

ULTRASONIC TESTING EN4179 LEVEL 2 SYLLABUS

DOCUMENT APPROVAL

Function	Name	Signature	Date
Nominated Level 3	KEITH PHILLIPS		09/03/2022
Lead NDT Instructor	ROB BILNEY		09/03/2022

General Theory

Instruction shall be given in the principles, limitations and theoretical aspects of the following:

- Introduction – brief history of the development of ultrasonic testing, essential features of ultrasonic testing and generation of ultrasonic waves; Basic aerospace product technology.
- Electromagnetic transducers (piezo-electric, magneto-strictive and electro-dynamic); Properties of the transducer (nominal and working frequency, plus bandwidth); Effect of different transducer materials.
- Wave properties – Types of wave, vibration, waves, sound waves, continuous wave and pulse; Units, relationship between frequency and velocity and wavelength.
- Principles of reflection and refraction of sound waves at inclined incidence; Factors affecting angles of reflection, refraction and mode conversion.
- Effect of reflector on echo response; Sound field: Influence of frequency, sound velocity and attenuation; Definition and use of decibel.
- Equipment construction and mode of operation.
- Block diagram of an ultrasonic instrument with a single and double transducer, controls and functions of ultrasonic equipment; Signal presentation: A, B, C scans.
- Types of probe – Normal beam, single and twin crystal and angle beam. Construction and mode of operation; Probe index; Beam angle and squint.
- Scanning techniques – manual, semi-automatic and automatic.
- Testing techniques (basic principles): Pulse-echo technique, measured values (transmit time echo amplitude), advantages and limitations.

**ULTRASONIC TESTING
EN4179 LEVEL 2 SYLLABUS**

- Contact scanning – couplant and protective layer; Gap scanning; Immersion testing; Through-transmission technique, measured value (intensity), advantages and limitations. Application of compression and shear waves.
- Calibration of testing systems – Timebase calibration: Normal, single & twin crystal and angle beam probes.
- Calibration blocks and reference blocks; Calibration checks; Effect of different sound velocities in calibration block and test piece.
- Measurement of wall thickness and flaw positioning using normal and angle beam probes.
- Sensitivity settings – simple methods, BWE, and DAC; Sensitivity and signal to noise ratio; Sensitivity and pulse duration.
- Effect of surface finish, geometry and attenuation in specimen.
- Physical principles of ultrasonic testing – Behaviour of sound waves for perpendicular incidences; Acoustic impedance; Reflection and transmission factors; Calculations of reflected and transmitted energy; Behaviour of sound wave for inclined incidence; Snell's law concerning reflection, refraction and mode conversion; Critical angles; Calculations; Interpretation and predication of boundary echoes; Time base position of mode converted echoes under known conditions; Influence on sound waves of reflector size (reflection, scatter, refraction, interference); Reflection at defined reflectors; Laws concerning distance and size of backwall echo, side drilled hole and disk reflectors; Comparison with real flaws; Sound field; Calculation and estimation of near field, far field and beam spread; Influence of properties of specimen on sound propagation, attenuation, cause, effect, measurement and attenuation coefficient; Surface shape and condition; Sound velocity, cause effect and measurement.
- Equipment – Probe construction and mode operation; Special probes, double crystal angle probes, focused probes and probes with different damping; Measurement of resolving power of angle probes; Correlation between resolution, frequency, penetrating power and damping; Amplifier characteristics, broad and narrow band, logarithmic, saturation, linearity suppression and DAC correction; Signal presentation and deeper knowledge of automatic test systems.

Specific Theory

Instruction shall be given in the following:

- Calibration of testing systems – Timebase calibration: Projected distance and shortened projected distance; Thin wall, curved surfaces and effect of different materials; Construction of reference lines and calibration of sensitivity with reference to backwall echo, side drilled hole and flat bottom drilled hole; Reference block and DGS methods; Measurement of the differences for surface condition and attenuation between test pieces and reference block. Correction for

**ULTRASONIC TESTING
EN4179 LEVEL 2 SYLLABUS**

transfer (coupling, attenuation) correction for attenuation depending on path length and correction for near surface defects.

- Detectability of defects – Advantages and limitations of the test method with regards to defect detection; Tandem techniques, transmission techniques, causes of spurious indications and other signals not associated with defects, also selection of methods for accurate sizing of defects; Types of signal from typical geometry, size, surface condition, metal composition and structure; Influence of surface coatings, heat treatment and repairs.
- Factors affecting the performance of ultrasonic testing – Relationship between properties of the material condition, attenuation and sound velocity; Testing of materials with differing attenuation characteristics, including austenitic steels; Selection of probe type, frequency and angle; Preparation of test surface; Selection of couplant and method; Influence of defect type, position and orientation on detection (size, geometry, distance from surface, orientation, reflectivity and opacity).
- Codes of practise and standards – Establishing of testing instructions considering application, equipment, technique, probes, calibration, operation of test and recording of test results.
- Conducting and recording the test – Procedure to be adopted to carry out the test required; Information to be recorded on the report including sensitivity levels; Flaw assessment and reporting.
- Interpretation of test results – Interpretation of test results to acceptance standards.

Reference material

- ASNT – Study guide
- Metals Handbook Volume 17 Non-destructive evaluation of quality control
- Supplement to SNT-TC-1A as appropriate
- Non-destructive testing handbook - R McMaster
- Inspection of metals: Visual Examination. - R Anderson
- Basic Metallurgy for NDT - JL Taylor
- Ultrasonic flaw detection for technicians – J. C. Dury
- Ultrasonic testing of materials – J and H Krautkramer
- Phased array testing – Basic theory for industrial applications – Olympus
- Ultrasonic testing classroom training book - ASNT