

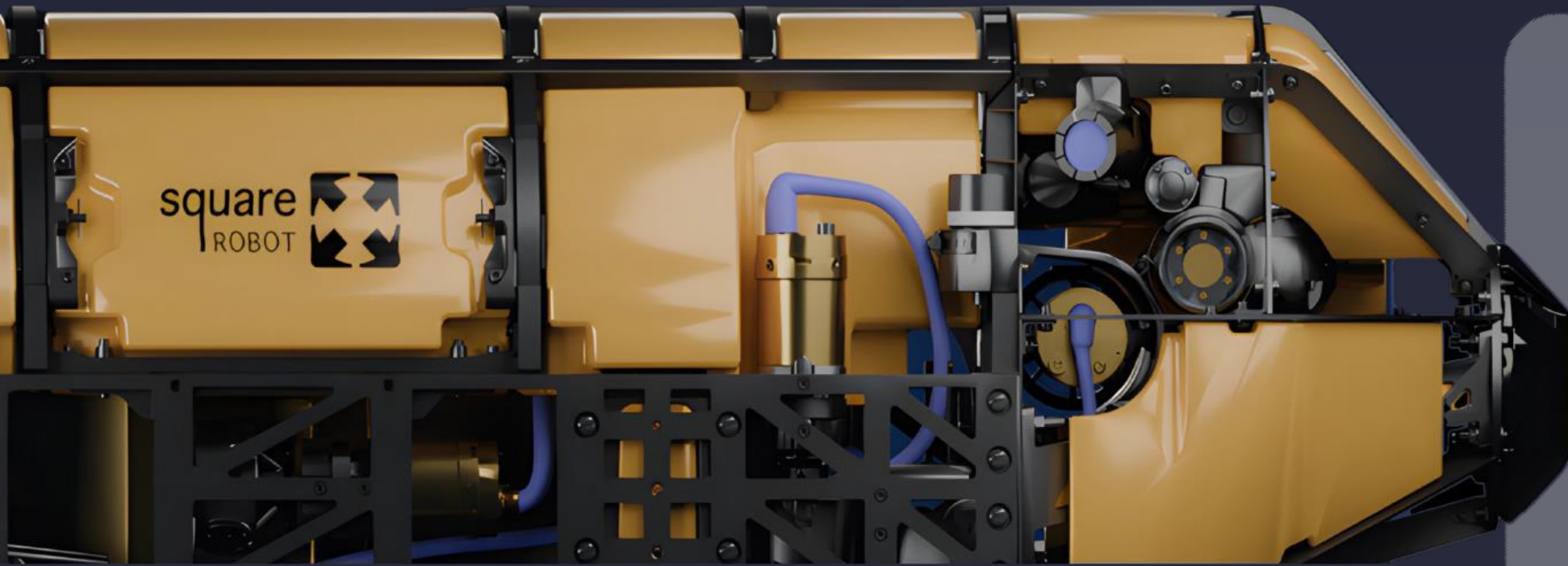


# Submersible Robotic Technology for Power Plant **Tank Inspections**

Advanced Robotics

State of the Art Sensors

High Density Data Acquisition





**Stephanie Nolan**

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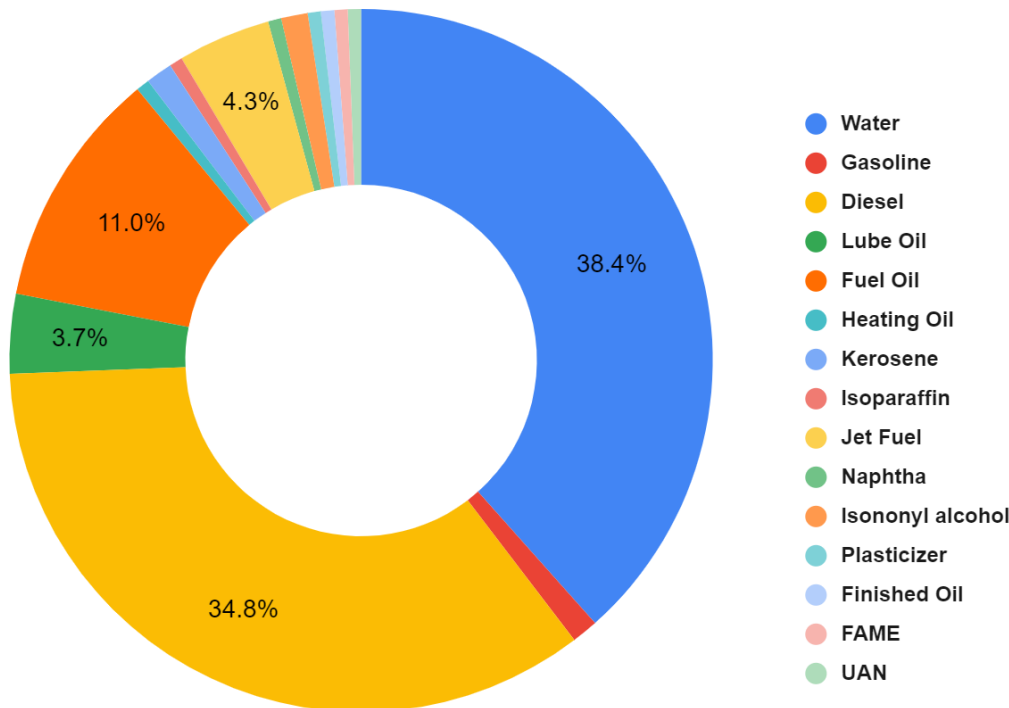
**Praneeth Varma**

