Advanced Electromagnetic Technology & Tools for Subsea Pipeline Inspection

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*Conclusions*
COMPANY INFORMATION

Established: 1998 (by Andreas Boenisch)

Focus: Advanced Electromagnetic Inspection Services & Application Solutions

Offices: Operations: Aberdeen (HO), Rugby (UK), Abu Dhabi (UAE)
         R&D: Stutensee (GERMANY)

Current Staff: # 37 Operations, # 20 R&D
INSPECTION ACTIVITIES

HE & BOILER TUBE INSPECTION
- Multiple Frequency ET
- RFET
- Magnetic Biased ET
- Iris
- ET Rotoscan
- Application developments

SUBSEA INSPECTION
- Caissons
- Riser
- Flexible Riser
- Rig Structures
- Ship Hull
- Application developments

SLOFEC INSPECTION
- Storage Tanks
- General Pipes
- Pressure Vessel Scanning
- Application developments

TECHNOLOGY & Equipement
- Principle R&D
- EC Application R&D
- Niche Pipeline Solutions
- Crack detection tools
- Equipment Production

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## Electromagnetic Technologies used

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<th>Inspection Task</th>
<th>Application</th>
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<td>Metal loss detection</td>
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<td>Remote Field Eddy Current</td>
<td>Detection of large volumetric defects or thinning</td>
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**SLOFEC INSPECTION**

**PRINCIPLE OF SLOFEC™**

Induced voltage for probe in non-defect area

Induced voltage for probe in defect area

- **MAGNET**
- **EDDY CURRENT SENSORS**
- **EDDY CURRENT FIELD LINES**
- **TEST PIECE**
- **MAGNETIC FIELD LINES**
- **DEFECT**
- **COMPRESSED MAGNETIC FIELD LINES**

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PRINCIPLE OF SLOFEC™ vs MFL

Defect Position Distinction/Phase separation

EDDY CURRENT SENSORS

EDDY CURRENT FIELD LINES

TEST PIECE

DEFECT

MAGNET

COMPRESSED MAGNETIC FIELD LINES

Impedance Signal Display

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Capabilities

- Doesn’t require magnetic saturation of pipe wall
- No need for liquid couplant
- Doesn’t require highest level of pipe cleanliness

Limitations

- Qualitative inspection technique measuring the volume of metal loss in relation to the nominal wall thickness
- Sensitivity and defect sizing depends on defect orientation

How to overcome limitations?

- Combination with other inspection technologies, "Multi Technology Approach"
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SUBSEA INSPECTION OVERVIEW

- STRUCTURAL LEGS
- SHIP HULLS
- CAISSONS
- RISER
- FLEXIBLE RISERS
- SUBSEA PIPELINES
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INTERNAL RISER INSPECTION

Internal tethered inspection systems
Mainly using SLOFEC technique, partly set up with PEC & camera
Focusing on detection of internal & external corrosion / wall loss
Range: Diameter from 3” , WT up to 1”
INTERNAL RISER INSPECTION REPORTING
External Caisson & Riser Scanning:

from > 6” to 48” WT Range up to 1”
external & internal corrosion detection

Coating up to 15mm

VIDEO available on request
SUBSEA APPLICATIONS – RISER

Riser Tests – 6 inch & 12 inch (each sample 12m long, 8m coated)

1. 12” x WT 25.4mm Neoprene (15mm) coating
2. 6” x WT 17mm Stopaq ~ 10mm coating
3. 6” x WT 17mm Epoxy ~ 5 mm coating
4. 6” x WT 17mm Epoxy ~ 5 mm coating

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SUBSEA APPLICATIONS – FLEXIBLE RISER

MEC-FIT™ - Evolution Steps

Feasibility Test
at 10inch Coflexip Riser Sample with existing Pipe scanner

- penetration depth with the existing scanners and sensors.
- detectability of various material dishomogenities
- distinction between defects and other caused indications
- signal pattern distinction defects/armour layer edge effects.
- possible capabilities of fatigue detection & analysis

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MEC-FIT™ PRINCIPLE
Magnetic Eddy Current – Flexible Riser Inspection Tool

a further development of the SLOFEC™ technique
Magnetisation Level

Comparison of different magnetization levels on the wire magnetization
SUBSEA APPLICATIONS – FLEXIBLE RISER

MEC-FIT TEST / QUALIFICATION

Defects

A1 (three wires)

A9
SUBSEA APPLICATIONS – FLEXIBLE RISER

MEC-FIT TEST / QUALIFICATION

Defects

Signal of B3 in three runs
Signal from a grinding defect (lower picture) and the same area before grinding (above)
Indication—cut out sample area

Cut out section of indication 4.2 (Pipe 4). Left picture shows the area cut out, facing to the inside of the wire layer. Yellow marking zoomed up, showing fine line in perpendicular orientation to the wire length orientation.
Riser Scanner System MEC-Hug

self crawling set up and controlled by ROV

buoyancy unit

wheels

measuring unit (not visible)

valve pack

Hydraulic Operational Control System
SUBSEA APPLICATIONS – RISER

MEC-Hug Riser Scanner next generation:

Videos available on request.
SUBSEA APPLICATIONS – RISER

MEC – Hug Riser Scanner
MEC – Hug Riser Scanner, in operation for overboard deployment
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SUBSEA APPLICATIONS – SUBSEA PIPELINES

Self crawling systems
The SUBSEA PEC is a static measurement with capability to inspect through up to 200mm stand off (coating)

Two sensors are guided to scan circumferentially and axially along the pipe. Pipe Diameter Range 8” – 36”
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CONCLUSIONS

- Electromagnetic techniques are available to cover a wide range of subsea inspection applications including risers, flexible risers and subsea pipelines.

- Components having multiple layers (i.e. coated risers, flexible pipe, CRA clad / lined pipe) can be inspected.

- Further technology / tool development is in progress and requires industry support.
THANK YOU FOR YOUR ATTENTION

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