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APPROVED TRAINING ORGANISATION

NASA 411

Phased Array Ultrasonic Testing Curriculum

Revision control sheet:

Rev No:	Date:	Compiled by:	Reviewed by:	Revision Description:
0	01-Apr-25	Acacia Sureschandra	Nish Kanhaye	Implemented into the QMS.

1.0 Course Duration:

1.1 Level 1 and 2 Combined:

a) The minimum training hours administered in Level 1 shall be 40.

b) The minimum training hours administered in Level 2 shall be 80.

c) For Level 1 and 2 combined courses the total training hours shall be a minimum of 120.

1.2 In all cases, level 1, level 2 or combined level 1 and 2, NASA shall administer the full theory content of Level 1 and 2.

2.0 Course Content:

2.1 Theory: The table below shows theory aspects covered:

Chapter Reference:	Level 1:	Level 2:
1. Introduction, Terminology, History of NDT	**History of PAUT:** History of phased array ultrasonic testing. **Introduction to PAUT:** Overview Applicability and limitations Difference between conventional and ultrasonic phased array Techniques.	**History of PAUT:** History of phased array ultrasonic testing. **Introduction to PAUT:** Overview Applicability and limitations Difference between conventional and ultrasonic phased array Techniques.

2. Physical principles and associated knowledge	**Mathematical and Physical basics:** **Terminology:** • Sinusoidal movement • Amplitude • Frequency • Wavelength • Propagation velocity • Longitudinal waves • Transverse waves • Consideration of near field, beam spread, element width • Active aperture • Elementary aperture • Primary axis of an array • Secondary axis of an array	**Mathematical and Physical basics:** **Terminology:** • Sinusoidal movement • Amplitude • Frequency • Wavelength • Propagation velocity • Longitudinal waves • Transverse waves • Consideration of near field, beam spread, element width • Side lobes • Grating lobes • Artefacts • Active aperture • Elementary aperture • Primary axis of an array • Secondary axis of an array • Influence of band width • Electronical beam steering and focusing of sound beams

3. Product knowledge and related capability of the method and derived techniques	**Applications of PAUT:** • Defects relating to the manufacturing processes. Welding, Forgings, and Castings. • Implementation of PAUT techniques according to products and to expected discontinuities. • Overall properties of Specimen. **Capabilities:** Implementation of PAUT techniques according to products and to expected discontinuities. **Techniques:** Likely flaw types and flaw orientations per product, including probe type, beam type and encoder to optimise the scanning.	**Applications of PAUT:** • Defects relating to the manufacturing processes. Welding, Forgings, and Castings. • Implementation of PAUT techniques according to products and to expected discontinuities. • Overall properties of Specimen. **Material properties influencing PAUT:** • Defects relating to the manufacturing processes. Welding, Forgings, and Castings. **Capabilities:** Implementation of PAUT techniques according to products and to expected discontinuities. **Techniques:** Likely flaw types and flaw orientations per product, including probe type, beam type and encoder to optimise the scanning.

4. Equipment	**1. Test instrument and combined equipment:** • Phased array instrument **2. Phased array probes:** • Linear array • Annular array • Annular sectorial array • Acoustic properties of wedge materials that affect phased arrays • Encircling array • 1,5D array • Linear array with separate transmitters and receivers	**1. Test instrument and combined equipment:** • Phased array instrument • Multi-channel instrument (number of pulses and receivers that can be addressed) • Transmitting delay • Receiving delay • Delay laws • Amplitude balancing • Multi-group capability • Number of focal laws • Digitisation concepts and associated instrument settings (replication of analogue signal) • Axial, lateral and encoder resolution (effects of instrument settings) **2. Phased array probes:** • Linear array • Annular array • Annular sectorial array • Encircling array • 1,5D array • Linear array with separate transmitters and receivers

		3. Multi-group capabilities: • Number of focal laws that may be addressed **4. Encoders:** • Different types of scanner and encoding system **5. Couplant and Coupling Techniques:** • Couplant types, built-in irrigation systems or manually applied **6. Adjustment blocks:** • Block No 1 according to ISO 2400 • Block No 2 according to ISO 7963 • Reference block according to ISO 13588 • Different reference blocks

5. Information prior to testing	Not applicable	**Applied standards for UT and PAUT:** • Content

6. Testing	**Techniques:** • Linear scanning with zero-degree (forgings and castings) • Linear scanning with constant angle (welding) Sectorial scanning (welding, forging) • Typical applications of phased array techniques	**Techniques:** • Linear scanning with zero-degree (forgings and castings) • Linear scanning with constant angle (welding) Sectorial scanning (welding, forging) • Multi-group scanning Compound scans • Focusing techniques, including overview of dynamic depth focusing (DDF), total focusing method (TFM) and full matrix capture (FMC). • Range setting: – Single-point adjustment – Two-point adjustment. • Sensitivity setting: – Angle correct gain (ACG) – Reference reflectors (BW, SDH, FBH) – Single-reflector technique (reference height) – Requirements for reference blocks – DAC method – TCG method – DGS method • Typical applications of phased array techniques

7. Evaluation And Reporting	Not applicable	**1. Evaluation of indications:** • DGS method • DAC method • TCG method • Distinction between defect and geometry echo • Location of defects • Interpretation and evaluation of indications • Sizing of defects • A-, E-, S-, B- and C-scan interpretation **2. Reporting:** • Recording • Classifying of results according to written procedure • Storage of data files • Generation of reports

8. Assessment	Not applicable	• Evaluation and confirmation of test reports • Application of the acceptance criteria according to standards, • codes and procedures

9. Quality aspects	Not applicable	**Personnel qualification:** (according to EN ISO 9712) Equipment verification Written instructions Traceability of documents

10. Developments	Not applicable	Not applicable

2.2 Practical: The table below shows practical aspects covered:

Level 1	Level 2
See section 6 above.	
Rolled Plate: Apply focal laws for all groups Confirm beam exit points Set filters Calibrate sensitivity Calibrate wedge delay Set screen range Set gates Set scan type Set encoder details Calibrate encoder 1 Set scan area details Confirm index offset Set inspection sensitivity Save set-up	**Weld:** Apply focal laws for all groups Set filters Set index offset Calibrate sensitivity Calibrate wedge delay Calibrate TCG Set screen range Set gates Set scan area Turn encoder on Calibrate encoder 1 Ensure complete coverage of test piece Set inspection sensitivity Save set-up

3.0 Learning outcomes:

3.1 Upon completion of training, students should be able to carry out and understand the following regarding PAUT:

Level 1	Level 2
Basic principles General advantages and limitations Discontinuity categories Carry out pre-test checks, set up equipment, carry out tests and report results according to written instructions	Basic principles General advantages and limitations Discontinuity associated with manufacturing processes, categories and types Select test technique to be used Interpret codes, specifications and procedures. Compile instructions according to specifications, codes or procedures Carry out pre-test checks, set up equipment, perform tests and report results Interpret and evaluate test results according to specifications, codes or procedures.

4.0 Course Outcome:

4.1 Successful Completion of Training:

Upon successful completion of the course, a successful completion of training certificate at the level attempted will be issued which meets eligibility to undertake the external PCN examination.