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**API Subject Matter Expert**

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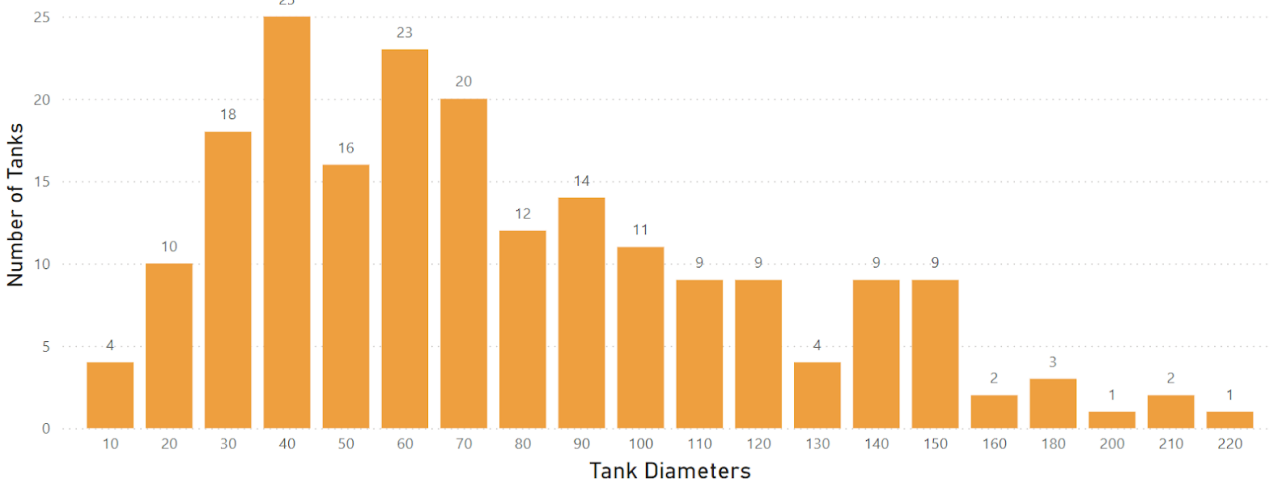
# Square Robot Inspection Track Record



KPI	Count
API 653 Tanks Inspected	200+
PAUT Bottom Coverage (includes obstacles)	60% average (95% max)
Confined Space Labor Hours Saved	127,259 (630/tank avg)
CO2 Emissions Equivalent Contained	925,919 lbs (7,800/tank avg)
Tank Utilization	95% - 99%
Cost Savings (assume \$300k x 200 tanks)	\$60 million

