



JAL Experience - 787 1st D-Check and NDI use cases

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JAL PROPRIETARY |

Table of Contents

- JAL group fleet outline
- “0-0-100” the ultimate goal of JAL E&M
- Experience of 1st 787 D-Check at NRT
- Field experience of NDI use
- Challenges with NDI solution for proactive/preventive measures

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JAL Group/Partners Fleet Outline



JAL	J-AIR	JTA	JAC	RAC	HAC	ZIPAIR Tokyo	Jet	SPRING JAPAN	AMX
									
									

(): Total of - own/operate by JAL or subsidiary, and maintenance coverage of group/partners' fleet

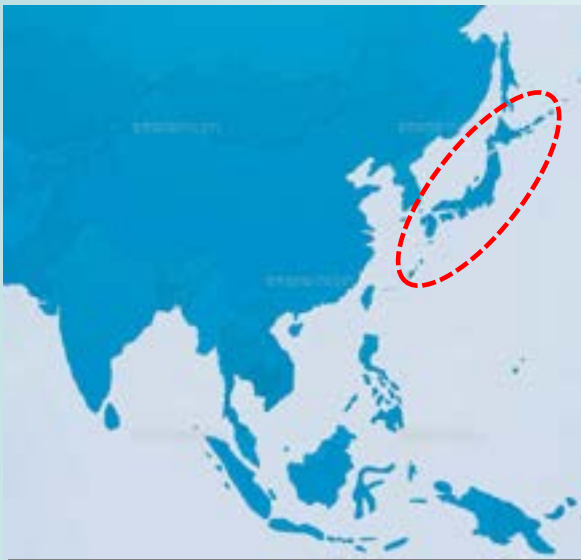
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"0-0-100" the Ultimate Goal of JAL E&M



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Small Country



High Dense & Busy



Higher Expectation



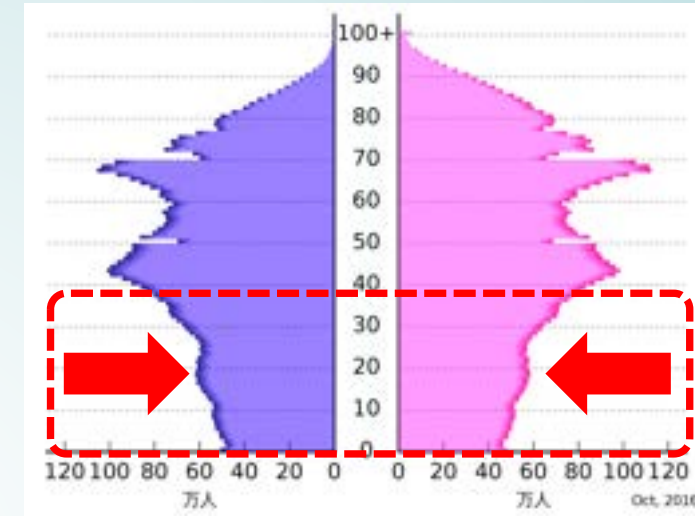
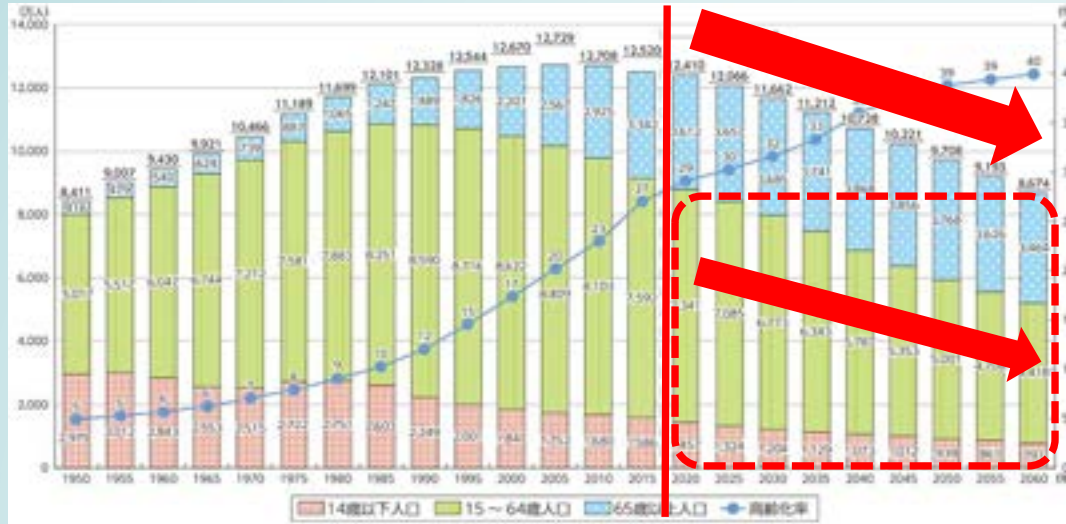
Competition

- One Time Operation
- Safety and Piece of Mind (Flight/Residential)
- Services/Comfort
- Pricing
- More...



Public Sensitivity

"0-0-100" the Ultimate Goal of JAL E&M



Labor Intensive

- To be less workforce
 - Still labor intensive
 - Still reactive actions/ measures
- ⇒ Need more proactive/ prognostic maintenance



Reactive

"0-0-100" the Ultimate Goal of JAL E&M

JAL's Unforgettable Two Turning Points

- 747 Accident (1985) 520 People Sacrificed ⇒ **ULTIMATE SAFETY**
- Bankruptcy (2010) Files for over \$25B ⇒ **PROFITABILITY**

Our Ultimate Target : **0-0-100 and Zero PDA***
0 (Flight Interruption) / 0 (Flight SQ) / 100 (Dispatchability)



Safety and Reliability



Piece of mind

Profitability



(*: Parts Departing from Airplane)

• Precautional/Predictive/Prognostic Maintenance

- ⇒ All maintenance action done before troubles happen
- ⇒ Passenger/crew won't experience/see any trouble



- Scheduled (Planned) Maintenance Only
- Reduce the burden (Man, Tool, Material, Part)
- No Stand-by Airplanes
- and more,,,

Expecting NDI/SHM evolution for Structures and Systems

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First 787 D-Check - Overview



