Assessment of Corrosion under Insulation and Engineered Composite Wraps using Pulsed Eddy Current Techniques.

Service • Safety • Quality • Innovation
Presentation Outline

• Introductions
• Brief overview of TRAC Oil & Gas Ltd.
• Factors affecting Probability of Detection - Review
• Perceived current challenges
• NDT methods to be verified – Overview and work carried out to date:
  • Radiography,
  • Pulsed Eddy-Current (PEC)
Established in 1999:

Incorporated in Scotland, based initially in Aberdeen.
10 years of growth & diversification.
2009 creation of group & subsidiary companies.

Group turnover circa £50m.

Steady state and controlled growth for initial 10 years, accelerated growth following 2009 reorganisation.

TRAC Oil & Gas:
Turnover circa £15m
Services

Rope Access
Engineering Support
Inspection & Testing
Remote Inspection
Marine Class Survey & Repair
Mechanical & Electrical Trades
Rigging & Lifting
Fabric Maintenance
Fire Protection Systems
Training
Accreditations & Approvals

Accreditations

- ISO 9001: 2008
- ISO 14001: 2004
- ISO 18001: 2007
- ISO 17020: 2012

Class Approvals & Hull Thickness Measurement Approvals

- ABS
- DNV-GL
- LR

Memberships & Affiliations

- IRATA
- FUAL
- Investors in People
- Step Change in Safety
- LEEA
- HOIS
- DECOM North Sea
- AREG
- Aberdeen & Grampian Chamber of Commerce
- Environment Agency

JOINT ICORR/IOM3 EVENT, ABERDEEN BRANCH, TUESDAY 28TH NOVEMBER, 2017
Perceived Current Challenges

In-Service Inspection relative to:

- Corrosion Under Insulation (CUI)
- Evaluation of Remaining Wall Thickness under Blisters/Surface Scabs
- Inspection of and through Composite Engineered Wraps
Factors Affecting Probability of Detection (POD)

- Competency of the Company & Personnel
- Well developed and verified procedures
- Appropriate Acceptance Criteria
- Effective scanning of the component -
  - Area of the reflecting surface
  - Orientation of the defect
  - Shape of the defect
Who Decides What to Use?

Compliance Responsibility - Roles & Responsibilities

The **Owner / End User** is the responsible party irrespective of any construction / maintenance / consultancy contracts etc. that might be in force.

The **Owner / End User** verifies that the **NDT Contractor (Employer)** is competent to carry out the contractual requirements.

The **Employer** is responsible for ensuring Inspection Personnel meet the competency requirements of the contract.
The inspection body should demonstrate that it has management control over the following stages in order to demonstrate that it has the personnel necessary to undertake the range of inspection activities covered by its scope of accreditation:

- Identify the range of inspection activities,
- Identify the competence required for each activity,
- Train & assess against the competence criteria,
- Authorise persons for activities under appropriate supervision,
- Monitor performance of persons to re-assess competence
What are we looking for & how do we know we will find it?

This is the pre-requisite for all Inspection / NDT activities.

Identify what the degradation process is likely to be and apply the most appropriate method/technique to find and quantify it.

Verify the procedure under site conditions – coating / surface condition, real degradation – not artificial flaws or verify that the artificial flaws truly represent the expected degradation.

NDT personnel competent to carry out the activities?

Certification is not a measure of competence
Project Outline

Project consists of:

• Market survey and evaluation of Pulsed Eddy-Current equipment available.
• Source relevant in-service samples with typical and varied degradation
• In-House research to be verified by competent Third Parties
• Research and source suitable additional and/or alternatives to Pulsed Eddy-current techniques
• Research and trial suggested innovative methods
Market survey and evaluation of Pulsed Eddy-Current equipment available.

In total three (3) Pulsed Eddy-Current systems were evaluated.

Two systems were found to be relevant to our project.

These were Eddyfi Lyft and Maxwell PECT
**Eddyfi LYFT Instrument**

- **Materials:** Carbon steel
- **Lift-off range:** up to 300mm (12”)
- **Wall thickness:** up to 100mm (4”)

- **Weather jackets:** Aluminium, stainless steel, galvanised steel
- **Probe:**
  - PEC-089-G2-HT05S
  - Footprint 95.2 mm
  - Circumferential Footprint 124.5mm
MAXWELL PECT Instrument

- **Materials:**
  Carbon steel and low-alloyed steel

- **Lift-off range:**
  0 – 250 mm (0-10”)

- **Wall thickness range:**
  3 – 50 mm (0.12”-2”)

- **Insulation covers:**
  Non metal, aluminium and stainless insulation covers; limited galvanised weather sheeting
Due to our positive experiences offshore using radiographic techniques we introduced this method to the project. Examples below:
Radiography
Radiography

Initial trials with Sentinel QSA Global Open Vision equipment.

