

ROBOTICS INSPECTION OF TANKS

July 9, 2019

Owner/User Perspective

Concept – Key Features

Certification

Launch, Operations & Recovery

Performance

Path forward



TANK ROBOTICS - CURRENT STATE



- **SAFETY & ENVIRONMENT**
 - Looking for reduce exposure to tank confined space
 - Environmental incentives keeping tanks in service
- **REGULATORY**
 - API-653 doesn't prescribe inspection method
 - Risk based incorporated in latest API-653 editions
 - Regulators don't recognize API-653 latest editions
- **BUSINESS**
 - Agility and efficiency appetite in midstream space
- **BARRIERS**
 - General skepticism – memories from old robots.



TANK ROBOTICS – HOW CAN WE HELP?



- Sponsorship/Participation in Industry R&D Projects
- API-SCAST Evaluation
- Identify current “in-compliance” space and try
- Identify where tank in-service data adds value
- Promote tank robotics conversations with regulators
- Propose risk & in-service data based deviations
- Support tank robotic inspection services development



CONCEPT – KEY FEATURES



- Robot certified Class 1, Division 2 by FM Approvals
 - High flash point products (diesel, jet, kerosene) and water
- Onboard battery power
- Fiber optic tether
- Self-contained navigation
- Ability to:
 - Hover in product for mapping of floor obstacles
 - Roll on bottom and critical zone for NDT data acquisition
- Automated surveys
- Camera and light on board for high clarity visual imaging
- NDT payload
 - 8” PEC array → 18” (Dec. 2019)
 - 12” Phased Array UT (Aug. 2019)



CERTIFICATION



- Certification provided by FM Approvals
- SR-1 is certified for use in Class I, Division 2, Group D hazardous locations
- Tanks containing products with flash points $\geq 100^{\circ}\text{F}$ (diesel, jet, kerosene, water)

○ MODEL: SR-1	PN: 26 Rev A	○
SQUARE ROBOT, INC. 21 DRYDOCK AVENUE BOSTON MA 02210		
CLASS 1, DIVISION 2, GROUP D		
FM CERTIFICATION: FM18US0208, FM18CA0099		
OPERATING TEMP: $0^{\circ}\text{C} \leq T_{amb} \leq 35^{\circ}$ TEMPERATURE CODE: T6		
WARNING: SYSTEM IS DESIGNED FOR OPERATIONS IN HAZARDOUS LOCATIONS. OPERATORS SHALL BE TRAINED AND ADHERE TO ALL ON-SITE SAFETY PROCEDURES AND WARNINGS DEFINED IN THE SR-1 USER MANUAL. AVERTISSEMENT: LE SYSTÈME EST CONÇU POUR OPÉRER EN ATMOSPHÈRES EXPLOSIVES PRÉSENTES ACCIDENTELLEMENT. LES OPÉRATEURS DOIVENT ÊTRE FORMÉS ET ADHÉRER À TOUTES LES PROCÉDURES LOCALES DE SÉCURITÉ ET AUX AVERTISSEMENTS DÉFINIS DANS LE MANUEL UTILISATEUR SR-1.		

CERTIFICATE OF CONFORMITY

1. HAZARDOUS (CLASSIFIED) LOCATION ELECTRICAL EQUIPMENT PER US REQUIREMENTS

2. Certificate No: FM18US0208

3. Equipment (Type Reference and Name): SR-1, Inspection Robot

4. Name of Listing Company: Square Robot Inc

5. Address of Listing Company: 21 Drydock Ave, Suite 750W
Boston MA 02210
United States

6. The examination and test results are recorded in confidential report number:
3063093 dated 11th November 2018

7. FM Approvals LLC, certifies that the equipment described has been found to comply with the following Approval standards and other documents:
FM Class 3600:2018, FM Class 3611:2018, ANSI/ISA 12.12.01:2015

8. If the sign 'X' is placed after the certificate number, it indicates that the equipment is subject to specific conditions of use specified in the schedule to this certificate.

9. This certificate relates to the design, examination and testing of the products specified herein. The FM Approvals surveillance audit program has further determined that the manufacturing processes and quality control procedures in place are satisfactory to manufacture the product as examined, tested and Approved.

10. Equipment Ratings:
Nonincendive for Class I, Division 2, Group D hazardous (classified) locations, with an ambient temperature rating of 0°C to $+35^{\circ}\text{C}$.

