic resonance imaging**. By absorbing or radiating a certain frequency of electromagnetic wave in the magnetic field.
5. **Magneto optical method**. This approach utilizes the magneto-optical and magneto-stricture effects.

TANK BOTTOM DEFECTS & CORROSION:

In Oil & petrochemicals industries, corrosion is one of the main causes of catastrophes to structures and equipment. Atmospheric storage tanks, pressure vessels and pipelines are gradually corroded by chemical or electrochemical reactions within their environment.

The most common types of corrosion are pitting and uniform corrosion, especially pitting corrosion in low carbon steel. Low carbon steel is widely used as the main material for atmospheric storage tank floors, and the atmospheric storage tanks play an irreplaceable role in storage and transportation of crude oil and oil derivatives.

However, over 80% of the storage tanks shutdown, bottom perforation and leakage accidents are caused by tank bottom corrosion. This can cause very serious consequences on the environment, health and safety, producing a very wide range of hazards and disasters. Therefore, the storage tank bottom corrosion has attracted more and more attentions all over the world in recent decades.

UNDERNEATH PITTING CORROSION IN BOTTOM OF CRUDE STORAGE TANKS:

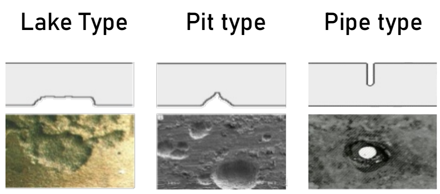
Soil-side corrosion of aboveground storage tank may be the main cause of tank failure, with thousands of Aboveground Storage Tanks (ASTs) installed, the MENA (Middle East & North Africa) region is not an exception. Ingress of chlorides and other corrosive species from the native soil and groundwater through the tank pad, along with the presence of bacteria such as SRB (sulfate-reducing bacteria), are believed to be the main causes for soil-side corrosion. Airborne chlorides and moisture can seep into the under-tank environment through the chime area, causing annular plates to corrode.

Underneath pitting corrosion is localized corrosion in bottom plates from soil side, this is most critical corrosion problem in tanks, and it leads to bottom failure. Corrosion rate depends on the soil characteristics, moisture content in the padding and extent of water ingress between padding & bottom plates. Cause of pitting corrosion and embedded stone particle assisted crevice corrosion based on field & laboratory inspections and alternatives to mitigate the underneath corrosion effectively in future, are included in this paper broadly.

DEFECTS & CORROSION COMMON TYPES:

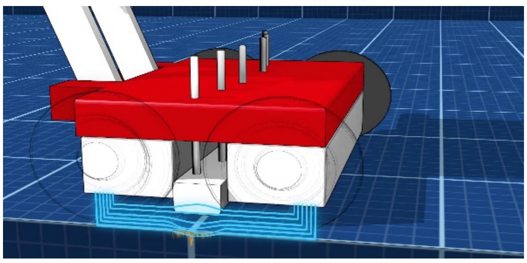
Corrosion comes in many different shapes and sizes grouped into three categories based on its geometrical shape:

1) Lake (Dish shaped corrosion)
2) Pit (Conical shaped corrosion pits)
3) Pipes



► Lake Type, have a large diameter compared to their actual depth.
► Pit / Conical Type, have some rounding at its deepest point.
► Pipe Type, have small diameter similar to the drilled hole.

As corrosion grows these basic shapes can join together, dish/lake shaped corrosion can be more difficult to detect due to the sloping edges. The MFL equipment will detect a change in plate thickness. Thus once the MFL inspection head is within a large area of corrosion the system can only detect further loss in plate thickness. It may be possible to detect the edges of such corrosion and with follow up ultrasonic thickness inspections determine that there is an area of general thinning due to extensive corrosion.



Continue MFL EXAMINATION

EQUIPMENT DESIGN CONSIDERATIONS:

EX. Tank Floor Scanner: the equipment shall consist of magnets, sensor or sensor array, and related electronic circuitry. A reference indicator, such as a ruled scale or linear array of illuminated light-emitting diodes, should be used to provide a means for identifying the approximate lateral position of indications. The equipment may be designed for manual scanning or may be motor driven. Software may be incorporated to assist in detection and characterization of discontinuities. ASME BPVC Section V, Article 16, T-1630

It is vital that MFL equipment produced for this particular application is designed to handle the environmental and practical problems which are always present. A piece of equipment designed in a laboratory and proved in ideal conditions invariably has significant short comings in the real world application. Some of the major considerations are discussed in the following paragraphs.

Some instruments can be disassembled for operation in and around obstructions or smaller surfaces. Alternatively, there are some specific "hand scanning" devices for such requirements.