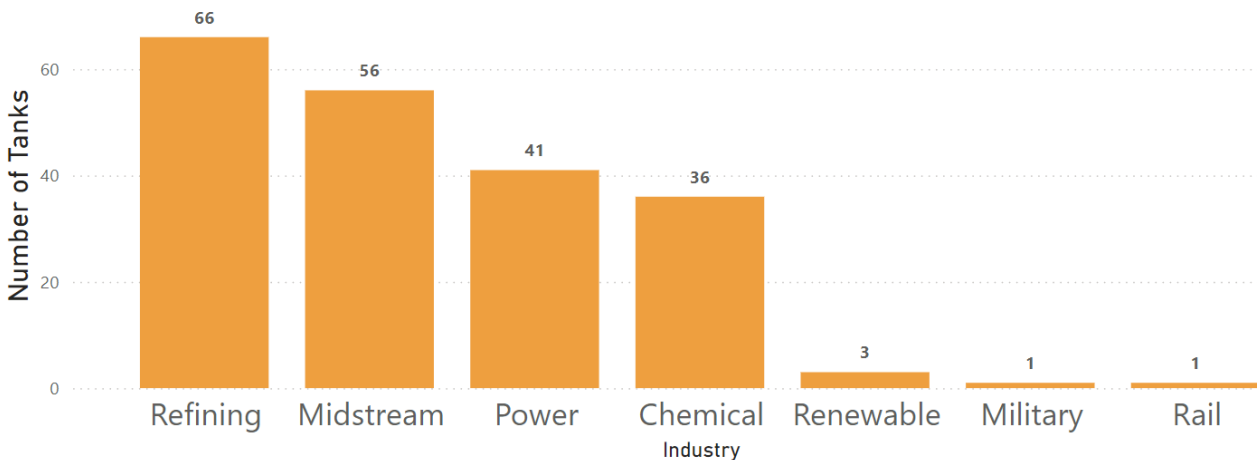
Range of Tanks Inspected by Diameter

200+ Tanks Inspected June 2024



Inspections Completed by Industry

200+ Tanks Inspected June 2024



# Power Plants - Tank Inspections



**TANK INSPECTIONS: INFREQUENT**



**OUT-OF-SERVICE: HEADACHE**



**ISOLATED TANKS: NO ALTERNATE STORAGE**



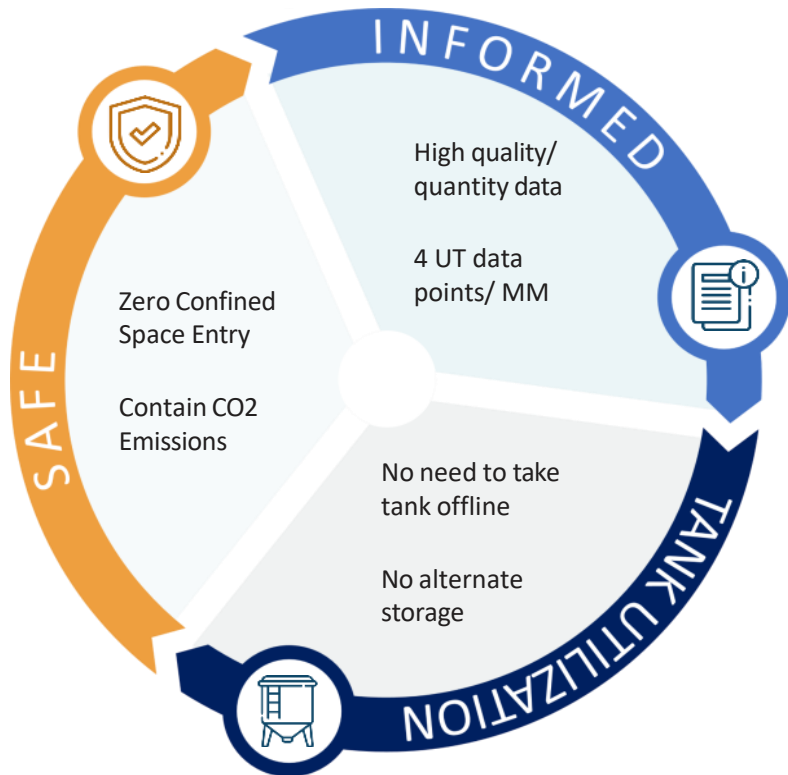


# Tank Inspection - The Traditional Approach

- ✓ PROJECT LASTS WEEKS OR MONTHS
- ✓ DRAIN, VENT, CLEAN, WASTE DISPOSAL
- ✓ INSPECT WITH MAGNETIC FLUX LEAKAGE (MFL)
- ✓ VALIDATE WITH SPOT ULTRASONIC (UT)
- ✓ REPAIR *"SINCE IT IS OUT OF SERVICE"*



# Square Robot - The Submersible Approach



# SR3 Robot Roof Launch Application

## Launch

- ✓ Robot hoisted to the tank roof and readied for deployment

## Submersion

- ✓ Bond robot and hoist to tank, lower robot into the product, detach lifting cable

## Data Acquisition

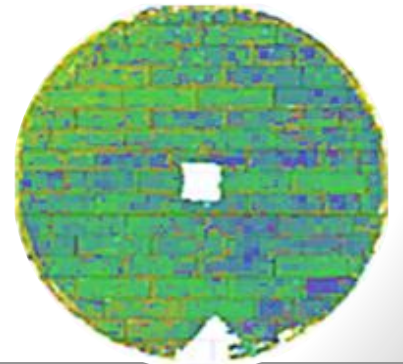
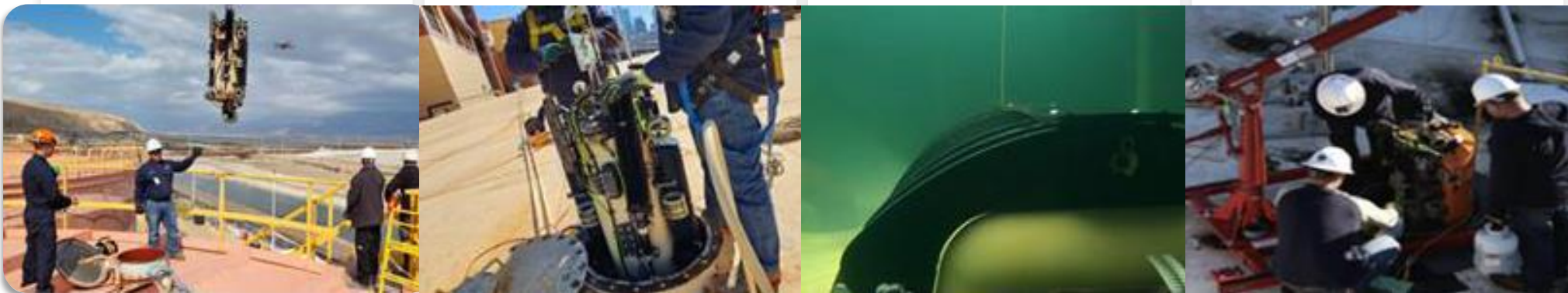
- ✓ Autonomously surveys, maps and scans the tank interior with the operator remotely monitoring

