

Nondestructive Testing reference standards, Airline/MRO challenges

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- Overview of Delta Air Lines & Delta TechOps MRO
- Four broad categories of NDT Reference Standards
 1. Standards made from aerospace grade metallic stock / aerospace standard hardware
 2. Composite Standards (solid laminate, sandwich, or combination thereof)
 3. Standards made from aerospace articles e.g. fittings, engine components etc.
 - *4. Other Reference Standards e.g. Barkhausen Noise Inspection (BNI), Hardness Testing etc.
- Examples of NDT Calibration Reference Standards (CRS)
- Slido Questions for an audience perspective
- The importance of NDT reference standard technical data drawings to Conformity, Quality, Safety and Sustainment
- Challenges Delta has experienced
- Perspectives
- Opportunities and Motivation for Collaboration
- Summary



Aircraft Fleet Information

As of Jun 17, 2026

Fleet Summary

	AIRCRAFT	ACTIVE	FIRM ORDER	TOTAL
WIDEBODY	767-300ER-----	36	-	36
	767-400ER-----	21	-	21
	787-10-----	-	30	30
	A330-200-----	11	-	11
	A330-300-----	31	-	31
	A330-900-----	39	16	55
	A350-900-----	41	18	59
	A350-1000-----	-	20	20
	TOTAL	179	84	263
NARROWBODY	717-200-----	80	-	80
	737-800-----	77	-	77
	737-900ER-----	163	-	163
	737-10-----	-	100	100
	757-200-----	63	-	63
	757-300-----	16	-	16
	A220-100-----	44	-	44
	A220-300-----	41	59	100
	A319-100-----	57	-	57
	A320-200-----	44	-	44
	A321-200-----	127	-	127
	A321-200NX-----	97	91	188
	TOTAL	809	250	1,059

Delta operates a diverse fleet of aircraft powered by a variety of Engines



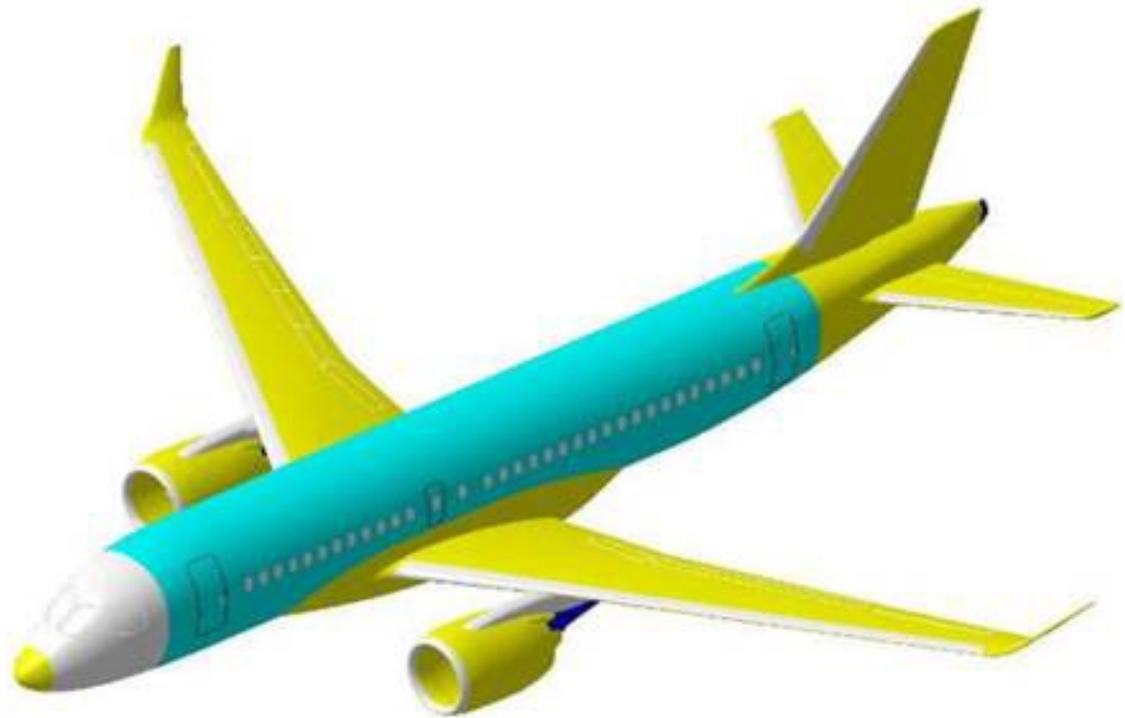
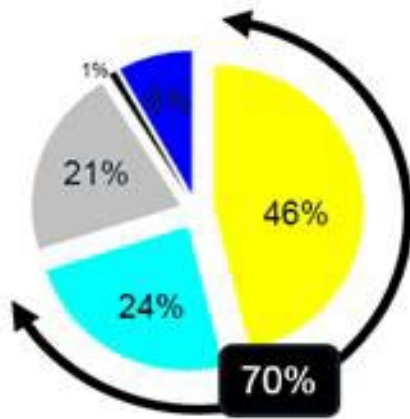
- Airbus

