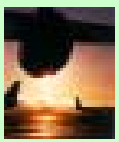
FAA Centers of Excellence
3rd Joint Annual Meeting
2003

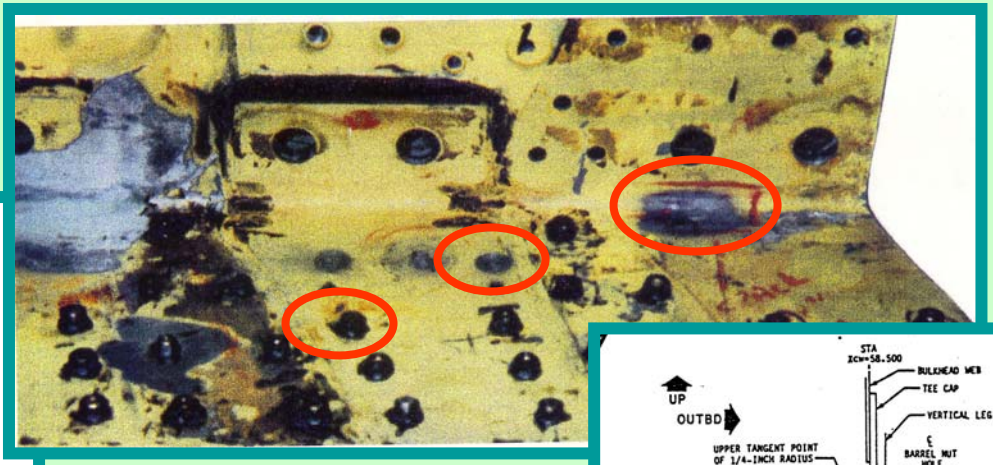
DC-9 Tee Cap Inspection

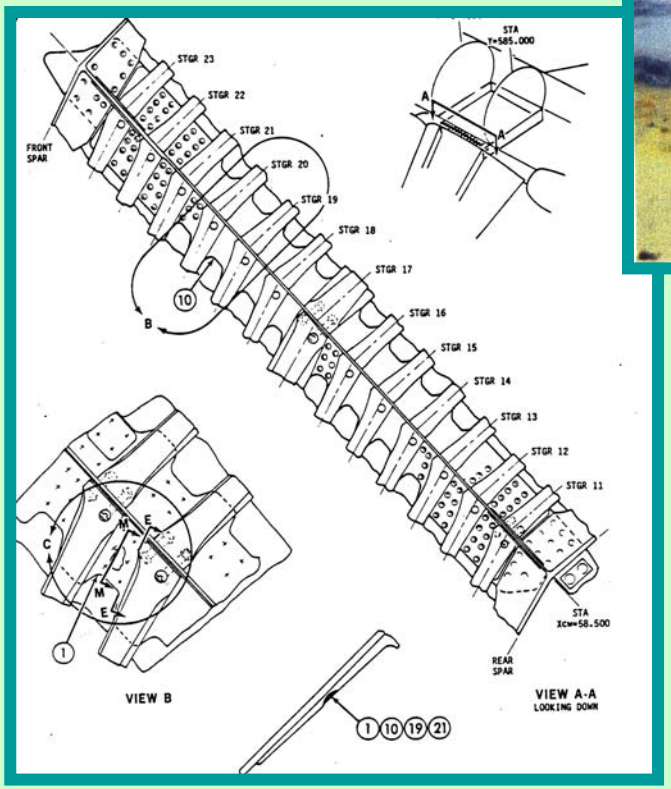
Christopher Smith
FAA TC
&
Igor Komsky
Northwestern University



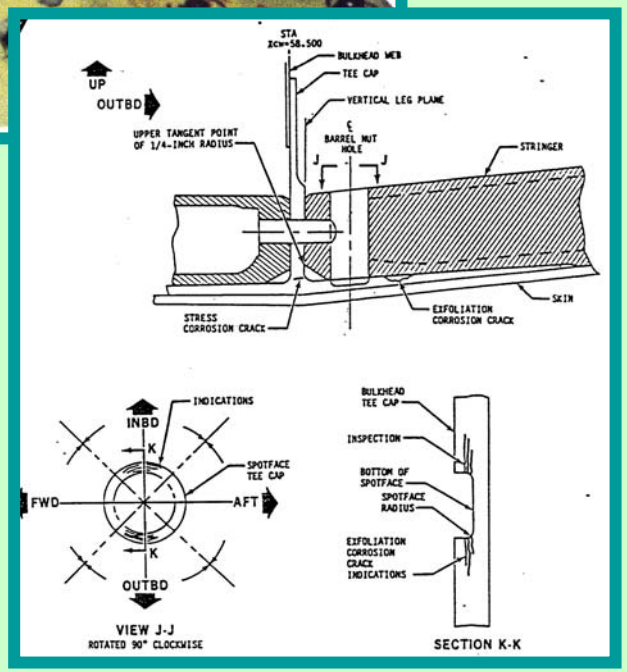
Importance of the T-cap inspection

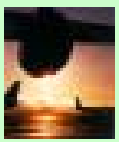
DC-9's T-cap is a structural member that redistributes load from the wing skin and stringers to the wing box





