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SPE workshop

Integrated Artificial Lift Excellence: Technologies, Operations, and the Digital Future

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From Conservative PT Screening to Quantitative Eddy-Current Array: A Risk-Based Polish Rod Inspection Method for Surface Artificial Lift

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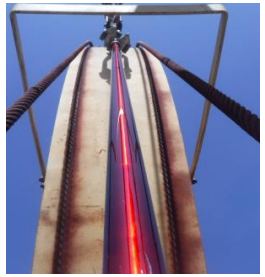
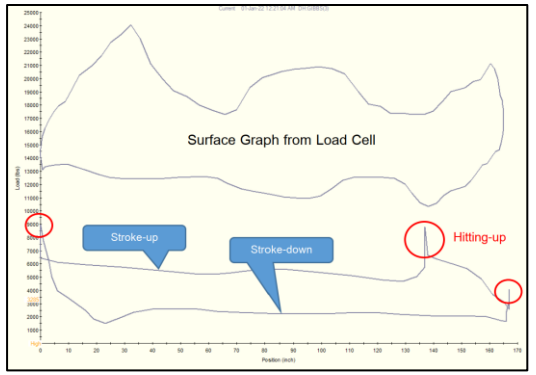
Background / Problem Defined

The Challenge

- Polished rods are critical to Sucker Rod Pumping (SRP) reliability.
- Failure can lead to Loss of Primary Containment (LOPC).
- 2018–2019: 3 LOPC events linked to polish rod cracking.
- PT introduced as an interim barrier—but had **major limitations**:
  - ❌ Cannot measure crack depth
  - ❌ Highly dependent on surface cleanliness
  - ❌ Operator subjective interpretation
  - ❌ High false reject rate (~42%)





Outcomes

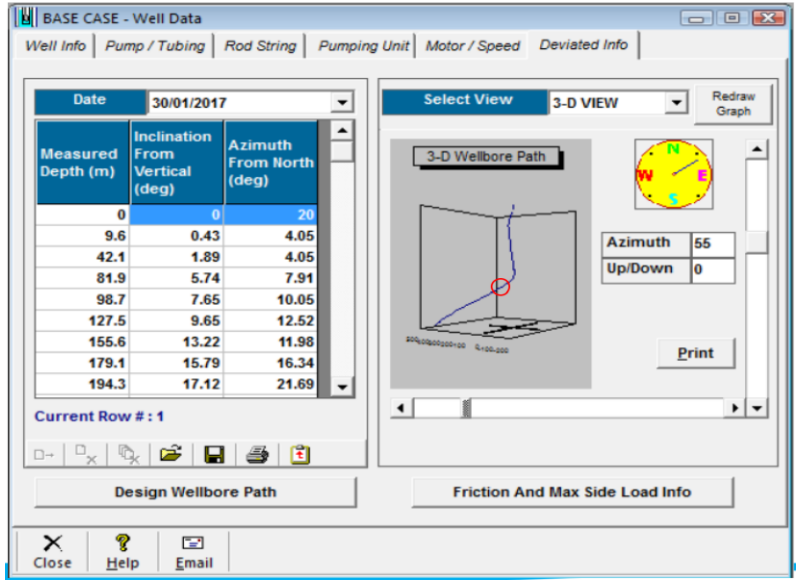
- Excessive rod replacement
- Increased well intervention
- Production deferment
- Elevated SSHE Risk

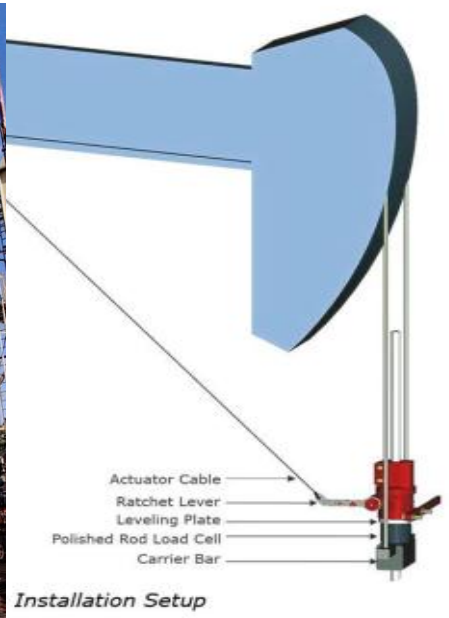
Background / Problem Defined

Why Cracks Occur in S1

Polish rods are critical to Sucker Rod Pumping (SRP) reliability.

