INTERNATIONAL NDT

Phased array ultrasonics for enhanced evaluation and monitoring

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What do we do?

Bespoke Inspections

- Yachts – Mast, Hull appendages
- Sailing/Motor vessels
- Superyachts/Grand Prix/Americas Cup

Other industries:

- Private aerospace
- Wind energy
- Tidal Energy

- EN4179/NAS410/SNT TC 1A
- BINDT Composite Certification Committee

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What do we do?

Preventative inspection

- Ultrasonic inspection - Composites
- Dye Penetrant Testing - Metallic parts
- Traditional survey inspection

Quality assurance

- Baseline inspection
- Risk assessment
    - Lightning protection

Damage assessment

- Detailed assessment of damage
- Improved repair planning

Contents

Standard inspection vs C-scan

Example 1 – Chainplate, Mixed materials

Example 2 – Monolithic, complex indications

Example 3 – Blind-bonded sleeve join

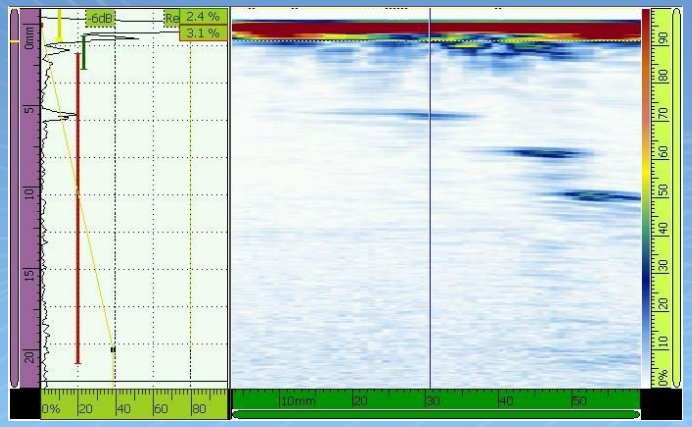
Decision making process

Questions

Ultrasonic testing

Phased Array Ultrasonic - High quality monolithic CFRP
- Manual recording

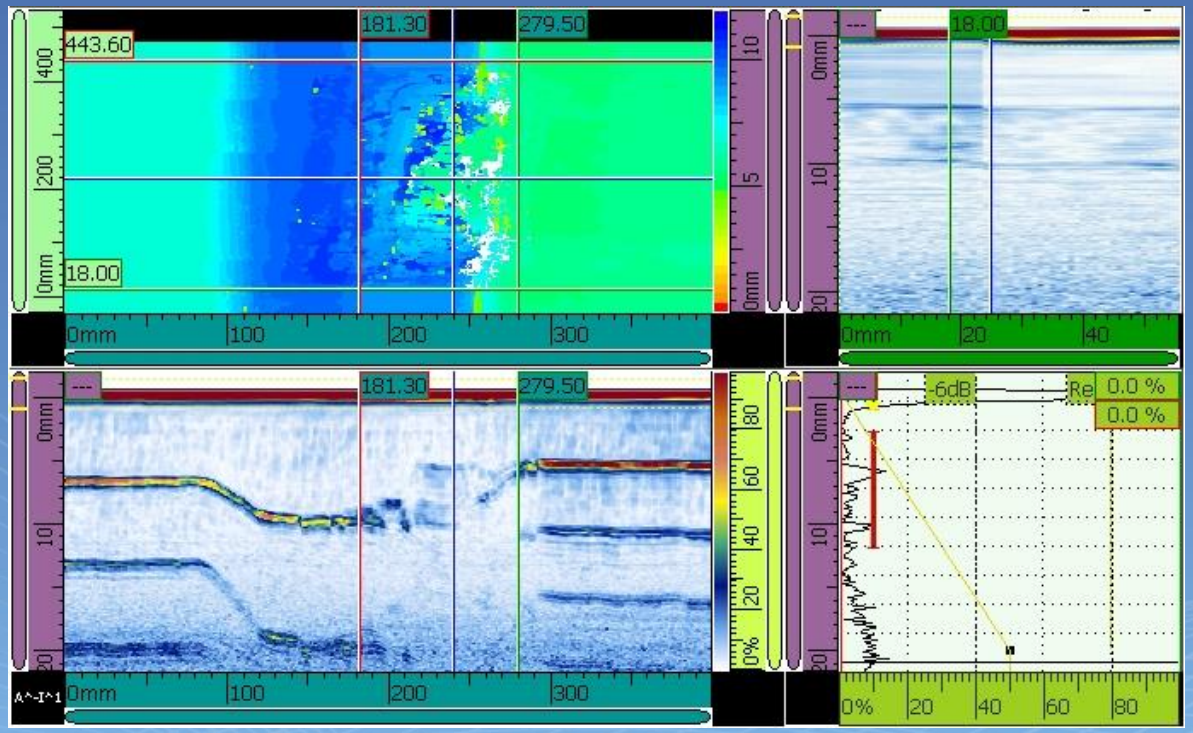
- Manual technique
- Single/Phased Array
- Sizing
- Classification
- Easy & quick
- Hard repeat



