2015 DoD Maintenance Innovation Challenge

USCG Aviation Composite “ Bonded Material Testing”

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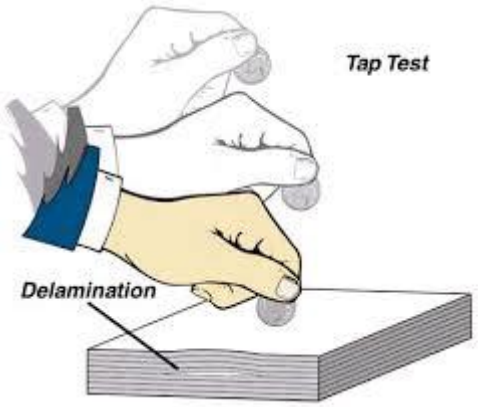
USCG Aviation Composite " Bonded Material Testing"

Problem

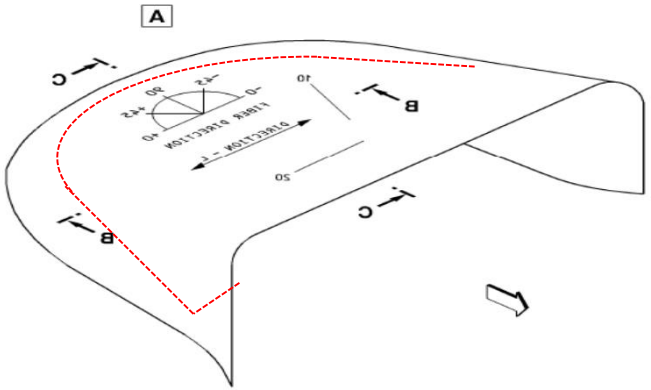
Training, Tap Testing (TT) and Ultrasonic's (UT).

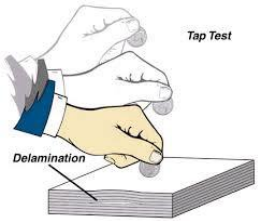
- Training: Attentiveness and knowledge of structures and technical documents. (Historical observations)
- TT is an inconsistent method to determine serviceability on metallic and nonmetallic composite constructions.
- TT leads to conflicting results leading to interpretational dialogue between inspectors and maintenance managers.
- UT can be time consuming and be difficult set up and to interpret. (Signals with poor resolution \ Signals with poor return properties)

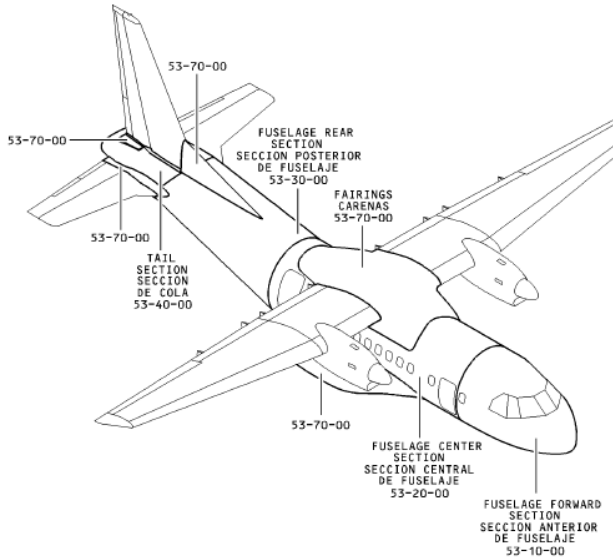


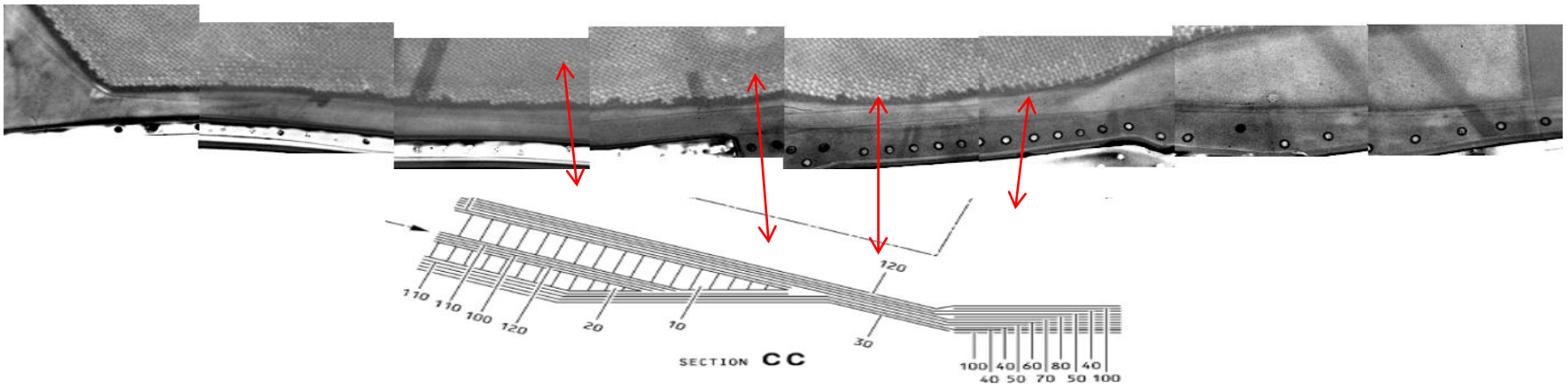
USCG Aviation Composite “ Bonded Material Testing”

Incipient Event









This is half of the inspection and it shows the thermal image obtained for review. The areas are mapped out using the C-C cross section slice.