- High dogleg severity
- Deviated wells
- High cyclic rod load
- Bending fatigue at stuffing box zone





Installation Setup

Key Insight

- We were rejecting rods based on **presence of crack**, but not based on **severity of crack**.
- We lacked quantitative decision criteria.

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What is ECA ?

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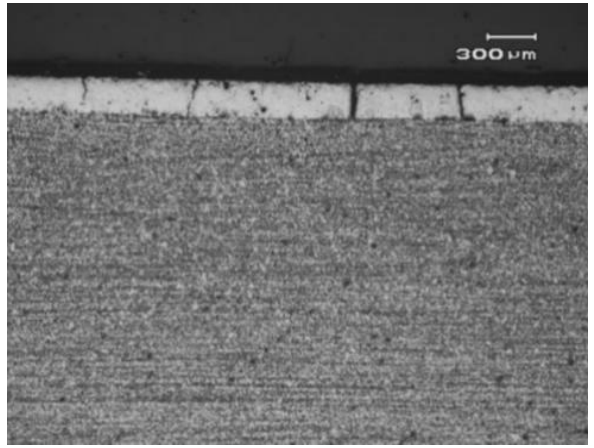
ECA (Eddy Current Array) is an advanced **Non-Destructive Testing (NDT)** method using multi-coil arrays for faster coverage, superior imaging, and high-resolution flaw detection.

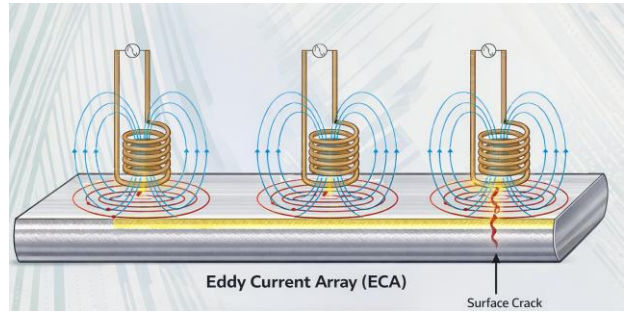


In the Polished Rod project, ECA demonstrated high effectiveness in detecting:

- ✓ Surface-breaking, Circumferential fatigue, Longitudinal (axial) cracks
- ✓ Small surface defects (~0.2 mm width)
- ✓ Reasonable depth estimation for shallow surface flaws
- ✓ ≤0.2 mm coating → not rejected

Polished Rod size: Outside diameter 1.5 inch with 1200 mm. of length
Polished Rod material: Carbon steel (Hard Chromium plating 0.3 mm.)

