Presentation plan

- EC/ECA testing and equipments
- Aerospace applications
- Other applications

Nortec N600

Omniscan ECA
Historique théorie

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

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

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

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

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

Donc \[ Z = U / I = \sqrt{R^2 + L^2 \omega^2} \]
History

Yesterday

Today

Tomorrow

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EC Testing
Equipment
OMNI-P-ECA4-32

- Conventional and Array ECT
- 4 input channel
- 32 channels
- 64 channels with external multiplexer
- 1-Analog output
- Frequency range from 20Hz to 6MHz
- Dual Frequency operation ECA
- 8 Frequency operation EC
- 2-Encoder input
- 3-Alarms output
ECA probes application

- Aircraft Corrosion
- Tubes inspection
- Gaz Turbine
- Pipe
- Rails
- Dovetail
- Train axis
- Doubler edge
- Weld
- FSW
- Blade
AEROSPACE INDUSTRY: VM OLYMPUS SOLUTION

FAA policy on rotating parts

Historic: accident, Pensacola, Florida

- Engine failure on take-off roll
- Pilot aborted take-off
- Stage 1 Fan Disk separated; impacted cabin

Represented second major premature failure of an engine disk in service due to unanticipated and undetected damage.

Spawned FAA Enhanced In-Service Inspection and Robust Manufacturing Initiatives.

Eddy current inspection on disk.
Fan Disk ECA INSPECTION

- MAKING THE KIT FUNCTIONAL

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Making the Kit Functional, Kit conception

- Define Technical Specifications
- Quotation through NDT integrator Company
- Design Review Meetings
- Evaluation of Proto 1
- Industrialization
  - Performance validation
  - Documentation validation
  - Application qualification
Project Management, Human factor

- **Cost**
  - Investment Cost nearly 10 Times Cheaper
  - Operation Cost: 90 Minutes from Start to Report

- **Operator Stand Point**
  - New Skills, New technology
  - Direct False Call Analysis

- **The Key Factors**
  - Encoded Acquisition
  - Guided Scanner
CFM56-7 Fan Blade ECA inspection

Faulty engine blade on Southwest Airlines jet broke free and smashed a HOLE in the hull of the plane moments before it was forced to make an emergency landing

- Faulty engine blade on Southwest Airlines jet 'showed signs of fatigue'
- A Southwest jet was forced to make an emergency landing on August 27, 2016
- It had been flying from New Orleans, Louisiana, to Orlando, Florida
- National Transportation Safety Board is investigating the mid-air incident

- Represented second major premature failure of a engine blade in service due to unanticipated and undetected damage
CFM56-7 Fan Blade ECA inspection
CFM56-7 Fan Blade ECA inspection

Critical area
Federal Agencies Recommendations

- NTSB Report recommended:
  - Changes in inspection methods, shop practices
  - Fracture mechanics based on damage tolerance

- Spawned FAA Enhanced In-Service Inspection and Robust Manufacturing Initiatives

- Eddy current inspection on Fan blade
CFM56-7 Fan Blade ECA inspection

**First Step**
Given the severity of the problem, the first step was the development of a very simple ECA inspection means but quickly available...

Solution:
Omniscan ECA + ECA flexible probe + 3D printer probe holder

**For this step we have delivered:**
- 6 omniscan ECA
- 24 ECA flex probe
- 12 ECA cable
ECA - Flexible Probe

- Two mode

**Absolut**
Need a encoder

**Reflection**
More sensitive to small defects
CFM56-7 / 5 Fan Blade ECA inspections

**Second Step**
The second step is the development of an industrial ECA inspection Kit for two engines CFM56-7 and CFM56-5.

**Solution included for each version:**
- Omniscan ECA
- 2 x ECA flexible probe
- Mechanical system
- Iplex probe holder
- Blade sample
- Case Pelicase
- Setup on USB key
- Certificate

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Project Management, the OEM Responsibilities

- **OLYMPUS JOB**
  - Designs the part and the global inspection system
  - Study EAC solution and tool
  - Create a setup and tests the tool on customer samples
  - Develops Inspection Application to service the products
  - Validation steps
  - Assisting the engine manufacturer to demonstrates to the Aviation Authorities the ability to guaranty the certified life span

- **CFMI JOB**
  - The Engine Manual
    - OEM issues the Engine Manual with all Inspection Requirements
    - The Manual Specifies an Inspection Application for all Areas
  - The Standard Practice Manual
    - The OEM issues a Manual of the Suitable Method for the Required Inspection
    - Customer training
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

Inside of the skin
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
Engine disk dovetail slot Inspection

- ECA probe
- 32 elements
ECA HF Inspection method
Inspection in the maintenance shop

Disk CHP D1

Tooling

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Screw inspection
Weld Inspection

- Pipe
- Windtower
- Rail
MagnaFORM on Weld

Flexible Probe

Good Contact

Increased Lift-Off

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Flexible Sensor Array

16 + 16 Sensors (two types)

Active Circuitry

Eddy Current Sensors: Multi-Layer PCB Etched Coils

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Weld Close-Up

- Lift-Off
- Raw Crack Signal
- Compensated Crack Signal
Notches identification on the C-Scan view

length: 6mm, depth: 1.2mm, width: 0.2mm
Travel quietly with Olympus SSD