- A220 Pratt-Whitney Geared Turbofan (GTF) 1500 Powered
- A319 CFM56 Powered
- A320 CFM56 Powered
- A321's CFM56 Powered
- A321neo Pratt-Whitney Geared Turbofan (GTF) 1100 Powered
- A330's PW 4168, GE CF6-80E2, and Rolls-Royce Trent 7000 powered A330-900neo
- A350XWB, Rolls-Royce Trent XWB

- Boeing

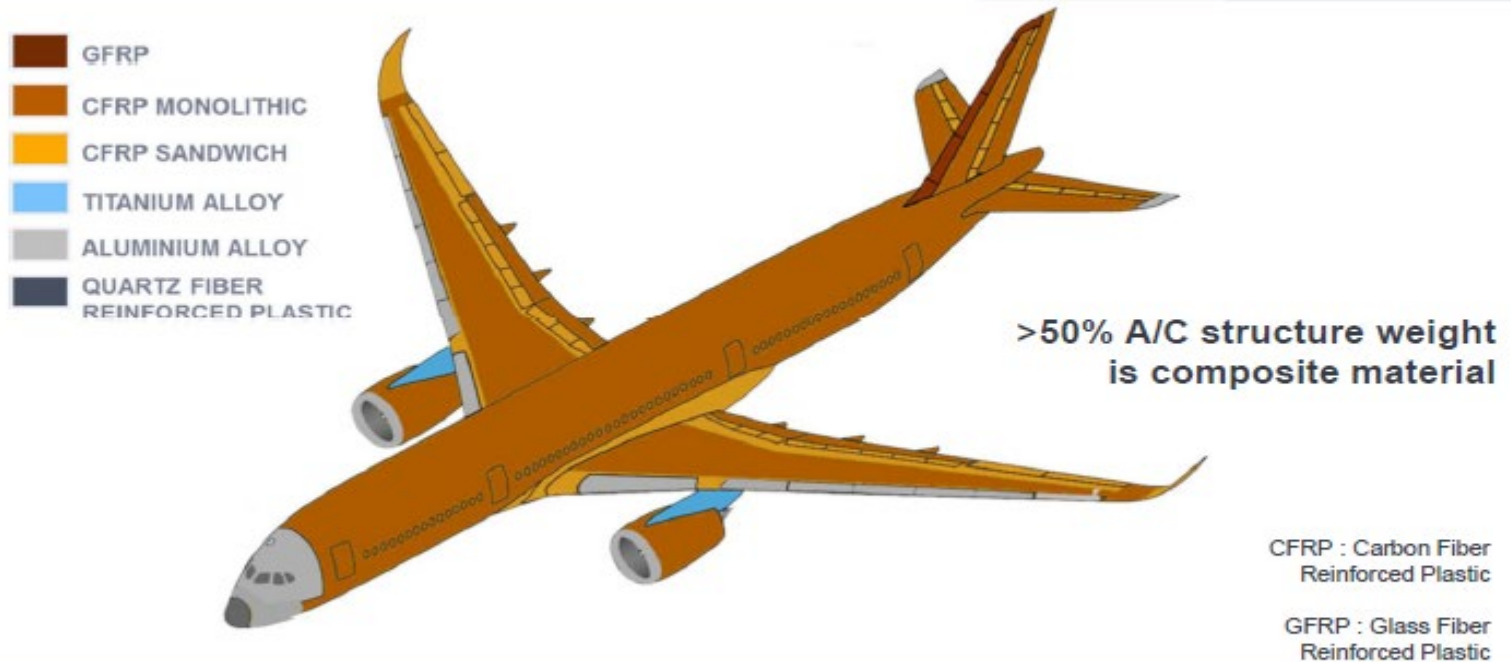
- B717 (MD95), BR715
 - B737, CFM56 (Boeing 737 MAX 10 LEAP powered)
 - B757, PW2000
 - B767, PW4000 & CF6
 - *B787-10, GE Aerospace GEnx
- 800+ Mainline aircraft under Delta's FAA Continuous Airworthiness Maintenance Program (CAMP) and Operations Specification. Fleet, Engine, and Component composition results in a large (~3,500) inventory of in-service NDT Reference Standards (Calibration Reference Standards, Calibration Blocks)

