

SPECIALIST PACKAGE

IN-SERVICE ROBOTIC TANK FLOOR INSPECTION

THE PURPOSE

This document is composed to assist our clients and the supply chain with a high-level understanding of the benefits and services associated with Direct Assessment as the primary inspection tools, acknowledged globally as an approved pipeline integrity inspection protocol.



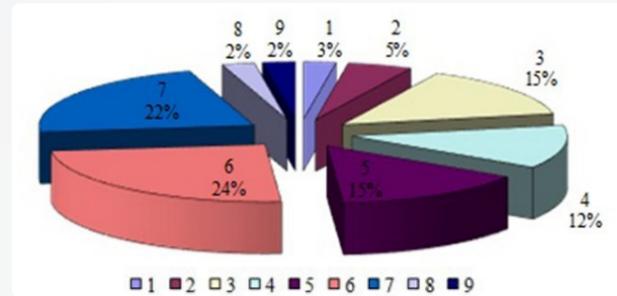
SONOMATIC



IN-SERVICE ROBOTIC TANK FLOOR INSPECTION

Robotic Tank Inspection (RTI) offers high-density Ultrasonic Thickness (UT) scanning of your tank floor while the tank is full and in service.

INSPECTION PLANNING



1. Product Transfer
2. Out-of-Service Inspection
3. Cleaning and waste processing
4. VOC Emissions
5. Environmental: Waste disposal
6. Out-of-Service Lost Revenues
7. Alternative Tankage
8. Health and Safety Worker Protection
9. Pollution Liability Insurance

Measure the savings – by adding up the true costs of conventional out-of-service inspection.

The total cost of conventional inspections is far greater than the expense of cleaning and MFE inspection. The cost of material transfer, product downgrades and tank downtime are enormous.

The hidden cost of premature repairs can be just as high. When the tank is empty, you'll have to complete all repairs quickly. This usually means paying a premium for service – and completing repairs that aren't necessary for another 5 to 10 years. Now you can reduce costs by completing an API 653 inspection of your AST (Above-Ground Storage Tank) without taking the tank down for manual cleaning and inspection.

BENEFITS

- ✔ Eliminate the high cost of taking down your tanks
- ✔ Complete an API 653 inspection in days instead of weeks or months
- ✔ Avoid disruptions in normal service and keep revenue consistent
- ✔ Provides Intelligence to the Shut Down Planning Team
- ✔ Perform repairs only as needed

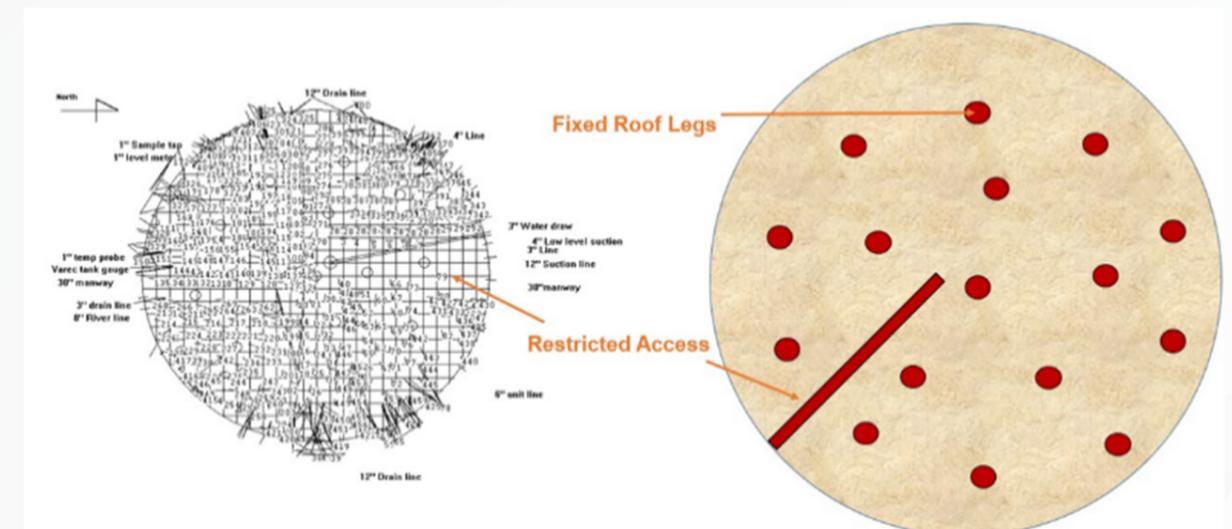
- ✔ Reduces NDT resources required during Shutdown
- ✔ Spreads the Schedule so that a high number of Assets do not require invasive inspection during the same calendar period.
- ✔ Minimise impact to your costs and operations
- ✔ Reduce environmental and safety risks without opening the tank or due to manned entry
- ✔ Supports Innovation and Operational Excellence Concepts.