ID	Datum A	Datum B	Length 'mm'	Width 'mm'	Depth 'mm'	Comment
P1	1250-1310	65-90	60	25	3.2	Void
P2	7340-7425	130-210	65	80	4.8	Layer porosity 55%
P3	19210-19335	290-330	125	40	0.4-5.5	Impact damage
S1	19870-19940	300-350	70	50	0.8-5.5	Impact damage

Ultrasonic testing

Phased Array Ultrasonic - High quality monolithic CFRP
- C-scan recording



- Detailed analysis
- Advanced analysis
- Accurate sizing
- Repeatable

- Bespoke on-site inspection
- Curved surfaces

Chainplate assessment

Ultrasonic scan from outside of hull

- Mixed materials

- Assessment of key chainplate area
- Assessment of surrounding laminate

Further analysis

- Accurate sizing
- Classification of defect
    - Type/position

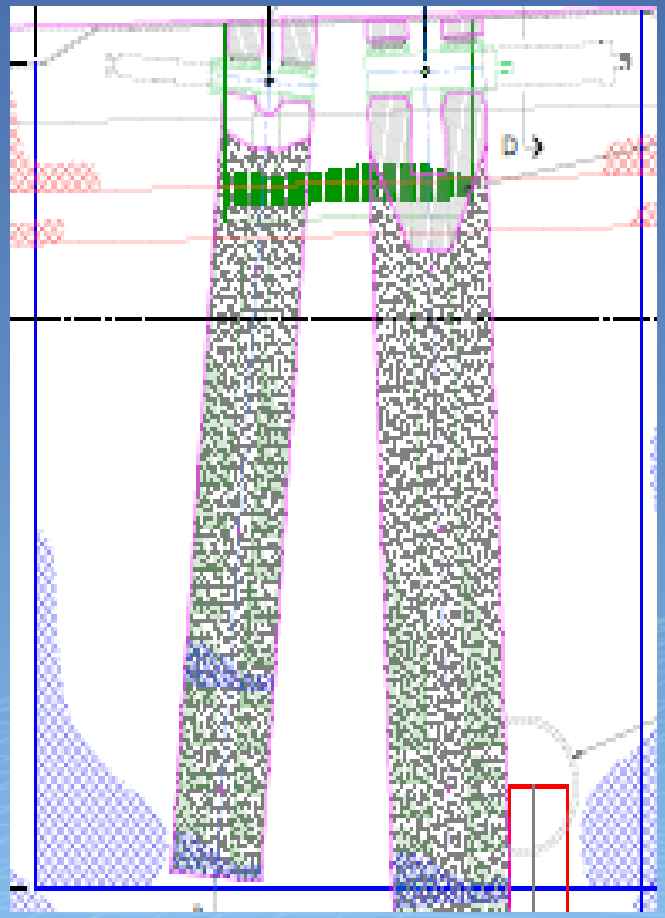
Set baseline

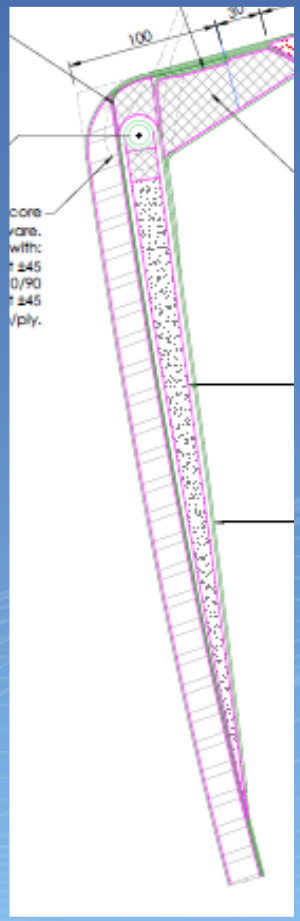
- Repeatable inspection
- Accurate monitoring