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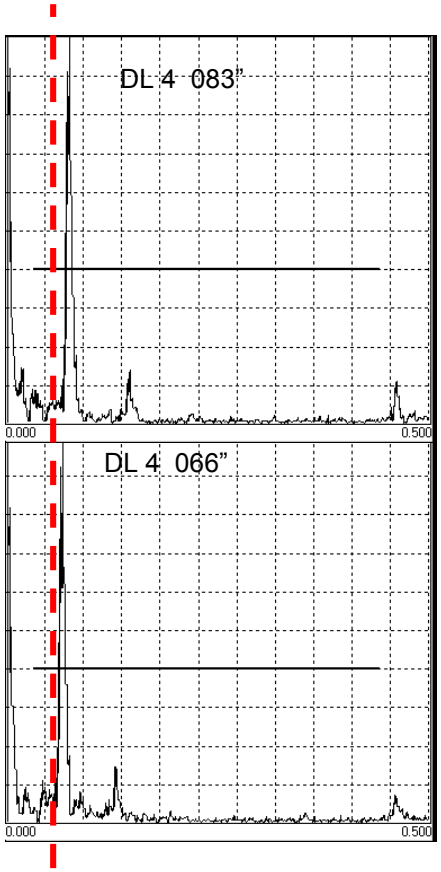

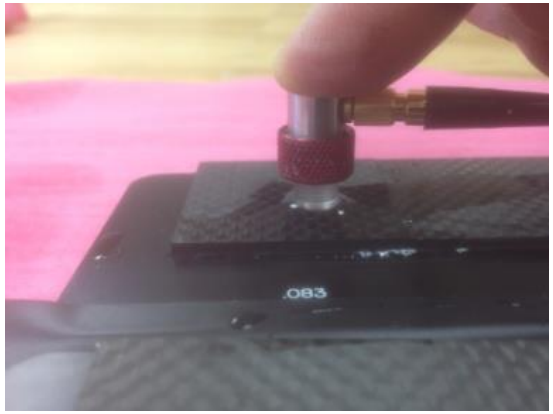

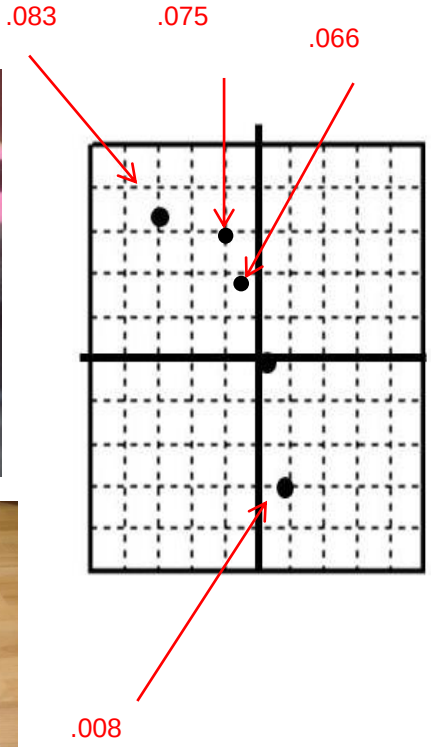

Discerning the difference in the ply thickness.
These screen captures show the resolution of the separation in plies.
The BMT resonance method clearly would be an easier interpretive skill.

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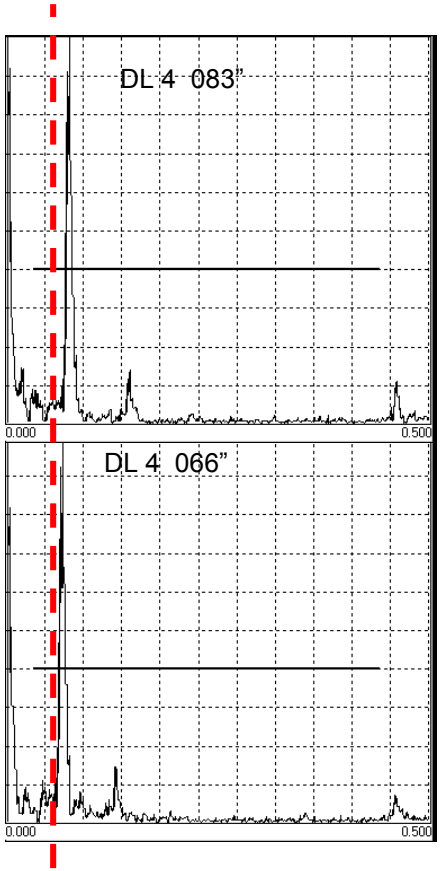