The Robotic Tank Inspection service follows a digital inspection grid and collects more than 200,000 PAUT scans* for computer analysis.

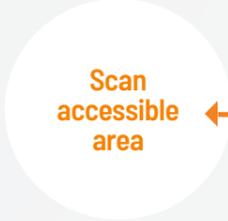
The RTI service systematically scans the tank bottom with a Phased Array Ultrasonic transducer, and relays high-volume PAUT data for analysis. The robot pushes sludge aside as it travels, making cleaning and waste disposal unnecessary in many cases. *Based on the average scan pattern in a 30m Diameter tank.



Typical Tank Bottom Coverage:



CALCULATING AST REMAINING USEFUL FLOOR LIFE

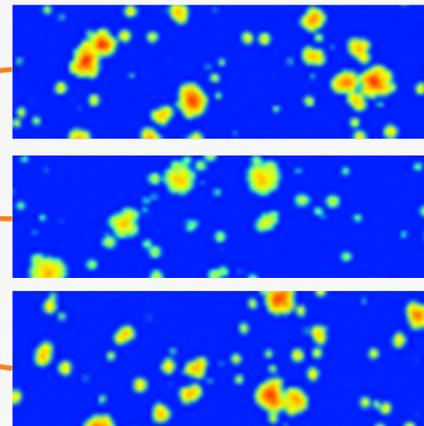
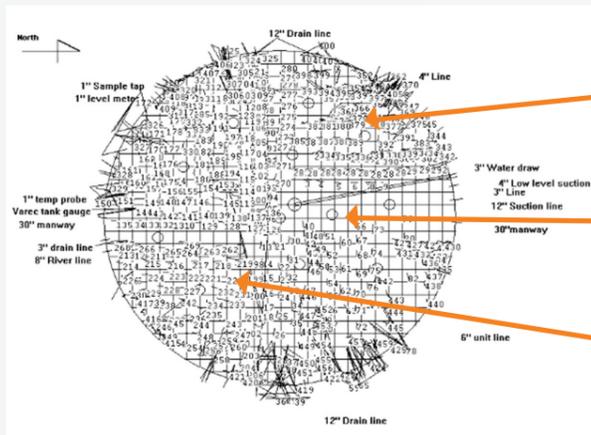


Typically using floor scanning screening technology such as MFL.

Follow up with localised NDT using UT or similar tools capable of quantifying through wall material loss. This will normally be fairly low-density sample set.

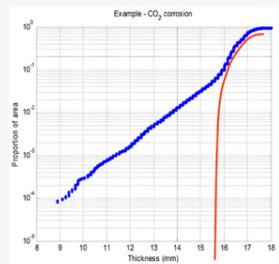
From this the minimum thickness is measured for the floor and annular plates from which a corrosion rate can be determined using a linear extrapolation over the history of the tank and assuming future use of a similar nature.

From the Corrosion Rate the remaining useful life of the tank can be assessed by applying the corrosion rate to the difference between the Minimum measured and minimum required thicknesses.



Using the robotics, the tank can remain in service and any sludge can be managed or removed by the robotics with the tank remaining full of product.

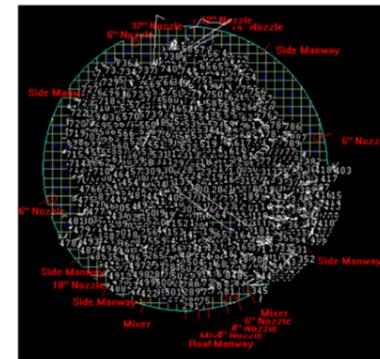
Here millions of highly accurate and repeatable UT readings collected in an immersion set up can be collected and analysed.