Chainplate assessment

Composite component – bonded and laminated into hull

- Mixed materials – GRP +CFRP + Foam + bonding

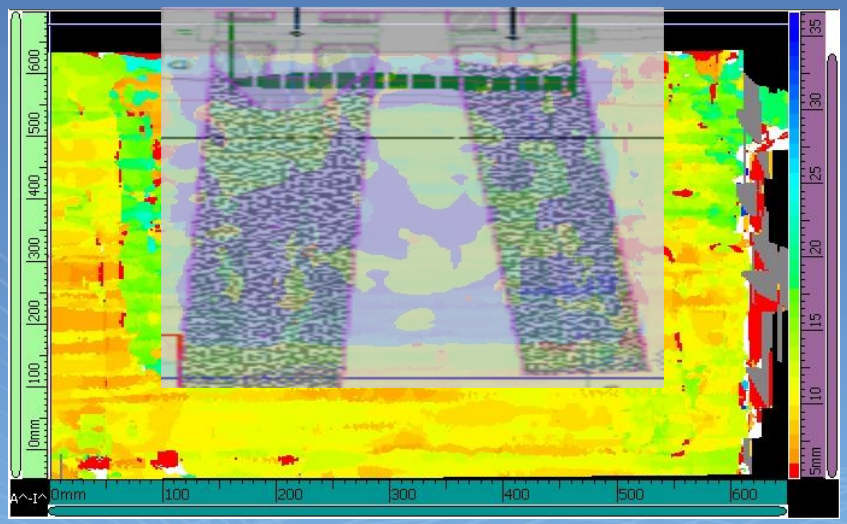




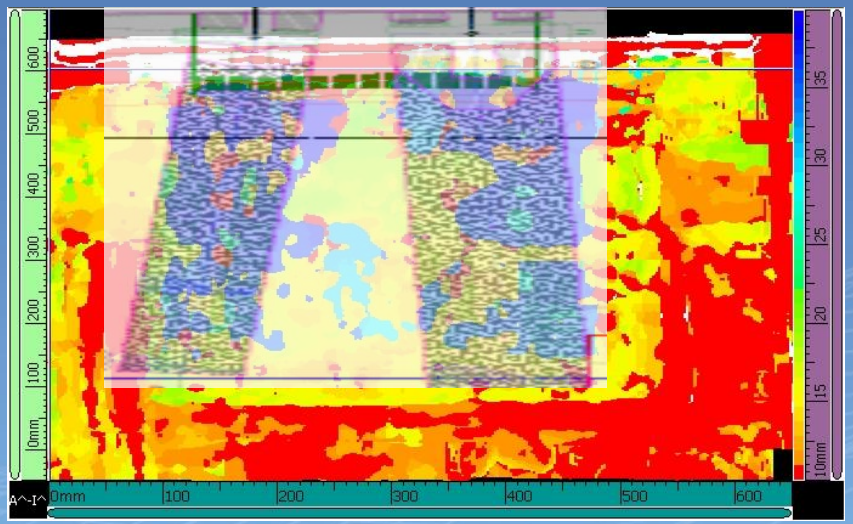
Chainplate assessment

Differences Port vs Starboard
- Monolithic skin thicknesses
- Variability across main area

Colours represent indications at varying depths
- Further analysis to determine position and classification



