Nondestructive Testing Reference Standards, an Airline/MRO Perspective

A4A NDT Forum, Fort Worth, Texas 2025

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Outline

- A little about Delta Airlines & Delta TechOps MRO
- Four broad categories of NDT Reference Standards
  1. Standards made from aerospace grade metallic sheet stock / aerospace standard hardware
  2. Composite Standards (solid laminate, sandwich, or combination thereof)
  3. Standards made form aerospace articles e.g. fittings, engine components etc.
  4. Other Reference Standards e.g. Barkhausen Noise Inspection (BNI), Hardness Testing etc.
- Examples of NDT reference standards
- Slido Question for an audience perspective
- The importance of NDT reference standard detailed drawings to Conformity, Quality, Safety and Sustainment
- Challenges
- Perspectives
- Opportunities and Motivation for Collaboration
- Summary

DELTA

Aircraft Fleet Information

As of Aug 28, 2025

Fleet Summary

	AIRCRAFT	ACTIVE	FIRM ORDER	TOTAL
WIDEBODY	767-300ER	41	-	41
	767-400ER	21	-	21
	A330-200	11	-	11
	A330-300	31	-	31
	A330-900	36	3	39
	A350-900	38	6	44
	A350-1000	-	20	20
	TOTAL	**178**	**29**	**207**
NARROWBODY	717-200	80	-	80
	737-800	77	-	77
	737-900ER	163	-	163
	737-10	-	100	100
	757-200	91	-	91
	757-300	16	-	16
	A220-100	36	-	36
	A220-300	34	66	100
	A319-100	51	-	51
	A320-200	57	-	57
	A321-200	127	-	127
	A321-200NX	75	75	150
	TOTAL	**807**	**241**	**1,048**

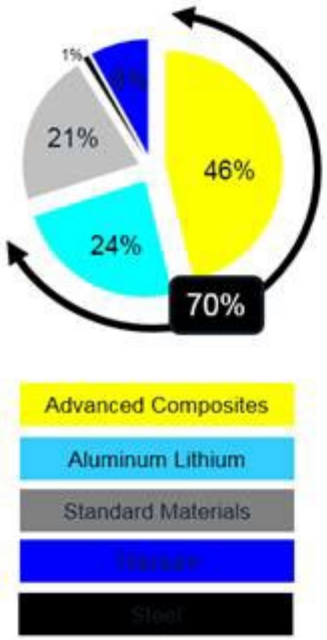
Delta operates a diverse fleet of aircraft powered by a variety of Engines

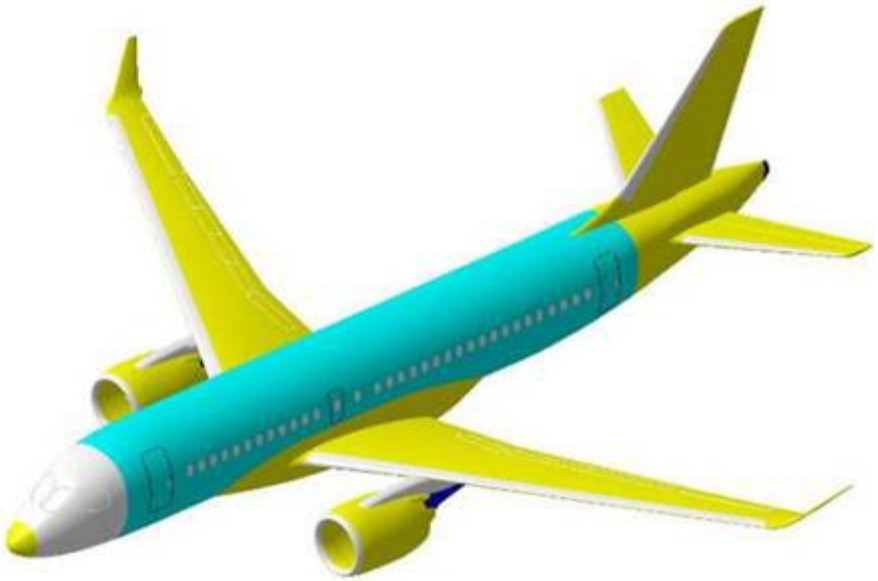
- Airbus
  - A220 Pratt-Whitney Geared Turbofan (GTF) 1500 Powered
  - A319 CFM56 Powered
  - A320 CFM56 Powered
  - A321's CFM56 Powered
  - A321neo Pratt-Whitney Geared Turbofan (GTF) 1100 Powered
  - A330's PW 4168, GE CF6-80E2, and Rolls-Royce Trent 7000 powered A330-900neo
  - A350XWB, Rolls-Royce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

