SCREW AND CRITICAL PART INSPECTION BY EDDY CURRENT ARRAY.

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Presentation plan

- What is ECA
- Critical parts inspections
- SCREW applications

Nortec N600

Omniscan ECA
History

Yesterday

Today

Tomorrow

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Historique théorie

\[ e = \frac{\Delta \Phi}{\Delta t} \quad \text{or} \quad \Phi = Li \quad \text{donc} \quad |\Delta \Phi| = L |\Delta i| \]

\[ J_x = J_0 e^{-\left(\frac{x}{\sqrt{\pi \mu \sigma_f}}\right)} \sin\left(2\pi ft - x \sqrt{\pi \mu \sigma_f}\right) \]

\[ \theta = 57 \frac{x}{\delta} \quad \text{J} = 100 \cdot \exp\left(-\frac{x}{\delta}\right) \quad \delta = 50 \sqrt{\frac{\rho}{f \mu_r}} \]

\[ U^2 = R^2 I^2 + L^2 \omega^2 I^2 = (R^2 + L^2 \omega^2) I^2 \]

D'où \[ U = I \sqrt{R^2 + L^2 \omega^2} \]

Donc \[ Z = \frac{U}{I} = \sqrt{R^2 + L^2 \omega^2} \]
Eddy Current Array – Basic Concept

- In ECA, several eddy current coils are placed in the same probe assembly to:
  - Allows larger coverage in a single probe pass while maintaining a high resolution.
  - Reduces the need for complex robotics to move the probe; a simple manual scan is often enough.
  - Improves flaw detection and sizing with C-scan imaging.
  - Inspect complex shape with a probe made with to the profile of the parts
What is Eddy Current Array?

- Eddy current array technology is the ability to *electronically drive several eddy current sensors*.

- Data acquisition is performed by *multiplexing the eddy current sensors*.

- Most eddy current probes and techniques for flaw detection can be used.
Equipment

1CH  BNC connector used for one single-coil eddy current probe using conventional eddy current technique.

4CH/MUX  19-pin connector used for eddy current probes that have up to four single coils.

EC ARRAY  R/D Tech® connector used for eddy current array inspection technique.
ECA – Signal Representation

- The C-scan can only show one component of the signal at a time (X or Y component).
- In the example below, the C-scan shows the vertical component of the signal (Y axis) and this is why the lift-off, which has been rotated horizontally, is almost not visible.
ECA Prepare the Future

ECA SOLUTION

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ECA industrial application

- Dovetail
- Aircraft Corrosion
- Gaz Turbine
- Tubes inspection
- Pipe
- Rails
- Train axis
- Doubler edge
- FSW (weld)
- Blade
- SCREW
Engine disk dovetail slot Inspection

- **ECA probe**
- **32 elements**
  - (2 x 16)

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ECA HF Inspection method

Inspection in the maintenance shop

Disk CHP D1

Tooling
ECA - Flexible Probe

Flex probe FBB-051-500-032
Frequency 50KHz to 4MHz
ECA - Flexible Probe

- Two mode

**Absolut**
Need a encoder

**Reflection**
Gas turbin  ECA Flexible probe and holder

- Special probe holder
- Flex probe 32 elements

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Gaz turbin

• One pass inspection
• Notch detection from 0.06 to 1 in to the edge
• Reliable inspection (100% full coverage)
• Easy interpretation on Cscan
• No need for encoder
TUBE INSPECTION

- Reference standard
- Banc

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TUBE INSPECTION

Eca flex probe kit
Custom probe holder
Method of ECA High-frequency inspection of the lower skin for scribe mark

0.06 in to 1 in to the edge
Method of ECA high-frequency inspection of the lower skin for scribe mark

- One pass inspection
- Notch detection from 0.06 to 1 in to the edge
- Reliable inspection (100% full coverage)
- Easy interpretation on Cscan
- No need for encoder
- General procedure
BOEING 757 LAP SPLICE C-SCAN INSPECTION

- Inspection procedure to Part 6, 53-30-06.
- Has at least a 32 channel probe head that can scan an area greater than 0.87 inch (22 mm) but less than 1.5 inches (37 mm) in width.
- Probe SBBR-026-300-032
- Operates at a frequency range of 200 kHz to 400 kHz.
- Has a linear position encoder.
- Has a C-Scan display mode
BOEING 757 LAP SPLICE C-SCAN INSPECTION Calibration Sample

NDT 588
5/32 and 6/32 rivet hole

Typical cross-section

EDM notch:
length .1 in from rivet shank
Thickness: through 1st skin
Results

Good rivet hole               Rivet hole with notch
ECA – Pipe inspection
Low-frequency EC array application:
Boeing 737 Skin crack detection at doubler edge

- Probe SAB-067-005-032 referenced in the NTM737 NDT 53-30-25 part 6, dec 2004.
- Description of the application:
  - Shear and compression loading cause cracking at the doubler edge.
  - Cracks need to be detected at their initial stage during the "C" Check,
  - If the crack reach the surface, the aircraft must be removed from service
Boeing 737 Skin crack detection at doubler edge

- The inspection is done from the outside and crack as small as 0.240” long by 0.010” deep located at the edge of the doubler need to be detected.
- Benefits:
  - Simple manual inspection
  - C-Scan allows easy location of the doubler edge for fast and simple detection of the initiating cracks
  - Better reliability
  - Better reproducibility
  - Time saving:
    » Normal time: 200 hours
    » With ECA: 48 hour
Boeing 737 Skin crack detection at doubler edge

- The user can see very well the doubler edge represented by the light to dark green color transition.

- Fastener will show up in light green.

- Defect above the rejection level are in red like shown in this picture.
Weld Inspection
Notches identification on the C-Scan view

length: 6mm, depth: 1.2mm, width: 0.2mm
SCREW INSPECTION
Conclusions about ECA

- Deployed in the field for many applications
- Referenced in procedures for aircraft and engine maintenance
- Fast (large area)
- Reliable (Full coverage and Cscan imaging)
- Many ECA standard probes
- Omniscan ECA module compatible with Bondmaster C-Scan.
- More to come…
BEST REGARDS