Starboard side

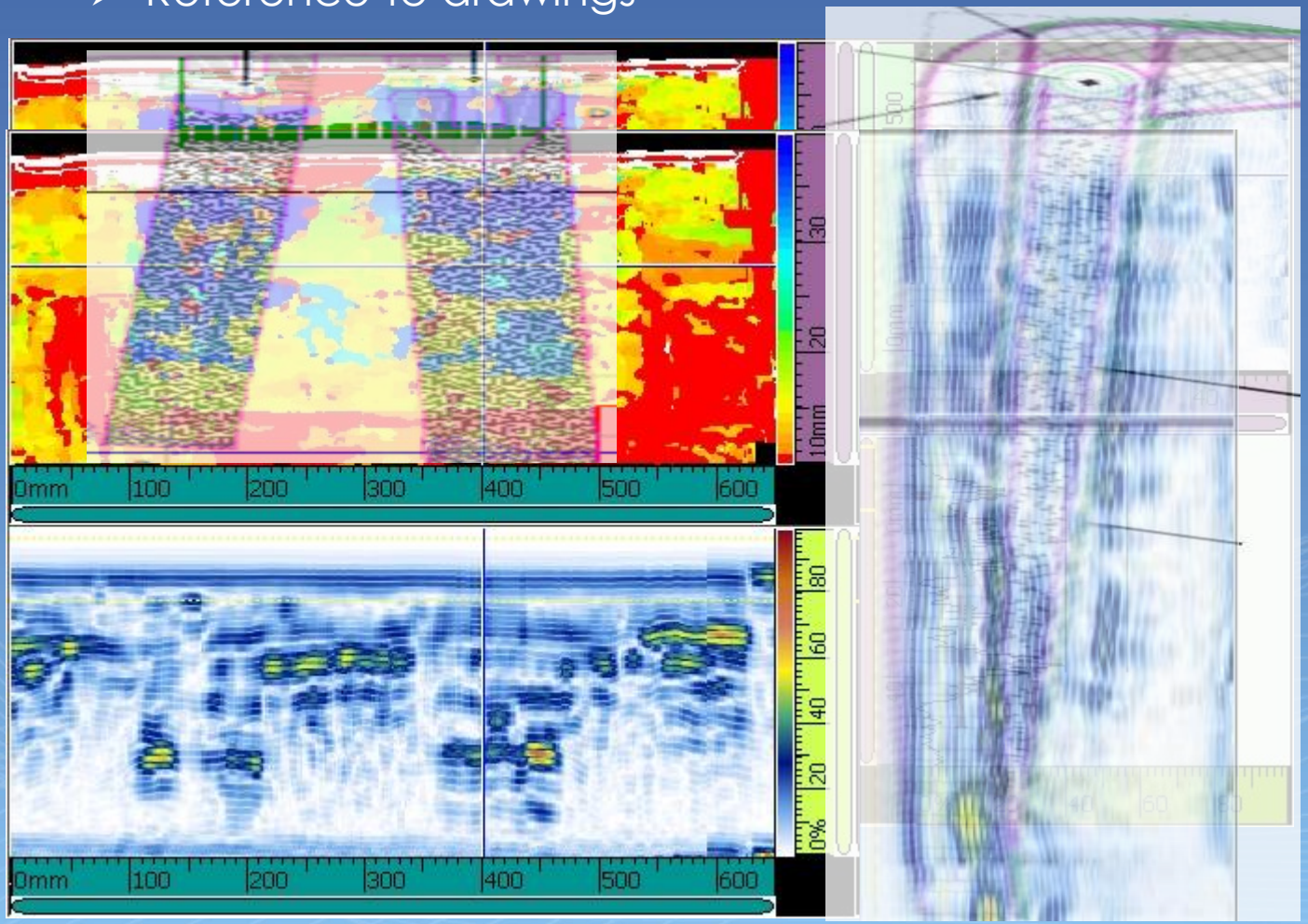


Port side

Chainplate assessment

Further analysis

- Reference to drawings



Chainplate assessment

Further analysis

- Clear explanation of findings

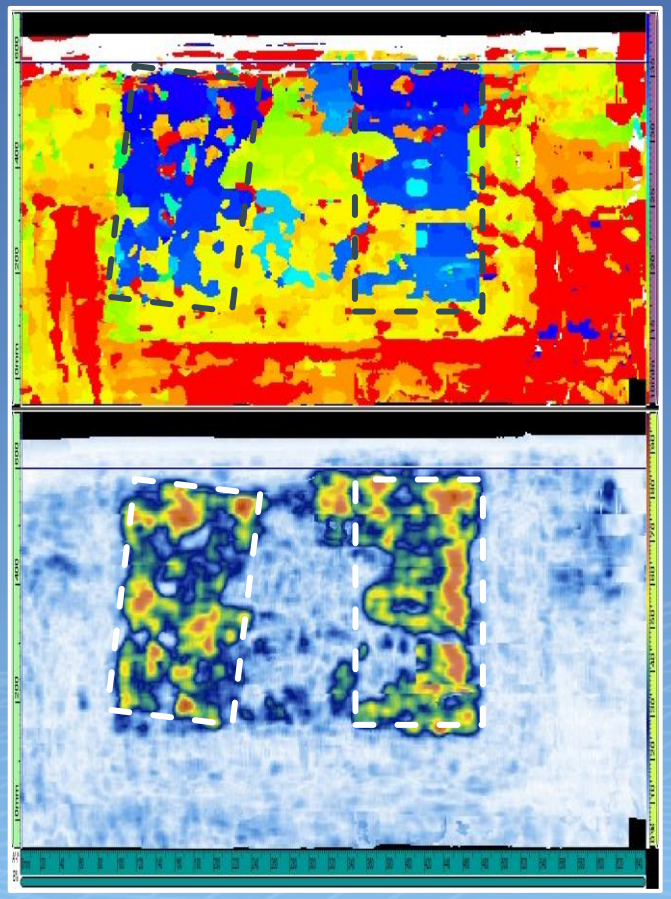
Blue – Full thickness through structure

Light blue – Far side former to QI infill interface

Green – Near side former to QI infill interface

Yellow – Skin tie to Chainplate structure interface

Red - Near surface (skin) indication



Orange – Strong amplitude response from full thickness

Blue – Moderate response from backwall

White – Very poor response from backwall indicating high impact of intermediate signals