- Boeing
  - B717 (MD95), BR715
  - B737, CFM56 (Boeing 737 MAX 10 LEAP powered)
  - B757, PW2000
  - B767, PW4000 & CF6

• 800+ Mainline aircraft under Delta's FAA Continuous Airworthiness Maintenance Program (CAMP) and Operations Specification

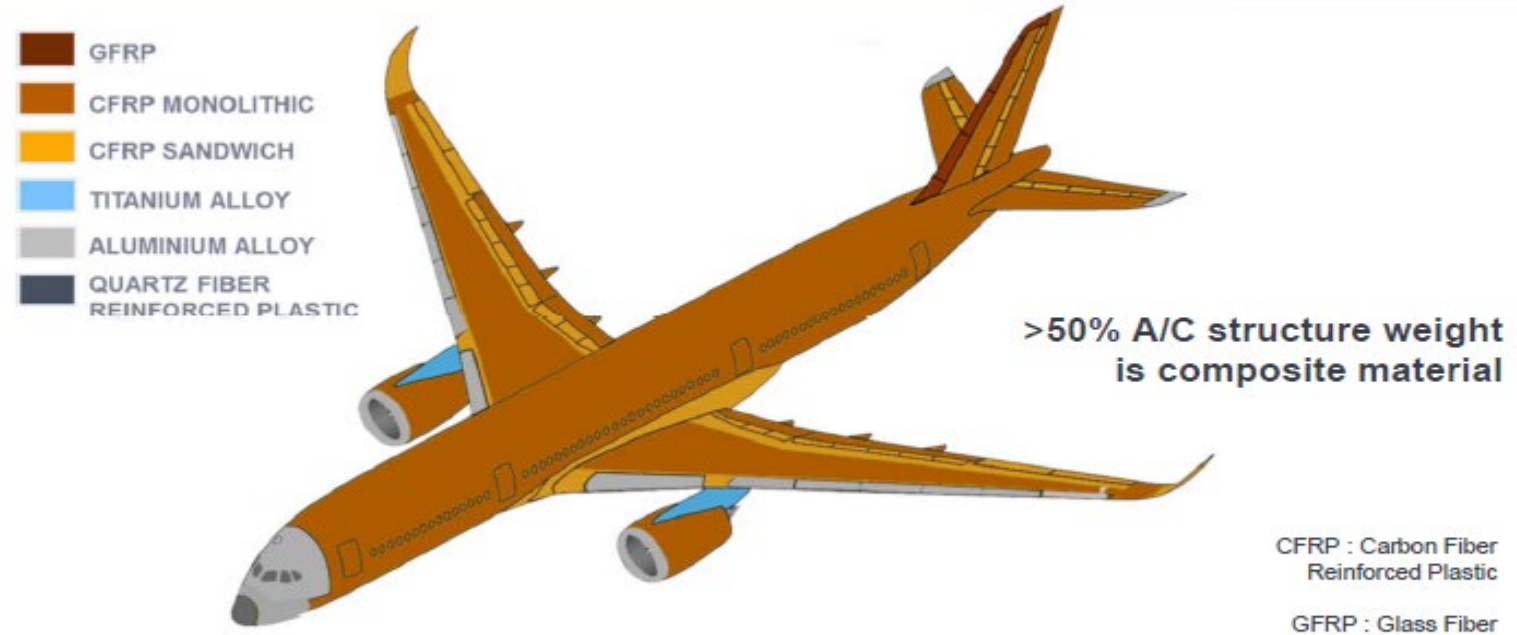
Airbus A220-100/300 (formerly Bombardier c-series)