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Fairing/Flaps Removed



Wing T/E and Fuel Cell



V/Fin
H/Stab



Flight Deck



Forward Cabin

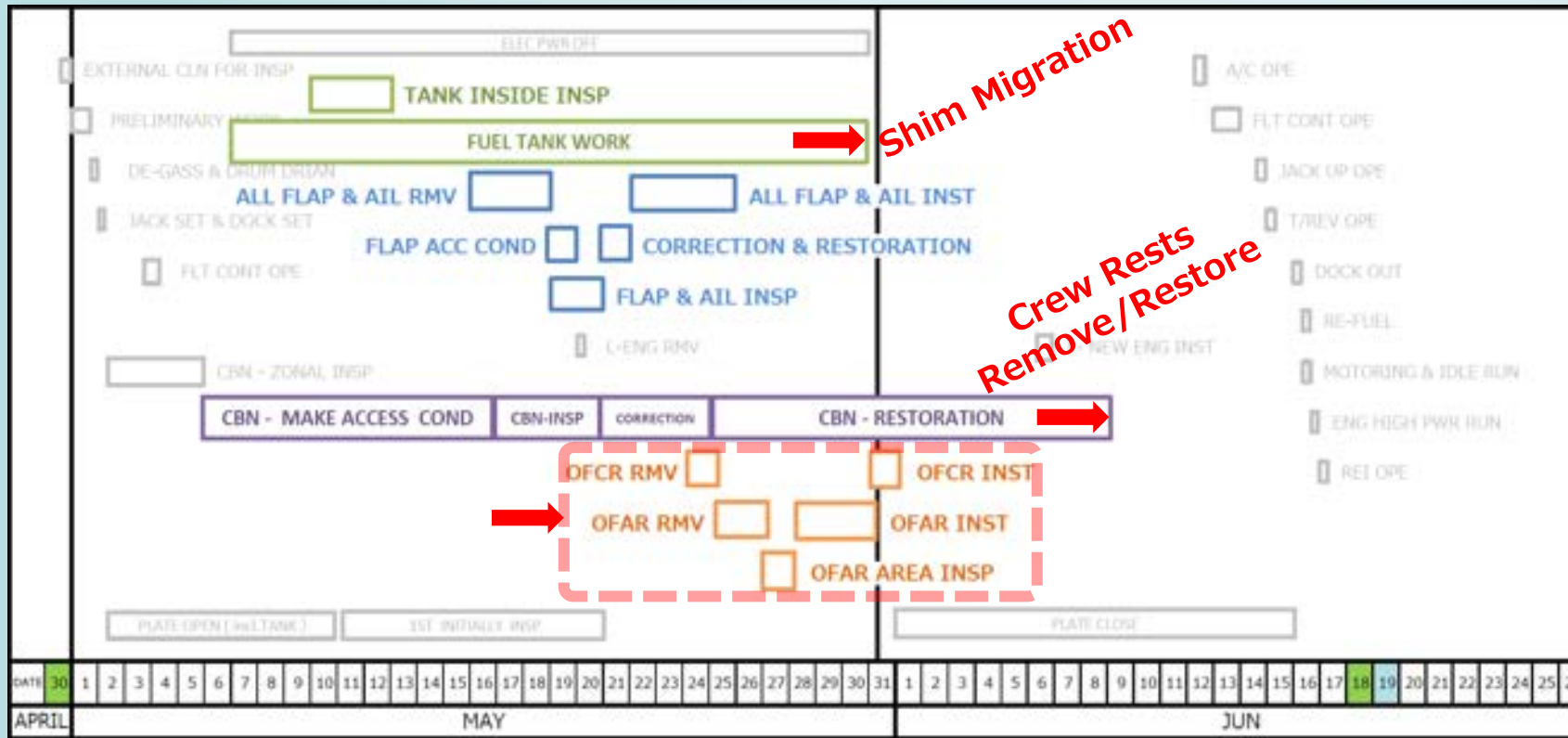


Aft Cabin
Crew Rest Removed



Forward Cargo

First 787 D-Check - Overview



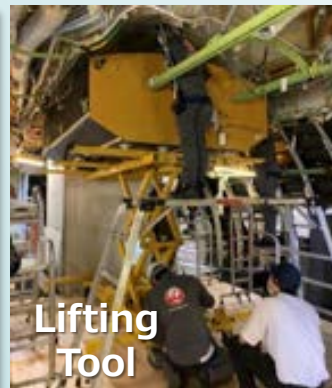
- ✓ **Site Location:**
JAL Maintenance Hanger at NRT
- ✓ **Actual Implemented Period:**
Total 50 Days (All completion within the planned shchedule)

Work Volume Breakdown

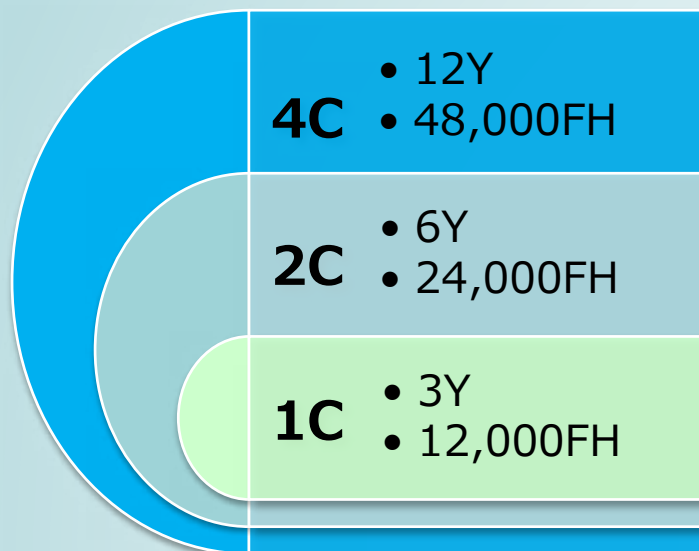
- Routine: 10,574 M/H
- Non-Routine: 7,706 M/H
- Modification: 3,307 M/H

Total: 21,317 M/H*

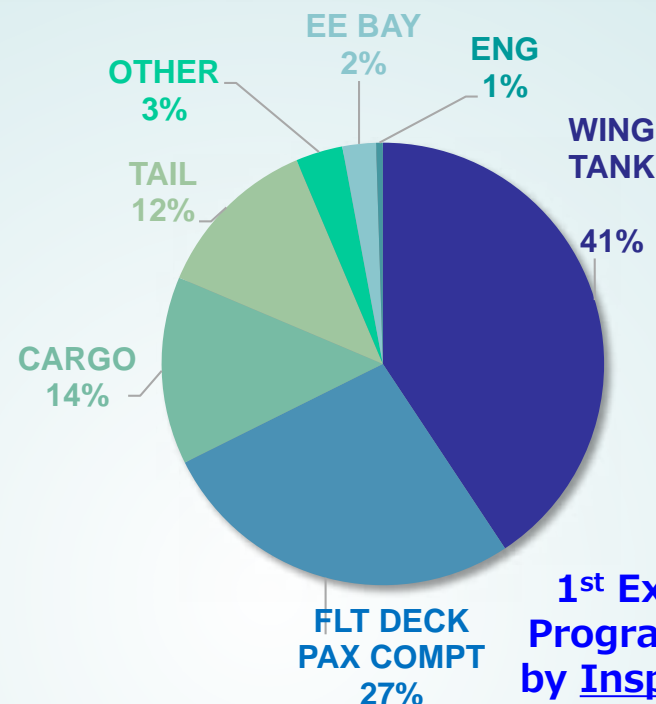
(*: Less than 777's D-Check
– JAL typically experienced)



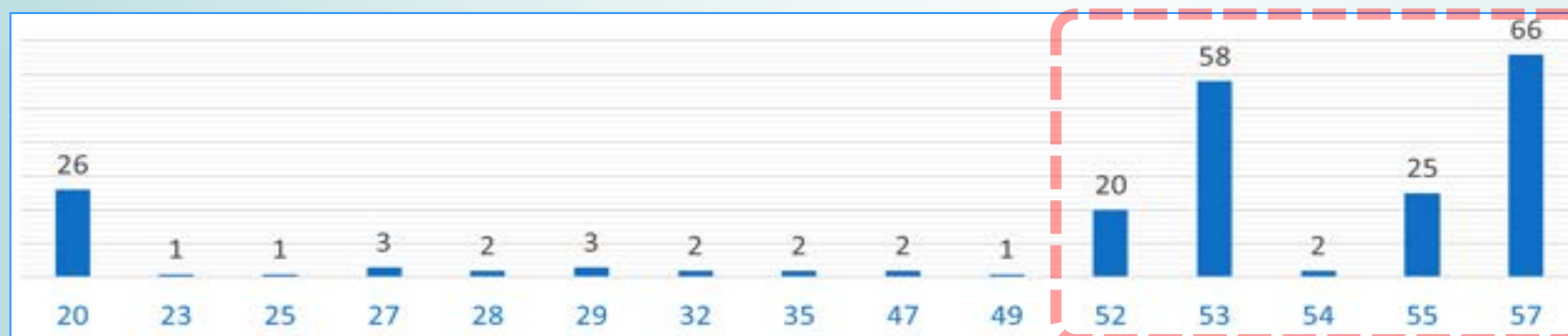
First 787 D-Check – Task Overview



D-Check = 4th C-Check



**1st Experienced
Programmed Task
by Inspection Area**

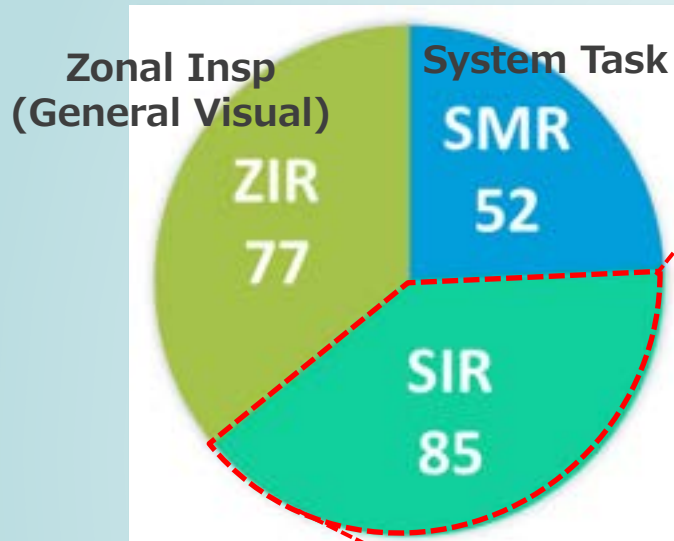


1st Experienced Programmed Task by ATA Chapter



First 787 D-Check – NDI Required Task Overview

NDI Required MPD Tasks



Programmed Task
by Category

SIR: Structural Insp. Requirement

60

tasks

Detailed Visual Insp.