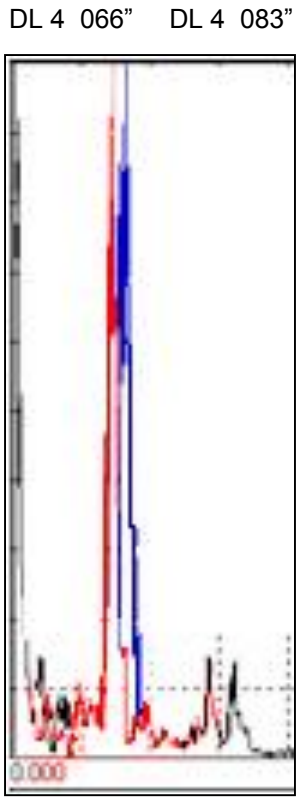

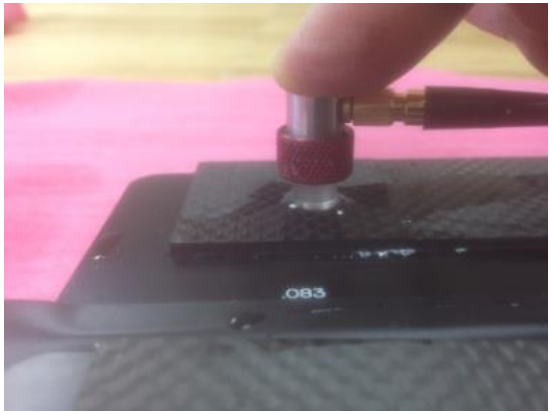

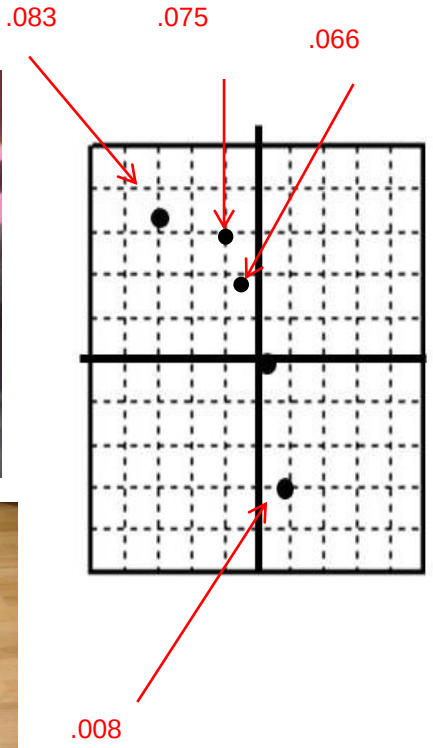

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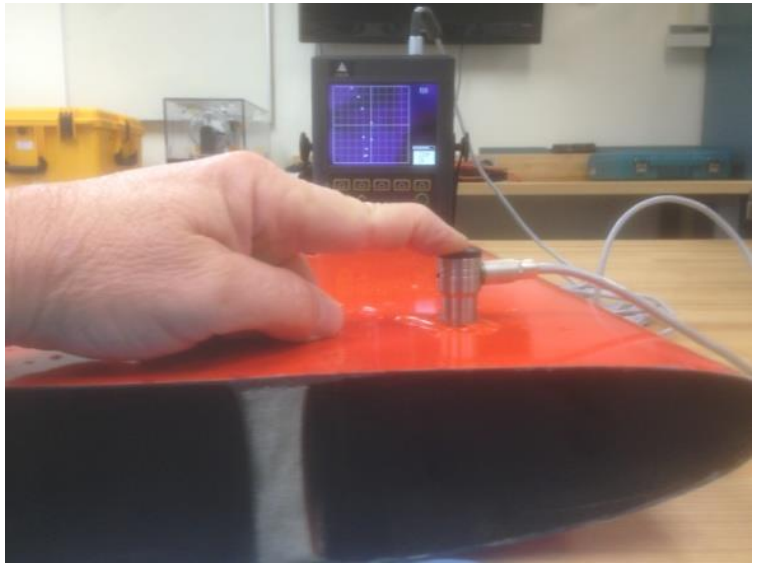

- Plies of bidirectional (quasi-isotropic) laminates can cause a loss of UT signals.

- This condition can be mistaken for internal structure damage of carbon fiber laminates, making difficult to properly interpret.

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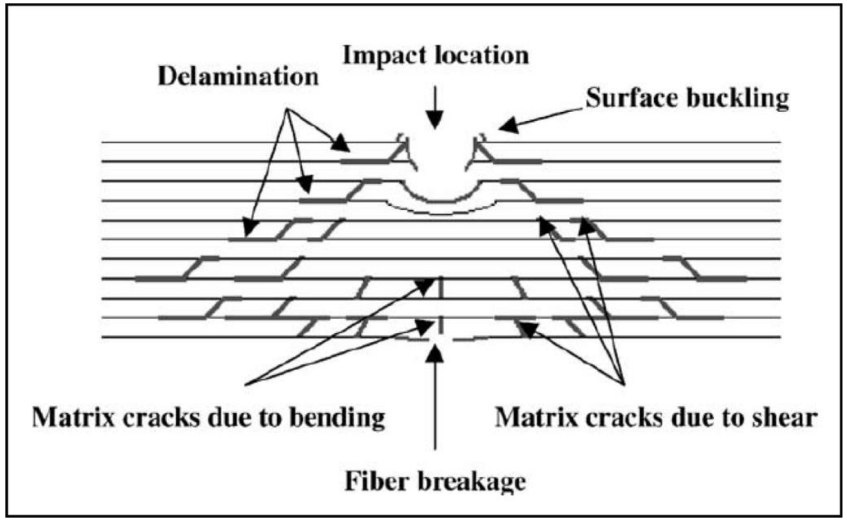

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Specific Technique Applied with Type of Inspection: TAP TEST

Equipment Settings: USING A TAP TESTER TO LISTEN FOR DELAMINATION OF BLADE. TAP TEST INDICATED THAT ON TRAILING EDGE OF BLADE BOTH CONVEX AND CONCAVE SIDES DELAMINATED 2 INCHES FROM EDGE.

Aircraft Type:	☐ HU25	☐ C130	☐ H60	☐ HH65	☑ Other

Other Type: HC-144

Location: ALC ☐	Other: NAS PENSACOLA

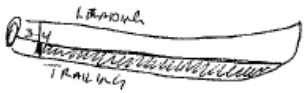
Technical Directive Applied:

Results:	☐ Acceptable	☑ Rejected

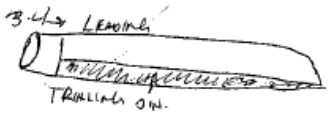
Desposition Report: Geometric and Material Property Characteristics:

for convex

CONVEX SIDE OF BLADE 3-4 INCHES IN, 2-3 INCHES FROM THE TRAILING EDGE

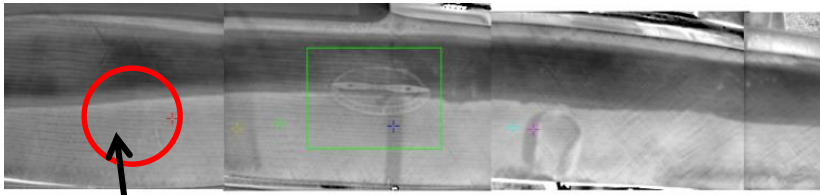


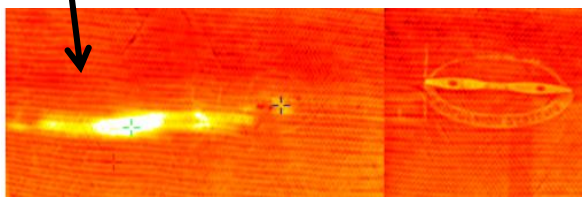
CONCAVE SIDE HAS DELAMINATION 3-4 INCHES FROM BLADE ROOT 2-3 INCHES FROM TRAILING EDGE. TAPERS OFF DELAM AS IT GOES TO TIP.