## Recovery

- ✓ Retrieve, decontaminate, and hoist down the robot

## Report

- ✓ Sensor data is reviewed & processed into a final deliverable report





# Mobilization and Lifting Advantages



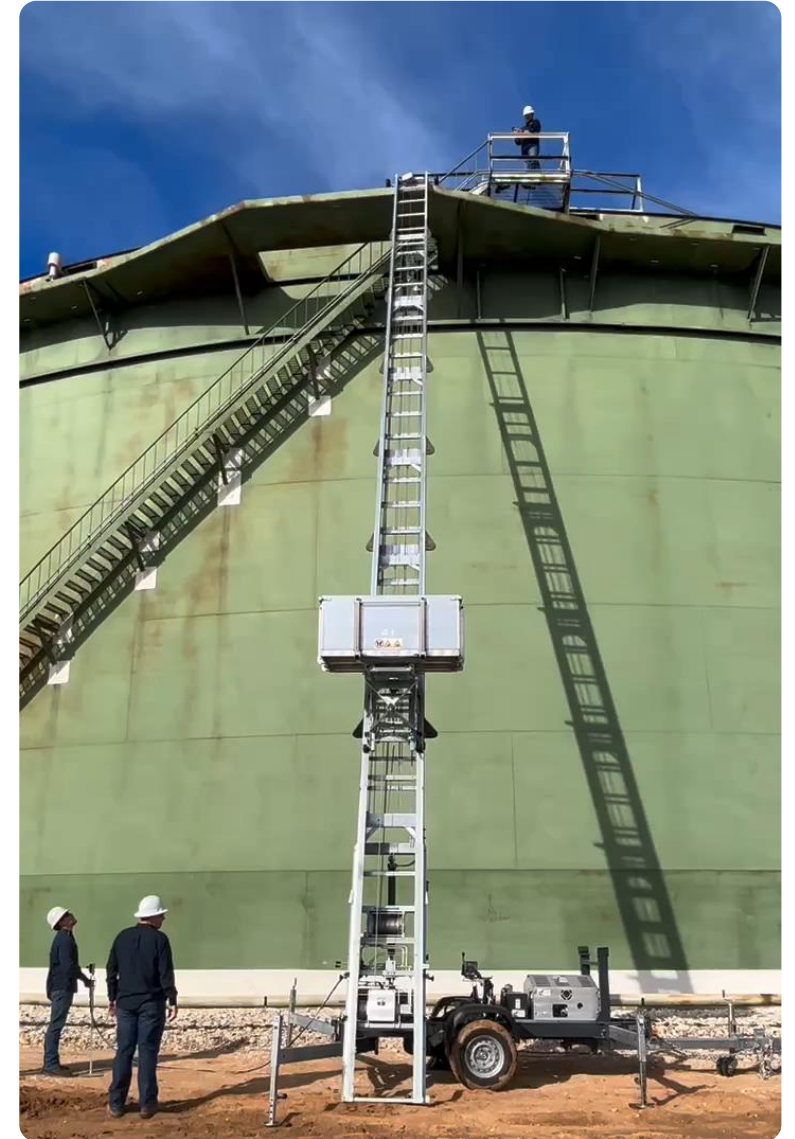
**Small, self-contained, mobilization footprint**