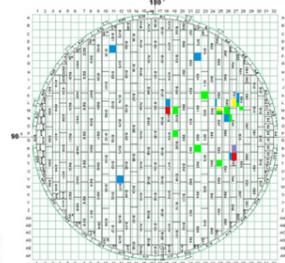
Localised pitting Normal distribution



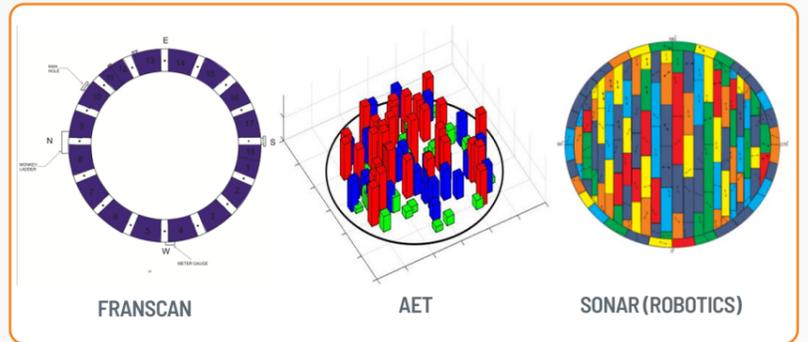
SAMPLE INSPECTION REPORT



QUANTITATIVE COLOUR-CODED UT RESULTS MAP



SAMPLE INSPECTION RUNS

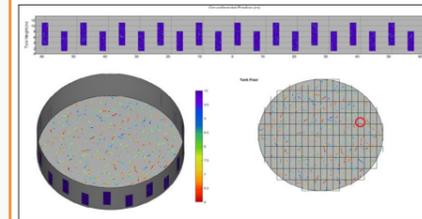


FRANSKAN

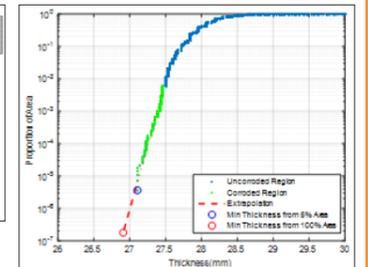
AET

SONAR (ROBOTICS)

AUT (CORROSION MAPPING)



STATISTICAL ANALYSIS



CR, FFS, RUL, RECOMMENDED INSPECTION INTERVAL

STATISTICAL ANALYSIS AND FINAL REPORT

Certificate of Proficiency

HOIS Recommended Practice for Statistical Analysis of Inspection Data

This is to certify that:

Has undertaken training covering statistical analysis of inspection data as covered in the HOIS Recommended Practice (HOIS12) RB and has demonstrated proficiency in its practical application.

Training course and examination conducted as per the recommendation of ASNT document SNT-TC-1A 2006 Edition and FTI written practice.

Classroom Training Hours: 20 Hours
Practical Training Hours: 20 Hours
NDT Experience Documented: >20 Years
Course Completed on 9 October 2020

Course Training, Examination and Certification by:

ESR Technology
Engineering, Safety & Risk

Dated: 9 October 2020

Certificate No: 01

• Measurements
— Type 1 distribution fit ($R^2 = 0.969$)
— Probability for min overall
• Expected min (8.28 mm)

• 10% probability min (7.68 mm)
• 5% probability min (7.49 mm)
• 1% probability min (7.06 mm)

TANK FLOOR FITNESS FOR SERVICE CERTIFICATE

TANK FLOOR FITNESS FOR SERVICE CERTIFICATE

Above Ground Fire Water Storage Tank 3460-F has been inspected whilst remaining in-service using the Internal Robotic Tank Cleaning and Inspection Technique (S.O.N.A.R). This Certificate confirms Tank 3460-F, Owned and Operated by WOODCO, is fit for service considering the condition of the Tank Floor for the period of 10.1 years (Remaining Useful Life) assessment is based on a Risk Based criticality ranking and the thickness data collected from the annular plate. The prediction is based on the data collected by the 2019 scope of work and assumes future use to be in line with the known history.

Probability level	Minimum thickness (mm)	Corrosion rate (mm/yr)	RUL (yrs)
5%	7.2	0.119	10.1

Based on the findings from the Robotic Tank Inspection and discussions with the Client, the level of risk to be applied to Tank 3460-F equates to the 5% probability level as show in the table above. This provides a 95% probability that the current remaining wall thickness is 7.2mm. Hence the calculated RUL of Tank 3460-F is set at 10.1 years. The next inspection interval shall be half of the RUL which is 5.05 years.

Summarized results are as follows:

- Remaining Useful Life is 10.1 years
- In Service Floor Inspection prior to half the remaining life which is 5.05 years.
- Out of Service Floor Inspection and repair prior to half the remaining life which is 5.05 years.