25

tasks

Special Detailed Insp. (Incl. NDI)

24

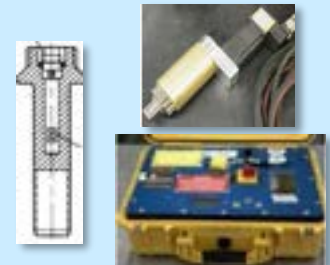
Borescope or Videoscope

Flap, Aileron, Wingtip, Stabilizer, Cargo, E/E Bay etc.

1

Re-torque with equipment

Vertical Stabilizer Mount Bolts
(Integrated sensor reading by XDCR)



- ✓ No NDI with equipment in the routine (MPD) inspection tasks
- ✓ Still utilizing NDI equipments for non-routine/mod items (see next page)

First 787 D-Check – NDI Required Task Overview

NDI Utilized in Non-Routine/Mod Items

669

items

Non-Routine Pick Ups
(incl. all ATA Ch)

36

NDI Required
items

76

items

Mod/Original Tasks
(Service Bulletin, Original
Inspection etc.)

3

NDI Required
items

57

NDI Operations

12

Bondtester



5

TTU



8

A scan



5

**Dry Film
Thickness**



7

**Roller
A scan**



4

**Open Hole
HFEC**



7

**Surface
HFEC**



3

**Guided
A scan**



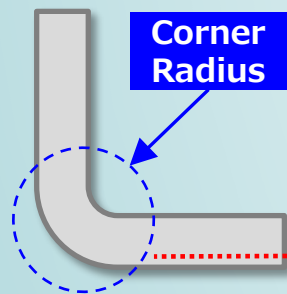
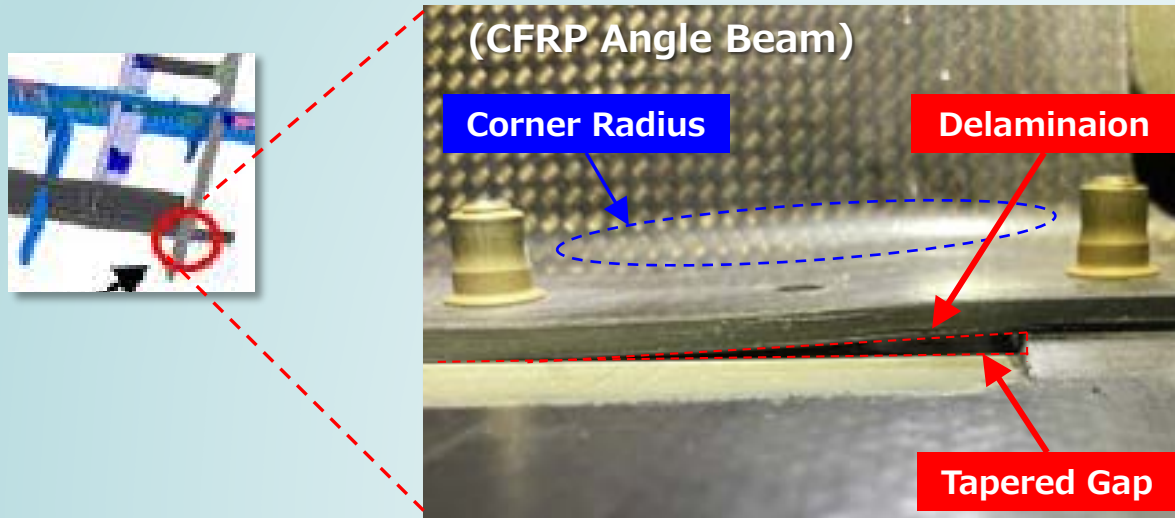
6

C-SCAN

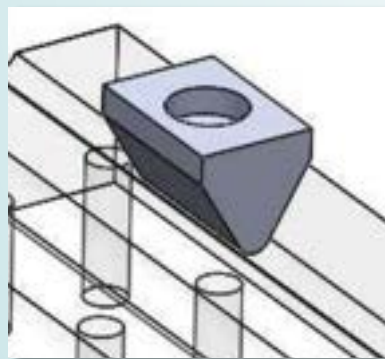


- ✓ Variety of NDI utilization incl. for CFRP primary structural element
- ✓ Less demand than legacies', but need equipment and qualified personnel readiness

Delamination at CFRP Angle Beam Flange



Needed to determine if the delam propagated into corner radius...



Probe Shoe and Reference Standard for corner radius



Transducer for delay lines

- **Finding:** Delamination at flange caused by a tapered gap
- **Challenges:** Needed to determine if delam propagated to corner radius to see if intensive cut & splice repair required, or minimized repair could be applicable.
⇒ Required the following equipment.
 - ✓ A scan instruments with TCG (Time-Compensated Gain)
 - ✓ XDCR for quick swap delay line (was not available)
 - ✓ Probe shoe for corner radius (was not available)
 - ✓ Specific reference standard (was not available)
- **Solutions:**
 - ✓ XDCR : Utilized alternate size
 - ✓ Probe shoe & Ref STD : Locally fabricated
- **Result:**
Confirmed the delam not extended to corner radius
⇒ Repaired with reinforce angle
(Avoided the cut & splice repair !!!)

NDI support operator/MRO for eliminating the concern/minimizing the impact

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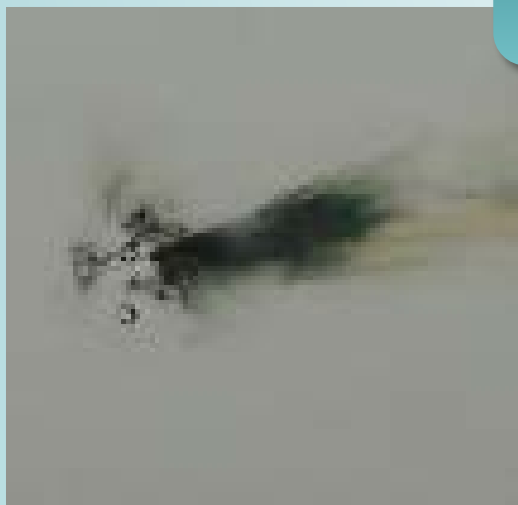
Troublesome - Inspection and Repair for Lightning Strike



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Which is serious ? Which is not ?
⇒ NDI is the key for determination...



Troublesome - Inspection and Repair for Lightning Strike

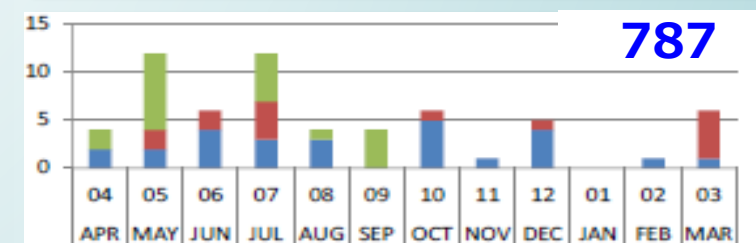
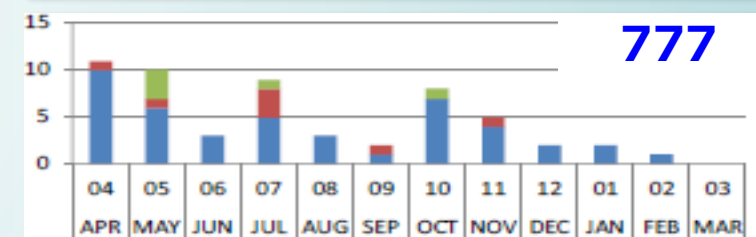
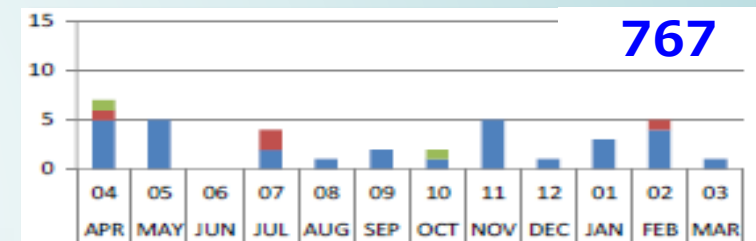
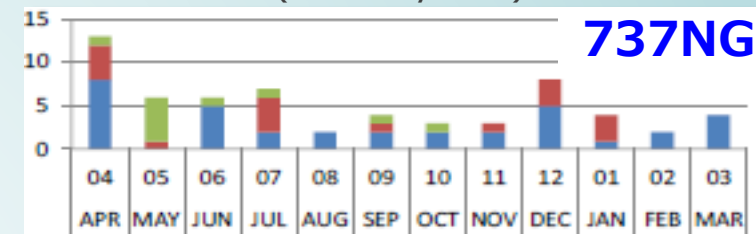