= SHADED AREA DELAMINATED.

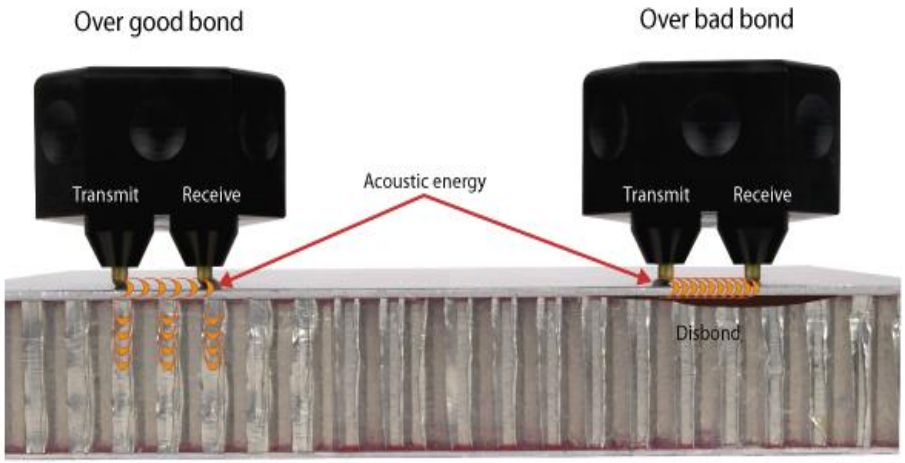
Signature: [signature] 18 Stamp Impression ☐ Accept ○ Reject ◉

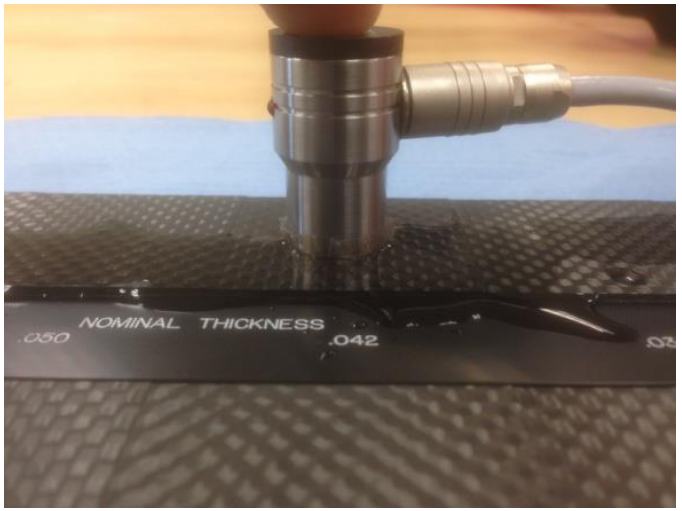




Solution

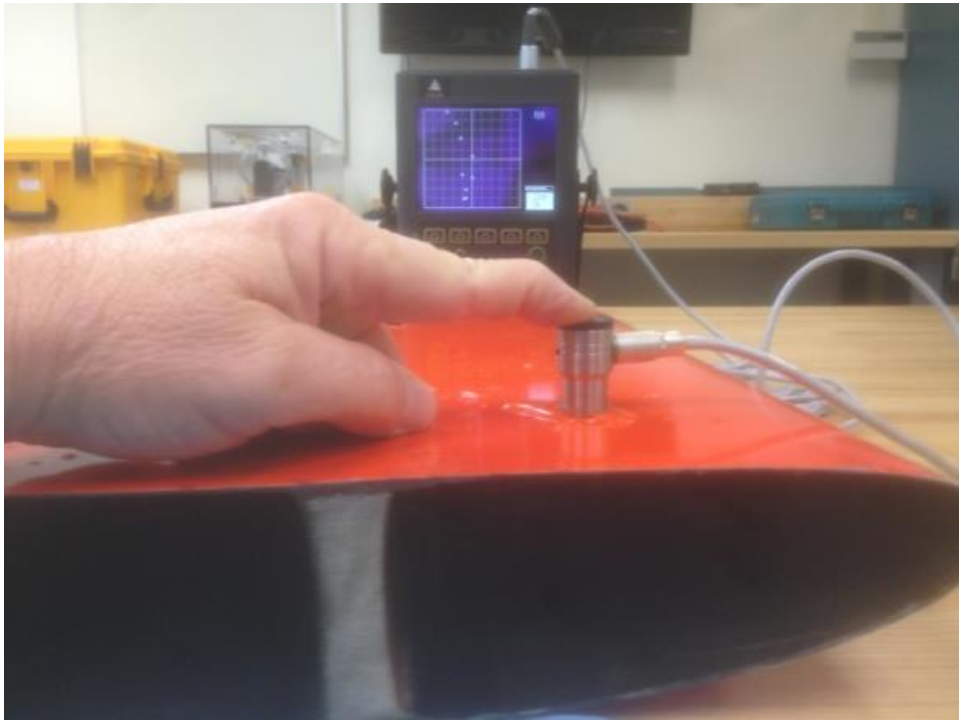
- Training / certification program that teaches various engineered material constructions, theory and application of BMT.
  - Validated through testing.
- Bonded Material Testing instrument (BMT). A portable instrument designed to detect unbonded conditions in laminate plies and in sandwiched constructed materials.