MFL scanning can be carried out in an automated manner, where information from a scan run is captured. This can be evaluated at this time or stored on a computer to build up an MFL picture of the whole tank floor. Subsequent analysis of the data can be performed out with the inspection environment. From these analysis areas for follow up UT inspections can be identified.

ADVANTAGES of MFL:

- Reliable results and ability to locate and estimate the size of defects over large areas in a quick and efficient manner.
- MFL covers a wide area not only random reading as conventional methods, which increase the (POD) possibility of detection of anomalies and reduce the remaining life assessment RLA.
- Saving time and cost due to the high inspection rate.
- Comprehensive reporting with statistical data, and color mapping.
- It can detect many types of defects. For example, surface defects, stomata, scars, shrinkage cavities, corrosion pitting
- Automated Corrosion Mapping Reporting & Data Analysis.
- Immediate result "Real time Display".

MFL in INTERNATIONAL CODES & STANDARDS:

- API 653 Standard - Tank Insp., Repair, Alteration and Reconstruct.-ANNEX G
- ASME BPVC Code - Section V – Nondestructive Examination - Article 16
- ASNT Volume 5 - Electromagnetic Testing
- The MFL Compendium – Published by API & ASNT

MFL APPLICATIONS:

► **Storage Tank Floors (AST)** (lined and unlined metallic bottom):
MFL is a widely used to detect corrosion in above ground storage tank floors (ASTs) within the oil industry where tank floors are inspected periodically, the AST to be taken out-of-service and emptied. This makes maintenance times that much more expensive and calls for techniques that are both reliable and fast. MFL is widely used in the context because of its inherent speed. MFL is accepted technology for locating defects on a tank floor. It is recommended by API 653 & ASME.

► **Pipeline External Inspection** (lined and unlined metallic):
MFL is a widely used to detect corrosion in pipelines externally within the oil industry where it inspected periodically, the pipe can be inspected while in service. MFL is widely used in the context because of its inherent speed.

► **Pipeline Intelligent Pigging:**
MFL Pig is a type of intelligent ILI pig used to measure pipe corrosion and metal loss.

► **Tubular Inspection**:
The MFL is used to detect circumferential cracks, wall losses, and pitting in ferromagnetic tubes such as carbon steel, nickel and ferrous stainless steel for Air cooler, Boilers & Heat Exchanger.

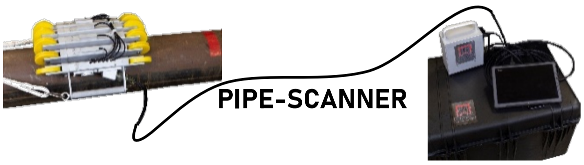
► **Wire Rope Inspection:**
The MFL measurement instrumentation supposed to be designed for detecting local faults (LF) & loss of metallic area (LMA) in external or internal layers of the wire rope.

SPOT ON SOME MFL EQUIPMENT:

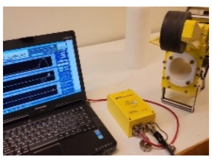
► Ex. 1: **Storage Tank Floor Inspection.**

MFL MARK IV & EDGE SCAN

► Ex. 2: **Pipeline External Inspection.**



► Ex. 3: **Wire Rope Inspection.**



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Bacterial cells preferentially adhere to surface irregularities, such as roughness, cracks, voids, cleavages and low-pressure points.

2014
Lisbon University, Portugal.

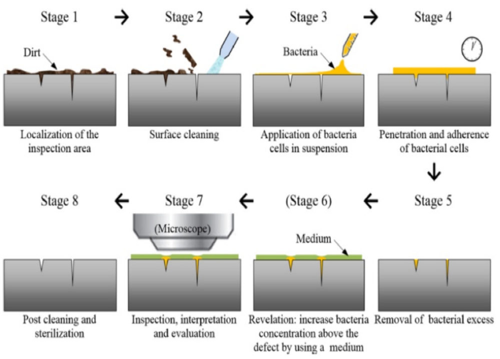
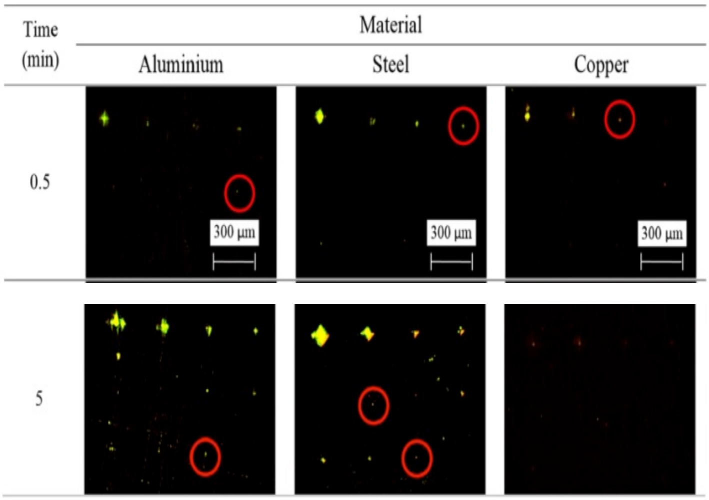


Fig. 1. Schematic representation of different stages to detect micro surface defects with bacterial cells.