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- ✓ One of the most severe lightning area in the world
- ✓ Significant intensity lightning in the winter season
- ✓ Likelihood of lightning hit on 787 is similar with legacies'

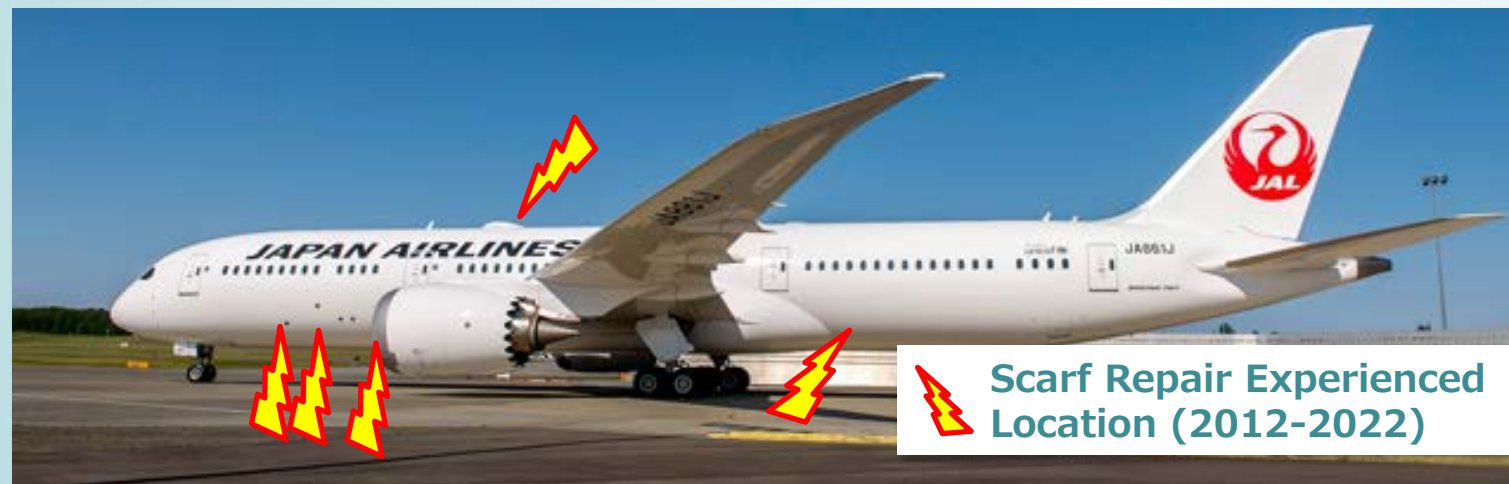
Lightning Hit count by model
(Last 3 years)



Troublesome - Inspection and Repair for Lightning Strike



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Scarf repair is always the impact for AOG period and resource constraint...

Troublesome - Inspection and Repair for Lightning Strike

AOG Duration Breakdown [HR] & Comparison (Based on JAL's experience)		
(Repair Type)	<u>Metallic Doubler Repair</u>	<u>Composite Scarf Repair</u>
Damage Removal/Smooth Out	2.0	4.0
NDI (Method)	1.0	72.0
	(e.g. HFEC)	(RDC, A-Scan, C-Scan etc.)
Initial Evaluation/Judgement	0.5	0.5
Assessment/Analysis by OEM (In-case beyond SRM limit)	6.0	12.0
Engineering Order	2.0	4.0
Repair Execution (Breakdown of work)	120.0	288.0
	<ul style="list-style-type: none"> ✓ Repair parts fabrication ✓ Drill & installation 	<ul style="list-style-type: none"> ✓ Scarf Sanding ✓ Repair Ply Lay-up & Pre-cure (for both surrogate & repair patch) ✓ Moisture Removal Process ✓ Thermal Survey Process ✓ Repair Patch Final Curing Process ✓ Post cure NDI (incl. OEM review)
TOTAL	131.5 [HR]	380.5 [HR]

Significantly longer duration – NDI, each scarf process, and post cure review...

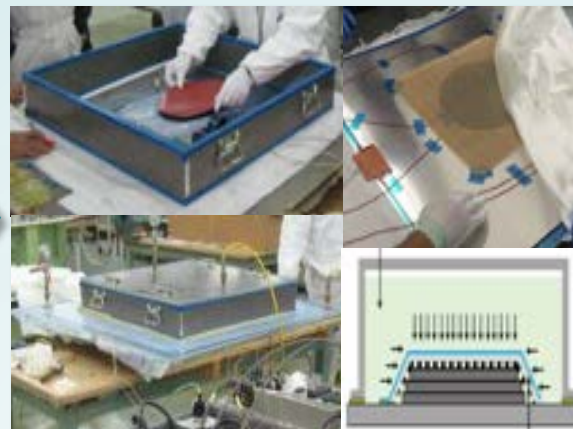
Troublesome - Inspection and Repair for Lightning Strike



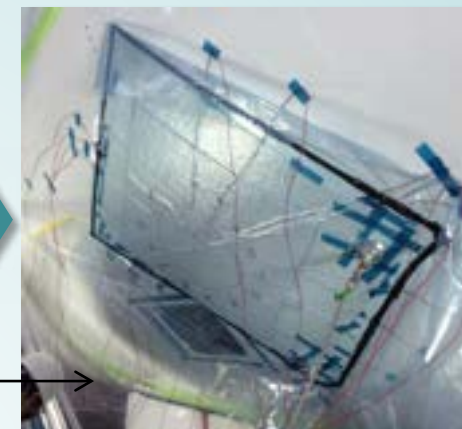
Scan



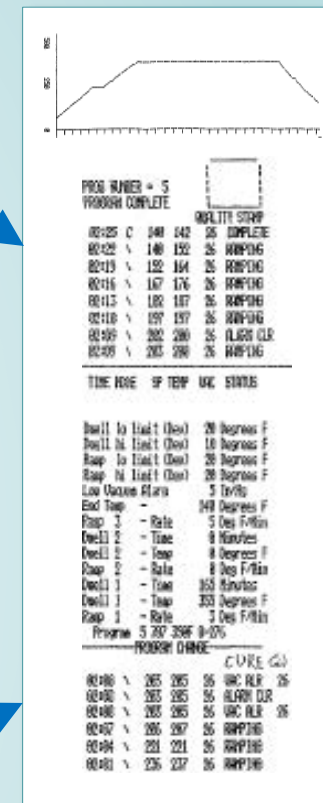
Scarf Sanding



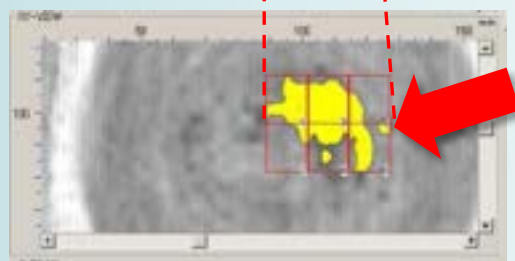
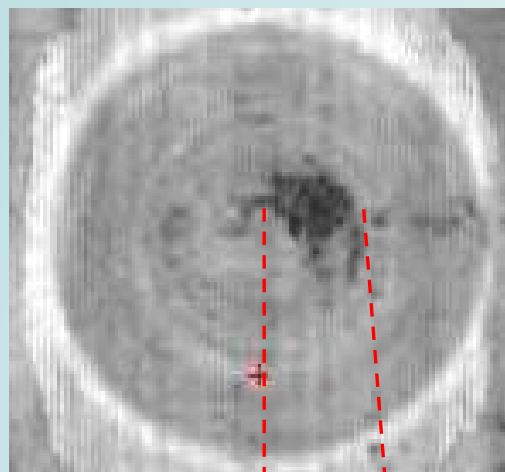
DVD Process
(Lay-Up & Pre-Cure)