Chainplate assessment

Inspection of complex laminate construction

- Assessment of various aspects of manufacture

  Further analysis
  - Accurate sizing
  - Classification of defect
    - Type/position

  Set Baseline
  - Communication of findings
  - Repeatable inspection
  - Accurate monitoring

Monolithic – complex indication

1. Quality assurance inspection
    - Complex pattern voids detected
        - C-scan analysis aids understanding and communication
    - Baseline report – including C-scans
        - Enable future comparison
    - FEA assessment
    - OEM warranty

2. Monitoring inspection
    - Comparison to baseline data
    - Repeat C-scan
    - Enable detailed analysis
    - Decision how to proceed

Monolithic – complex indication

High modulus, pre-preg, autoclaved, monolithic CFRP

Scan Area – S33

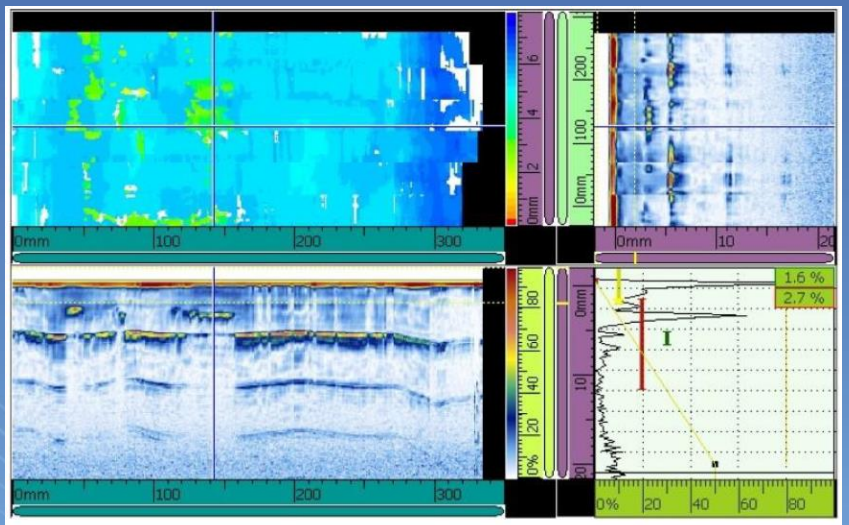


Figure 29 - Area S33 - ABCD scan - BASELINE.

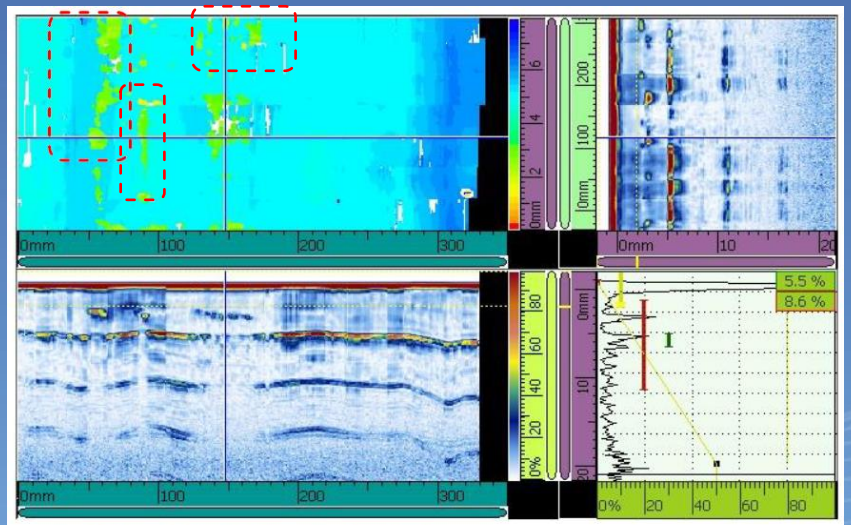


Figure 30 - Area S33 - ABCD scan - Jan 2021

1. Baseline Inspection
   - Complex indications
   - Assess scan images
   - Clustered voids on layer
   - Refer to OEM for analysis