A350XWB

A350XWB Composite Structure – Overview



AIRBUS

Delta TechOps MRO Engine Lines

GE Aerospace

- CF34
- CFM56
- LEAP
- CF6

Pratt-Whitney

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

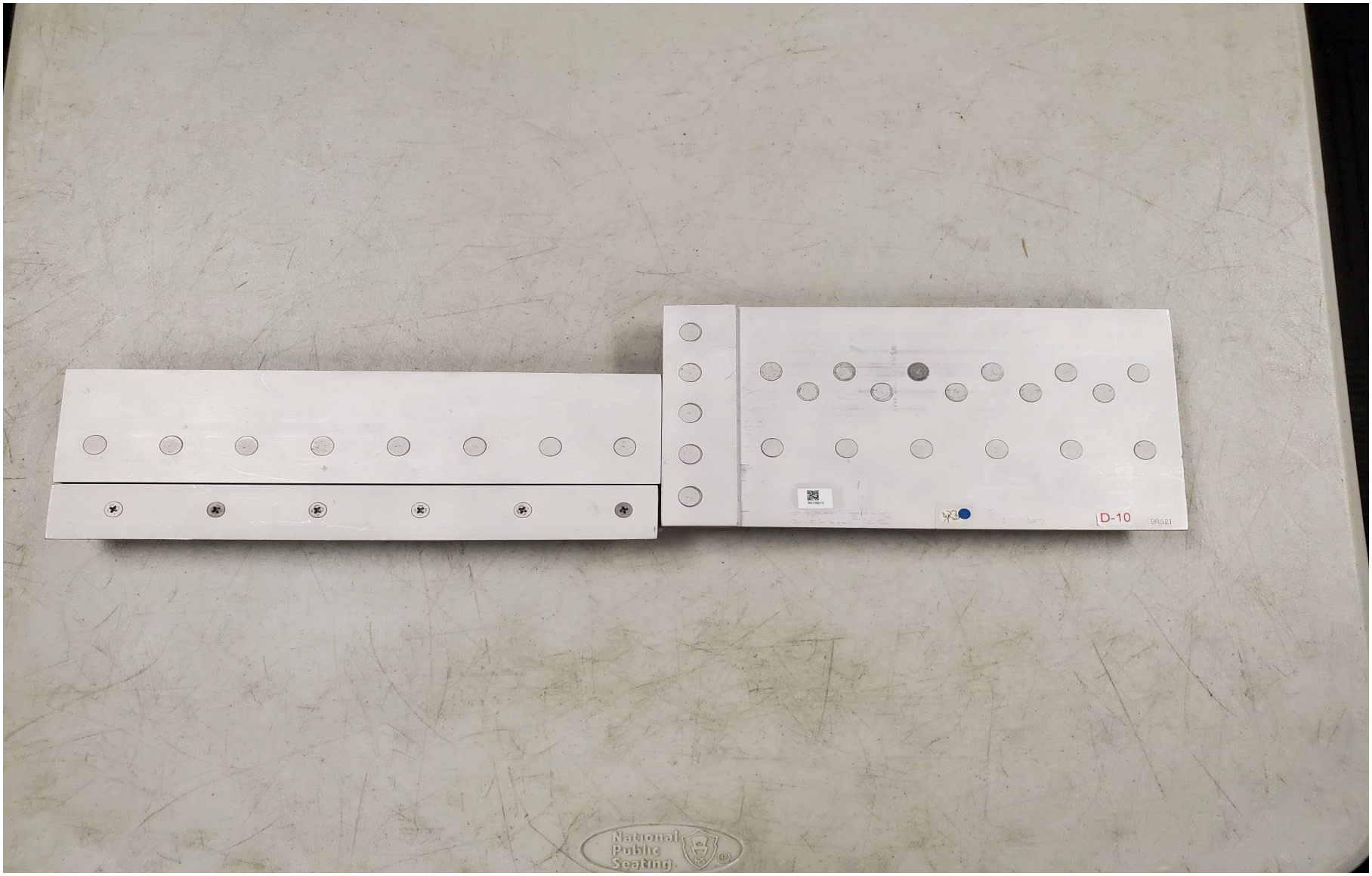
Rolls-Royce

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

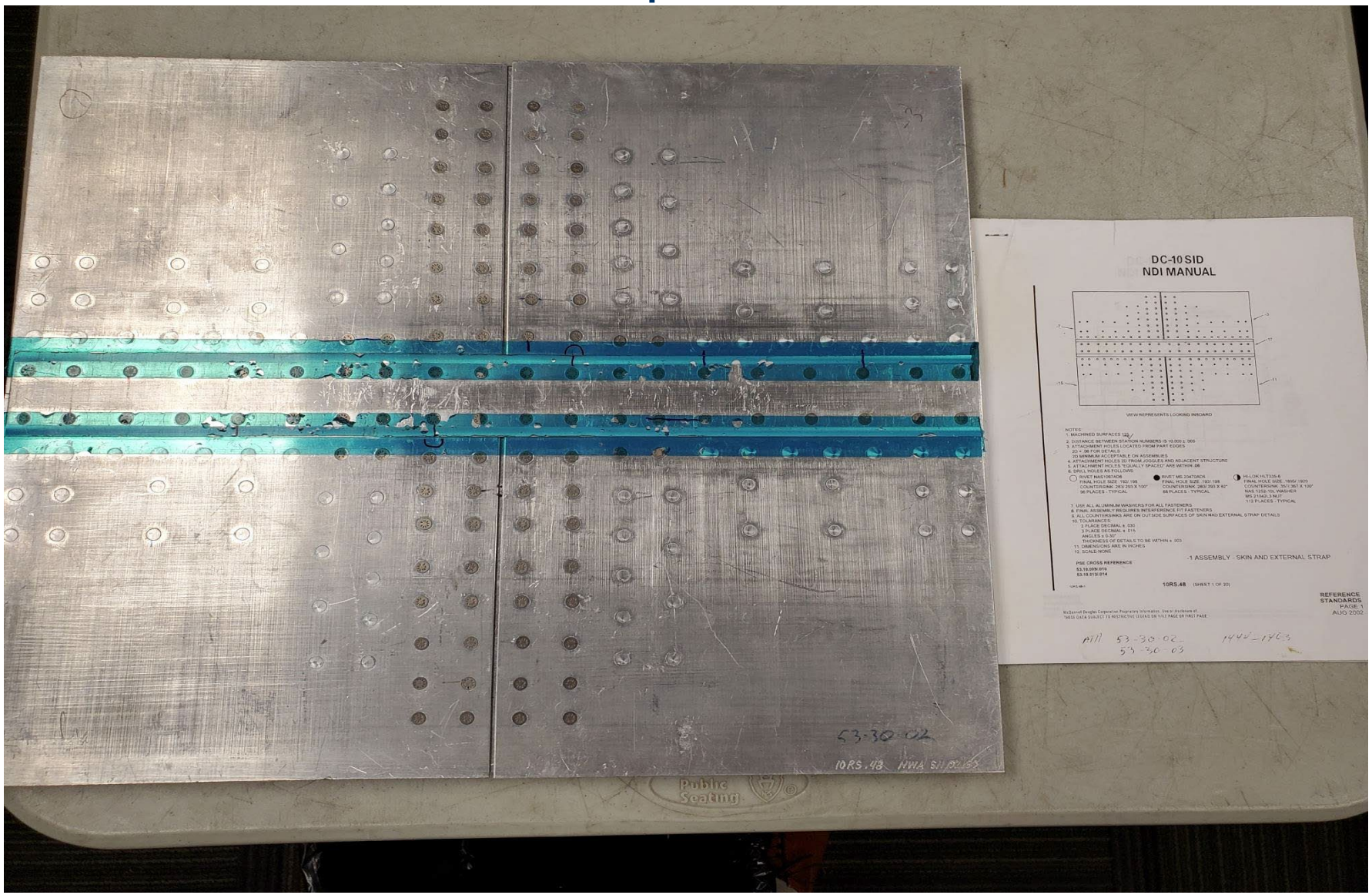
Airline/MRO Nondestructive Testing (NDT) scope