Certificate issued by:
J.E. Marquedant
Vice President, Manager, Electrical Systems

11 November 2018
Date

To verify the availability of the Approved product, please refer to www.approvalguide.com

THIS CERTIFICATE MAY ONLY BE REPRODUCED IN ITS ENTIRETY AND WITHOUT CHANGE

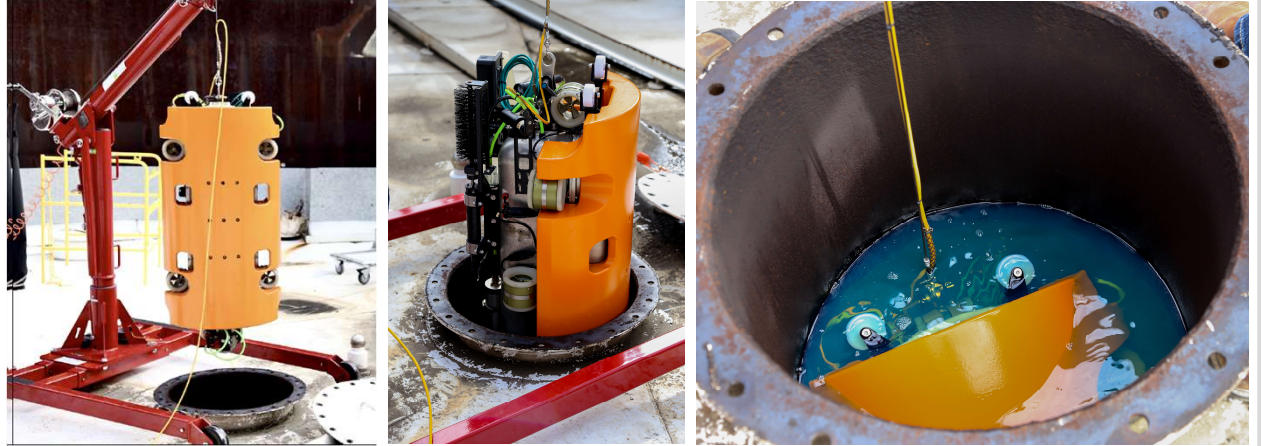
FM Approvals LLC, 1151 Boston-Providence Turnpike, Norwood, MA 02062 USA
T: +1 (1) 781 762 4300 F: +1 (1) 781 762 9375 E-mail: information@fmapprovals.com www.fmapprovals.com

F 347 (Mar 16) Page 1 of 2

LAUNCH, OPERATIONS & RECOVERY

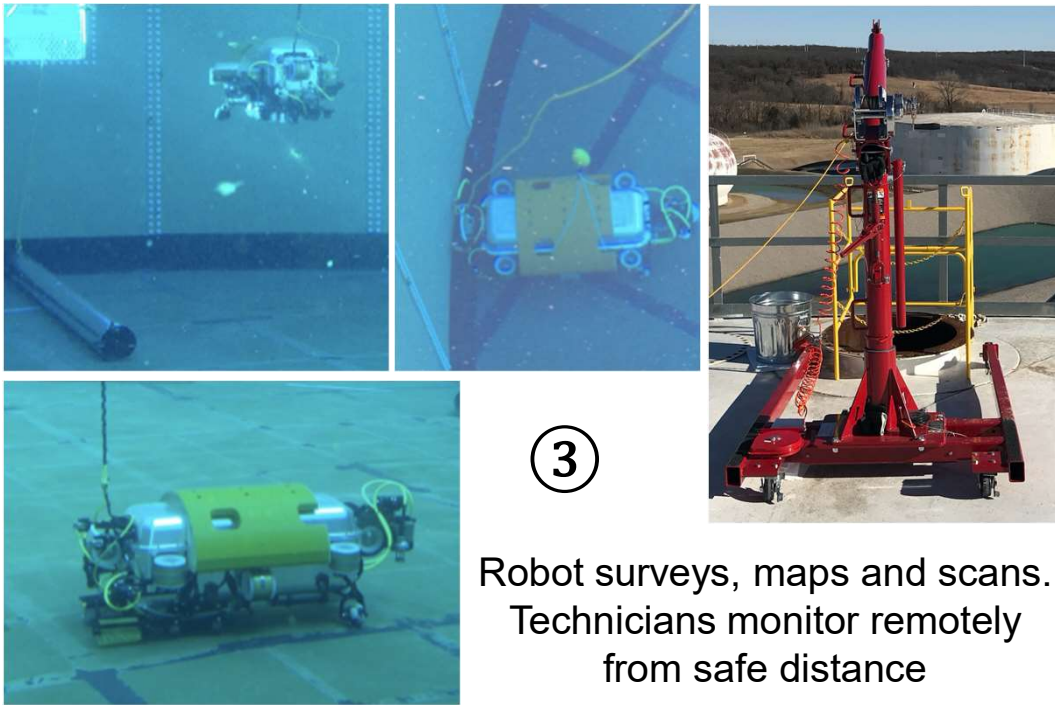


① Lift hoist and robot to tank top with small crane or boom truck



② Bond robot and hoist to tank. Lower robot into product and detach lifting cable

