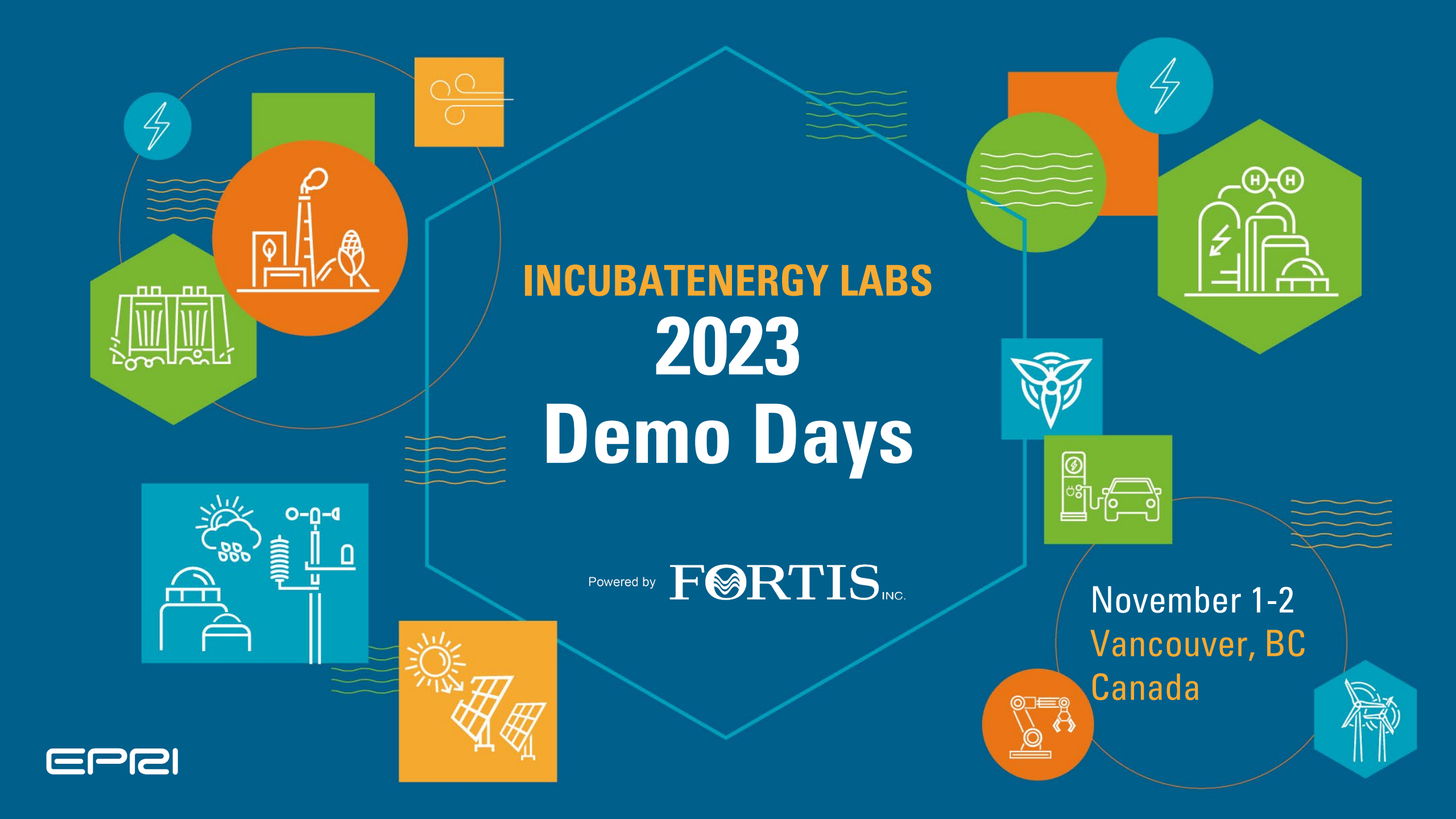
INCUBATENERGY LABS
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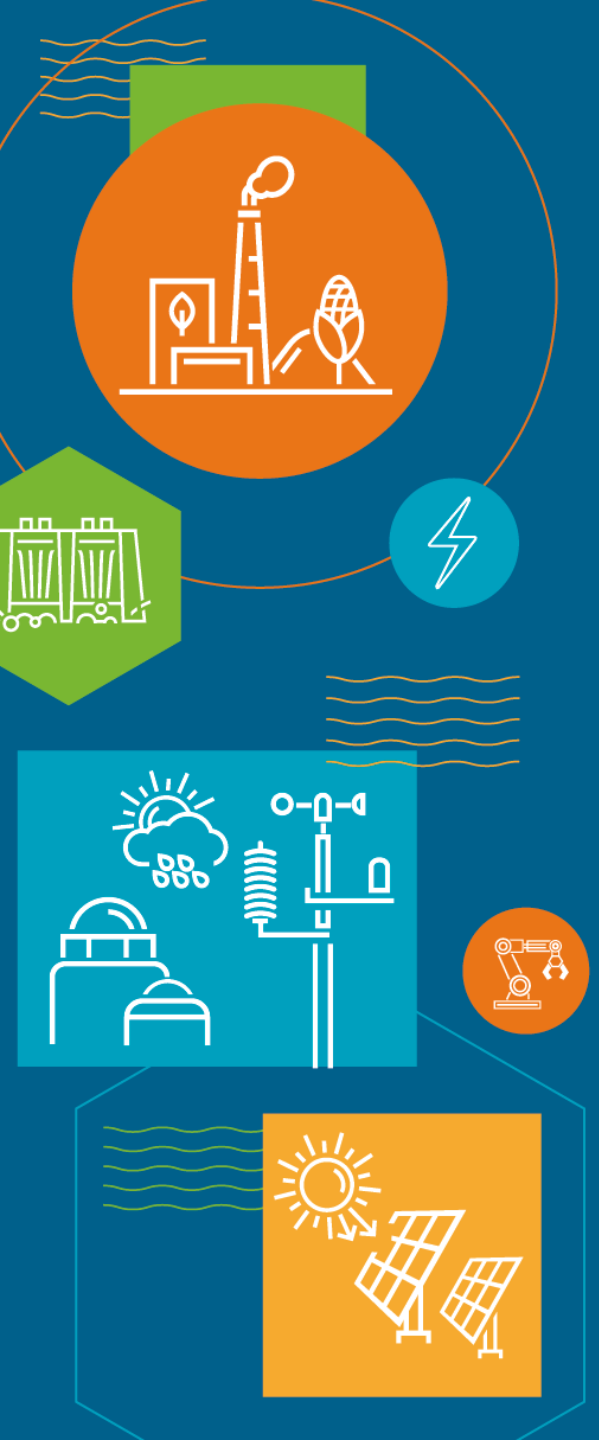
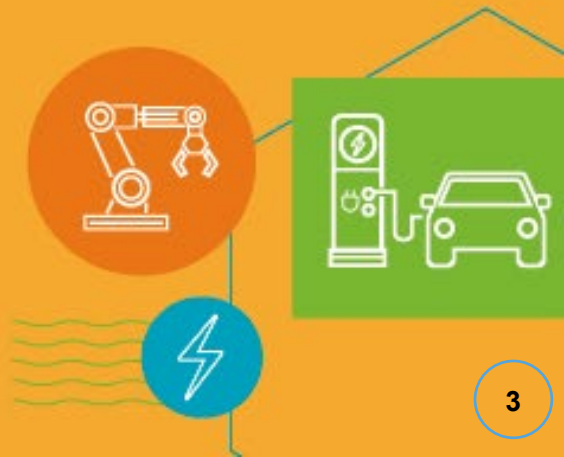