560 DC-9s that required inspection



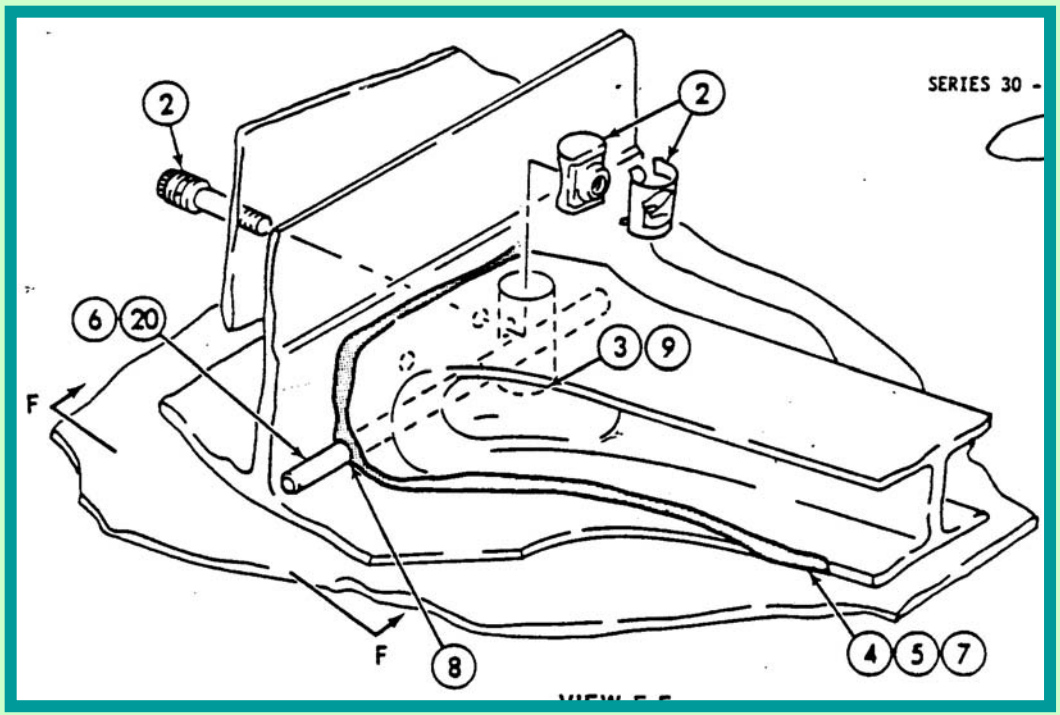


The originally-installed T-caps were fabricated from 70-75T6 aluminum and were prone to exfoliation corrosion and stress corrosion cracking

Why the new inspection method was needed?

Service Bulletin 57-98:

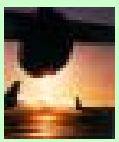
Gain access to the center wing tank
by removal of access panels,
purging of the tanks,
removal of barrel nuts.



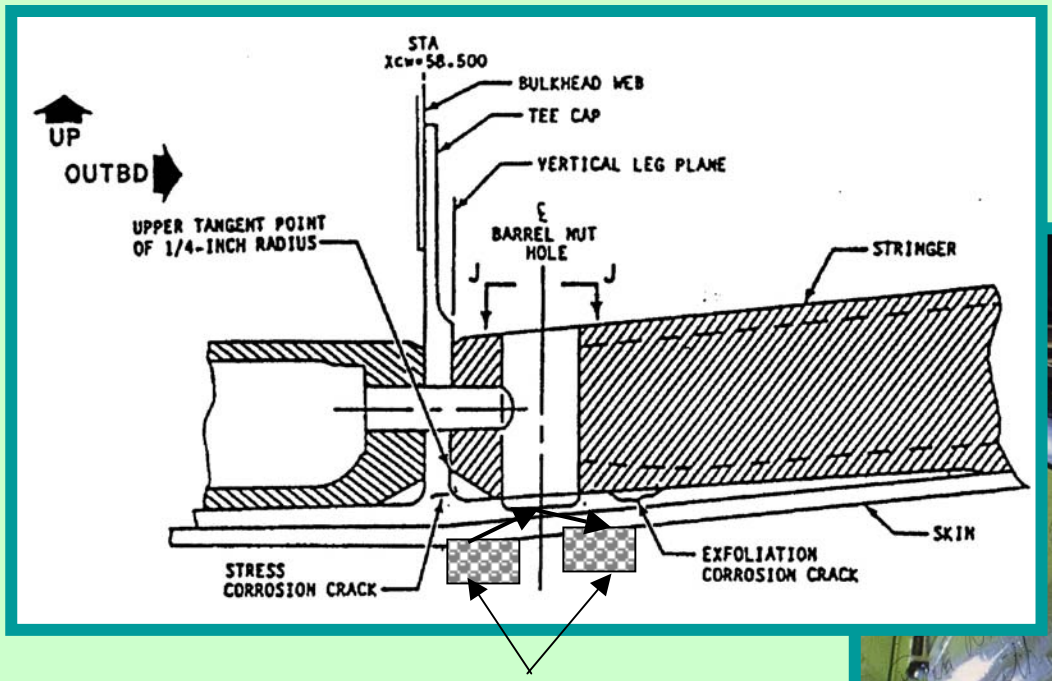
Perform visual inspection
of the area between
and under the stringers.

Reassemble the aircraft.

800 man-hours
without repair

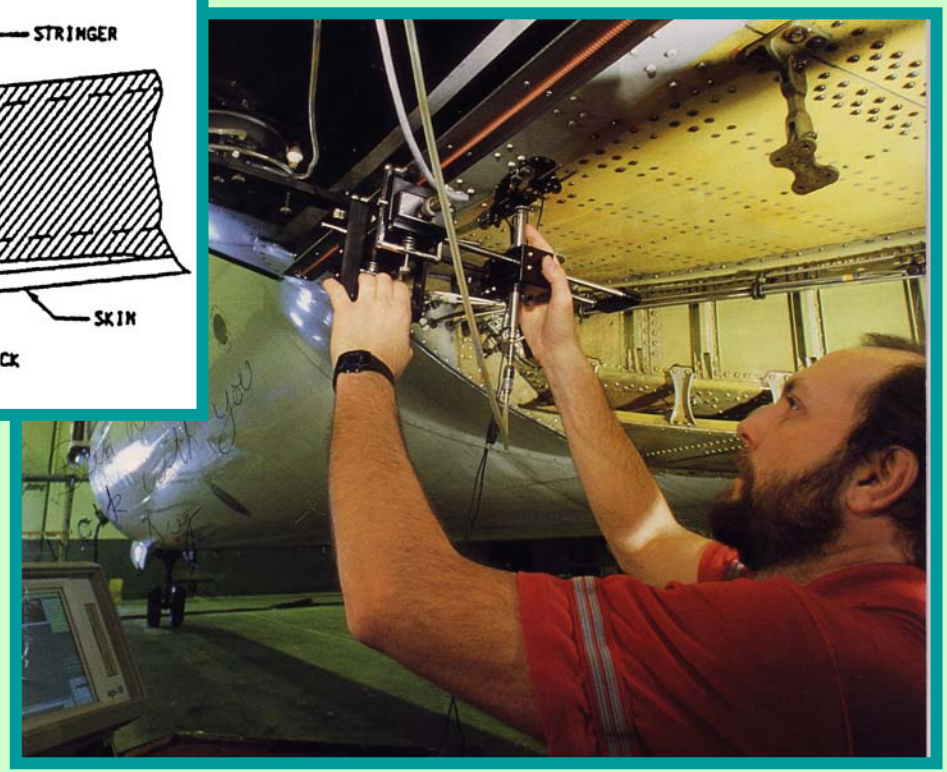


Alternate inspection method – ultrasonic scanning from the aircraft skin without disassembling of the aircraft