Airbus A220-100/300 (formerly Bombardier c-series)



A350XWB

A350XWB Composite Structure – Overview



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 AIRBUS

B787

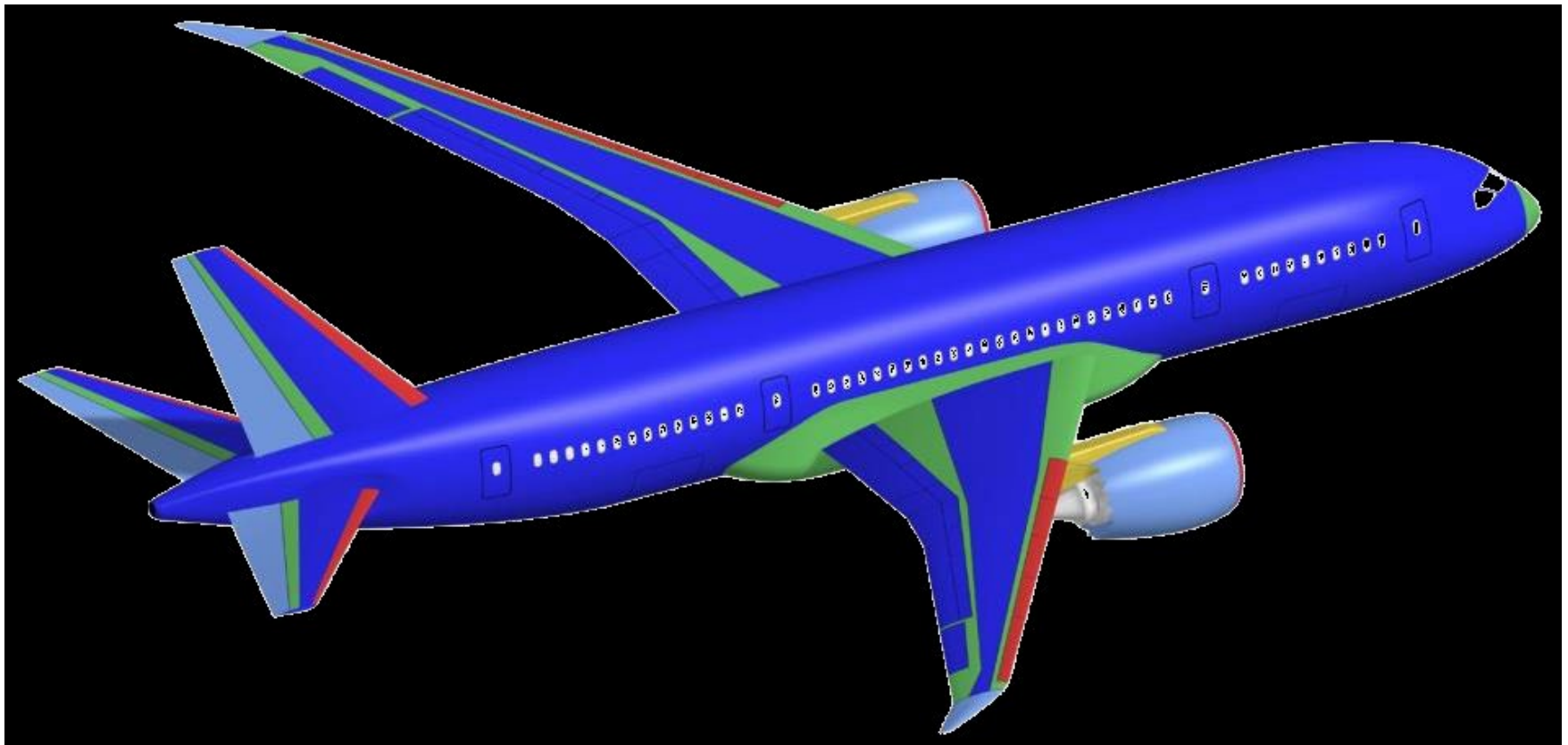
Dark Blue – Carbon Solid Laminate

Light Blue – Carbon Sandwich

Green – Fiberglass

Red – Aluminum