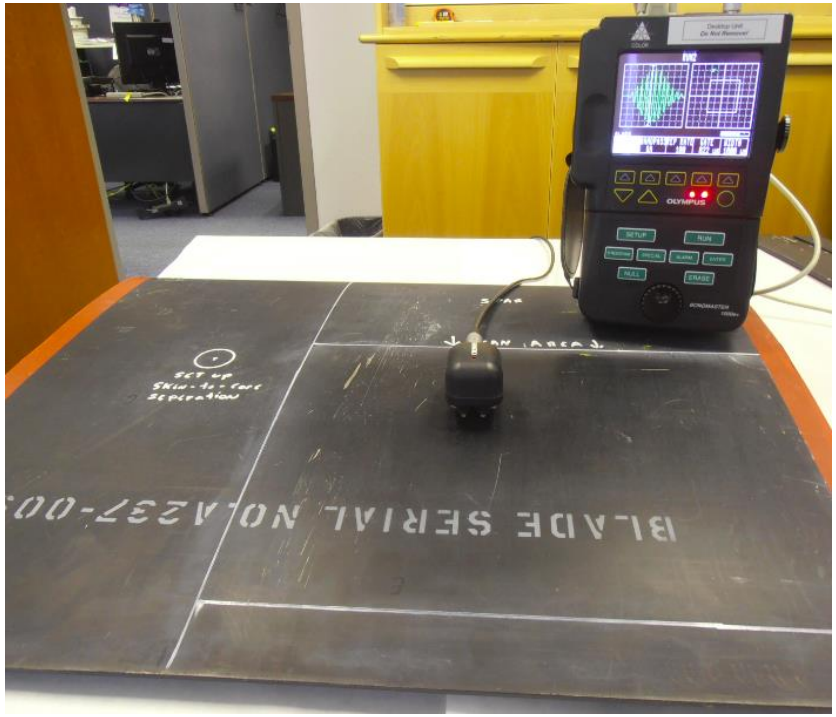




Solution

- BMT details a positive output to a situation that is an electronic signal and is audio. Both methods eliminate interpretational debate.
- Precise output of material integrity. The output material condition eliminates production scrutiny.





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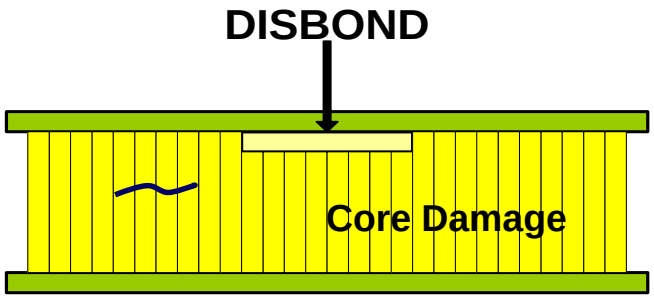
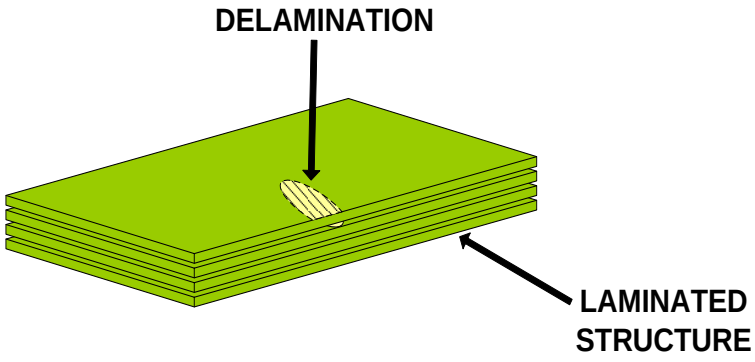
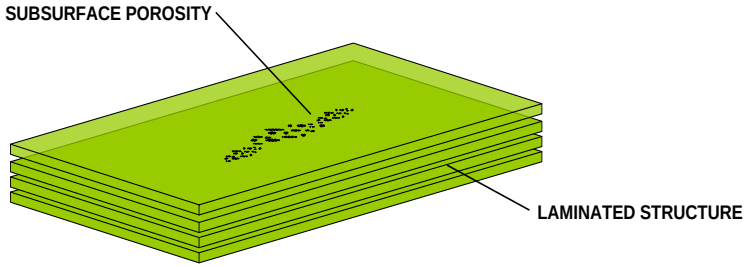
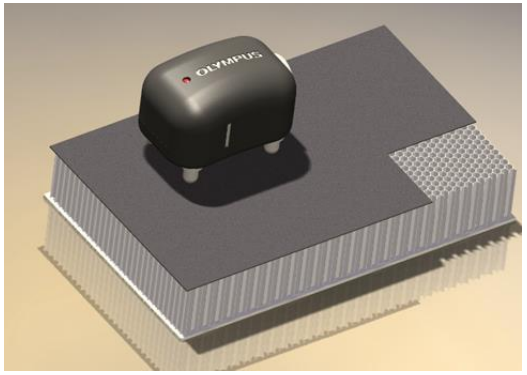
Training

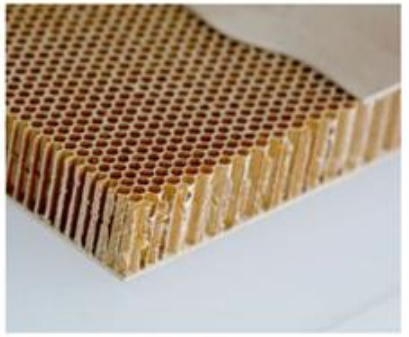
(Knowledge)