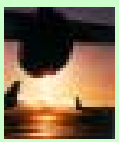
Ultrasonic probes

48 man-hours
without repair



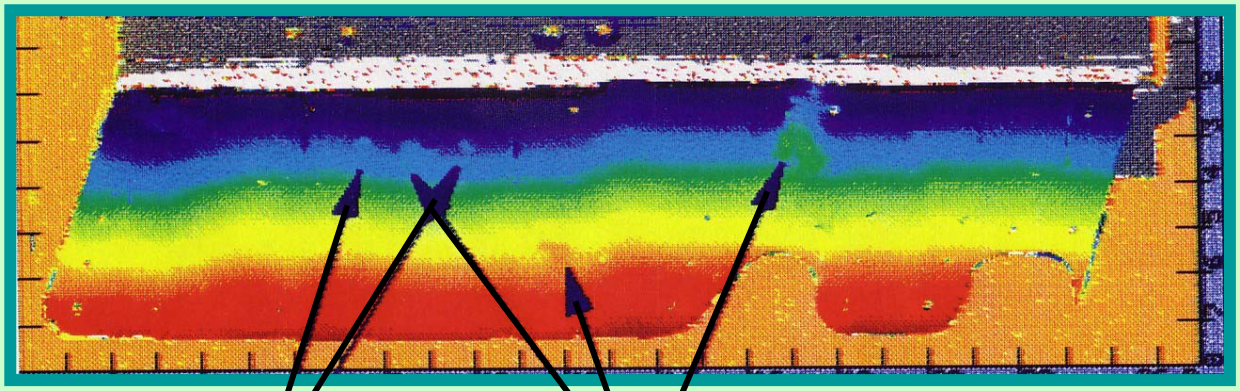
New concept:

Ultrasonic inspection of the multi-layered aircraft structures through the sealant layers from the aircraft skin



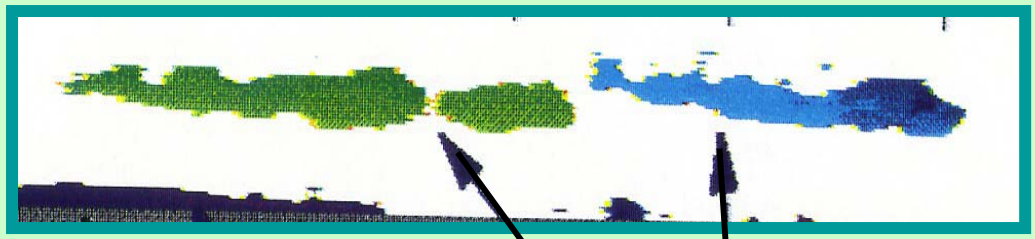
Ultrasonic images of cracks and corrosion

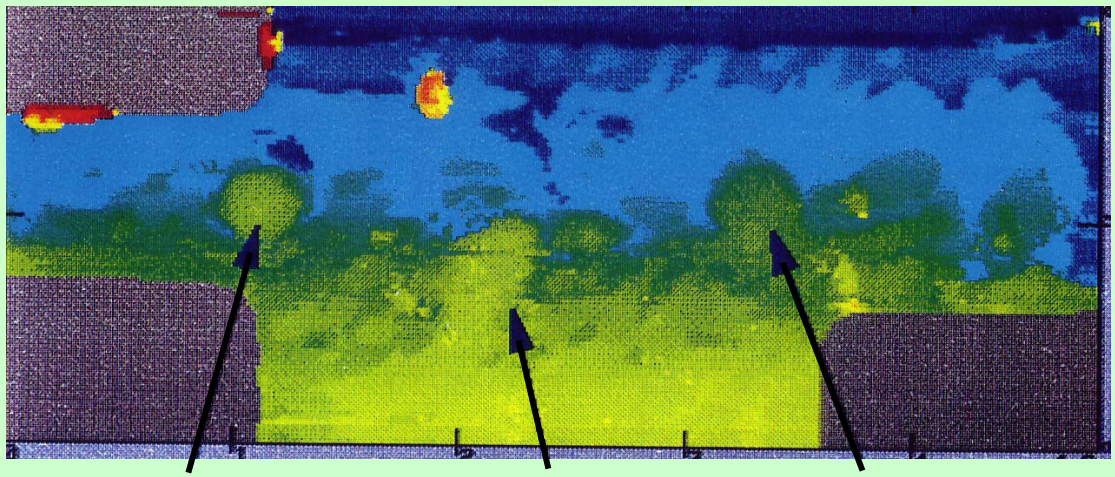
Cost savings-
about $9,000 per aircraft
An additional savings of
$20,000 per day
is achieved due to the reduction in maintenance downtime (NTIAC)



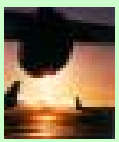
Spotface 7% & 4%

Exfoliation corrosion
7%, 5%, & 10%





Stress corrosion cracks
In the vertical flange



Spotface 7% loss

Exfoliation corrosion 7% loss

Spotface 4% loss

Key to a successful technology transfer

Northwestern University
Northwest Airlines

Northwestern University
Northwest Airlines
SAIC/Ultra Image

Northwestern University
Northwest Airlines
SAIC/Ultra Image
AANC
McDonnell Douglas

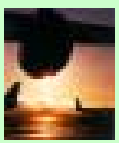
Northwestern University
Northwest Airlines
SAIC/Ultra Image
AANC
McDonnell Douglas

Concept development
November 1993

Inspection technology development
Nov. 1993-Oct. 1994

Beta Site Testing
Nov. 1994-Feb. 1995

Technology Transfer
SB revision
1995



Support through the ongoing R&D program

FAA

Support through the special tech transfer program

Applications of the new inspection technology

DC-9

DC-10

Boeing 777

Commercial aircraft

Airbus 300-600

C-141

F-15

KC-10

Air Force

Ultrasonic inspection of the multi-layered aircraft structures through the sealant layers from the aircraft skin