Yellow -Aluminum/steel/titanium pylons



Delta TechOps MRO Engine Lines

GE Aerospace

- CF34
- CFM56
- LEAP
- CF6

Pratt-Whitney

- PW Geared Turbo Fan (GTF)
- PW2000
- PW4000

Rolls-Royce

- BR715
- Trent 1000 Family (T1000, T7000, XWB & sub variants)

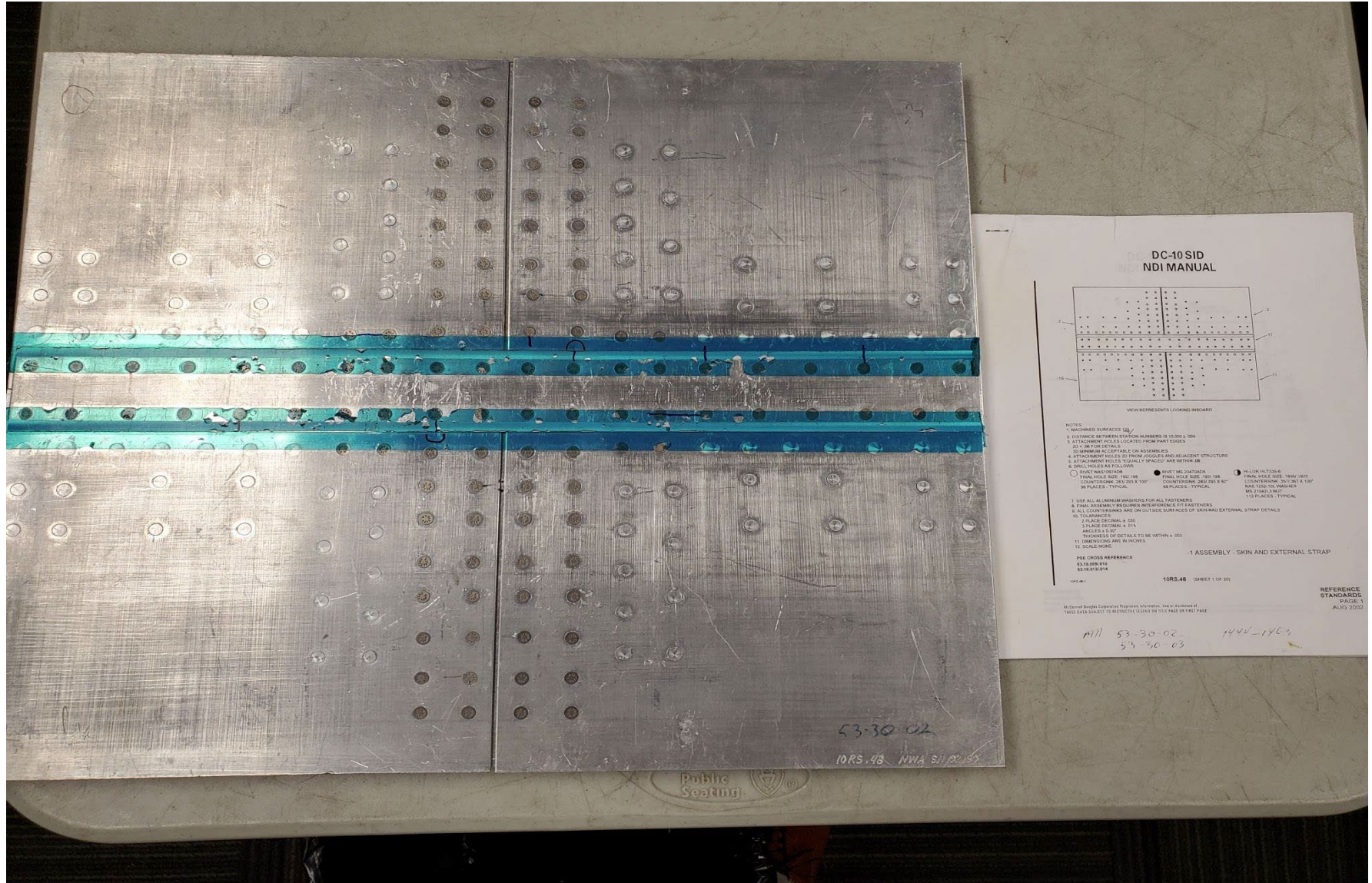
Airline/MRO Nondestructive Testing (NDT) scope