2. Monitoring Inspection
   - Compare images
   - Growth/new indications
   - Refer to OEM for decision

Monolithic – complex indication

Scan Area – P35

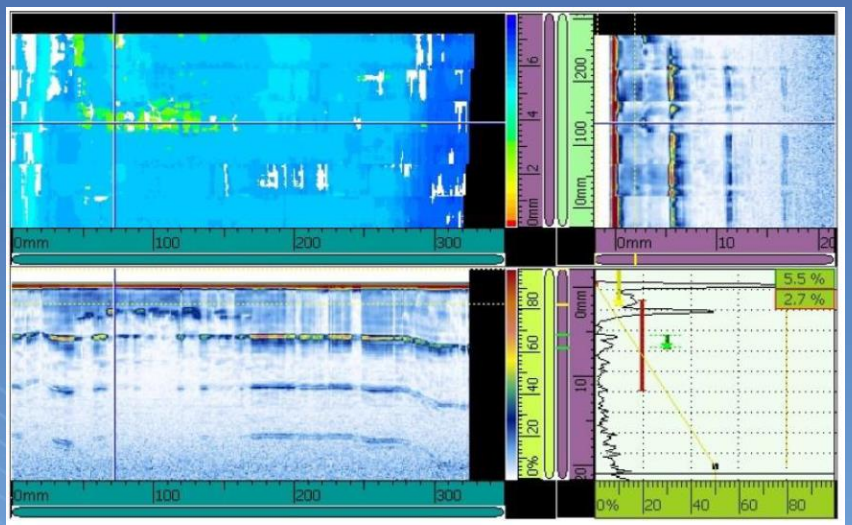


Figure 9 - Area P35 – ABCD scan - BASELINE.

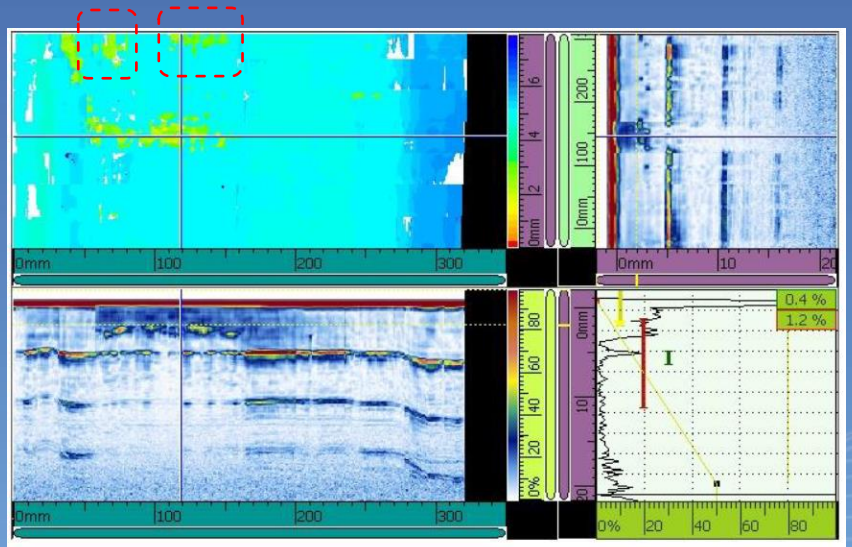


Figure 10 - - Area P35 – ABCD scan - Jan 2021

Comparison of images

- Some indications propagating
- Some indications stable
- Detailed information to OEM

Monolithic – complex indication

Non-destructive ultrasonic scan
- High quality monolithic CFRP

- Assessment of laminate

  Further analysis
  - Accurate sizing
  - Classification of defect
    - Type/position