Working Principle of ECA

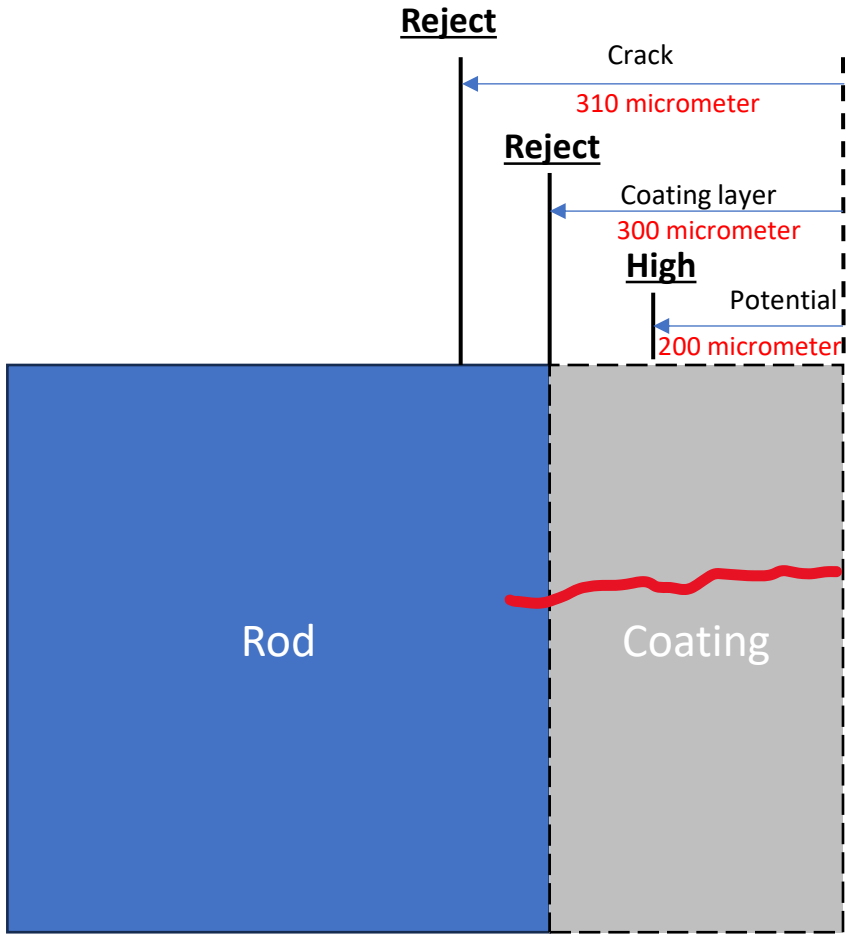


Magnetic Field Generation
AC applied to the coil induces an alternating magnetic field.

Eddy Current Induction
Magnetic fields generate circulating currents contact with conductive surfaces.

Interaction with Defects
Flaws disrupt current flow, causing impedance changes.

Criteria for 2025 Campaigned ECA (Eddy Current Array)



Criteria for acceptable and alarm

- Crack depth > 200 µm: Reject criteria
- May consider increasing allowable crack depth in future campaigns for cost optimization, subject to evaluation of 2026 baseline data

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Scan Polished Rod Workflow

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Start

Personnel Qualification Check
ET Level II + ECA Training ≥ 20 hours

Equipment Inspection
Probe must be suitable for rod's curved surface

Reference Standard Verification
Rod-matched material with multi-angle notches (L/T/45°) and full-Certified.

Polished Rod Surface Preparation
Cleaning and Visual Inspection

Setup & Calibration
Optimize frequency and gain, standardize channels.

Calibration on Reference Standard
Multi-directional detection with depth calibration and alarm settings (e.g., ≥ 0.2, 0.3, 0.5 mm).

Perform Scan Polished Rod

Data Recording
C-scan, Phase-Amplitude (Lissajous) and Strip chart

Indications Inspection

Indications detected

Analyze size/depth, re-inspect specific areas, and confirm via PT/MT as needed.