Commercial inspection systems

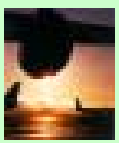
MAUS IV

Scan Master

Commuter aircraft

Fairchild SA 226/227

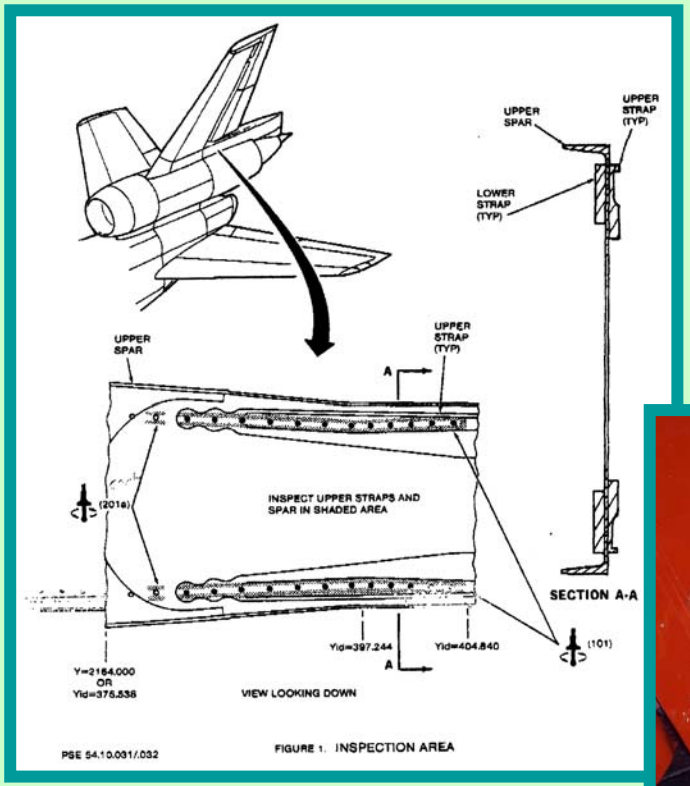
Cessna Citation 7

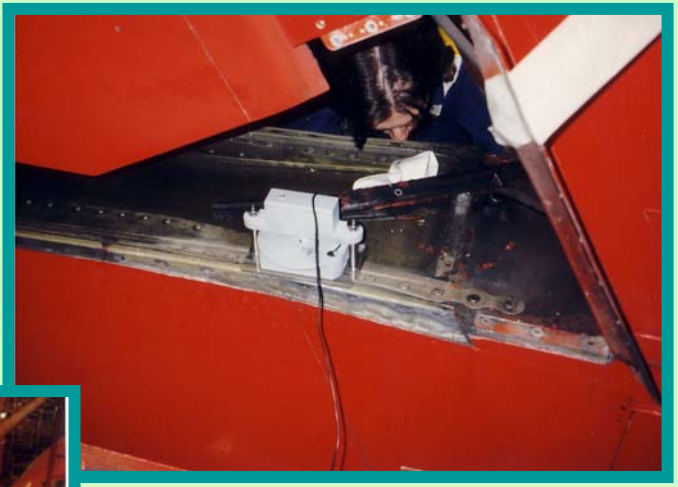


AACE

Applications of the new inspection technology

DC-10
spar-cap/strap connection

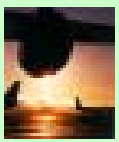




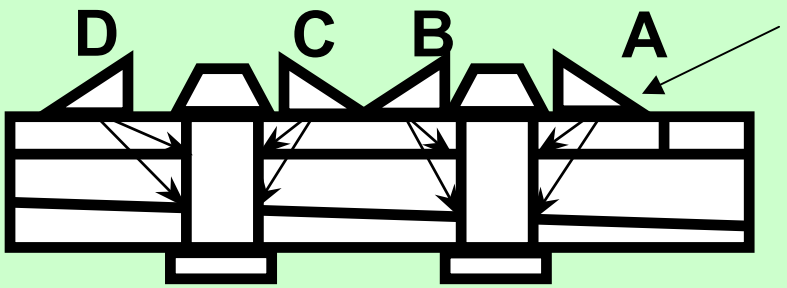
Revision of the DC-10 SID NDI Manual was issued in October 1997

Ultrasonic scanning system

Bill Jappe (Boeing, Long Beach) inspects DC-10 at Northwest Airlines

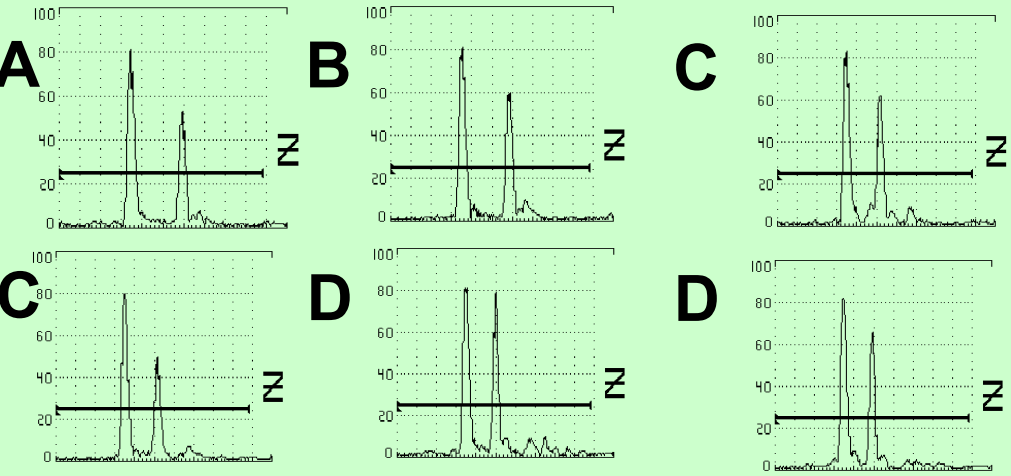


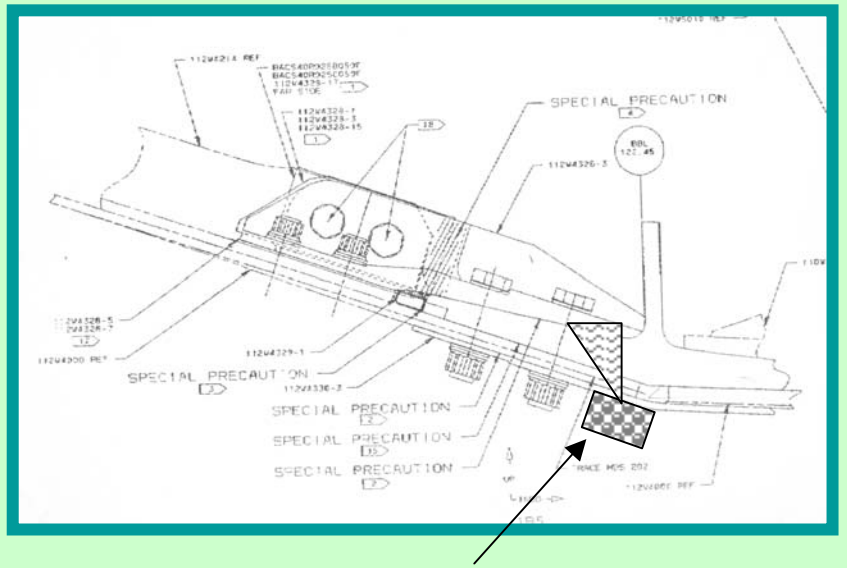
Applications of the new inspection technology