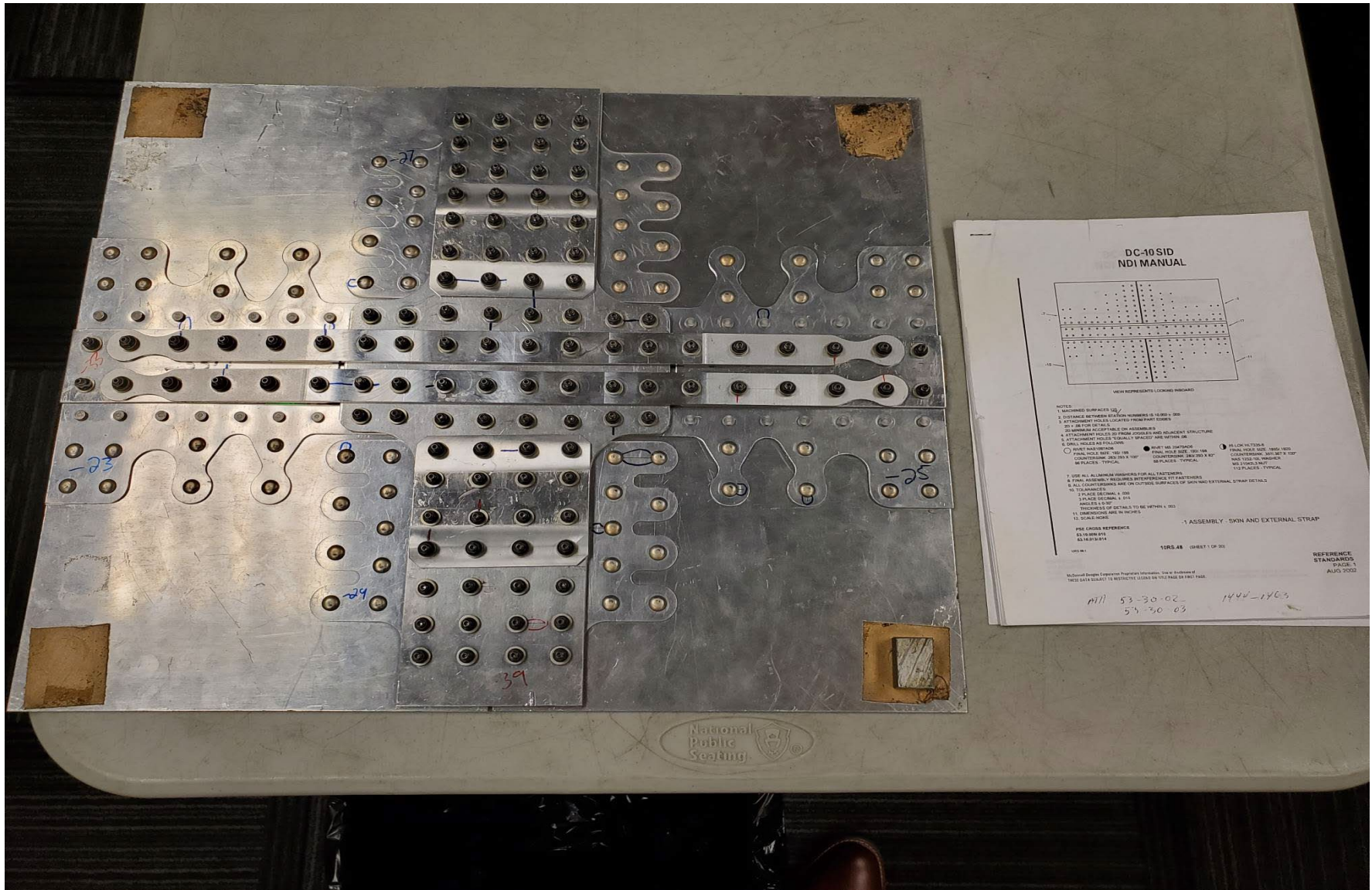
NDT Methods in use at Delta

- Eddy Current (ET)
 - *Magnetic Barkhausen Noise Inspection (BNI)
- Ultrasound (UT)
- Magnetic Particle Inspection (MT)
- Fluorescent Penetrant Inspection (PT)
- Radiography (RT)
- Infrared (IR/TIR)

DC-10 SID 10RS.48 NDT reference standard top surface



DC-10 SID 10RS.48 NDT reference standard bottom surface





A320 Gear Rib 5 FWD Lug Ultrasonic Inspection Kit



A220 solid laminate composite



Airbus Solid Laminate Composite



Importance of drawings to NDT standards Conformity, Quality, and Sustainment

- Historically NDT reference standards technical data drawings have been found in Nondestructive Testing Manuals
- Detailed drawings provide for 3rd party manufacture by NDT standards manufacturing specialists provided benefit to airframe OEM's, Operators and MRO's
- NDT Standards manufacturing specialists are demonstrably capable of providing the industry with quality standards at competitive cost
- Detailed drawings support sustainment of standards through periodic evaluation to drawing requirements
- When Quality concerns present, detailed drawings are essential to investigation and mitigation.

Slido Question

Which NDT Calibration Reference Standards (CRS) are most suitable for manufacture by NDT CRS manufacturing specialists?

- A. Standards produced from aerospace grade metallic stock and aerospace fasteners?
 - B. Solid laminate composite standards / composite standards with core
 - C. Standards produced from aerospace articles or components
- *Hint, there is no single correct answer. The question is intended to gage audience perspective

Slido Question

Have you encountered nonconforming Nondestructive Testing Calibration Reference Standards?

Yes / No

How did you discover the nonconformance?

- A. Technique not performing in alignment with expectations