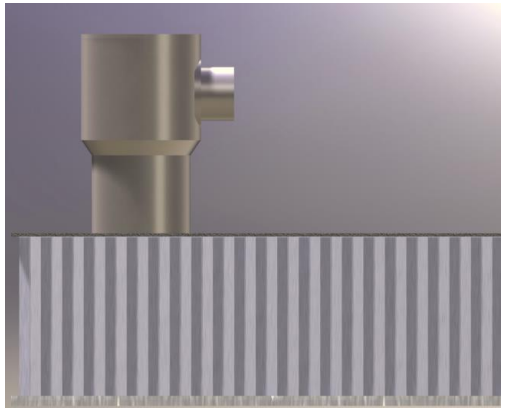


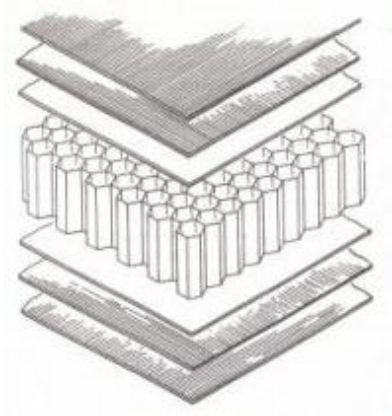












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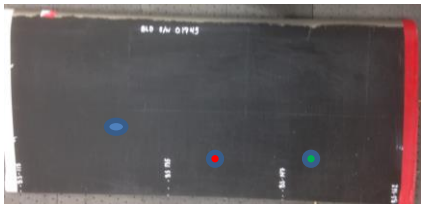
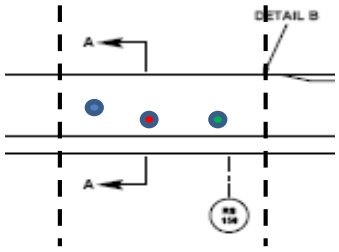
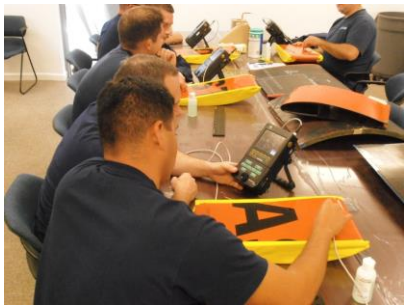


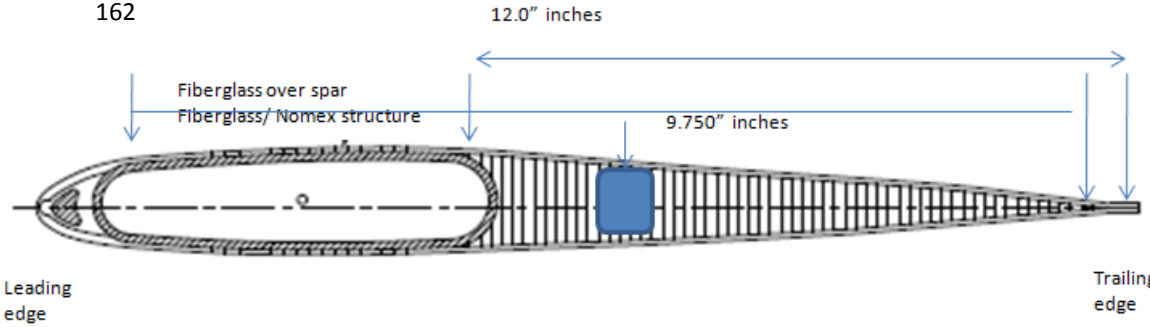


BS115 BS 162

Training

(Applications)





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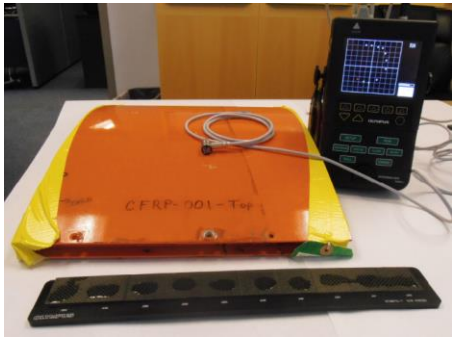
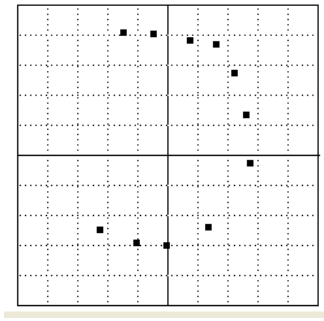
Training

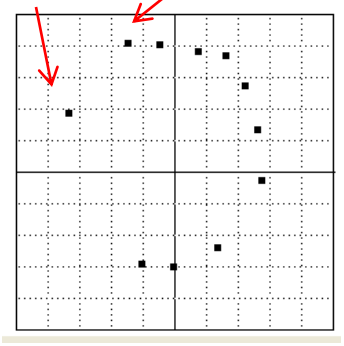
(Applications)



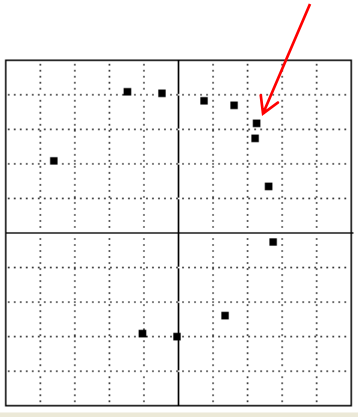


Spar in horizontal Stab.