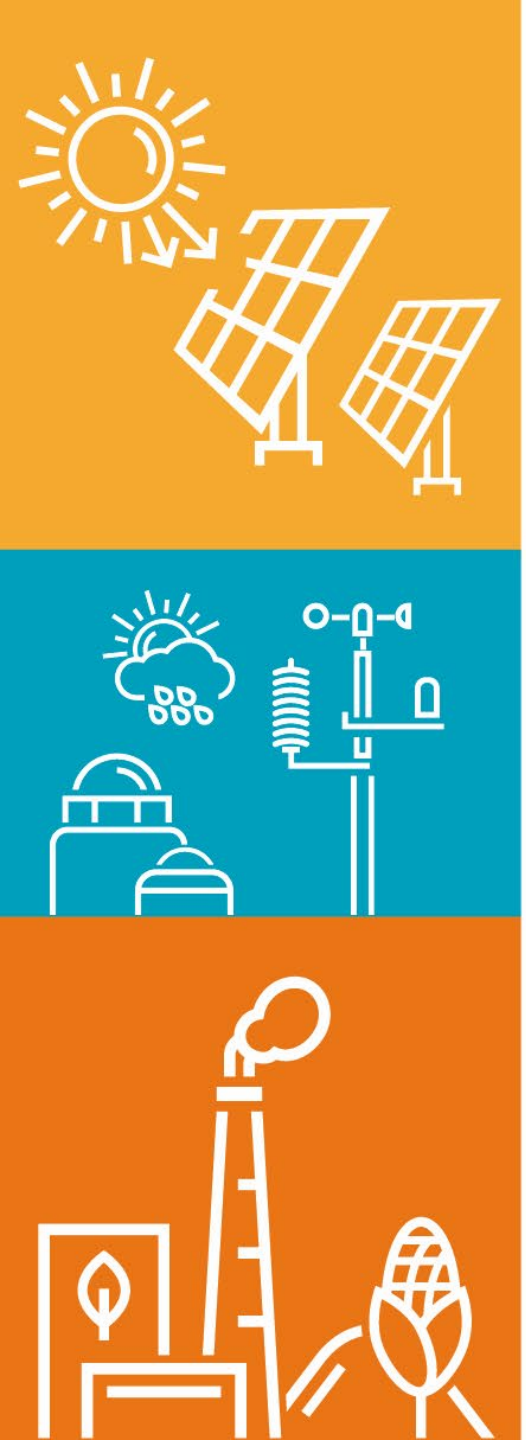
Submersible Robotic Above Ground Tank Inspections