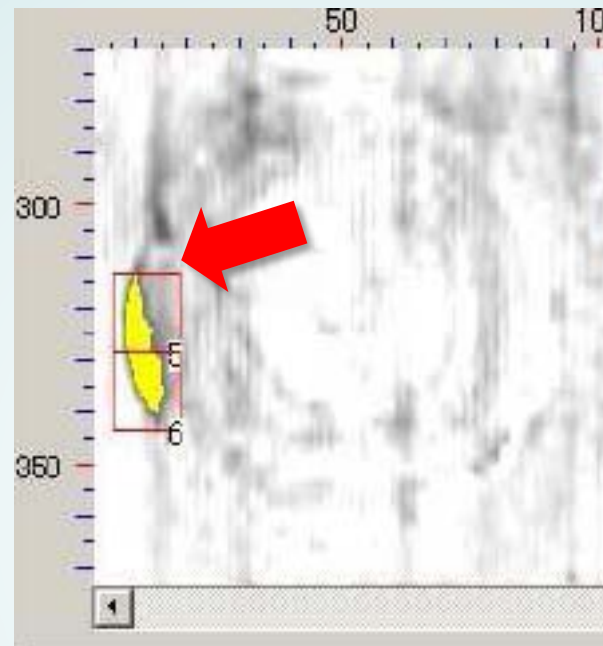
Thermal Survey
(wz Surrogate Patch)



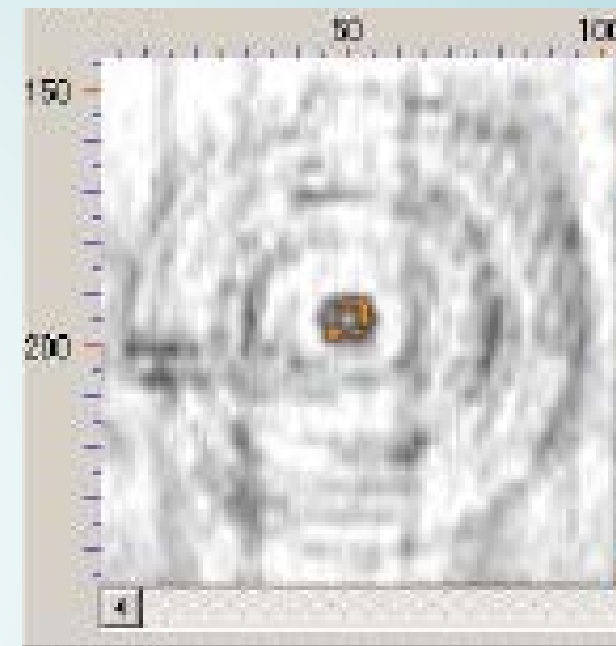
Troublesome - Inspection and Repair for Lightning Strike



VOID,,,



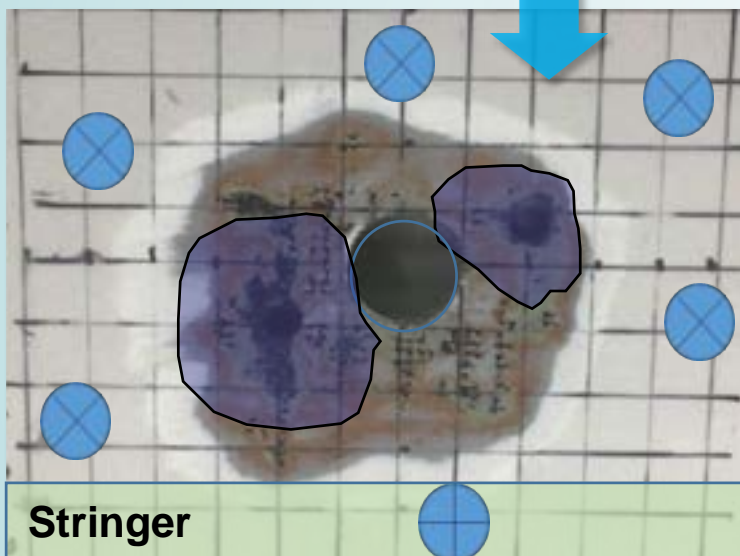
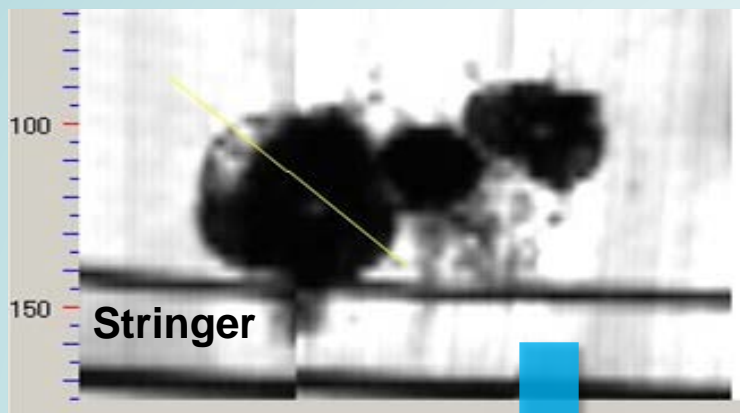
VOID,,,



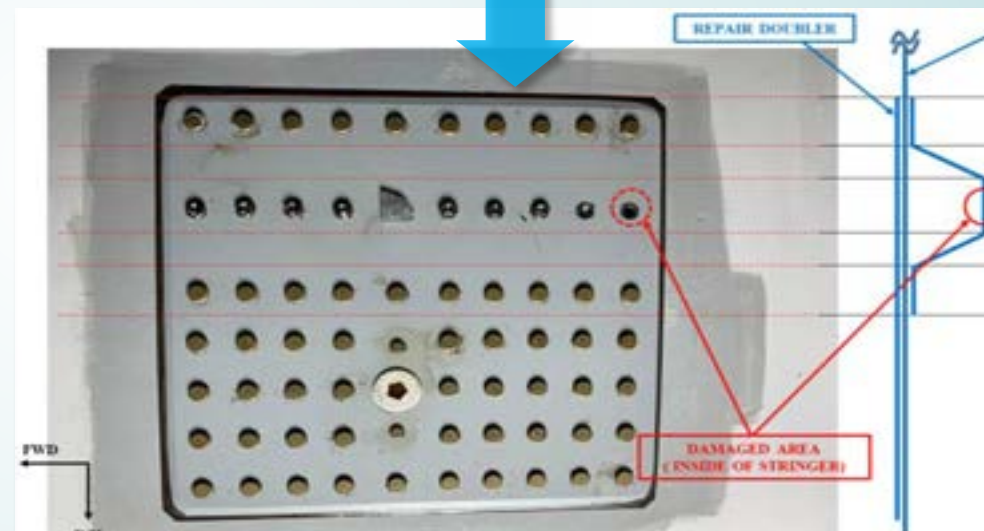
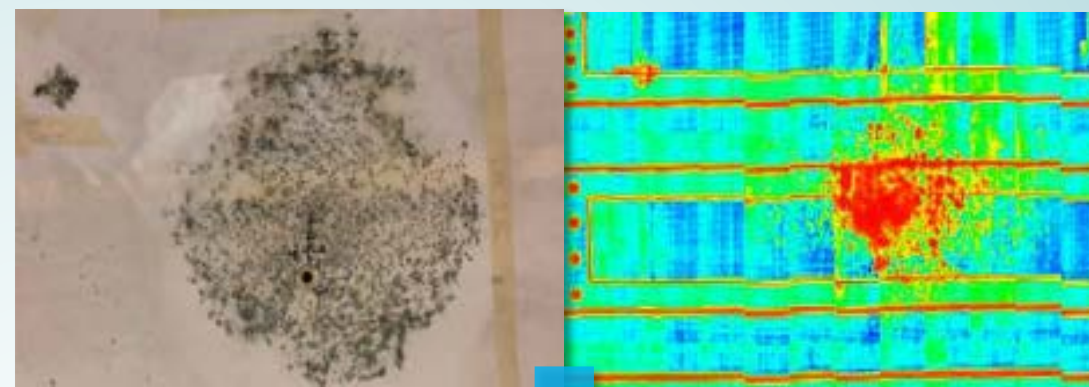
NO VOID!!
(wz acceptable porosity)