- B. Failed conformity inspection
- C. Consultation with Technique author/OEM
- D. All of the above

* Let's take a look at some examples

1. 2010-2011 timeframe DAL A330 aircraft 3306,3307,3351,3352, 3353 and 3354 are affected by SB A33/34-32-222 initial and repeat inspections
2. Nonconforming sealant at actuator ram, rod end area, allowed moisture to enter ram interior and cause corrosion which could lead to fracture. Shear Wave Ultrasound under SB A33/34-32-222
3. A330 Main Landing Gear retract actuator ram inspection SB A33/34-32-222 DRT 95406 calibration blocks (Calibration Reference Standard) were sole source with initial lead time greater than 9 mo. which challenged inspection preparation
4. Initial provisioning of DRT 95406 calibration blocks (Calibration Reference Standard) were found through investigation of the A/C 3354 event to be nonconforming. What was supposed to be a Flat Bottom Hole (FBH) was in fact a conventionally drilled hole.



- A220 Circumferential Skin Joint (53-31-08, 53-41-08, and 53-51-08) accomplishes Eddy Current and Ultrasonic inspections using Calibration Reference Standard PN CE9900409.
- Delta issued Purchase Order to sole source supplier for 3 standards at unit cost in the \$20K range in May of 2025.
- Sole source supplier has provided a notional delivery estimate of December 2026.
- Access to the technical data drawing is not contained with associated ANDTP
- Based on available information, 3rd party nondestructive testing calibration reference standard (CRS) fabrication specialist estimate a cost of approximately \$2,800 ea with improved delivery time and comparable quality.
- ❖ Significant cost difference will directly affect ability to provision multiple locations which may result in special routing of aircraft to select locations, elevated shipping risk, and reduced breadth of inspection capability.