Tennessee Valley Authority + Square Robot

Above ground storage tank (AST) inspections are a mandated necessity for utilities. Often, this includes venting, draining, cleaning and inspecting the tank by putting humans inside the tank. Square Robot partnered with Tennessee Valley Authority to showcase the capabilities of above ground storage tank inspections using a submersible robot.

The Pilot





Pilot Overview

Host Utility: Tennessee Valley Authority
Scope: In-Service, Robotic Inspection of 4 of TVA's tanks

- 3 fuel oil tanks
- 1 firewater tank

Goal: Understand the impact that robotic inspection can have on the power industry

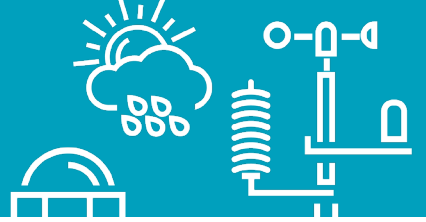
- Evaluate robotic inspection vs out-of-service inspection
- Evaluate Square Robot's submersible robot vs previous robotic inspection
- Quantify benefits of Square Robot's in-service robotic inspections

The Challenge: Square Robot In-Service Robotic Tank Inspection

Square Robot set out to demonstrate the advantages of deploying its autonomous, submersible robot.

Marshall Combustion Turbine Inspections

Marshall Combustion Turbine Tank Inspections



3 Fuel Oil ASTs

62’ diameter, 48’ height

~1 million gallons of fuel per tank

Inspection Averages

~1 day of inspection per tank

~ 95GB of data per tank

~60% tank bottom coverage

Tank Inspection	In-tank Time	Coverage	Obstacles	Data Retrieved	API 653 Report/ Delivery	Confined Space Hours (estimated)	CO2 Emissions (estimated)
TVA Marshall Tank 4 7/10/23	4 hours 58 min	61% of tank bottom	Floating suction, center column, 2 steam lines & sump	98.9GB	July 31 - 20 yr inspection interval	286 confined space entry hours for OOS	1.96 tCO2e
TVA Marshall Tank 3 7/11/2023	4 hours 50 min	60% of tank bottom	Floating suction, center column, 2 steam lines & sump	109.8GB	Aug 11 - 20 yr inspection interval	286 confined space entry hours for OOS	1.96 tCO2e
TVA Marshall Tank 2 7/12-7/13/2023	5 hours 54 min	56% of tank bottom	Floating suction, center column, 2 steam lines & sump	91.4GB	Aug 11 -20 yr inspection interval	286 confined space entry hours for OOS	1.96 tCO2e

Marshall Combustion Turbine Tank Inspections

Square Robot Inspection

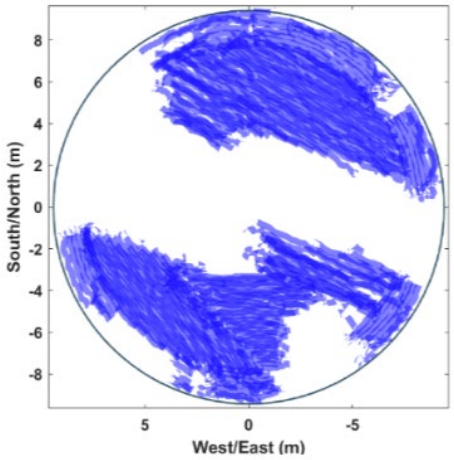


Figure 1 - Robot Survey Tracklines (blue)