May need multiple round ⇒ Down time to be extended...
The more experienced, the more efficient and less errors

Troublesome - Inspection and Repair for Lightning Strike



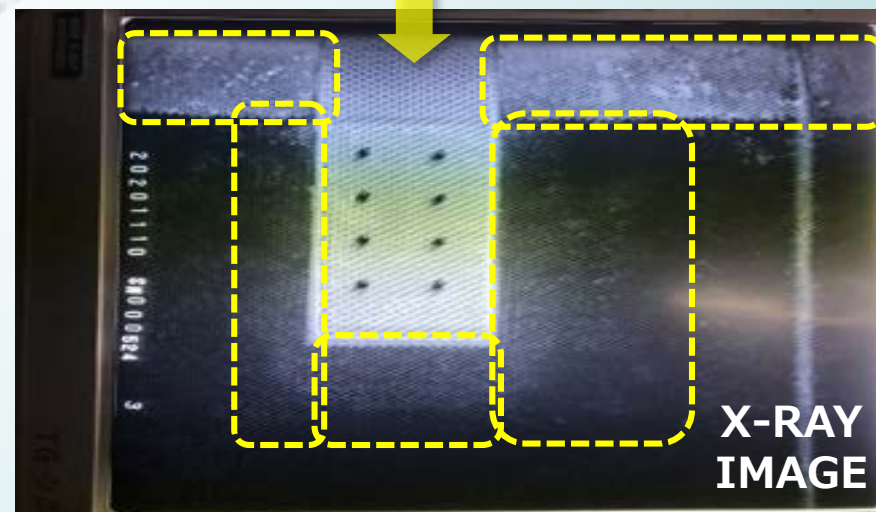
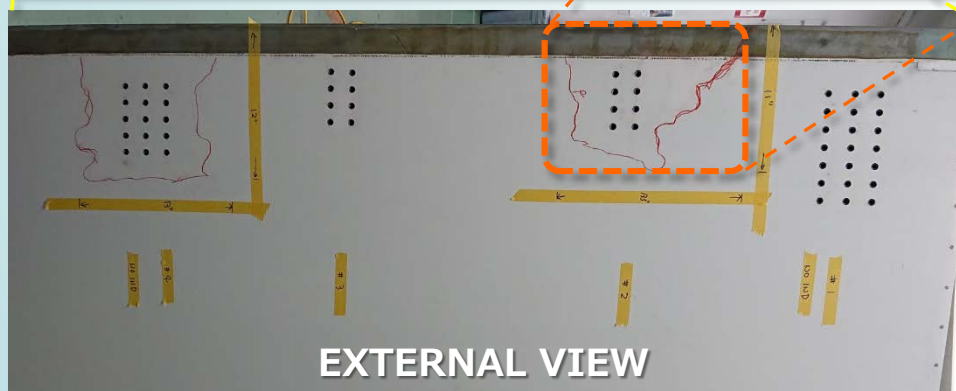
**Arresting Fastener Repair
(Restraining Delam Propagation)**



Metal Doubler Repair

NDI & analysis for easier repair solutions ⇒ reducing down time !!

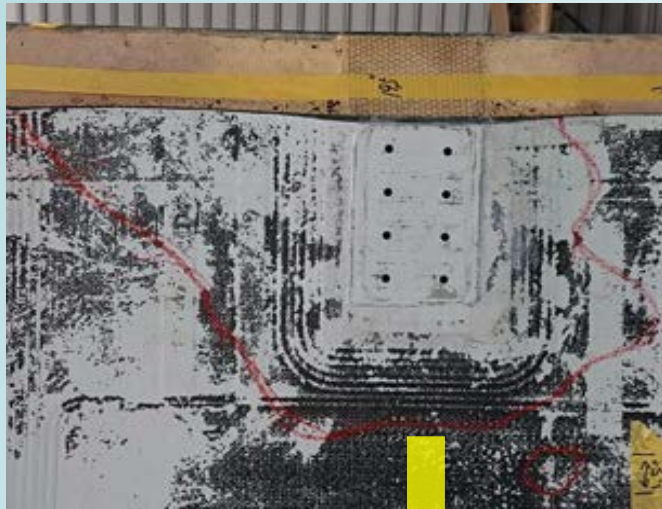
Moisture Ingress - Engine Cowling



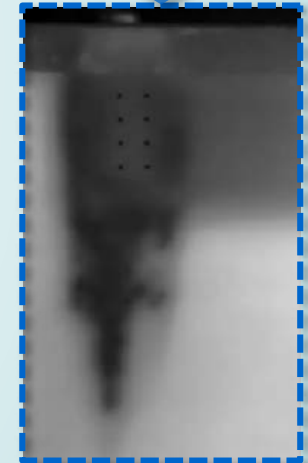
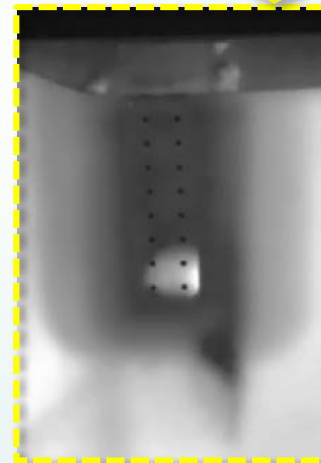
(MOISTURE INGRESS AT MILKY WHITE AREA)

Nature of H/C structure, freeze-thaw cycle could cause core damages

Moisture Ingress - Engine Cowling



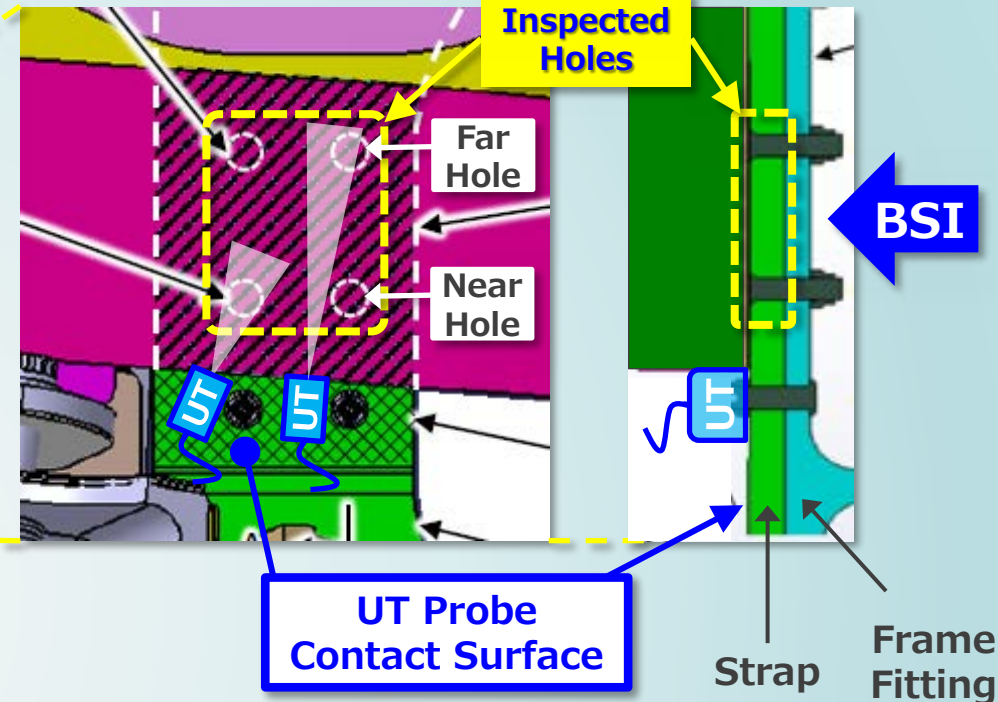
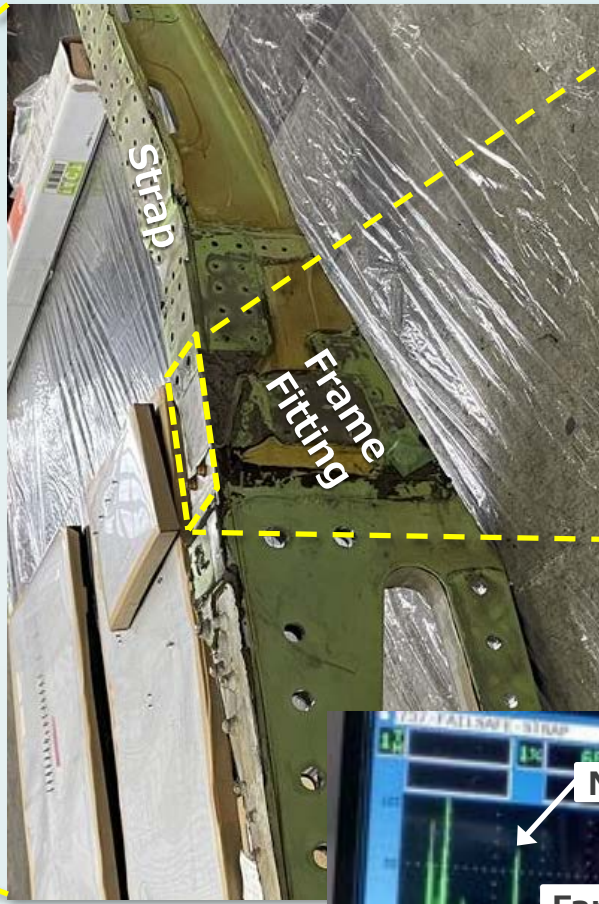
X-RAY IMAGE