Sign: Dr Mark Stone, Integrity Specialist

Sign: Eng. Manan Betani, API 653

Annular Plate Statistical Analysis Results

Probability level	Minimum thickness (mm)	Corrosion rate (mm/yr)	RUL (yrs)
5%	7.2	0.119	10.1

SELECTIVE PROJECT EXPERIENCE

PROJECT TITLE	CLIENT	SCOPE OF WORK	ROLE IN PROJECT	PRODUCT
Robotic Crude	Exxon, Nigeria	AE/FRANSCAN/Floor/API/ Sludge Management	Sub-Contractor	Crude
Online Tank Floor Inspection	NLNG, Nigeria	Robotic Floor	Sub-Contractor	Diesel / Water
Cooling Tower Tank Inspection	Sutro, UK	Visual Inspection	Sub-Contractor	Water
Online Water Tank Floor Inspection	Shell, Germany	Robotic Floor	Sub-Contractor	Fire Water
Online Water Tank Floor Inspection	Shell Bacton, UK	Robotic Floor	Sub-Contractor	Water
Robotic Crude -SARB	ADNOC	100m AE/SRUT/Floor/API/AUT Shell/ Sludge Management	Sub-Contractor	Crude
Water	ADNOC BAB	Robotic Floor	Sub-Contractor	Fire Water
Water	ADNOC Fujairah	Robotic Floor	Sub-Contractor	Fire Water
Condensate Tank	Petronas	Robotic Floor, AE, SRUT	Sub-Contractor	Condensate
Water Tank	Petronas	Robotic Floor, AE, SRUT, Visual	Sub-Contractor	Process
Water Tank	Petronas	Robotic Floor, AE, SRUT, Visual	Sub-Contractor	Demin
Water Tank	Petronas	Robotic Floor, AE, SRUT, Visual	Sub-Contractor	Fire Water
Diesel Tank	Petronas	Robotic Floor, AE, SRUT, Visual	Sub-Contractor	Diesel
Water	ADNOC NEB	Robotic Floor, AE, SRUT, Visual	Sub-Contractor	Fresh
Robotic Volatile Slop	ATPL	Cleaning and Test Inspection	Sub-Contractor	Volatile Slop
Robotic Crude ZIRKU	NDTCCS/ADNOC	100m AE/SRUT/Floor/API/AUT Shell/Sludge Management	Sub-Contractor	Crude Oil
Robotic Diesel T 10	Taweelah Power Station	Cone SRUT/Floor/API//AE/Set Survey	Sub-Contractor	Diesel
Robotic Diesel T 11	Taweelah Power Station	Cone SRUT/Floor/API//AE/Set Survey	Sub-Contractor	Diesel
Robotic Diesel T 12	Taweelah Power Station	Cone SRUT/Floor/API//AE/Set Survey	Sub-Contractor	Diesel
Robotic Diesel T 13	Taweelah Power Station	EFR SRUT/Floor/API//AE/Set Survey	Sub-Contractor	Diesel
Robotic Diesel T 14	Taweelah Power Station	EFR SRUT/Floor/API//AE/Set Survey	Sub-Contractor	Diesel
Robotic Water	BHS Fujairah UAE	Fire Water Tank Internal Visual and UT	Sub-Contractor	Fire Water
Robotic Crude	BP	Follow up to AE Inspection	Sub-Contractor	Crude Oil
Robotic Condensate	BP	API 653 Floor Inspection in-service	Sub-Contractor	Condensate
Robotic Lean Meg	BP	API 653 Floor Inspection in-service	Sub-Contractor	Lean Meg
Robotic Water Tank	Qatar Petroleum	Internal Floor API and Visual	Sub-Contractor	Fire Water
Robotic Crude Tank 1	Qarun - Apache	Repeat customer for Robotic/AE/SRUT	Sub-Contractor	Crude Oil
Robotic Crude Tank 2	Qarun - Apache	Repeat customer for Robotic/AE/SRUT	Sub-Contractor	Crude Oil
Robotic Crude Tank 3	Qarun - Apache	Repeat customer for Robotic/AE/SRUT	Sub-Contractor	Crude Oil
AE	AGIP - Nigeria	AET on 9 Fuel Oil/Water Tank Bottom	Sub-Contractor	Water
AE	STOMO - OMAN	AET on 6 Tank Bottom Plates	Sub-Contractor	Diesel
Robotic - Crude	ADMA - UAE	Floor, Annular plate, AE, SRUT	Lead	Crude Oil
AE	QAPCO - Qatar	AET on 1 ETHYLENE Tank Bottom	Sub-Contractor	Ethylene
Robotic Crude	ADMA-OPCO/BP/TOTAL	Floor Inspection, Annular plate	Sub-contractor	Crude Oil
AE	GASCO UAE	Screening of Tank Floor	Sub-Contractor	Fire Water
Robotic Crude	ADMA-OPCO/BP/TOTAL	Floor Inspection, Annular plate	Sub-contractor	Crude Oil

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