Recent Advances in Underwater remote ACFM® Inspection

Subsea Integrity and Efficiency
1st December 2015

Dr Michael Smith
Topics

- Subsea Inspection
- Review the ACFM® technique
- ROV remote deployment
- Q&A
The need for inspection
The ACFM® technology

- Alternating Current Field Measurement (ACFM®)
- Alternating current induces a uniform electromagnetic field into the surface
- The electromagnetic field is disturbed by surface-breaking defects
- Sensors measure this disturbance and locate the defect
- The interaction is recorded and modelled using advanced mathematics, which allows sizing for depth and length without the need for on-site calibration
Diver deployed ACFM®
TSC’s remote inspection capability makes use of ROV’s to either carry out the inspection, or place sub-systems that guide the probes while the ROV stands off.

TSC develops solutions to suit the specific application, usually based on the TSC ‘toolkit’ of remote tooling.

Remote weld inspection using ACFM® has been carried out across a wide range of applications including:

- Structural node welds on jackets.
- Caisson inspection.
- Inspection of welded plate structures.
- Inspection of mooring systems including chains.
- Inspection of spudcans.
Why Arrays?

- Multiple sensors in one probe
- Broad sensitive area
- Tolerant to error in tracking
- Tolerant to lift-off variations
- Data density improves interpretation
Deployment Classes

Types of deployment:

- Crawler – scanned array
- Scanner – scanned array or standard probe
- ROV Manipulator
  - Pick and Place with array
  - Scanned with array or standard probe
- Mini ROV
  - Pick and Place with array
  - Scanned with array
ACFM® MagCrawler™
Compact, magnetic tracked vehicle
On-board cameras and lights
Deployed by workclass ROV
150m operating depth
Fitted with ACFM® array probe
Probe mount can translate vertically and rotate
Suitable geometry:
  - Flat plate butt welds
  - Large diameter circumferential welds
  - Fillet welds
ACFM® MagCrawler example deployment video
Scanner Deployment

- Scanner is deployed and powered by ROV
- Probe is deployed along the weld line mimicking a diver’s movement
- Standard or array probes can be used
- Scanners are limited in scope and are created for specific geometries
- Some geometries are common and so common solutions are used
- Currently working down to 100m
Scanner Case Study

- Talisman Norway 2012
- Scanner designed and built by DeepOcean
- Tripod Support structure
- Previous visual inspections had indicated potential crack like defect

- ACFM® inspection confirmed that indication had no significant depth
- No repair necessary
Requires less dexterity from the delivery system
Can be used with simple passive tooling between probe and manipulator
The manipulator just has to hold the probe in place and still for a few seconds
The ACFM® NodeScanner™ has been developed by TSC for the inspection of node connections and has been used offshore on a jacket structure.

The scanner uses a scanned array probe that is capable of covering a complete weld cap.

This scanner has a combination of active and passive degrees of freedom.

The drive systems are electric and so can be deployed easily by electric or hydraulic ROVs.
ACFM® NodeScanner™ animation

Node Scanner
ACFM® NodeScanner™ deployed in Gulf of Thailand
For really tight access – use a Micro ROV

- For inspection of areas where a manipulator or crawler cannot gain access, another option is to use a tethered micro ROV delivered by Workclass ROV
- An ACFM® array probe (either pick and place or scanned) is fitted to the micro-ROV and then driven along the surface by the micro-ROV
- Results are dependent on the skill of the micro-ROV pilot, but the technique can work well on straight welds
- Performance demonstration conducted prior to mobilisation
Independent approval of the TSC ACFM® technique

Section 6 – Alternating Current Field Measurement Technique

Classification Note No. 7, March 2012
Section 2.1 – Detection of surface breaking cracks

“Accepted technique for the in-service examination of structural welds, heat-affected-zone and adjacent parent material in uncoated or coated structures.”

ACFM® is referred to in LR Survey Procedures Manual and NDE training programmes.

TSC is an LR certified ACFM® Inspection Services Provider.

Approved technique surface breaking crack detection.
ACFM is a mature and certified technique
Surface crack detection and sizing
No need to remove and re-apply coatings
A variety of methods available to deploy ACFM® on subsea structures
Experience with ACFM® inspections using ROVs includes:
- Norwegian Sector of North Sea: Talisman, Statoil, Shell, Total
- Australia: Woodside, Apache
- UK Sector of North Sea: Elf, Enquest, Britannia
- Gulf of Thailand: Chevron
Working with partners to provide inspection service solutions:
- Fugro, DeepOcean, Sonomatic, Oceaneering, Technip, LBO
Any Questions?

Dr Mike Smith
Technical Director
Contacts – TSC Inspection Systems

**Head Office**

TSC Inspection Systems
Davy Avenue
Knowlhill
Milton Keynes
MK5 8PB
UK

Tel: +44 (0) 1908 317444
Fax: +44 (0) 1908 220959
www.tscis.com
info@tscis.com

**Aberdeen Office**

TSC Inspection Systems
Unit D17
Wellheads Industrial Centre
Wellheads Crescent
Dyce
Aberdeen
AB21 7GA
UK

Tel: +44 (0)1224 725 136

**Singapore Office**

TSC Inspection Systems Pte Ltd
Loyang Offshore Supply Base,
23F Loyang Crescent, Box 5188
Blk 602 Tops Avenue 6
SINGAPORE 509022

Tel: +65 6543 9728