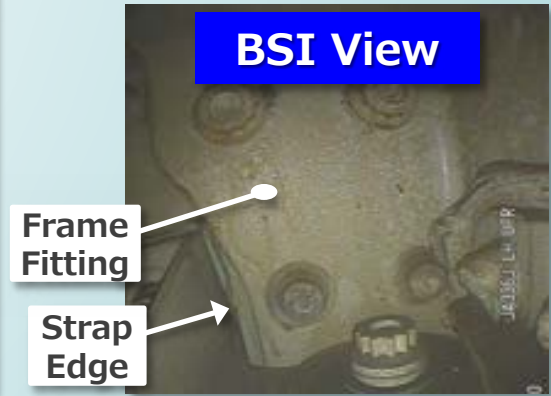
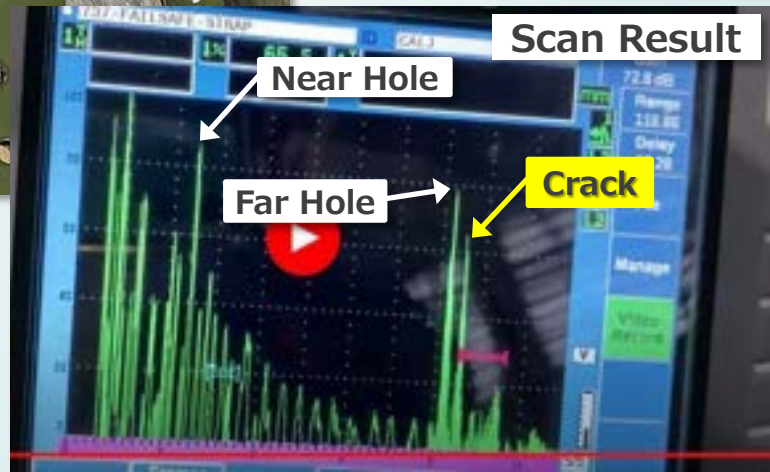
THERMOGRAPHY IMAGES

NDI support the determination/judgement for repairability

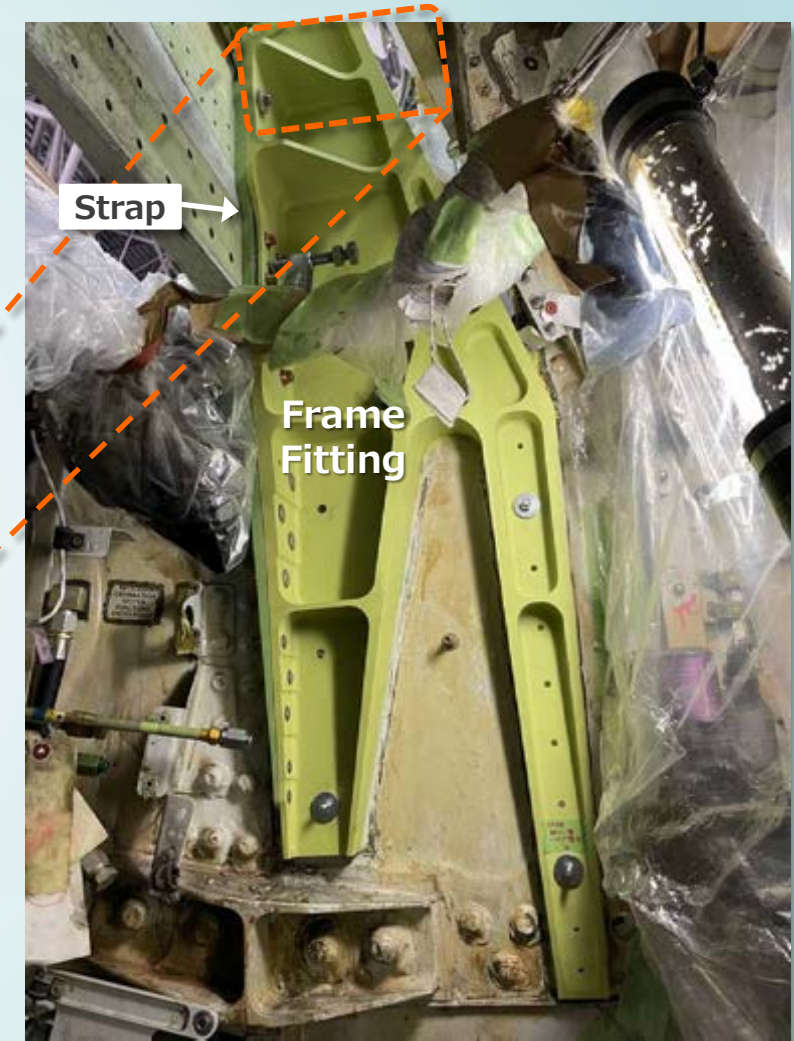
Fuselage Frame-Fitting UT Inspection



NDI enables earlier detection, and detecting the flaw at invisible area



Fuselage Frame-Fitting UT Inspection



NDI prevents the significant damage and maintain satisfied level of safety

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Challenges with NDI solution for proactive/preventive measures



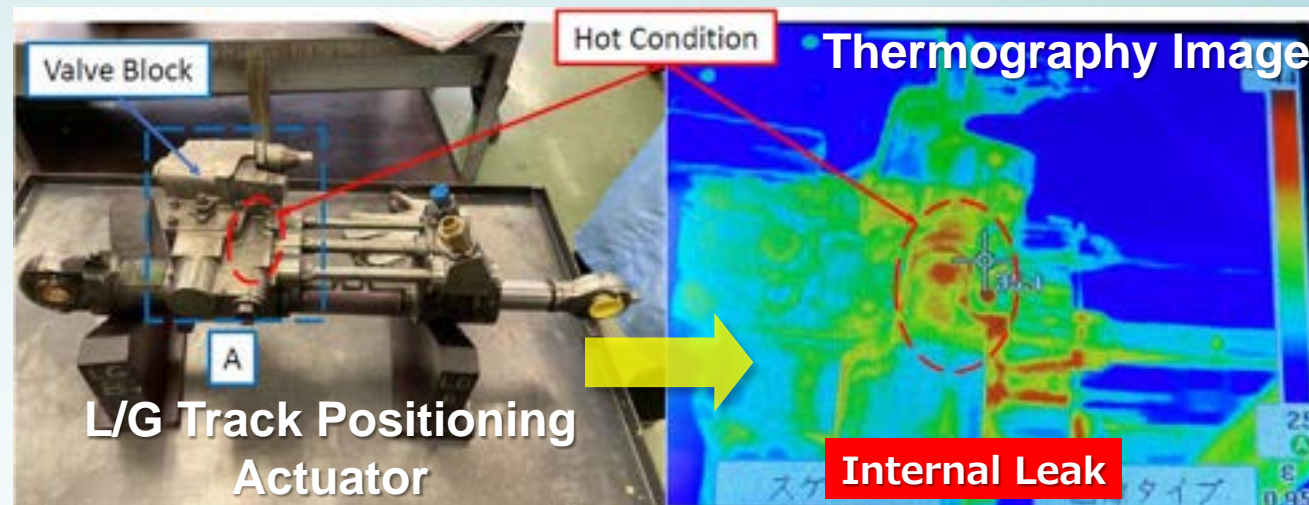
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Air Conditioning Bay