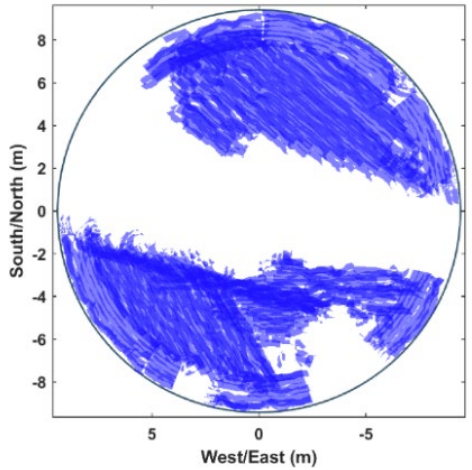


Figure 1 - Robot Survey Tracklines (blue)

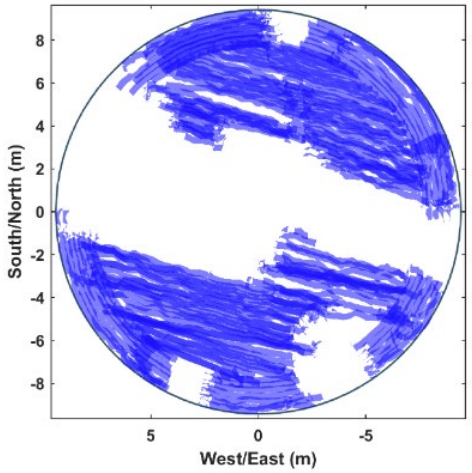
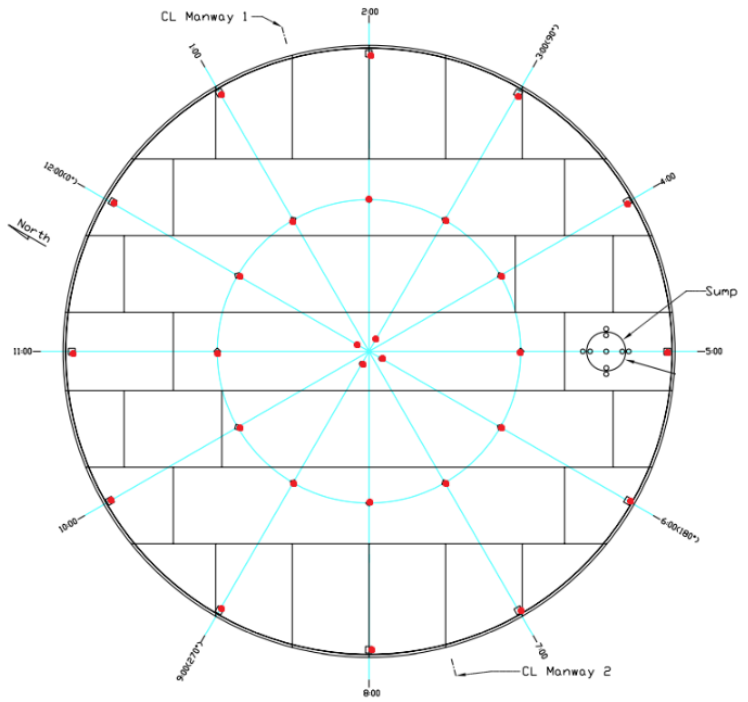


Figure 1 - Robot Survey Tracklines (blue)

Previous OOS Inspection



Red dots denote single point UT readings

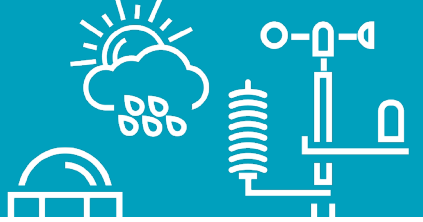
Marshall Combustion Turbine Inspection Comparison

	OOS Inspection per tank	Square Robot Inspection per tank	Total Savings per tank	Total Combined
Inspection days	30	1.15	28.85	86.55 days saved
Confined space entry hours	286	0	286	858 hours saved
Emissions release	1.96tCO2	0	1.96tCO2	5.88tCO2
Costs	$90-120k	$55k	$35-65k	$105-195k

ROI: 1000s of project management hours, dedicated personnel for confined space entry, the need to truck fuel in & out or transfer fuel, more insight into assets at a higher level