Unsuccessful due to Safety issues
Radiography

Two Digital Detector Array (DDA) systems were evaluated.

Little or no difference in technical performance.
The project continued combining Pulsed Eddy-Current & Digital Radiography
Principles PEC

Phase 1 The emission phase (the pulse) during which the probe injects magnetic fields that penetrate and stabilize in the component thickness.

Phase 2 The cut-off phase which induces strong eddy currents into the component. When the magnetic field emission is stopped abruptly.

Phase 3 The reception phase during which magnetic sensors measure the decay of the eddy currents as they diffuse into the material thickness.
Footprint Definition

• The footprint is the sensitivity area of the probe on the inspected component.

• The size of the footprint is affected by:
  • The probe size and configuration
  • The coating/insulation thickness
  • The jacket material
  • The WT of the component
PEC v UT

UT Readings

No Insulation PEC-025
PEC v UT

- Averaging Effect
- Point 1 a Dip
- Point 2 A Peak
- Point 3 PEC Averaging
Initial Work

Sample: Pipe OD 323mm
Thickness: 8.3mm
Length 1200mm
Engineered Composite Wrap 9mm

- Sample inspected after being removed from service (picture 1)

- After inspection a section of pipe was cut and the ID exposed to reveal a large scabbed area after initial cleaning. (picture 2)
Initial Work

- The Pipe was sent for cleaning and on return reviled the sever corrosion on the ID at what was the 6 O’clock position (picture 3)
Initial Work – Anomaly Report

- The original anomaly report identified two areas
- Area of anomaly A 80mm x 30mm 6 o’clock position 5.2mm minimum
- Area of anomaly B 20mm x 30mm 6 o’clock position 4.9mm minimum

Cross Section Of Defect
PEC Results show large area of general wall loss containing deep pitting along the length. The minimum reading recorded by the PEC 4.2mm.

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<tr>
<th>3 O'clock</th>
<th>Wall thickness values</th>
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<tr>
<td>9 O'clock</td>
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</table>

![Image of wall thickness values](image-url)
Example 1

Inspection carried out on off-shore facility
Sample: Pipe OD 798mm
Thickness: 6.35mm
Length 750mm
Engineered Composite Wrap 9mm

- Sample inspected off shore still in service.
  (picture 1)
The original anomaly report identified many areas of wall loss.
All anomaly's predominantly between 3-9 O’clock positions.
Minimum reading Location 1 3.8mm
Minimum reading Location 2 3.6mm
PEC Results show large area of general wall loss containing deep pitting along the length. The minimum reading recorded by the PEC is 4.2mm.

**Example 1**

- **Wall thickness values**

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**Joan ICORR/IOM3 Event, Aberdeen Branch, Tuesday 28th November, 2017**
Table shows 14 test point inspected off shore in service.

<table>
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<tr>
<th>Line ID  Test Point</th>
<th>Nom (mm)</th>
<th>Min Reading</th>
<th>UT (mm)</th>
<th>PEC (mm)</th>
<th>Difference (mm)</th>
<th>Indication Position</th>
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Example 2

- Nominal 7.92mm
- PEC (48% Remaining) 3.8mm
- Measured remaining before wrap applied 3mm
Example 3

- Pitting with leak path through to wrap PEC detected 68% remaining (pit approx. 10 mm diameter hole approx. 5mm)
Example 4

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Example 4

- A-scan for Position E9
- Red line calibration White Line the A-scan for the reading Notice they follow the same path until the white A-scan falls off 4ms
Example 5

- Remaining wall measured through blister then blister removed.
- PEC measured 7.2 remaining
- UT measured 6.8
Example 6
Example 6

Section 0-24
Example 6

Section 36-68
Example 6

Section 58-88
Example 6

Section 74-100
Example 7
Example 7

Section 22-54
### Example 7 - PEC Results

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**JOINT ICORR/IOM3 EVENT, ABERDEEN BRANCH, TUESDAY 28TH NOVEMBER, 2017**
Example 7 - PEC Results
Example 8
Example 8

Section 4-36
Example 8 - RAD & PEC of Elbow

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Example 9