**Easy, safe, and efficient daily operation**



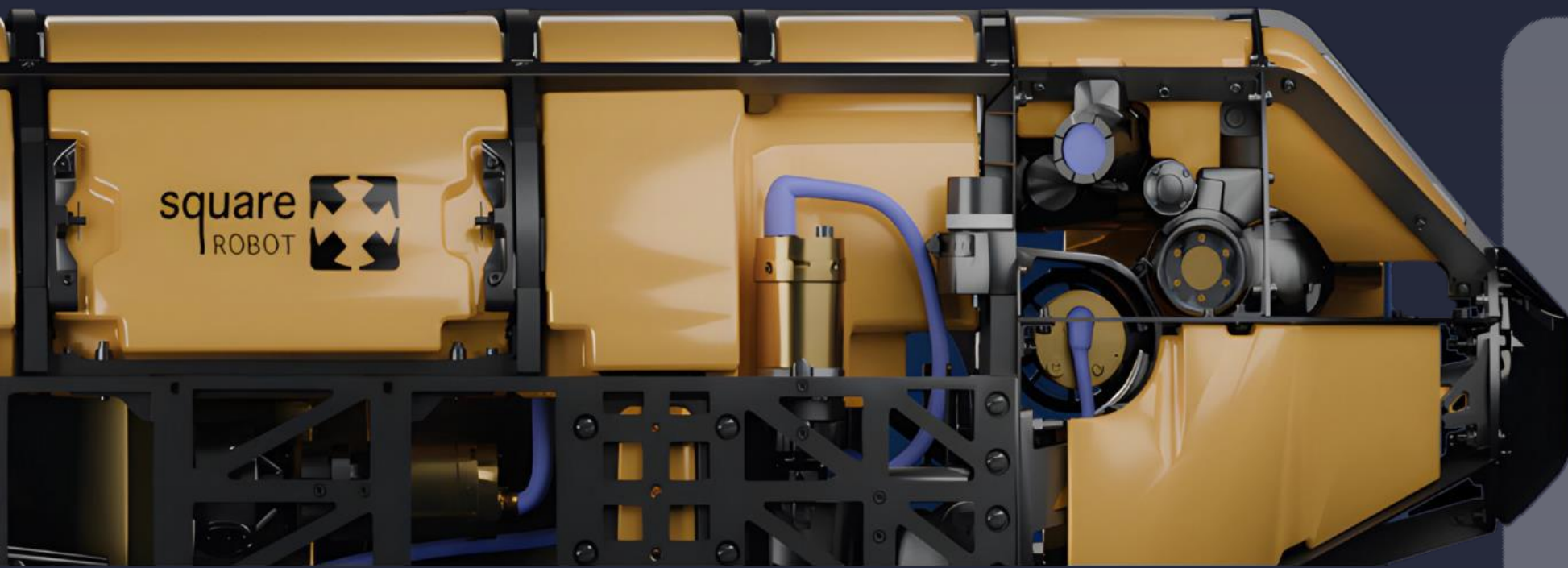
**No overhead lifts or rigging**







# Our Technology

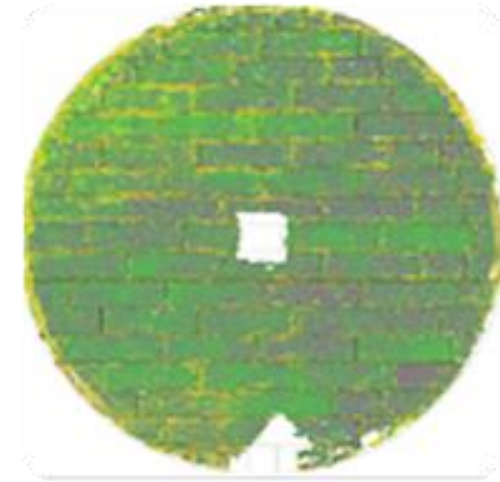


# API 653 / NFPA Compliance

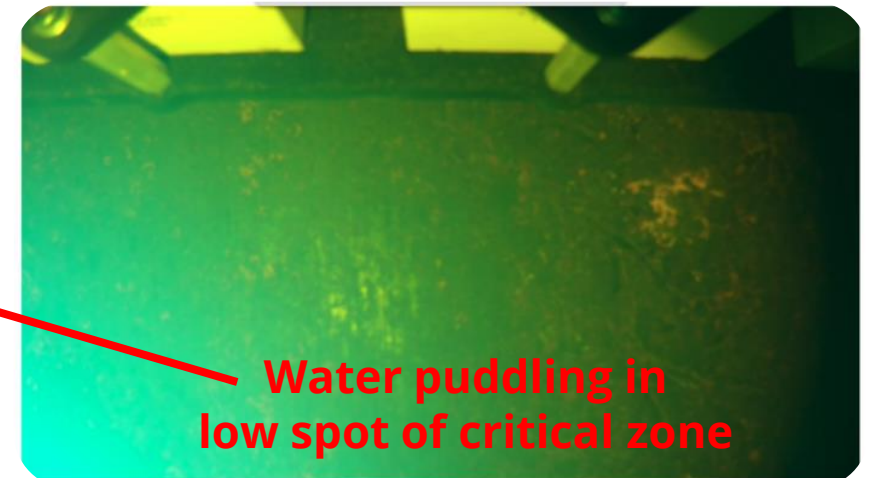
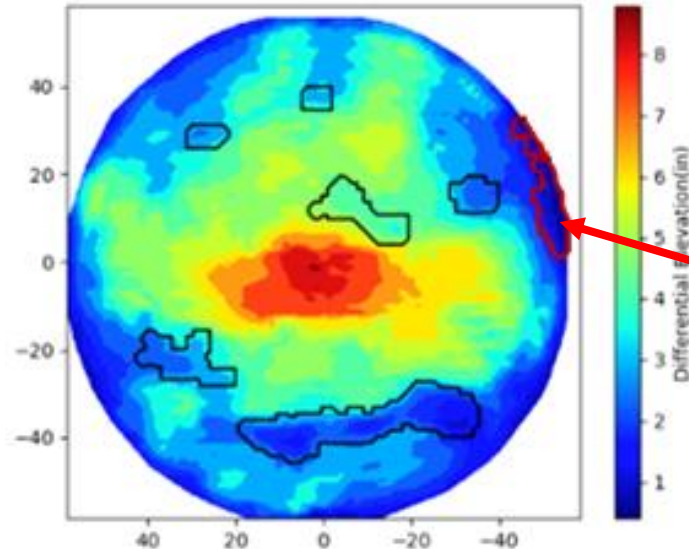


## Internal tank inspection using Square Robot:

- ✓ Tank Bottom Thickness using PAUT
- ✓ Differentiate Product and Soil Side Corrosion
- ✓ Internal Visual using 2 onboard video cameras
- ✓ Tank Bottom Settlement *under loaded conditions*
- ✓ Internal PAUT shell inspection



External tank inspection  
conducted by  
certified inspector



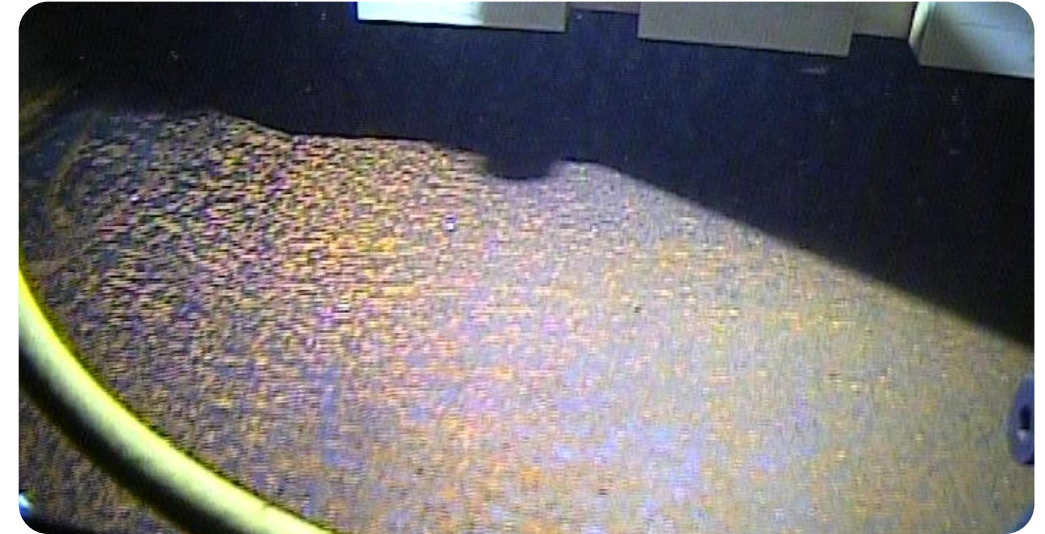
Water puddling in  
low spot of critical zone