Dual-beam ultrasonic transducers

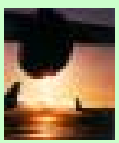
Boeing 777
side of body splice





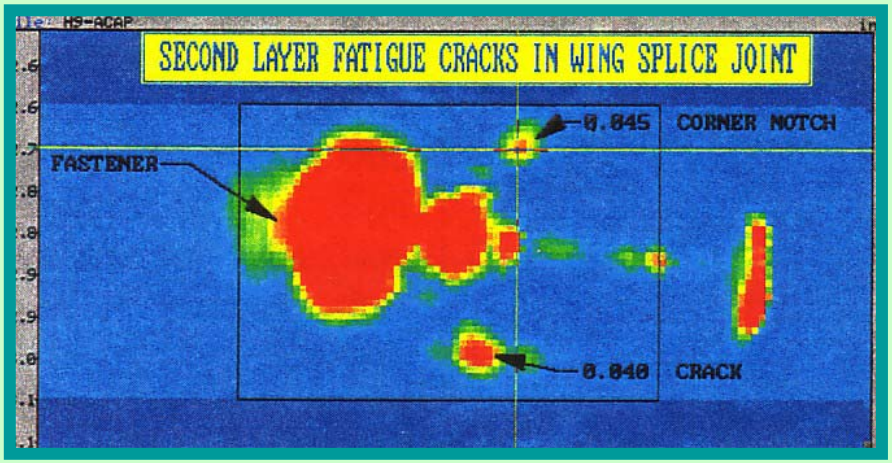
Crack detection in the T-chord/Paddle fitting interface of the Boeing 777 side of body splice.

Dual-beam ultrasonic transducers



Applications of the new inspection technology

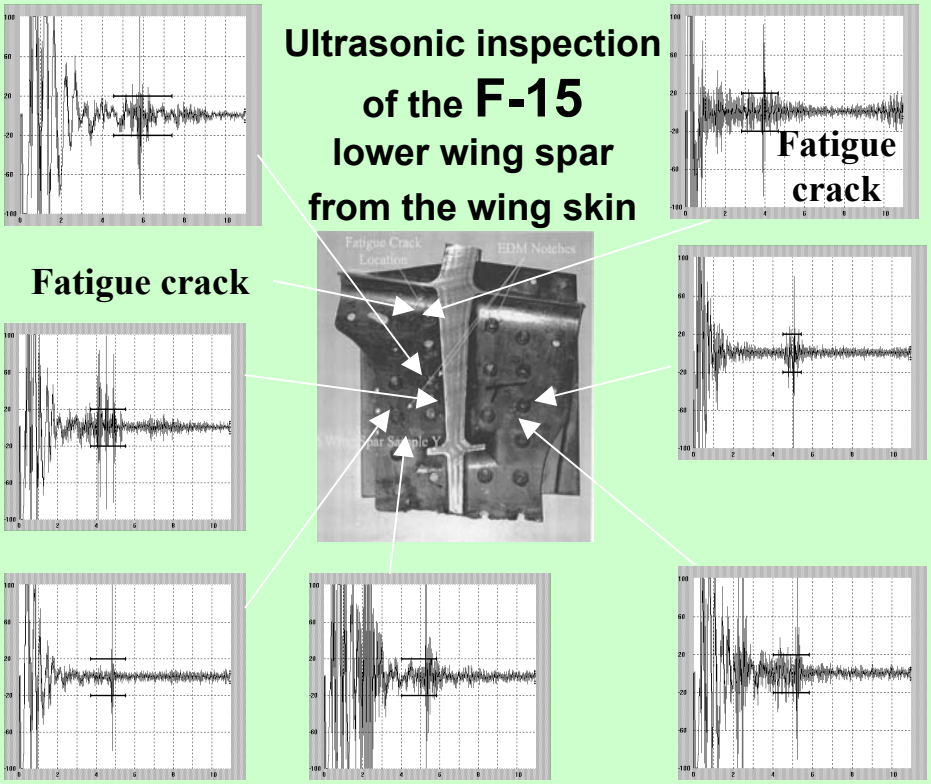
C-141: Ultrasonic inspection of the fastener holes in the spanwise splice joints (inspection performed by SAIC/UII)



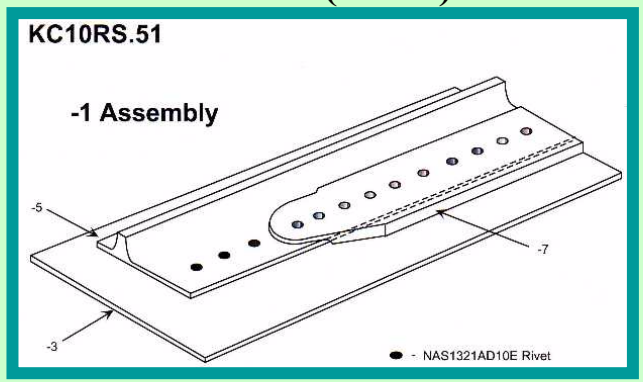
Eddy current inspection - **9,000 man-hours**

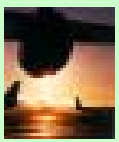
Ultrasonic inspection - **400 man-hours** (SAIC)

Ultrasonic inspection of the **F-15** lower wing spar from the wing skin



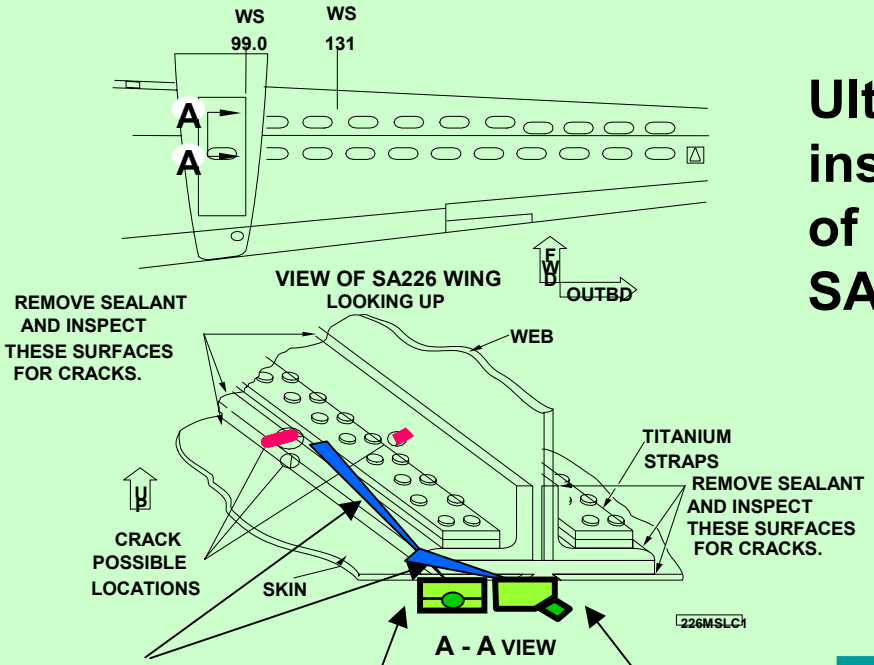
Ultrasonic A-scans from the fatigue crack and EDM notches