LAUNCH, OPERATIONS & RECOVERY



③

Robot surveys, maps and scans.
Technicians monitor remotely
from safe distance



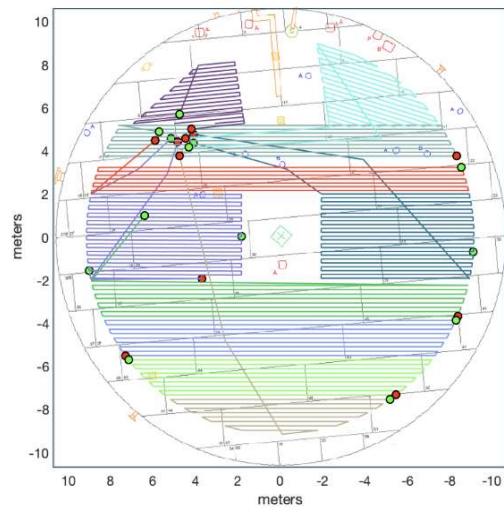
④

Recover, decontaminate

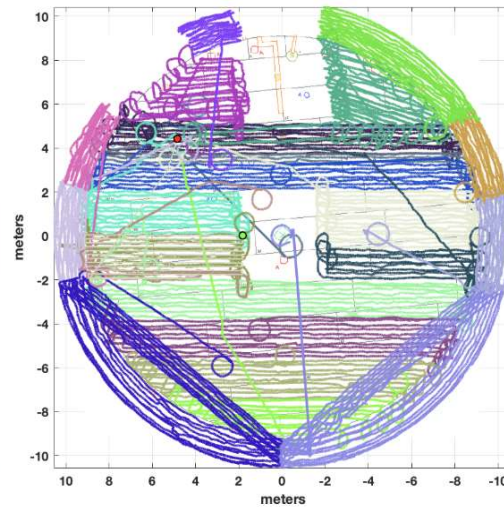
PERFORMANCE



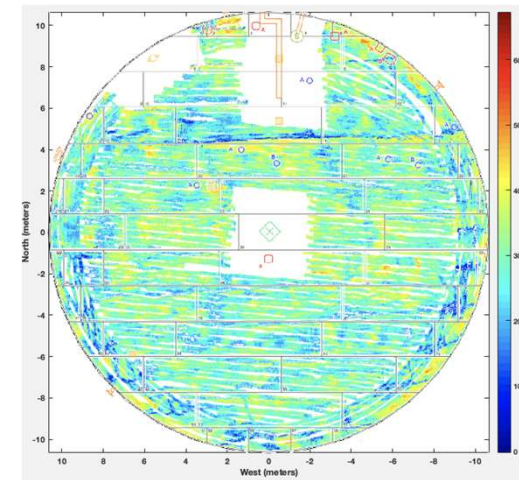
- Upwards of 95% floor coverage depending on obstacles (columns, piping, etc.)
- Efficient, autonomous floor scanning
 - 70' D tank in less than 9 hours
 - 100' D tank in less than 18 hours
 - Coverage rates will continue to improve as larger NDT probes are deployed



Dive Plan



Actual Track Lines



NDT Results

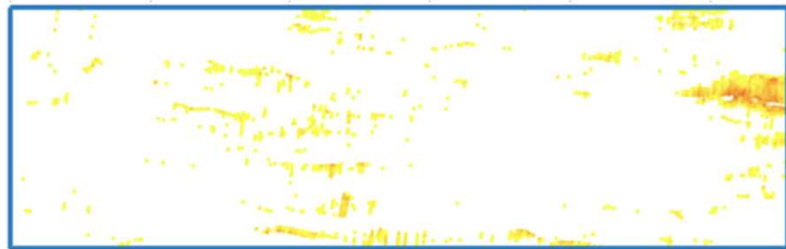
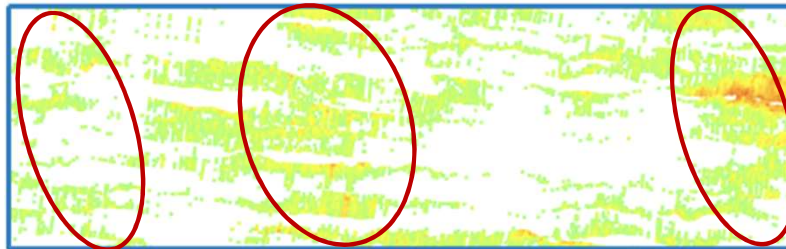
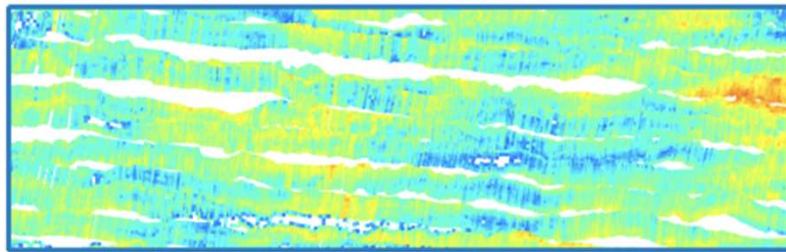
PERFORMANCE