  Set baseline
  - Repeatable inspection
  - Accurate monitoring

    Improved:
    - Analysis
    - Communication
    - Decision making

Blind-bond assessment

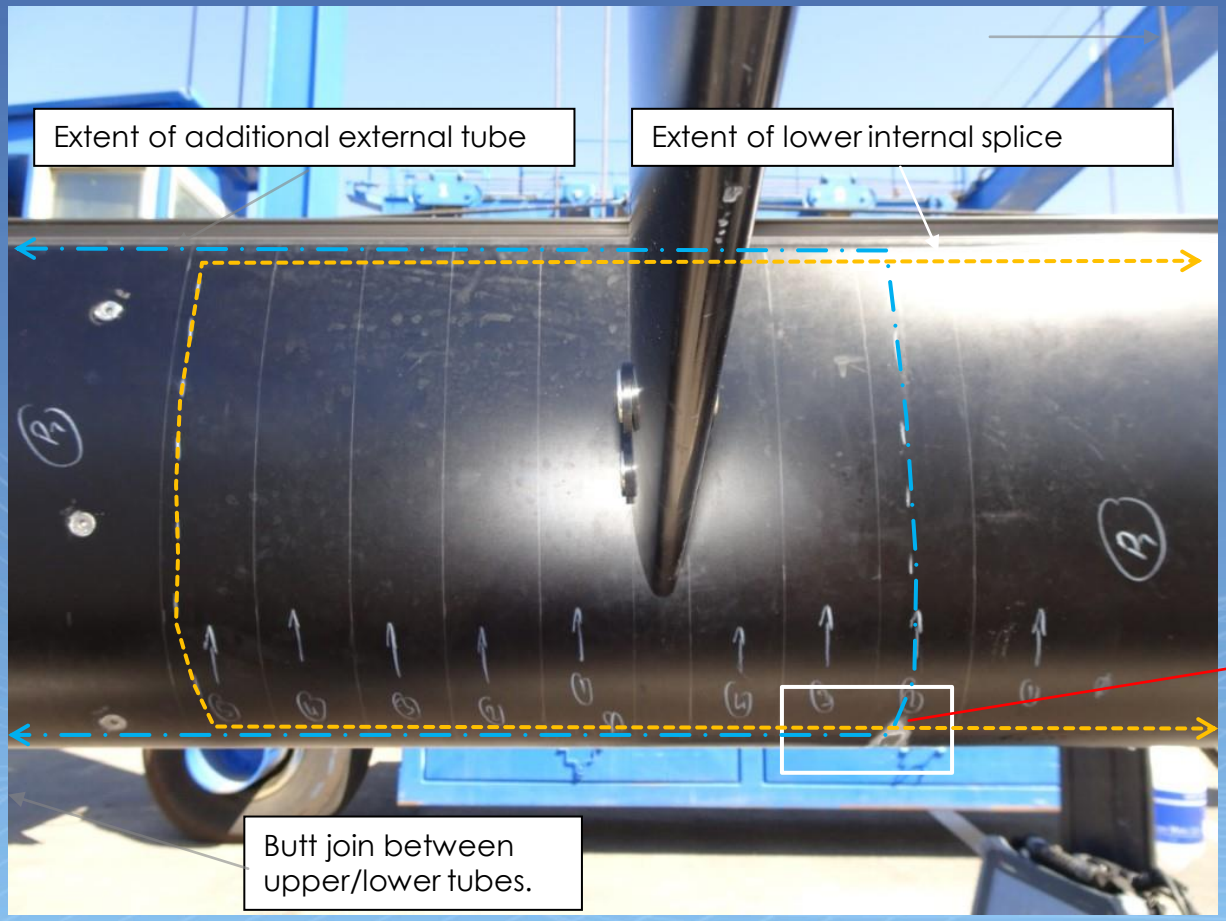
Investigation of reported issue
- Faulty bonded joint – poor performance
- Assessment of part
- Sizing of successful bond
- Communication of issue

Comparison to equivalent
- Assessment of findings
- Communication of findings

- Baseline report
  - Enable future comparison

Blind-bond assessment

High quality monolithic CFRP tube
- Blind-bonded sleeve join



- Lacking stiffness
- Leaking water
- Tricky construction
- One of several similar parts
- No other reported issues