- NDT Requirements are often prescribed by:
  - Original Equipment Manufacturers (OEM's Boeing, Airbus, GE Aerospace, Pratt-Whitney, Rolls-Royce, Honeywell etc.)
  - Regulatory Authorities Federal Aviation Administration (FAA). European Aviation Safety Agency (EASA), Transport Canada (TC), Japan Civil Aeronautics Bureau (JCAB) etc.
  - Airline Maintenance Program
  - Airline Engineering Organization
  - 100+ Part 145 MRO Customers
- 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/FTIR)

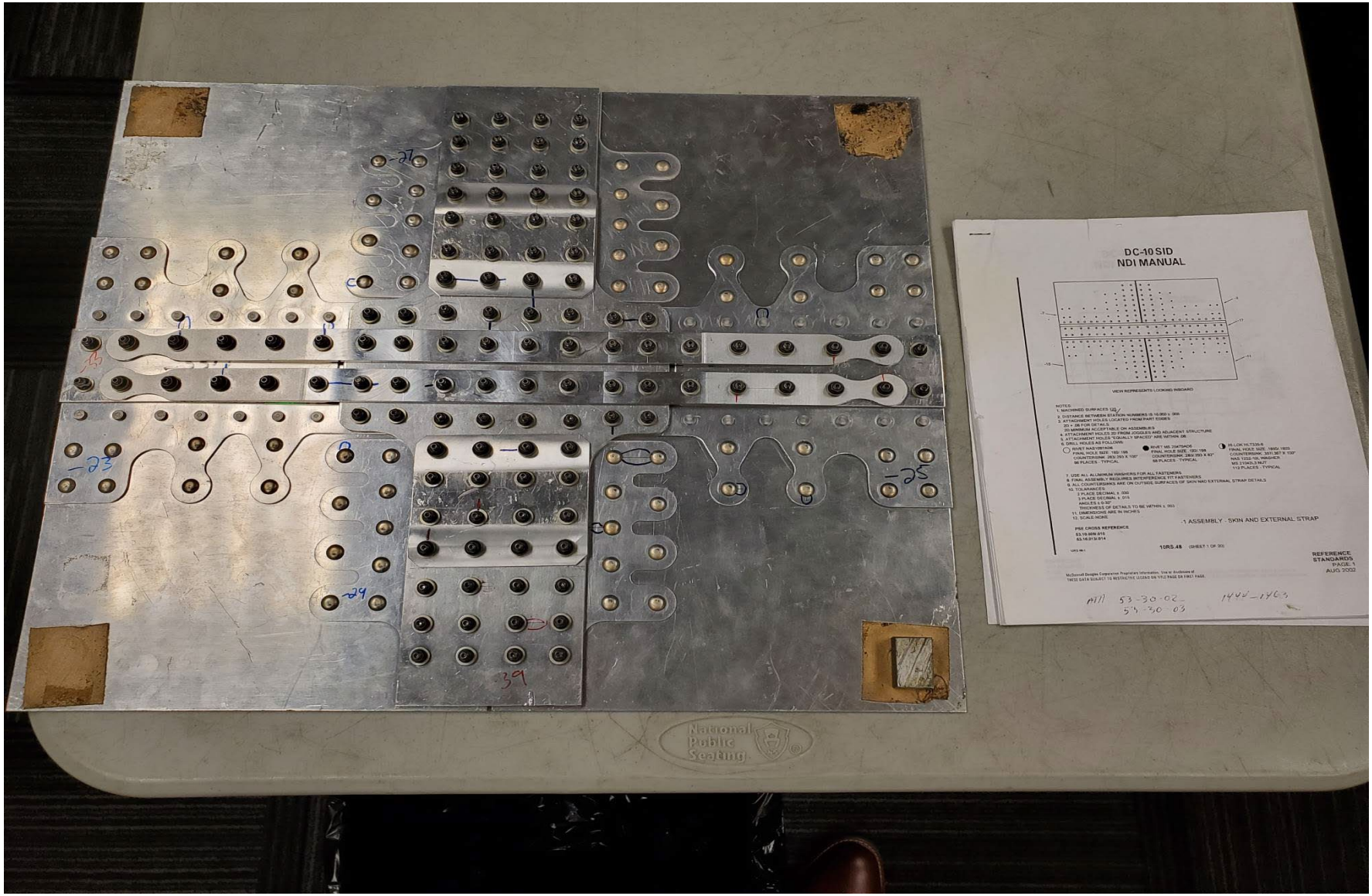
9RS21 - DC9 SID - WING REAR SPAR



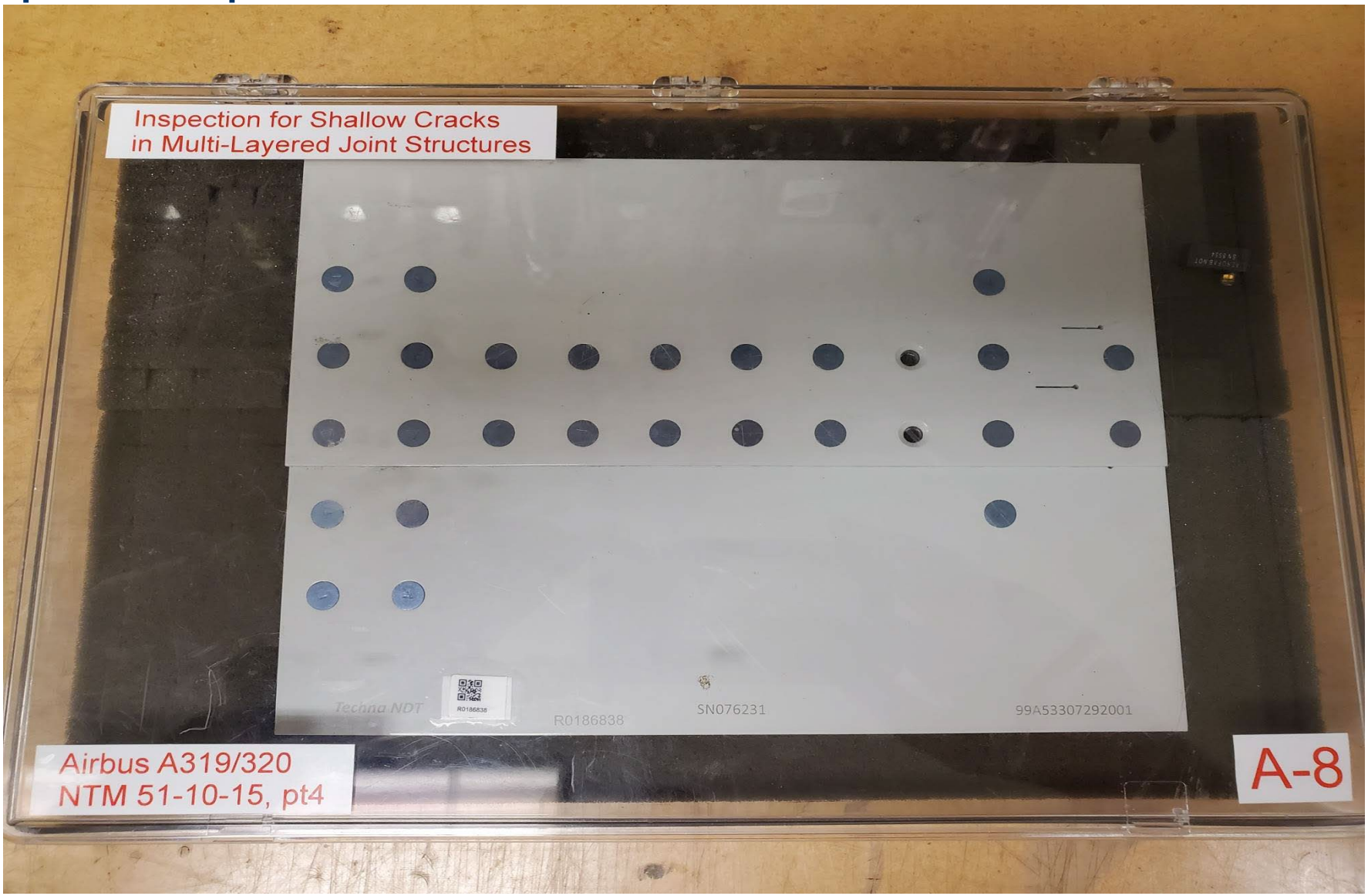
DC-10 SID 10RS.48 NDT reference standard top surface