4 Minutes: Microscope
4.3 um depth in Al,
2.9 um in steel
6.8 um in Cu (3min)
17 Hours: Naked eye
24 Hours: Biocorrosion

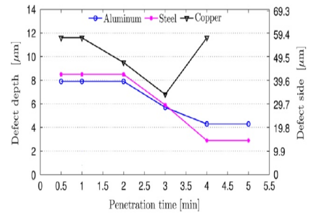
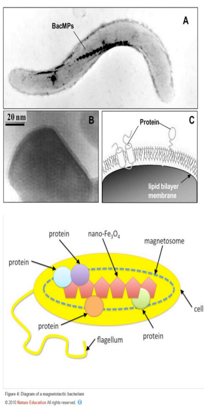


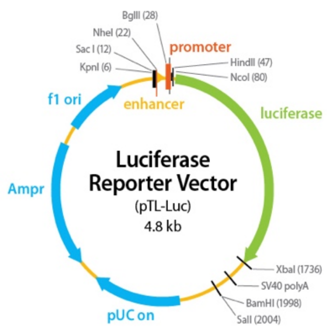
Fig. 7. Variation of detection limit with penetration time for tested materials.

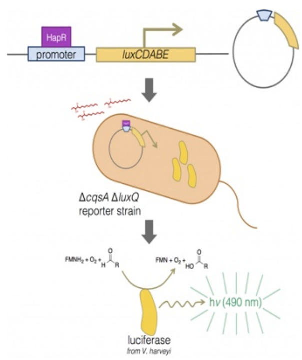
2014
Universidad de de Lisboa, Portugal.

Nano Magnetic Particles based on Magneto-tactic bacteria and Eddy Current Arrays



- Nano-scaled, single crystals of iron magnetite encapsulated in a magnetosome membrane.
- Used experimentally to detect cracks and flaws in materials.





Development of New Micro Surface Penetrant NDT using Bacteria

SciAps ApNotes

July 2024

Grading Carbon in Small Parts On-Site with LIBS

Introduction

Manufacturing processes that require quality control throughout the supply chain often hit delays and obstacles when it comes to analyzing carbon in small parts such as weld wire, small fasteners, thin metal plate, small diameter tubing, or small diameter pipe. Current processes either require users to sacrifice material for destructive testing or to send parts to a laboratory for analysis. Even reliable third-party testing facilities can cause material mix ups, added cost to the project, and lost time. These factors can result in regulatory fines or penalties, disrupt project start-up schedules, or worse, create critical safety-related issues. This application note reviews current small-part testing methods and shows how the design of SciAps handheld LIBS eliminates such variables with fast, comprehensive, in-field carbon analysis.

Method

When performing material analysis in the field on incoming, outgoing, existing, or new material using a portable handheld analyzer, most inspection companies, metal fabricators, production managers, quality control managers, and field technicians have faced the dilemma of testing material that is too small to analyze. The job becomes increasingly difficult when carbon content is required to grade that material rather than just to identify it.

The industry solution has been to adapt the tools of optical emissions spectrometry, perform less-comprehensive handheld X-ray analysis, or send materials to a lab.

Optical emissions spectroscopy:

OES has been used in the field for many years and can reliably grade material for verification of stringent specifications. But it still comes with some major challenges in testing small parts. An example of this would be large console-type instruments that have probes equipped with a chamber requiring an argon seal to create an inert atmosphere to properly test for accurate carbon content. If the part is smaller than the burn chamber (piping or tubes typically smaller than 1.5″ to 2″ in diameter), the analyzer cannot maintain an argon seal to complete the analysis, resulting in unacceptable or poor results. Some manufacturers have developed small-parts adapters that can be attached to the probe. However, multiple types of adapters are needed to accommodate the varying sizes and geometry of the parts. For example, an adapter for weld wire would be different than an adapter for piping nipples. Without the proper adapters, testing small parts with OES becomes almost impossible and other options need to be pursued.

X-Ray fluorescence:

Handheld XRF analyzers have been the workhorse for material verification in the field. XRF can test some small parts, and there are some manufacturers who have collimated the X-ray beam to further help test small parts. But they cannot always provide the analysis required for detailed verification programs. In one example, if a part is very small, it may not get a sufficient number of X-rays to provide an accurate chemistry because of beam spread. Another hurdle is that XRF analyzers cannot measure carbon. So, while these portable analyzers can verify if material is 316ss, 304ss, or carbon steel, XRF instruments cannot identify 316 or 304 L or H grade, or whether that carbon steel piece is 1020 or 1030. That analysis requires carbon content. Therefore, alternative methods are required to analyze effectively and grade these parts.