Ultrasonic inspection of the KC-10 lower-wing/fuel-cell structure

Applications of the new inspection technology

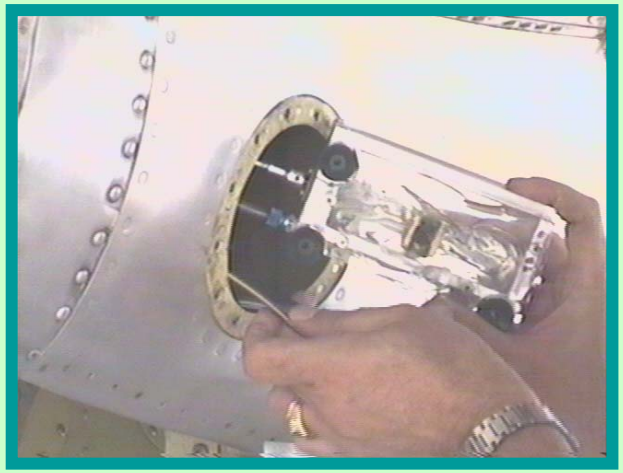


Directions of ultrasonic beams

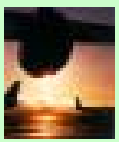
Transducer for crack detection

Transducer for sealant monitoring

Ultrasonic inspection of Fairchild SA226/227

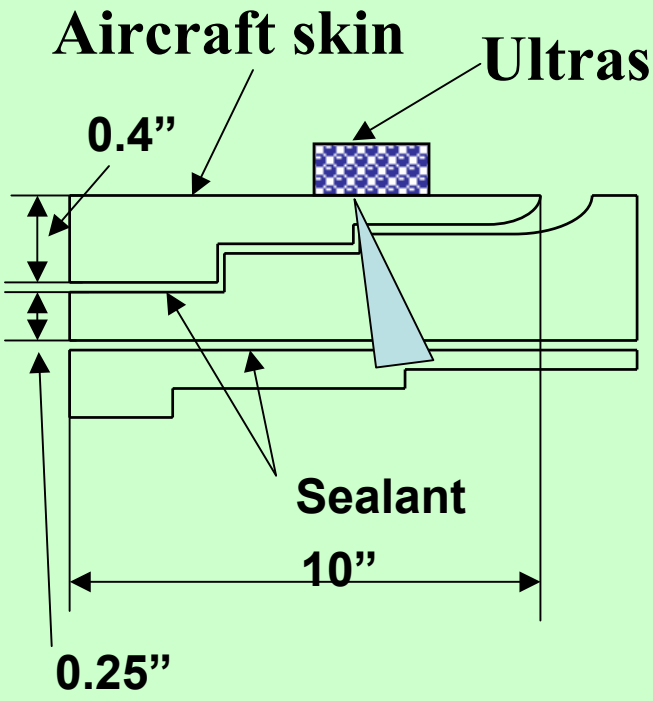


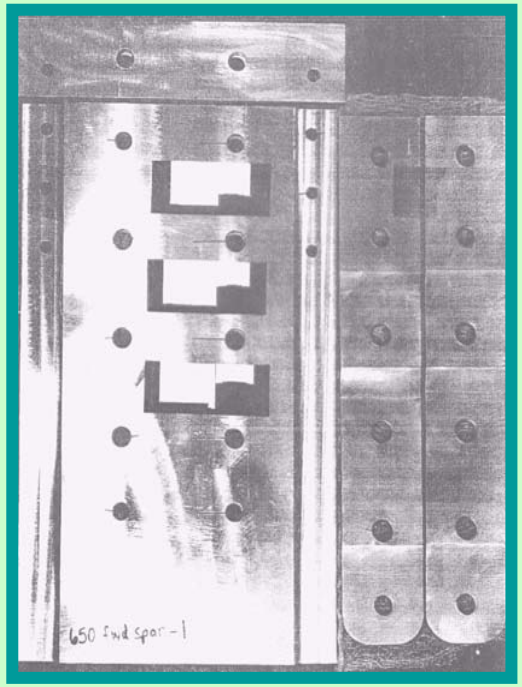
Field tests at Superior Aviation, Iron Mountain, MI



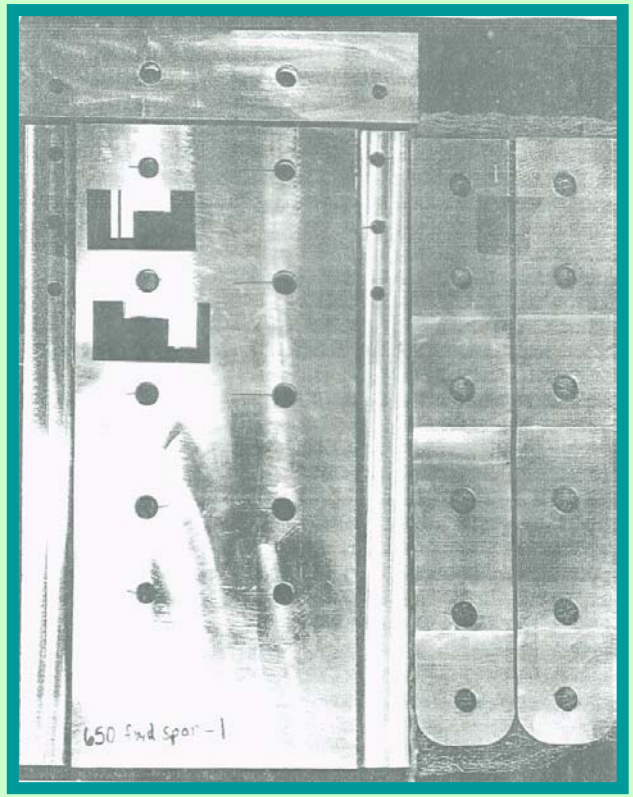
Applications of the new inspection technology

Cessna Citation 7 wing structure

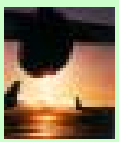




Unassembled Citation 7 wing structure with B-scan images of the fastener holes with long cracks in the second layer. Inspection has been conducted from the top layer (wing skin).