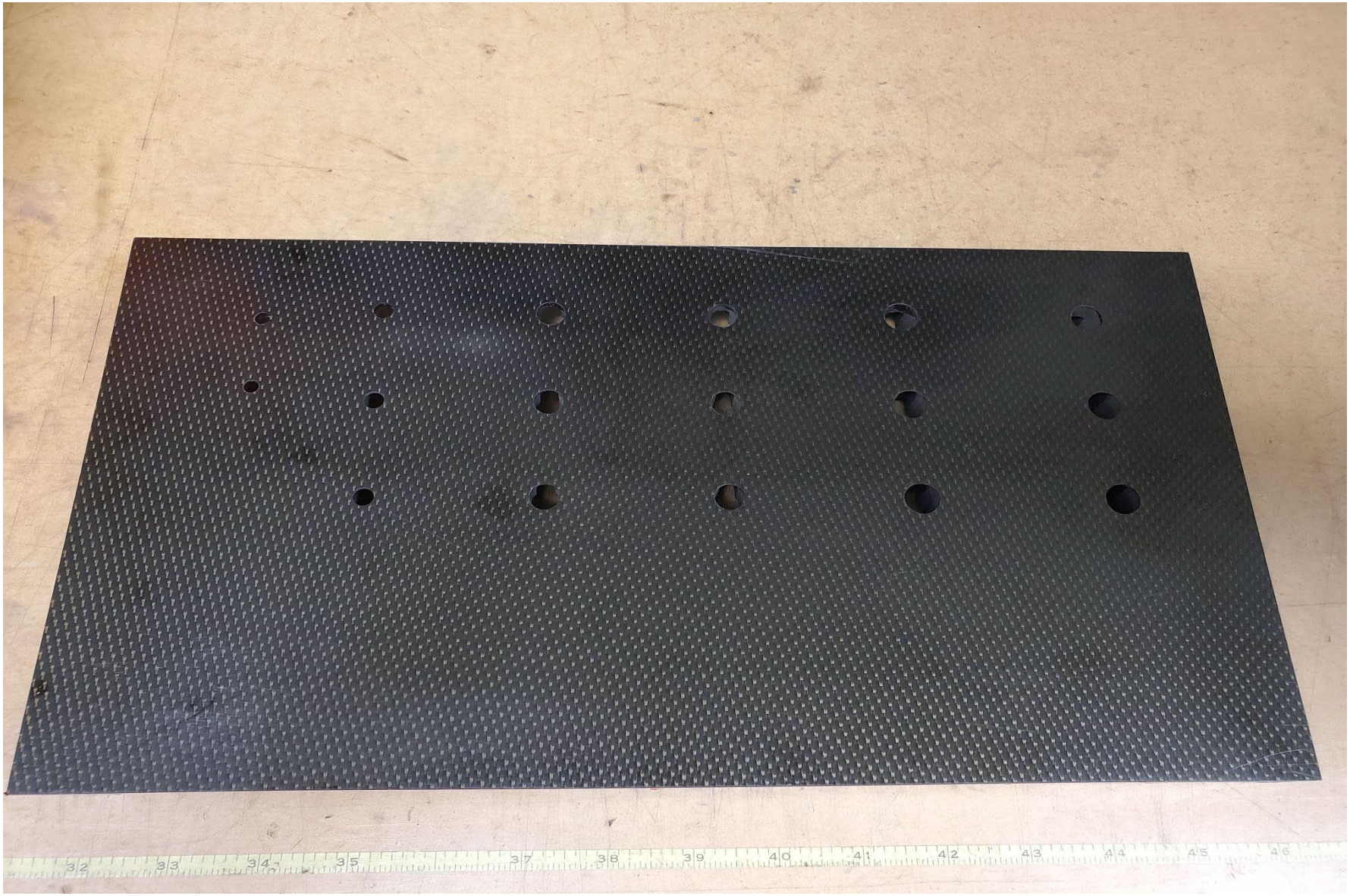
DC-10 SID 10RS.48 NDT reference standard bottom surface