All Thicknesses

Example Plate #26

ADJUST THRESHOLDS



Thinnest Spots

PEC (In-Service)

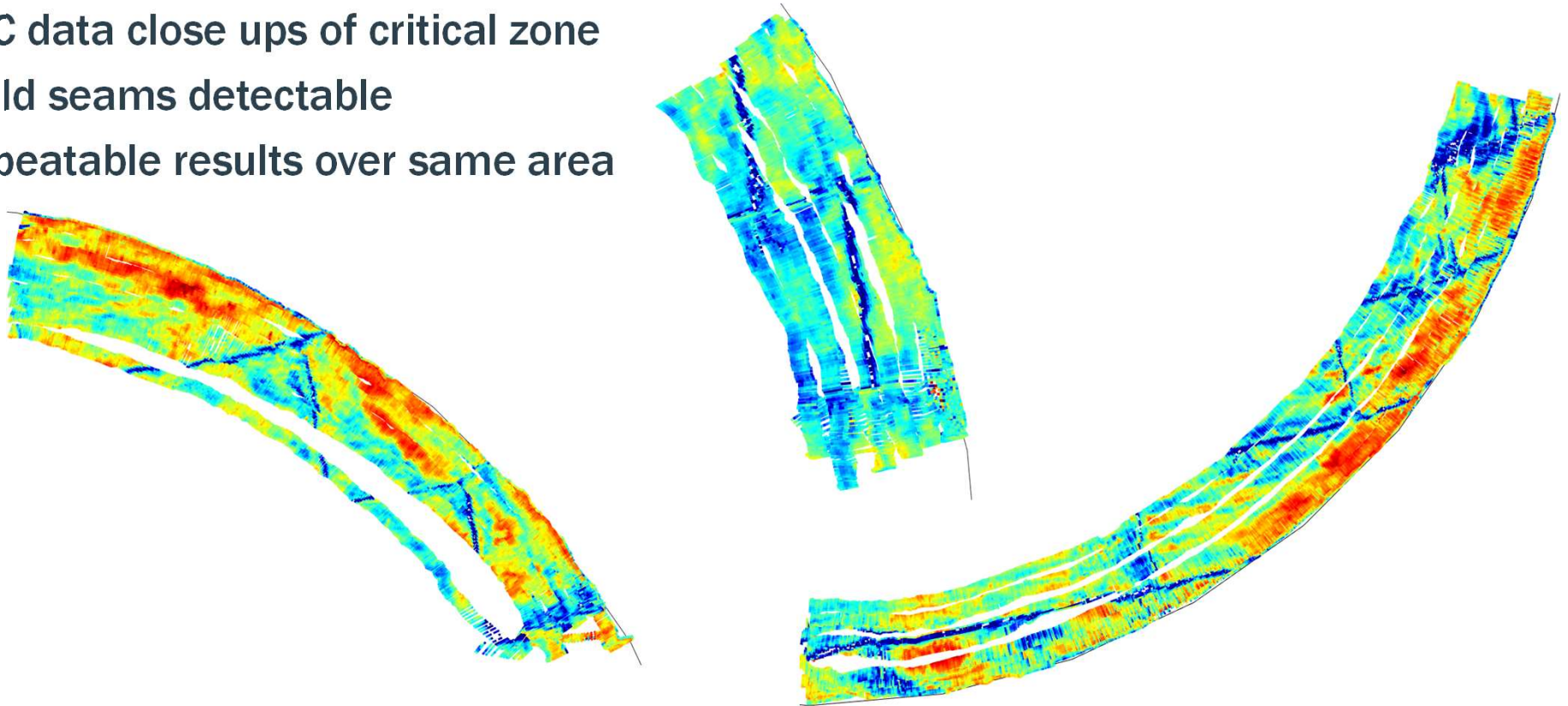


MFL (Out-of-Service)

PERFORMANCE



- PEC data close ups of critical zone
- Weld seams detectable
- Repeatable results over same area



PATH FORWARD



- **NDT payload**
 - 8” PEC array → 18” (Dec. 2019)
 - 12” Phased Array UT (Aug. 2019)
 - **Class 1 Division 1 System**
 - Un-tethered
 - PEC and/or PAUT payloads
 - **FM Approval certification by end 2019**
 - **Operational early 2020**
 - Gasoline
 - Crude
-

CONTACT INFORMATION



Info@Veritank.com

Clint.Collins@Veritank.com

Matt.Crist@Veritank.com

Rafael.j.Rengifo@p66.com