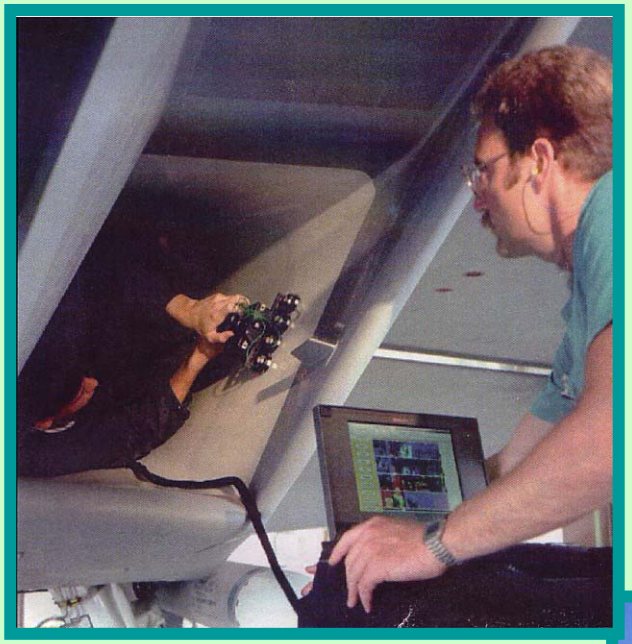


Unassembled Citation 7 wing structure with B-scan images of the fastener holes with short cracks in the second layer. Inspection has been conducted from the top layer (wing skin).

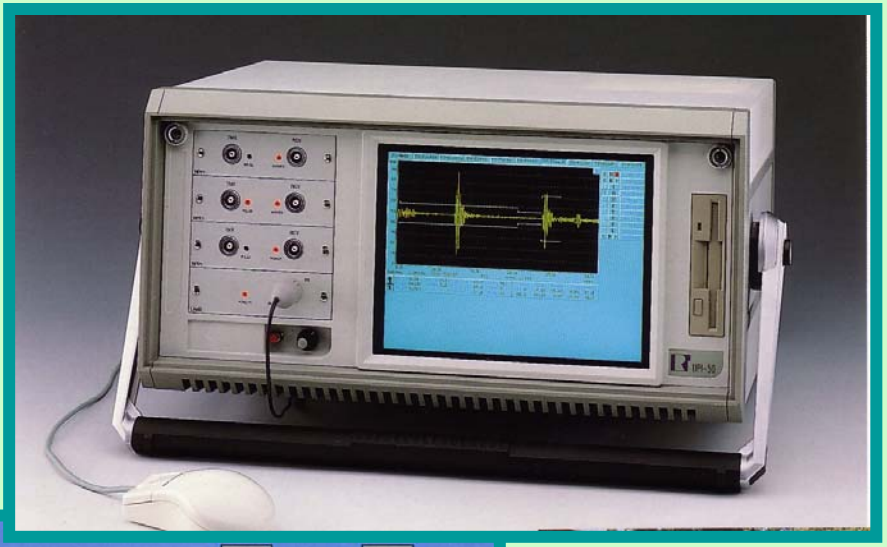


Applications of the new inspection technology

Commercial inspection systems

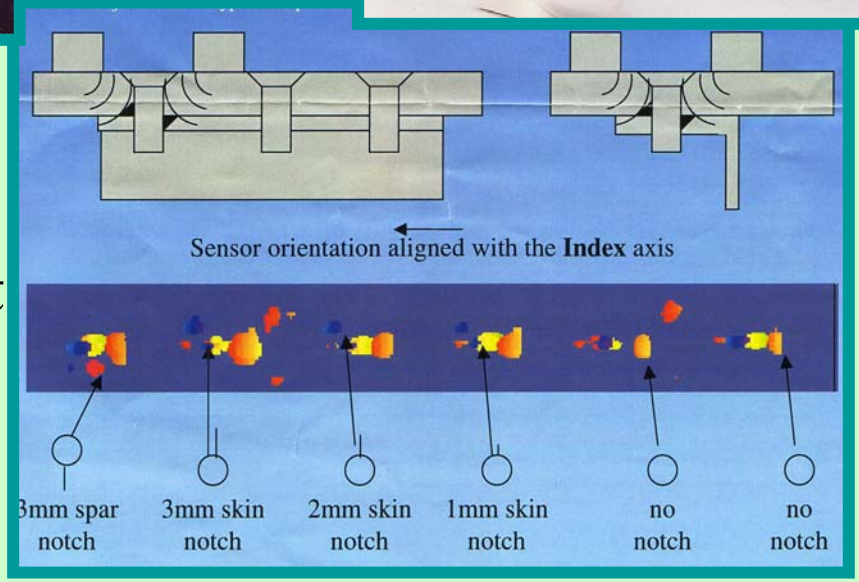


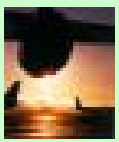
MAUS IV
Boeing



ScanMaster
IRT

Ultrasonic imaging of the second layer cracks with concurrent sealant monitoring





What is next?

Boeing 747 NDT

Rear Spar Upper Chord	SID 57-10-09
Rear Spar Lower Chord Horizontal Flange	SID 57-10-08
Front Spar Lower Chord Horizontal Flange	SID 57-10-17
Front Spar Upper Chord Horizontal Flange	SID 57-10-20
Center Section Midspar Lower Chord	SID 57-10-21
Wing Midspar Lower Chord – WS 586.0 to WS 862.0	SID 57-10-23
Wing Midspar Lower chord Inboard Nacelle	SID 57-10-24
Wing Center section Lover Skin Splice Stringers S-5C and S-15C	SID 57-10-26
Wing Upper Midspar Chord	SID 57-10-27
Wing Center Section Upper Aft Skin at BBL 0.00	SID 57-10-28
Wing Rib Upper Chord Horizontal Flange at Side-of-Body Splice	SID 57-10-29
Inboard Nacelle and stringers S-5 and S-15	SID 57-10-32
Internal Splice Plate	SID 57-10-33
Mid-spar splice	SID 57-10-34

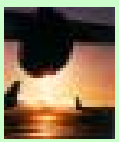
Boeing 757 NDT

Rear Spar Lower Chord	SID 57-10-01
Lower Chord	SID 57-10-02
Lower Splice Stringer	SID 57-23-01