Ultrasonic Acoustic Imager



Valve Block

Hot Condition

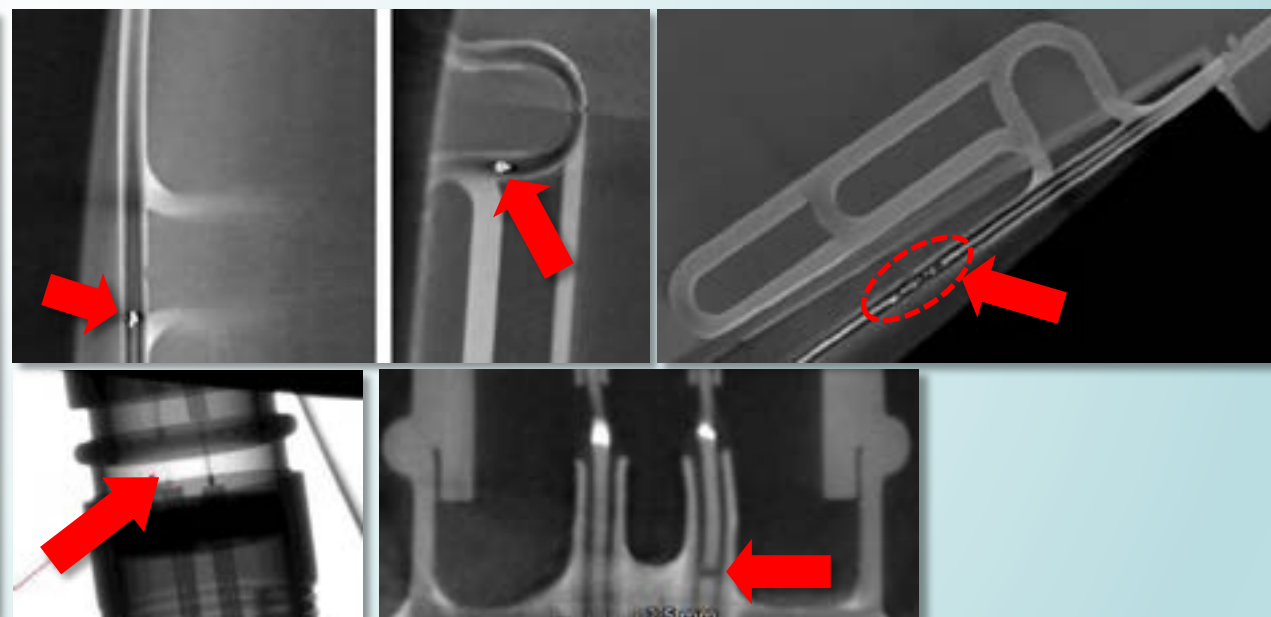
Thermography Image

L/G Track Positioning Actuator

Internal Leak



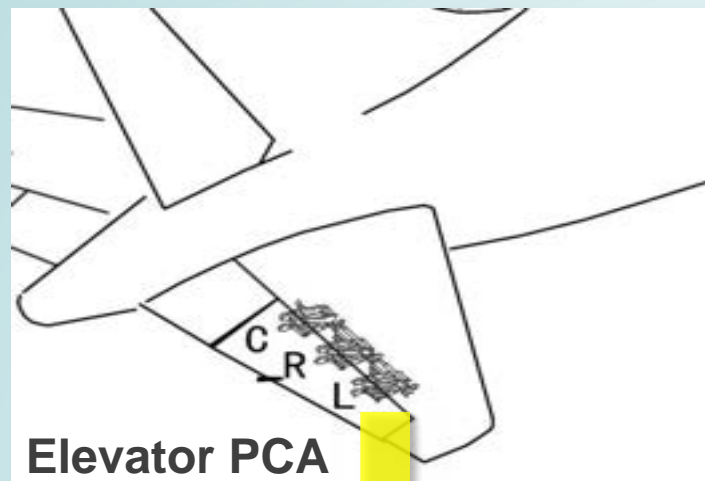
Pitot Tube



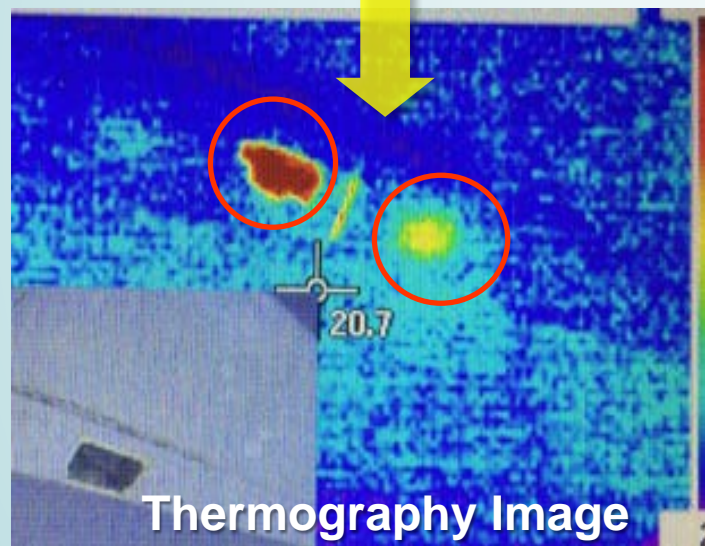
Challenges with NDI solution for proactive/preventive measures



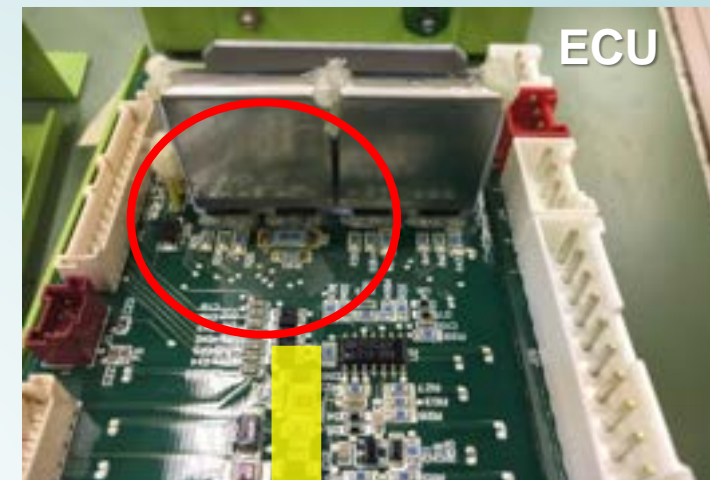
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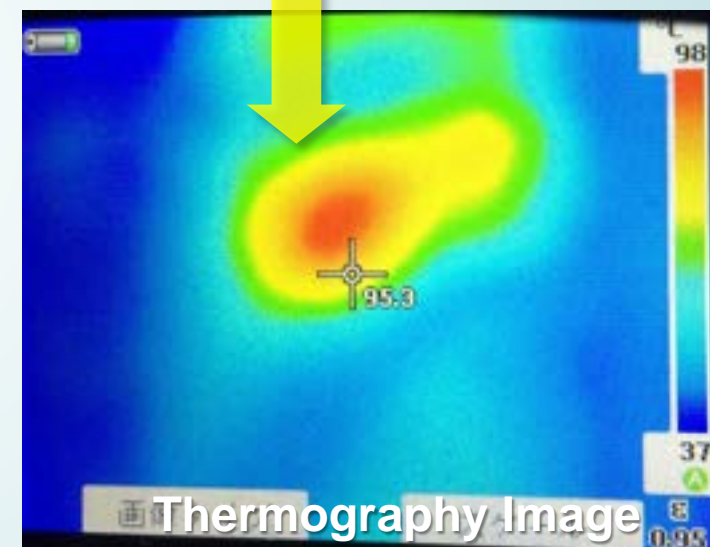
Elevator PCA



Thermography Image



ECU



Thermography Image

Utilizing NDI for system component investigation and solution development

- Appreciates – products, technologies, supports, solutions – make operator/MRO maintain airplane safety
- Challenges – down time, equipment/qualified resource readiness, and maintaining
- Expects – further evolution of NDI technologies, incl. SHM implementation – for more efficient/economic/reasonable operation, inspection and dispositions



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Thank you!! Arigato!!