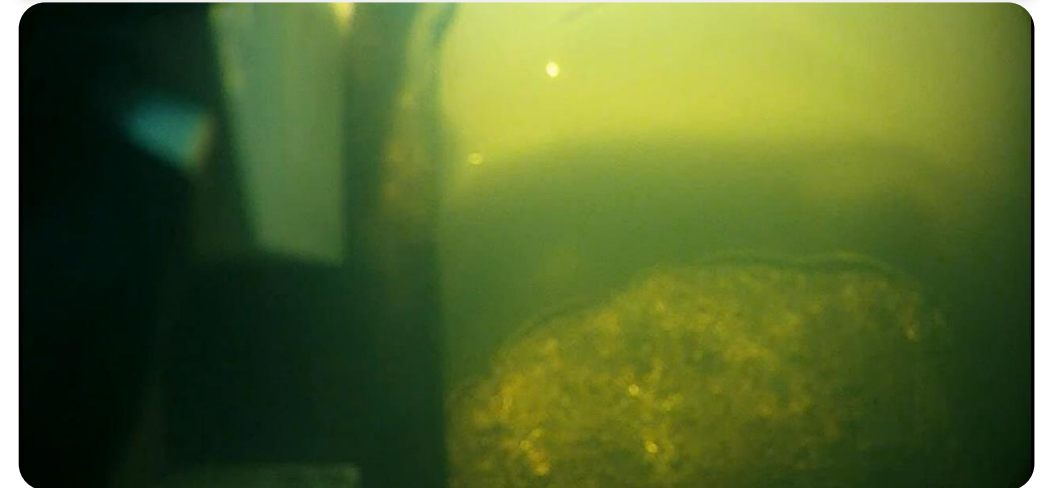
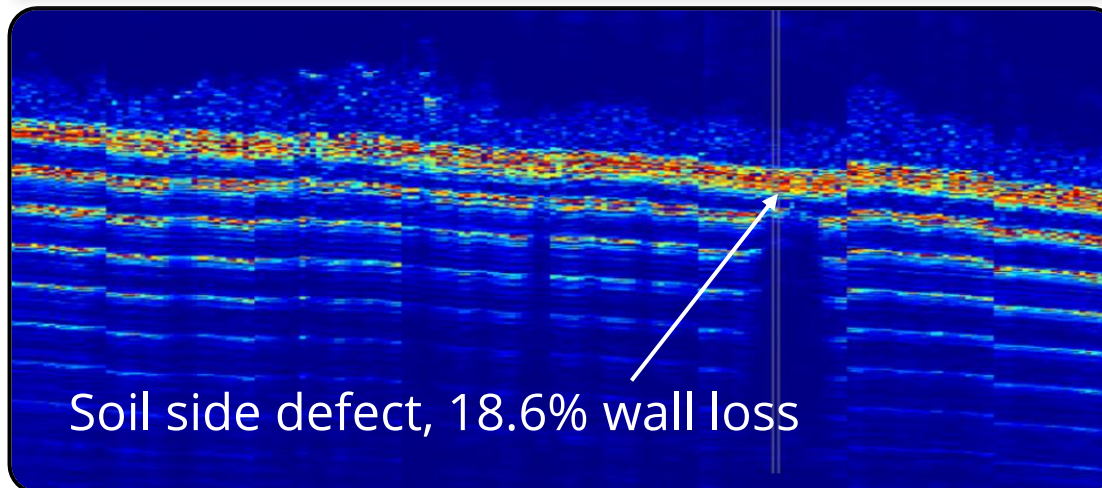
# High Resolution Sensors and Navigation