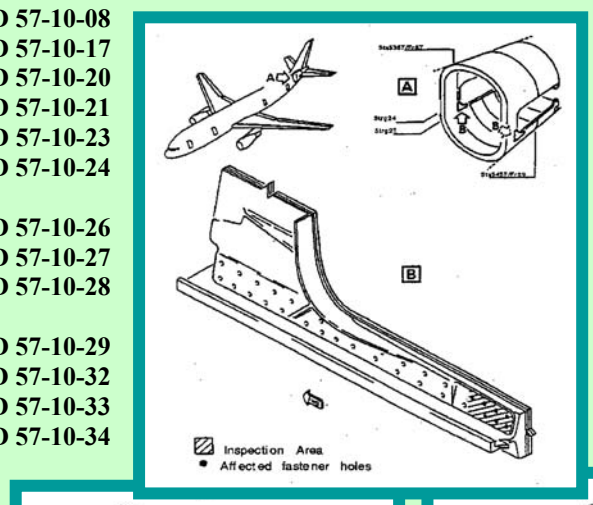
Boeing 767 NDT

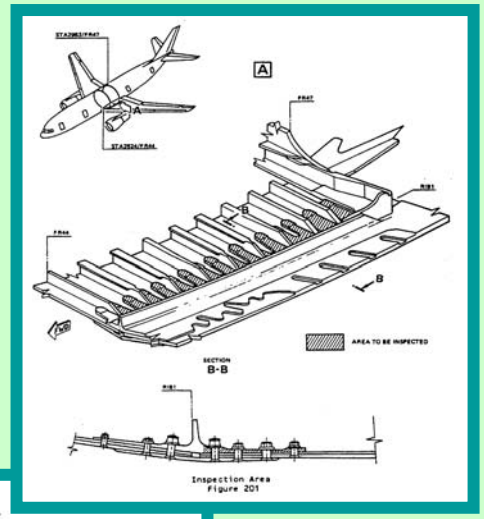
Stringers at WS 694.2 to WS 344.3	SID 57-20-01
Splice Stringer at WS 694.2 to WS 344.3	SID 57-20-02
Wing-Lower Chord	SID 57-20-03
Rear Spar Lower Chord	SID 57-20-04

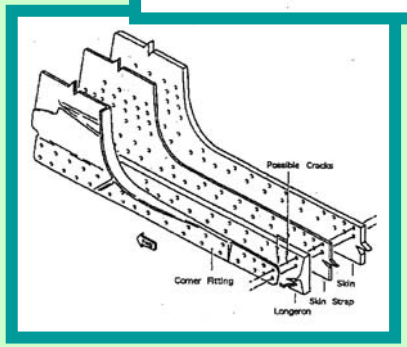
Boeing 777 NDT

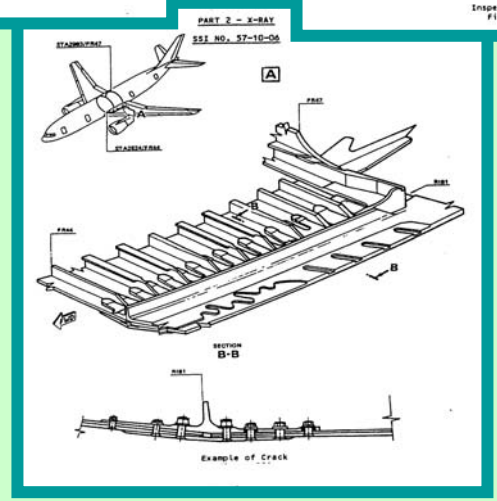


Side of Body Joint SID ???







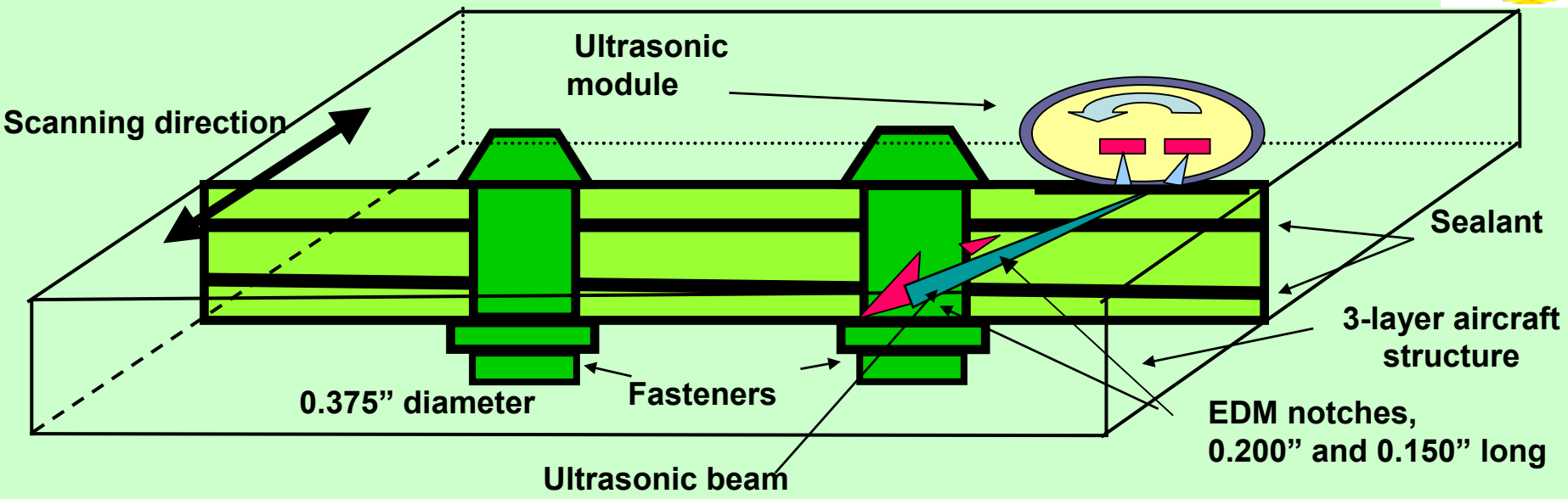


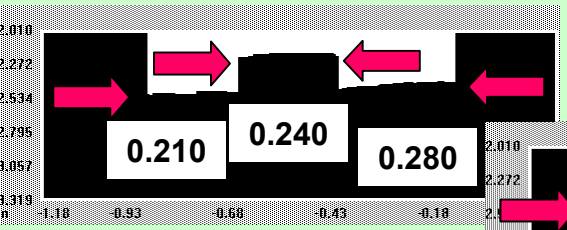
American Airlines

FedEx

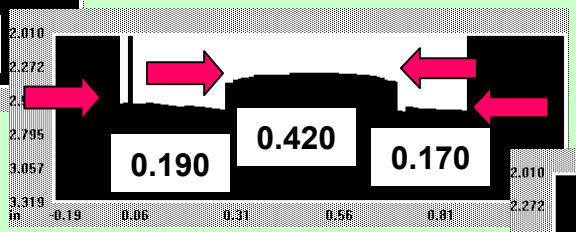
Airbus 300-600

What is next?

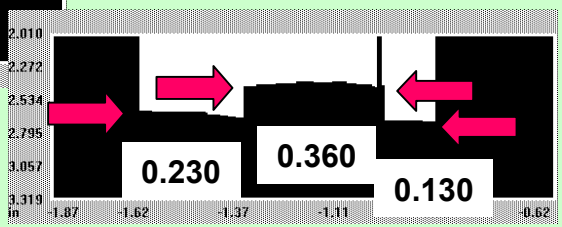




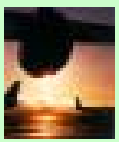
Conventional one signal technique



Dual- signal technique



Ultrasonic crack sizing using dry-coupled transducer modules



Any more challenges?