Airbus A319/320 NTM 51-10-15, pt4 Inspection for shallow cracks



A220 solid laminate composite



Airbus Solid Laminate Composite

Rolls-Royce Trent 800

Rolls-Royce Trent 800

DELTA TechOps

A320 Gear Rib 5 FWD Lug Ultrasonic Inspection Kit

Slido Question

Which NDT Reference Standards are most suitable for by NDT Reference Standards manufacturing specialists?

1. Standards produced from aerospace grade metallic sheet stock and aerospace fasteners?

2. Solid laminate composite standards / composite standards with core

3. Standards produced from aerospace articles or components

   - *Hint, there is no single correct answer. The question is intended to gage audience perspective

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

- Historically NDT reference standards 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
- When Quality concerns present, detailed drawings are essential to investigation and mitigation.
- Detailed drawings support sustainment of standards through periodic evaluation to drawing requirements

Challenges

- Aerospace supply chain constraints
  - Technical drawings and Material availability
  - Lead time from placement of purchase order (e.g. ~9mo sole source, versus 15-30 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)
  - 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
  - Nondisclosure Agreements

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 of their aircraft/engines/components (Don't forget about MRO's when you plan fleet support)
5. Protecting Intellectual Property

Operator / MRO

1. **Safety and Quality**
2. Supporting inspection implementation
3. Lead time and cost considerations
4. Long term inspection sustainment
5. Regulatory responsibility

Opportunities and Motivation for Collaboration

1. **Safety & Quality**

2. Ensure availability of NDT Reference Standards

3. Ensure a competitive market for NDT reference standards where applicable
   - Avoid monopolistic constraints and materials constraints
   - Supply chain viability
   - 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 Airline & MRO operational requirements: Be Prepared!

Summary

NDT Reference Standard technical drawing availability

- Drawings support Safety, Quality, and Conformity
- Drawings support commercially viable and responsive supply chain
- Drawings support competitive pricing
- Drawings support long-term sustainment

Potential Solutions for making NDT Reference Standard technical drawings available

- Publication within Nondestructive testing manuals in alignment with decades long 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

- Delta Air Lines Quality Control Department 523 Shop Inspection
- Delta Air Lines Quality Control Department 524 Aircraft Inspection
- Delta Air Lines Quality Control Department 525 Aircraft Line Inspection
- Delta Air Lines Quality Control Department 526 Aircraft Inspection
- 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?