PAUT A, B, C-Scan for Plate Thickness

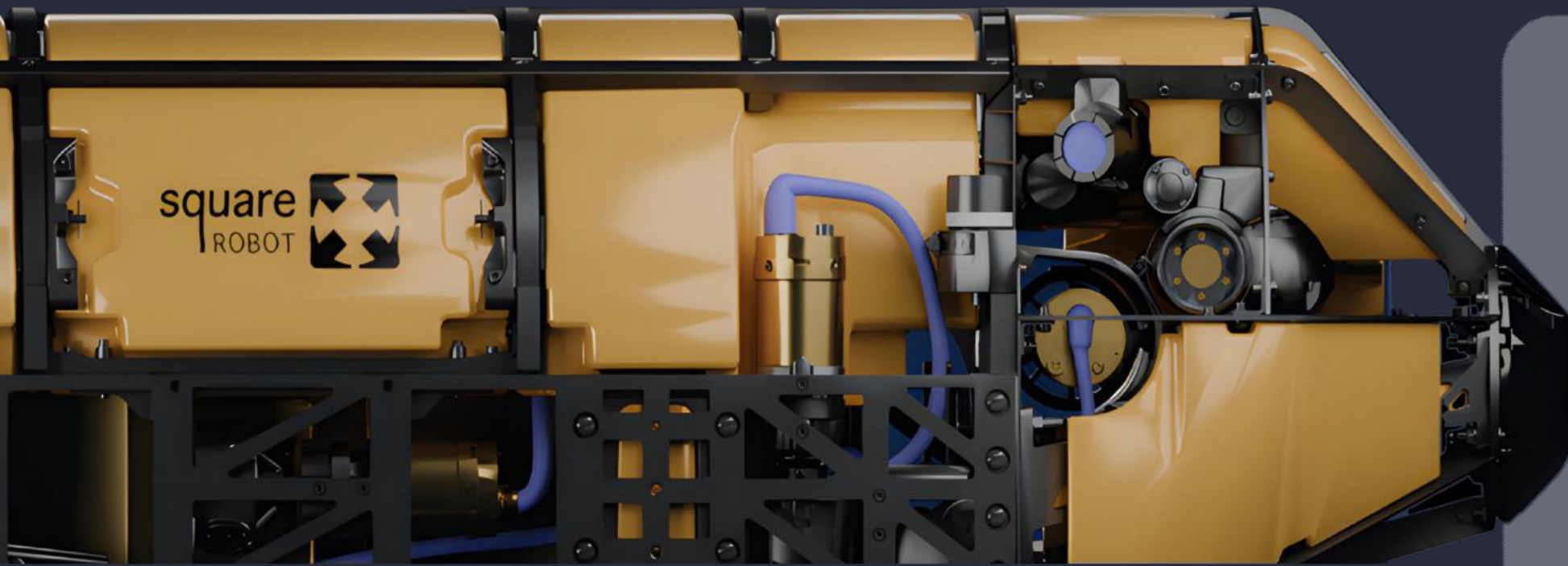


Critical Zone and Water Puddling





# Case Studies





# Case Study: Multi-Tank Inspection



## Square Robot Inspection

- Inspected 4 tanks in 3 days
  - ✓ 2x 59' fuel oil tanks, API 653
  - ✓ 2 water tanks, NFPA visuals



## Savings: Square Robot vs Traditional Inspection

- +Multi-tank discount on inspection and decreased mobilization
- ~ Eliminated 1,000 hours of confined space entry
- ~ Contained 4 tonnes of CO2e emissions
- + \$100K's in out-of-service inspection costs
- + 20 year API 653 inspection intervals



# Case Study: 92' Diameter Diesel Tank

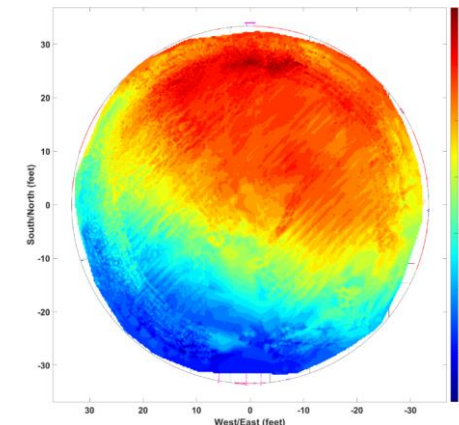
## Similar tanks nearby suggest internal tank bottom repairs required

- ✓ Proactively manage risk ahead of 2025 API inspection date
- ✓ Obtain API 653 compliant report
- ✓ Gain clear understanding of expected repairs
- ✓ Budget for repairs and project timeline in 2025

## Savings: Square Robot vs Traditional Inspection

- ✓ >\$400k temporary storage, prep, inspection cost
- ✓ + 27 days of out of service time
- ✓ + Contained > 5 tons of CO2e emissions
- ✓ + Eliminated 550 confined space labor hours
- ✓ + Higher density/Higher confidence data
- ✓ + Extended API 653 compliance > 20 years

- Inspection Time: 3 DAYS
- UT Tank Bottom Coverage: 78%
- UT Plate Coverage: 29/31 plates
- Confidence Level: High



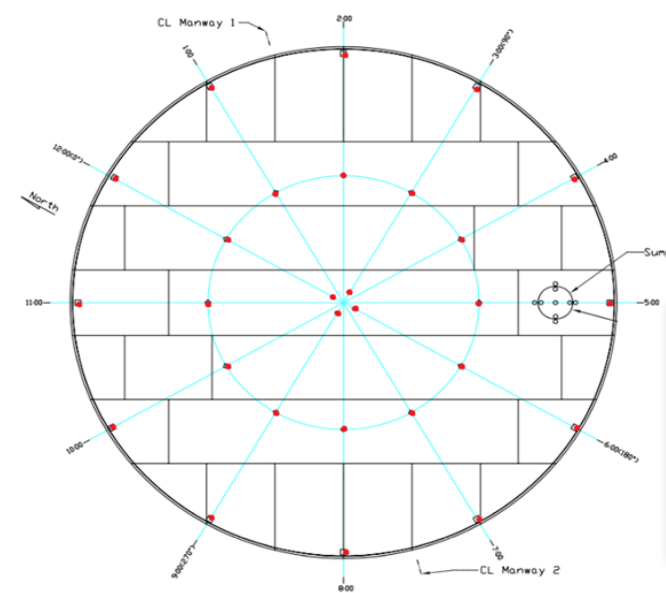
# Case Study: EPRI & TVA

## Inspected 3 Fuel Oil Tanks in 3.5 Days

- ✓ EPRI cohort program to showcase new technology to utilities
- ✓ Case study compared previous OOS inspection and coverage vs submersible inspection