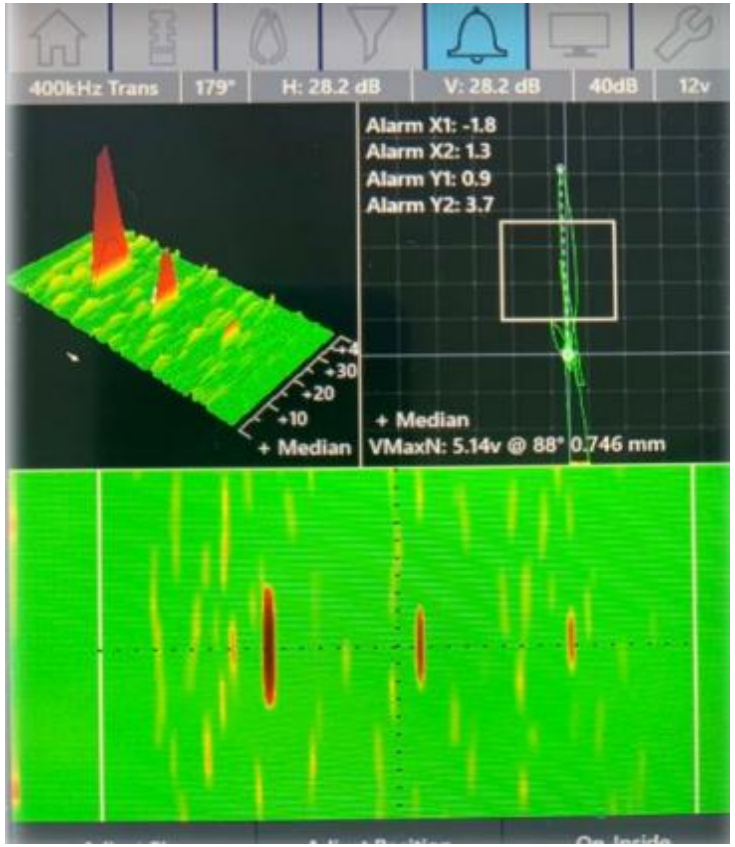
Evaluation based on Reference Standards
ASME Sec. V or customer agreement

Reporting
Record test conditions, C-scan images, and defect depth/location.

End

Pass

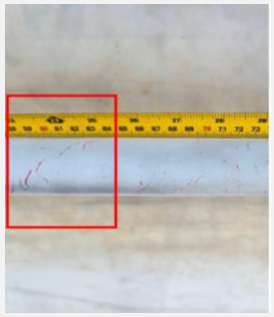
Indications not detected



Innovation Overview

PT (Penetrant Testing)

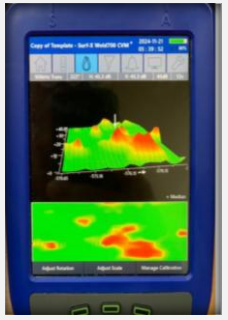
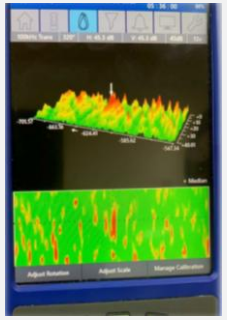
2023-2024

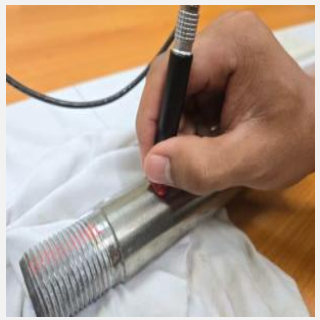




Cracks Detected → Reject

ECA (Eddy Current Array)