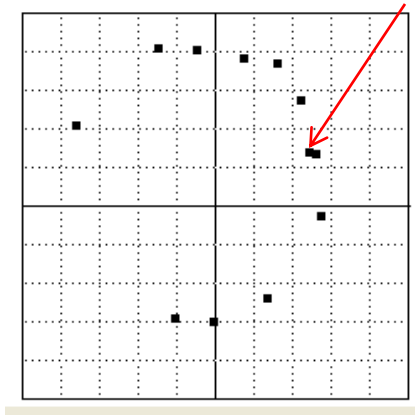
Horizontal Stab Skins
9 plies of CFRP.



Delamination between stringer and skin



Delamination between CFRP plies 5 & 6 in the skin



Challenges & Risks

- Innovation Immaturity: This is a proven application. The method has been used for approximately 30 years in various industries but the knowledge of the concept and its application has always been on back burner. USCG has dedicated this program for success through knowledge, applications and personnel certification.
- DoD Community Awareness/Exposure: Success through awareness, the more it is used the more success it will have and the blue collar fleet personnel will find ways to use it that white collar engineers cant think of. Provide the knowledge and they will it will be used. (INNOVATION GROWTH)
- Transition to a Program: USCG has a natural smooth transition into a program that holds promise in reliability, proficiency and accomplished in a reasonable amount of time.
- What are the risks?
  - Lack of knowledge will lead to lack of acceptance.
  - The task of inspection will now rest on the shoulders of the few that are trained and certified verses the mass of personnel in the maintenance departments.
  - Old school maintenance methods and practices.
- This will require me to maintain diligence in open discussions about the system concept. The NDI program manager must be vocal about the successes and be vigilant in solving hurdles.

Innovation Status

- Where is the technology in the Life-Cycle Continuum?
  - This is a demonstrated capability. Current use is minor but it is in an industrial strategically growth state.
- What are the most probable applications and locations for the technology?
  - Will be accomplished with nonmetallic components and structures.
    - Fleet in-service components.
    - Depot level in-service and secondary processing stages of structures and components.
- What are the possible obstacles?
  - Lack of production managers and engineers to demand its use to provide a quality consistent inspection.
  - The battle between the few trained certified individuals verses the mass performing the inspections.
  - Managers will need to better plan personnel work shifts and hours to ensure a timely inspection.
- What is the likely outcome that we should expect?
  - Slow but steady growth and acceptance over a careful implementation strategy

Benefits

- Engineering Benefits: BMT offers more accurate results and exact measurement of defects compared to TT.
- When the UT delay line is used the beam spread inhibits an exact measurement and is never consistent between inspectors. Return signals can be difficult to interpret.
- Increase repair quality and potentially reduce repairs and size. Most defects when tapped are generally marked larger then actual size.
  - Repairs can be evaluated for quality.
- Reduced Repetitive Tasks: The discovery of defects with tapping will usually involve seeking second and third opinions.
- Reduce maintenance production scrutiny in rejected indications or acceptable conditions.

Vision / Final Thoughts

- How can the innovation be integrated into DoD maintenance processes?
  - DOD aviation has begun implementation but the DOD community has not inserted a vigorous specific training for the technology with specific testing.
  - USCG has incorporated the process into the training program for inspectors which includes written examination and proficiency applications testing.
- What further development is required?
  - Repairs and far side inspection procedures.
- Aircraft structures are changing to the lighter stronger bonded materials. Don't be reactive be proactive. Get the knowledge of the materials and the tools in the tool box. Grow this knowledge and applications now to avoid from being behind the curve when its time to react.

Questions

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<u>If there is time the next slides are more application examples</u>

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USCG Aviation Composite " Bonded Material Testing"

Specific Technique Applied with Type of Inspection: TAP TEST

Equipment Settings: N/A

Aircraft Type:	☐ HU25	☐ C130	☐ H60	☐ HH65	☑ Other

Other Type: HC-144

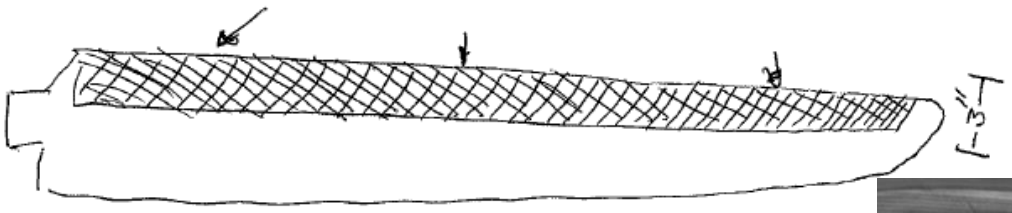
Location:	ALC ☐	Other:

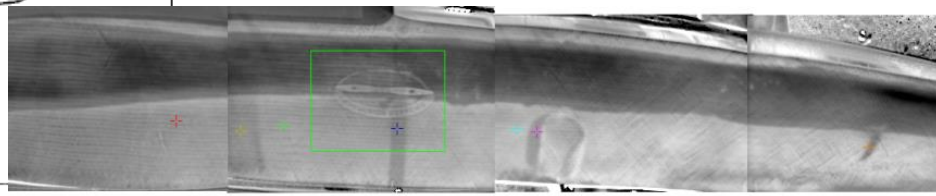
Technical Directive Applied:

Results:	☐ Acceptable	☐ Rejected

Desposition Report: Geometric and Material Property Characteristics:

