Phased Array Ultrasonic Testing (PAUT)

2015 DoD

Maintenance Innovation

Challenge





<u>Phased Array Ultrasonic Testing for Increased Accuracy and Repeatability</u> <u>of Structural Hull Weld Inspections</u>

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Background

- Maintenance Environment Hull Cutş
 - SUPSHIP 1-3-8 Rule
 - Rigging path / services
- SUBSAFE
 - Maximum Reasonable Assurance
 - Dives = Surfaces
 - "Keep Water Out of the People Space"
- URO MRC NDT Requirements
 - NDT surveillance inspections of hull cut welds
 - Ultrasonic statistical sampling inspections of hull welds
 - Ultrasonic monitoring inspections of hull welds with known discontinuities





Conventional Ultrasonic Testing - Challenges









- Discontinuity length and location are measured manually and are only recorded on paper.
- No permanent record of raw inspection data.
- Detection of discontinuities is highly dependent on orientation and the angle of the single fixed ultrasonic beam used.
- Follow-up ultrasonic scans to determine critical flaw size requires multiple set-ups utilizing several angles (transducers) and significant time.

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| | | UL | TRASON | IC WE | LD INS | PECTI | ION RI | EPORT | | | | |
|---|-----------------|---------------------------|-------------------|---|-------------------------|--------------|---------------|------------|------------|------------------------|----------------|-----|
| 1.SHIP/38 | -2 | 2. WELD IDENTIFI | CATION BB2 | | | | | | | | | |
| | | 5. STATION | 6. Швот. | 7. NO. | DISTANCE | | 10. LENGTH | DEPTH | | 13. AMPL. | 14. BEAM | ACC |
| 138 | STBD | 0" | | | ^{8.} FROM A | 9. FROM B | | 11. MIN | 12. MAX | | DIREC | REJ |
| | Сомр | MT | | 1 | 1.81 | .50A | ,63 | .00 | .05 | 3 | A | Аc |
| A HALF SKIP | | | X) N/A | 2. | 3.68 | ,00 | .63 | ,00 | .10 | 5 | A | Re |
| INSPECTION SURFACE | | | | 3 | 7.50 | .18F | .78 | .00 | .10 | 8+ | A | Re |
| ACCEPTABLE | | | | 4 | 9.13 | 1.19A | 1.25 | .00 | , /5 | 9 | F | Re |
| 20. PLATE MATERIAL 21. | | 21. PLATE THKNS | 22. WELD WIDTH | | | | | | | | | |
| | INSTR | UMENT | | | | | | | | | | |
| 3. MANUFACTURER and MODEL NUMBER 24. SERIAL NO. GEUSN60 GE-3 TRANSDUCER | | | | | | | | | | | | |
| 5. FREQUENCY | 28. SIZE | 27. SERIAL NO. | 28. ANGLE | | | | | | | | | |
| 2.2.2 D. COUPLANT | <u>94 x 1.0</u> | 30 CALIBRATION 38 3 9 | STANDARD | | | | | | | | | |
| NDTP 13 | URE 58-UTW | 32. ACCEPTANCE MIL-STD | STANDARD 2035A | | | | | | | | | |
| A INSPECTED BY 34. REVIEWED BY | | | 35. date 10-3 | MTE 37. WELD LENGTH REQUESTED 12.,0" 38. WELD LENGTH INSPECTED 10.0" ☑ ACCEPT WELD LENGTH INSPECTED 10.0" ☑ REJECT | | | | | | | | |
| 9. WELD JOIN | | ØF (FORWA | , RD, PORT, UP | ward) C | A (AFT, | STARBOA | RD, DOW | (NWARD) | | | , | |
| ⊢ | 2. | 34 | 56 | 7 | 89 | 10 | 11 | 12_ - | | $\frac{1}{2}$ | T ^V | Ţ |
| в | | **2. | | | #3 + | | ····· | | ₹. | 展 <u>2~</u> 1 14 | \mid | Y |
| A | · · | | PLAN VIE | w | | жŮг | | | L | N. | $\Box \gamma$ | |
| | | | | | | | | | | | | |





Solution: Phased Array Ultrasonic Testing



Phased array technology uses multiple ultrasonic elements (up to 256) and electronic time delays to create beams that can be steered, scanned, swept, and focused electronically for fast inspection, full data storage, and multiple angle inspections.





+35° to +70° Sectorial Scan





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PAUT Displays & Reports Provide

Traditional A-Scan (depth & amplitude)

S-Scan (Section view) Volumetric location, depth, height

C-Scan (Top view) Length, location, width

B-Scan (End view) Length, location, depth







<u>Video</u>

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Benefits

 Inspection data is encoded and stored digitally providing composite images of discontinuities, reducing dependence on the operator to visually identify discontinuities while scanning manually.



- Encoded data provides consistent location and length measurements resulting in increased accuracy for determination of indication growth for baseline and monitoring inspections.
- •Less time is required for inspection, saving on cost and schedule.
 - Calibration off ship, quick scan, analyze in shop/lab with supervisor.
 - Example: King's Bay

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Challenges & Risks

- Initial purchase cost of equipment ~\$78,000.
- Training of inspectors and oversight ~\$1,400 and 80 hours / person minimum training.
 - Level II Analyst
 - Level III Test Examiner
 - Maintaining certified personnel
- Possible obstacle: Need to develop requirements for personnel, equipment, and procedure qualification.
- DoD community awareness/exposure Today.
- Transition to a new program Current work at PHNSY, validating the technology / cost savings.

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Innovation Status

- Not only proven more accurate and reliable over traditional methods, also faster and less expensive.
- This is a mature technology with demonstrated capability.
 - Recently approved for use on USN Carbon steel pipe inspections, eliminating costly Radiographic Testing (RT)
 - Widely used in industry
- Current improvements:
 - Beam steering (-15 to +15).
 - Surface scans using creep waves.





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Vision / Final Thoughts

- With awareness and testing this can be integrated into other Navy and DoD maintenance processes, structural or otherwise.
- Technology is currently being further developed for increased use in materials other than carbon steel.
- Thoughts to Leave with You: Champion Change.

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Questions





detector screen

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