2025

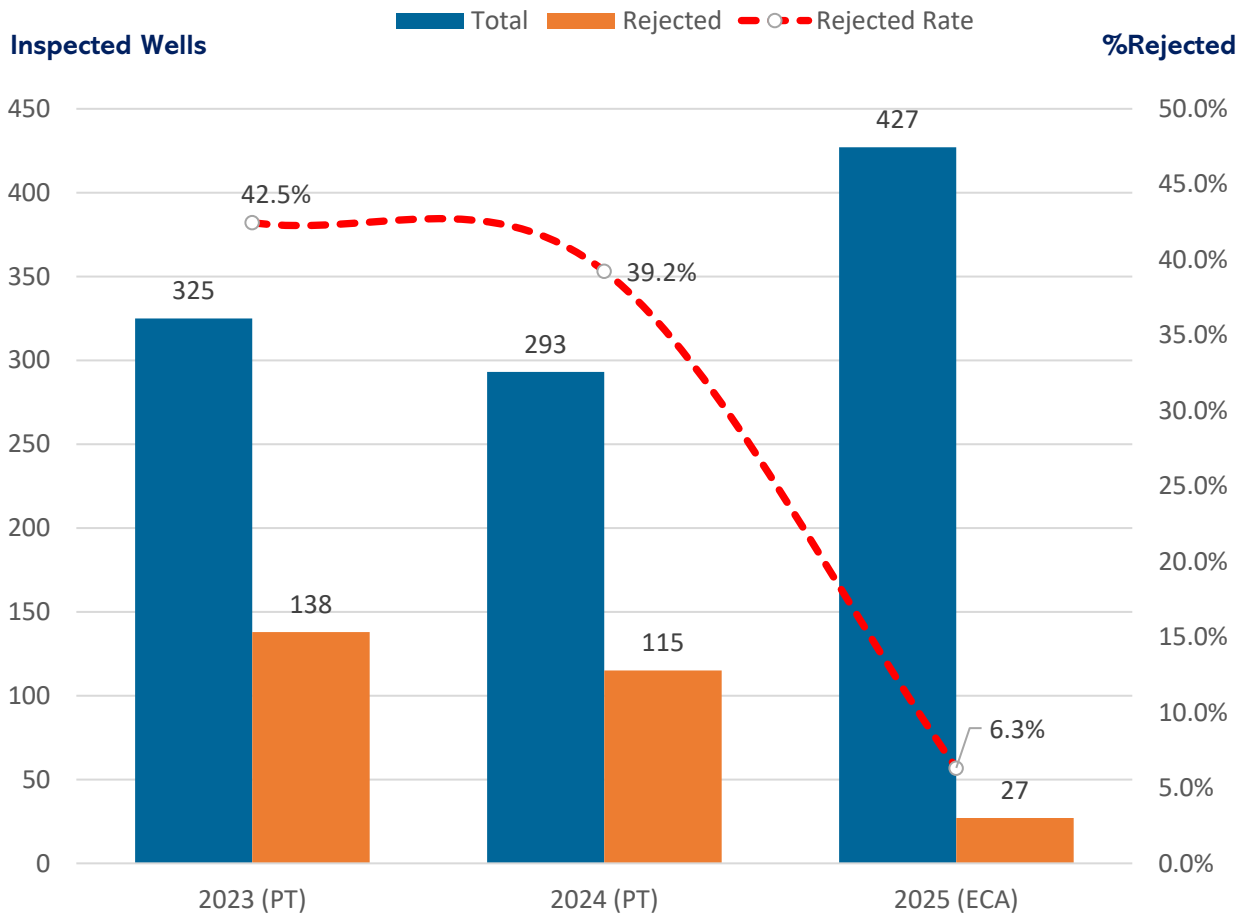


Crack Measured → Engineering Assessment

Criteria	PT	ECA
Crack detection	Surface only	Surface + depth response
Depth evaluation	No	Yes
Data record	None	Digital
Repeatability	Operator dependent	Calibrated & standardized
Surface sensitivity	High	Very High
Decision basis	Visual	Quantitative

S1 Deferment Improvement

Polished Rod Inspection Result in 2023-2025



No.	Descriptions	PT	ECA
1	Surface Cleaning	Serious	Not serious
2	Speed of testing	Very slow	2 times faster than PT
3	Sensitivity level	High	Very High
4	Identify the depth of surface crack	Unable	Able
5	Interpretation	Naked eye	Digital mapping & Sound Alarm

The Eddy Current Array (ECA)

- ❑ **High-sensitivity** detection for **small**, **narrow** and **shallow** surface defects.
- ❑ Reliable, **fast**, and **cost-efficient**.
- ❑ **Reduced inspection time**, measurement of indication depth,
- ❑ **Elimination of unnecessary rejections**.
- ❑ As a result, significantly reduced reject rate
- ❑ 194 Wells were accepted with indication, **deferment avoidance**

  8,548 bbls from 111 opening wells.

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Q&A

Thank You