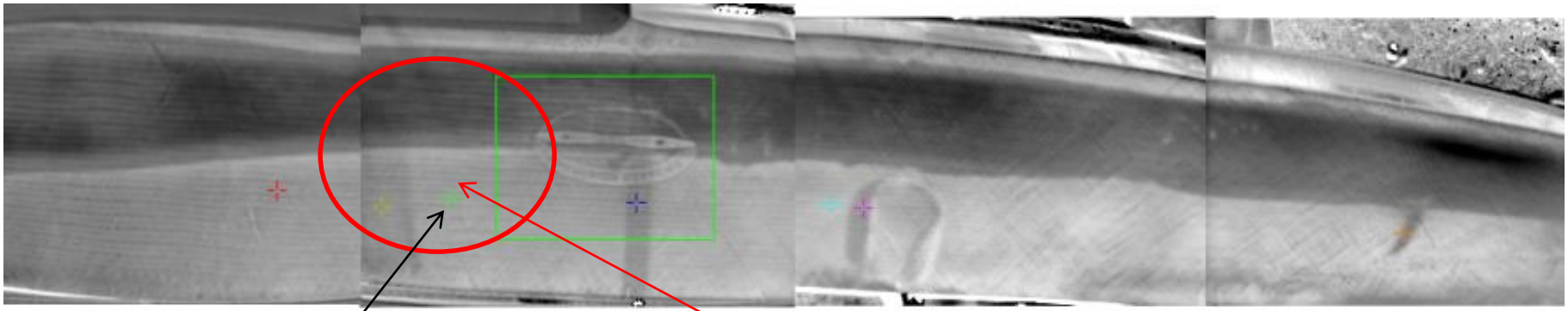
FIBERGLASS SKIN DELAMINATING FROM TRAILING EDGE TO 3 INCH UP BLADE, ENTIRE LENGTH OF BLADE ON BOTH SIDES.

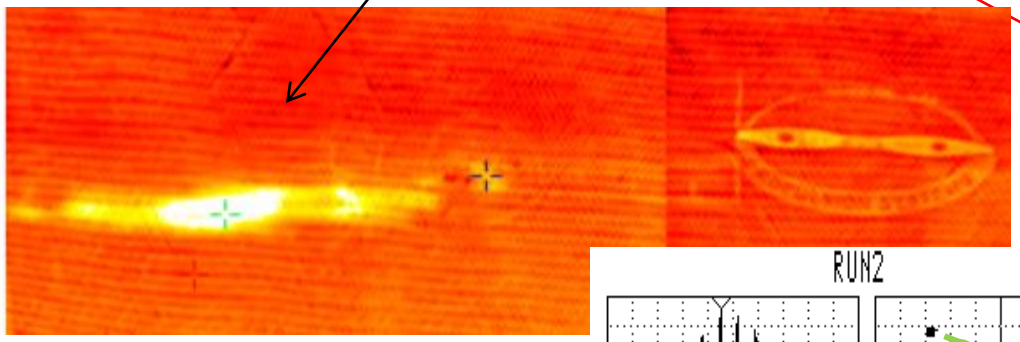


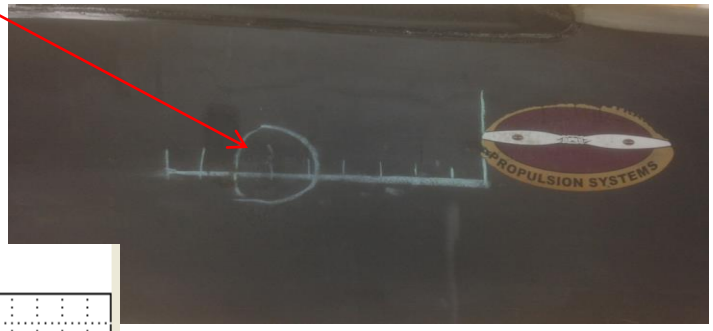


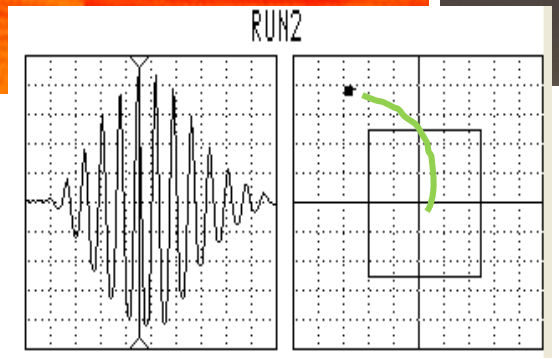
Signature: _____ Stamp Impression ☐ Accept ○ Reject ○

HC 144 Prop Blade
S/N : 2005040643 Convex Side
Pre-Induced Defect









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Other Type:

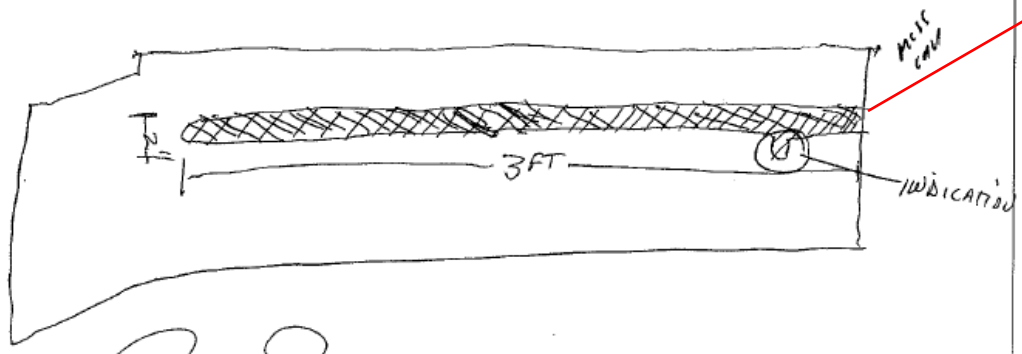
Location: ALC ☐	Other:

Technical Directive Applied:

Results:	☐ Acceptable	☑ Rejected

Desposition Report: Geometric and Material Property Characteristics:

#1 MAIN ROTOR BLADE HAS ~~2 FOOT~~ 2 INCH BY 3 FOOT VOID RUNNING LENGTH WISE IN MIDDLE OF BLADE.



Signature: _____ Stamp Impression ☐ Accept ○ Reject ○

Spar

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