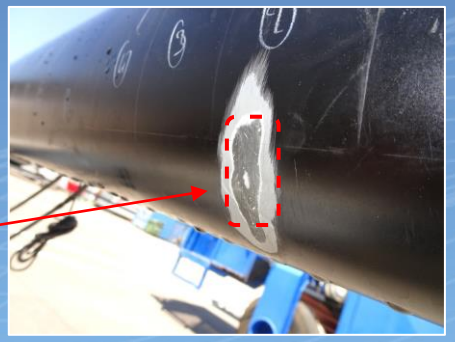
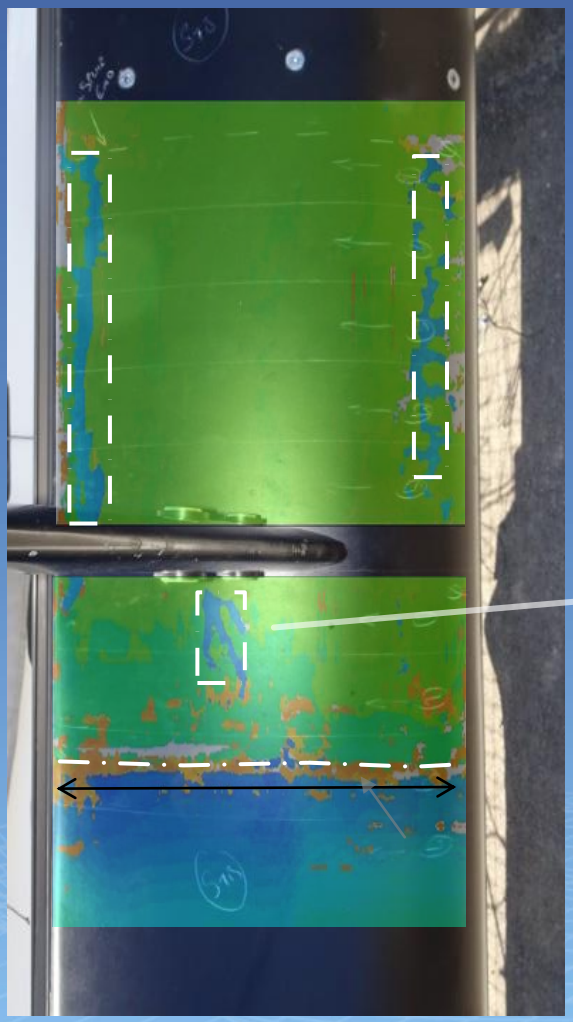
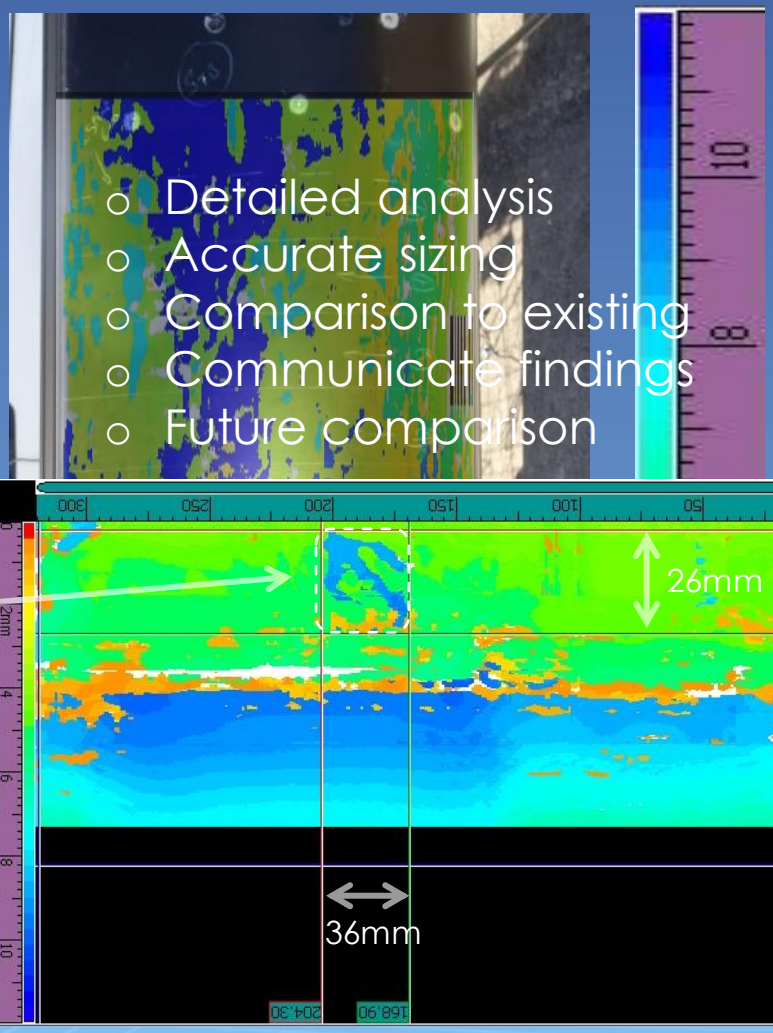


Figure 2 - Surface crack (ground back) where water leaks.

Blind-bond assessment





- Detailed analysis
- Accurate sizing
- Comparison to existing
- Communicate findings
- Future comparison

Mast A – Starboard side

Mast B – starboard side

Blind-bond assessment

1. Investigation of reported issue
    - C-scan to illustrate findings
        - Detailed analysis
        - Improved communication
    - Baseline report
        - Enable future comparison

2. Further assessment
    - Comparison to equivalent
    - Repeat inspection on similar part
    - Comparison to baseline data
    - Assessment of findings
    - Communication of findings

Decision making process

- Inspect
- Detect
- Assess
- Review

    - Action
        - Repair
        - Into service

            - Inspect
            - Detect
            - Assess
            - Review

Summary

Extra detail provided by C-scan recording
- Defect classification and sizing
- Accurate analysis
- Complex flaws
- Easier communication of findings

Baseline record
- Repeatable inspection
- Improved monitoring

Better decision making

Range of applications

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Any questions?

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