## Savings: Square Robot vs OOS

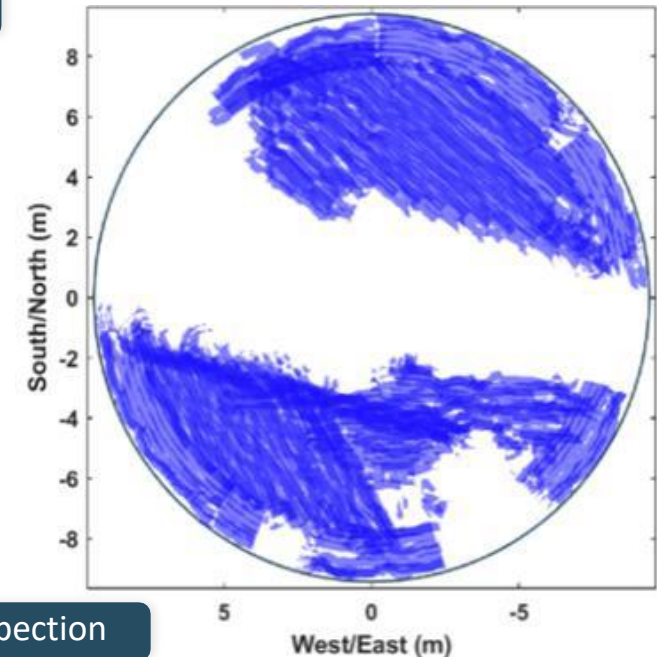
- ✓ ~\$200k in savings
- ✓ ~3 months of out of service time
- ✓ ~Contained 6 tons of CO2 emissions
- ✓ ~Eliminated 550 confined space labor hours
- ✓ + Higher density/Higher confidence data
- ✓ + Extended API 653 compliance > 20 years



- Inspection Time: 3.5 DAYS
- UT Tank Bottom Coverage: ~60%
- Confidence Level: High

Red dots denote single point UT readings

### OOS Inspection

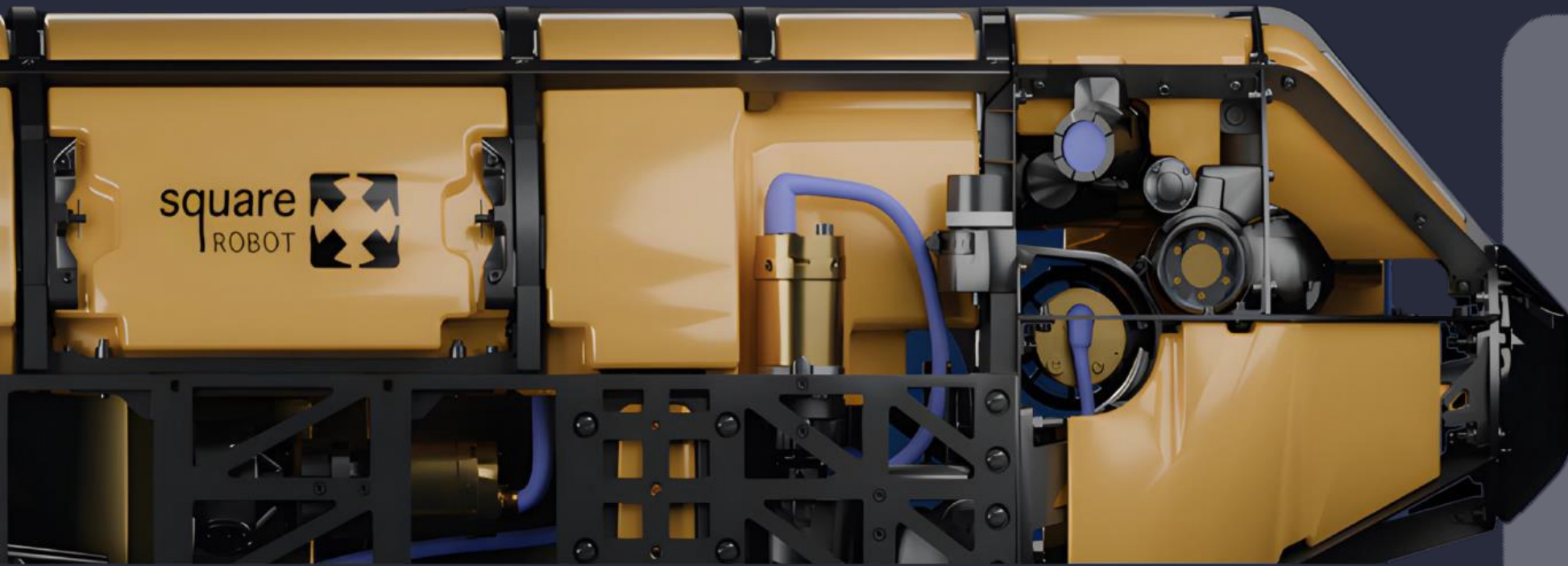


### Square Robot Inspection

Figure 1 - Robot Survey Tracklines (blue)



Any Questions?







# Global Leaders in Robotic Tank **Services**

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