1. Bronze standard 99V51304007000 (A220 and A350)
2. 99V51304007000 (A220 and A350) Technical Data Drawings not available in associated Aircraft Nondestructive Testing Procedure (ANDTP)
3. Unscheduled requirements for Calibration Reference Standard 99V51304007000 emerged with no viable path for procurement.
 - Engaged Airbus vis TechRequest for support and received allowance for use of available alternative Calibration Reference Standard (CRS)

ANDTP (NTM) call-outs for unavailable CRS is a challenge for Operators and MRO's

Slido Question

Thinking about the issues outlined on the prior slides, do issues such as these have the potential to drive compliance and safety considerations?

- A. Compliance concerns
- B. Safety concerns
- C. Both Compliance and Safety concerns
- D. No concerns, can be dealt with as one-off's

Challenges

- Aerospace supply chain constraints
 - Technical drawings and Material availability, revision control of technical drawings
 - Lead time from placement of purchase order (e.g. ~9 mo or more for sole source, versus 30-60 days 3rd party NDT standards manufacturing specialist)
 - Monopolistic constraints (competition spurs customer focus and superior performance in organizations)
 - Cost (e.g. ~\$30,000K from sole source OEM versus ~\$2000 from 3rd party standards manufacturing specialist). Excessive cost may result in limited capability and special routing of aircraft for inspection accomplishment which comes at significant cost and operational impact.
 - Long term sustainment (aging fleets, low volumes, lack commercial viability for producers)
- Safeguarding intellectual property
 - Increase in digital data has exacerbated Intellectual Property (IP) protection challenges
 - Operator , MRO, Supplier secure request system for drawings

Perspectives

Original Equipment Manufacturer (OEM)

1. Safety and Quality

2. Responsible for NDT standard design and associated technique development and validation
3. Significant investment in design, development, validation and implementation of NDT technique
4. Supporting operators and MRO's aircraft/engines/components
5. Protecting Intellectual Property

Operator / MRO

1. Safety and Quality

2. Supporting inspection implementation
3. Lead time and cost considerations *High Cost and lead time can constrain implementation / accomplishment
4. Long term inspection sustainment
5. Responsible to Regulatory Authorities

Opportunities and Motivation for Collaboration



1. Safety & Quality

2. Availability of NDT Reference Standards when needed
3. Competitive market for NDT reference standards where applicable
 - Avoid monopolistic constraints and materials constraints
 - Supply chain responsiveness, resiliency, and robustness
 - Commercially viable competitive pricing
 - OEM support for Operators and MRO's
4. Ensure availability of technical drawings to those who need them while safeguarding Intellectual Property
5. Support for Airline & MRO operational requirements: Be Prepared!

Summary

NDT Calibration Reference Standard technical drawing availability

- No technical justification for omission of technical data/drawings for NDT Calibration Reference Standards (CRS) technical data/drawings for CRS produced from aerospace grade metallic stock and aerospace fasteners
- Drawings support Safety, Quality, and Conformity and are Technical Data
- Drawings support commercially viable, robust, and responsive supply chain
- Drawings support competitive pricing
- Drawings support long-term sustainment

Potential Solutions for making NDT Reference Standard technical drawings availability as Technical Data

- Publication of NDT Calibration Reference Standards technical data/drawings for CRS produced from aerospace grade metallic stock and aerospace fasteners within Nondestructive Testing Manuals in alignment with decades of historical precedent
- Operator, MRO, & 3rd party NDT Standards Manufacturing specialists request system for drawings with provisions for protection of Intellectual Property and vendor approval by OEM or Operator MRO Approved Vendor List (AVL)

Acknowledgements



- Airbus
- Boeing
- Bombardier
- Embraer

- GE Aerospace
- Pratt-Whitney
- Rolls-Royce
- SAFRAN Landing Systems (Formerly Messier-Dowty Ltd)

- Delta Air Lines Quality Control Department 530 NDT Programs
 - ❖ Michael Hall, Sr. Specialist NDT – Level III
 - ❖ John Bohler, Sr. Specialist NDT – Level III
- Delta Air Lines Engineering Department 493
 - ❖ David Piotrowski Sr. Principal Engineer / SAE Fellow

Questions?

KEEP CLIMBING



DELTA