Third-party laboratory analysis:

Sending out small parts to a laboratory to be tested for grade specification provides accurate results. However, testing takes days rather than minutes to test on-site, and it requires the parts to be sent to the laboratory. Another method is collecting shavings from the material, using manual or mechanical assistance to remove small amounts of material to send to a laboratory. This method allows the producer to keep original parts on site, but it still requires a delay.

Laser induced breakdown spectroscopy:

LIBS is an established laboratory laser technique with many similarities to OES. Where OES uses a continuous electric spark as its excitation source, LIBS fires a pulsed laser at the material to create a plasma. An on-board spectrometer measures light from the plasma and individual wavelengths to reveal elemental content, which is quantified via on-board calibrations. In moving this technique to a handheld, SciAps LIBS analyzers provide a comprehensive solution for in-field materials verification that includes carbon analysis. SciAps LIBS instruments additionally feature a small exit aperture and patented design so that a good purge is achieved without requiring a seal to curved surfaces or small parts. SciAps handheld LIBS can test parts smaller than the burn chamber, with no adapters required. Once the sample surface is prepared and the small part is lined up with the internal camera, a focused laser ablates the material and produces the plasma. The test area is approximately 50 microns (about the diameter of a single hair), which can easily accommodate even the smallest of parts. In comparison, conventional OES requires a very large area (about the diameter of a quarter) and an argon seal to complete the testing.

Data and Discussion

Figure 1
SciAps Z-902 Carbon analysis of ER308L weld ¼” in width

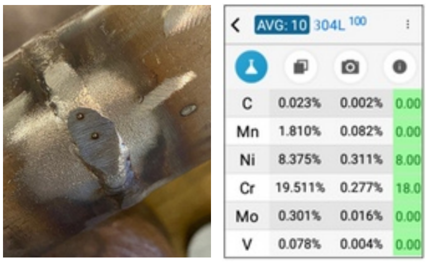
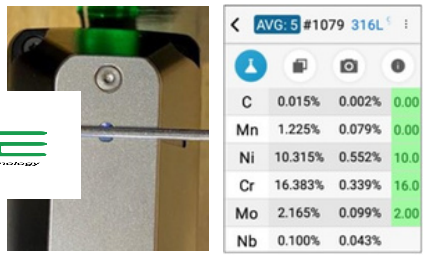


Figure 3
SciApsZ-902 Carbon analysis of 1” s/160 A106pipe nipple for HF Alkylation service

Figure 2
SciAps Z-902 Carbon analysis of ¼” machine screw, 316H material

Figure 4
SciAps Z-902 Carbon analysis of 1/8” wire,



API Recommended Practice 578

The owner/user shall establish a written material verification program indicating the extent and type of PMI to be conducted during the construction of new assets, retroactively on existing assets, and during the maintenance, repair, or alteration of existing assets. For higher-risk systems, the owner/user should consider the need for employing a higher extent of examination (up to 100%) rather than random sampling which may be more appropriate for lower-risk systems.”

Deploying a comprehensive material verification program includes testing weld wire, round bar, small bore pipe and bolting. All SciAps LIBS analyzers are designed to optimize access to such parts. The days of rubber gaskets that tear and bulky external bolt-on adapters are over. Testing for carbon content in L and H grade stainless is now easy, convenient, and productive.

Summary

Instead of dealing with the headache of collecting shavings, sending out material to a third-party laboratory, or having to collect and attach various adapters, SciAps provides a comprehensive, on-site solution for carbon analysis in QA/QC programs using handheld LIBS.

Especially designed for curved surfaces and small parts, with a small exit aperture and patented argon purge/bleed design that requires no seal to the material surface, SciAps LIBS provides greater inspection coverage of critical assets. This includes even the smaller pressure-retaining items that too often get passed over due to their smaller size or challenging geometry.

In conclusion, SciAps has provided the industry with an efficient, cost-effective solution to analyze all critical components instantly, including the small parts that are so commonly left out of the testing process or have been a burden to verify.

Industry leading LIBS & XRF analyzers which can analyze any element anywhere on Earth SciAps specializes in portable analytical instruments with the power to measure any element across every major industry.

The Z series: Harnessing the power of LIBS: Handheld Laser Induced Breakdown Spectroscopy (HH LIBS), the Z is the ONLY high-precisionlaser-based gun for sophisticated analysis of ultra-low elemental concentration in alloys, ores, brines and powders, to basic material or scrap sorting.

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