Magnolia Combined Cycle Inspection

Magnolia Combined Cycle Tank Inspection



1 Firewater AST

Necessary for daily plant operations

92’ diameter, 40’ height

Inspection Averages

~3 day inspection

~ 126GB of data

~17% coverage/ 10% usable data

Tank Inspection	In-tank Time	Coverage	Obstacles	Data Retrieved	API 653 Report/ Delivery	Confined Space Hours (estimated)	CO2 Emissions (estimated)
TVA Magnolia Firewater Tank 8/14-8/17/2023	13 hours 24 minutes	10% of tank bottom	Tank bottom bolts, sediment build up, active flow monitoring	126.4 GB	Sept 15 – 5.47 yr inspection interval	544 confined space entry hours for OOS	N/A – water tank

Magnolia Combined Cycle Tank Inspection

Square Robot Inspection

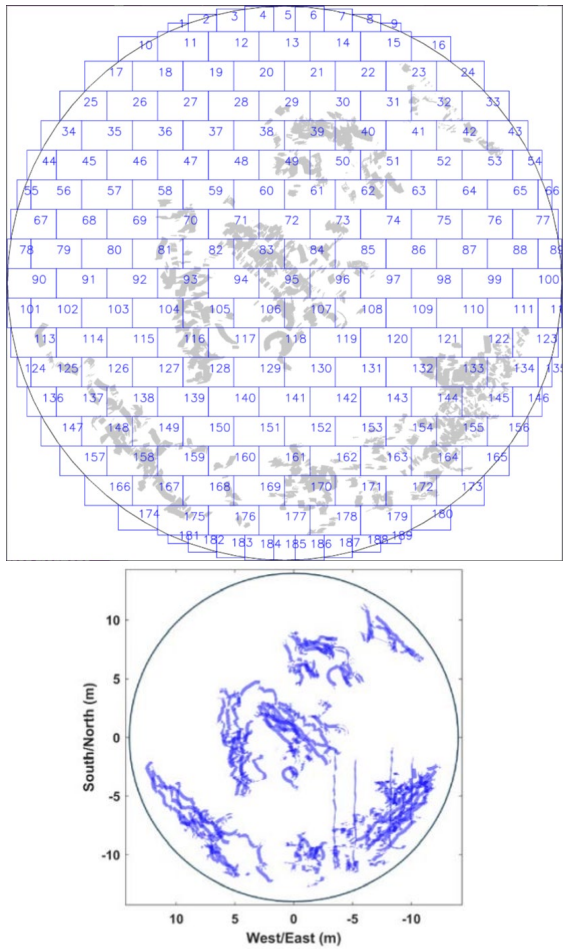
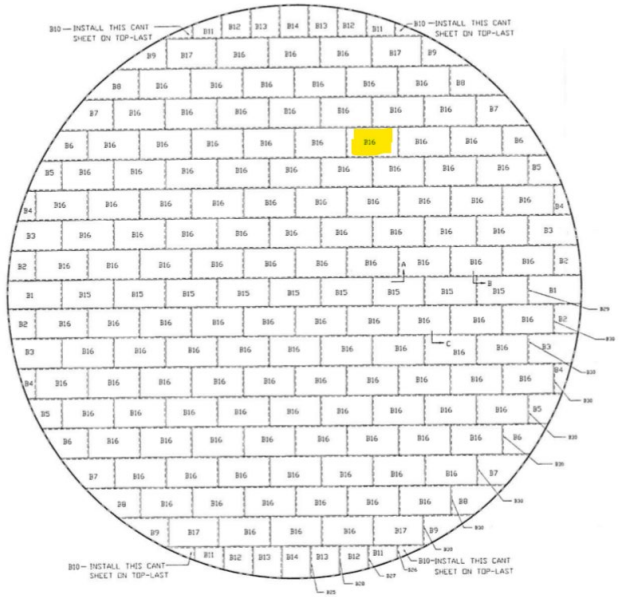


Figure 1 - Robot Survey Tracklines (blue)

Previous Robotic Inspection



Highlighted plate indicates estimated location of previous robotic inspection

Magnolia Combined Cycle Inspection Comparison

Square Robot Inspection VS Prior Robotic Crawler

- Acquired PAUT data on an estimated 90 tank bottom plates
- Combined data with extreme value analysis to further bolster insights
- Ability to maneuver over tank bolts and access closer to critical zone

	Prior Robotic Inspection	Square Robot Inspection	Total
Data coverage	1 plate	90+ plates	+10x data collection
Costs	$110k	$76k	$34k savings

ROI: 544 confined space entry hours needed for OOS inspection, greater insight into tank conditions, eliminating OOS during plant outage and the need for an alternate water source


What’s Next?
Growth &
Nuclear

Our Team

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Questions?

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