ULTRASONIC TESTING
EN4179 LEVEL 2 SYLLABUS

DOCUMENT APPROVAL			
Function	**Name**	**Signature**	**Date**
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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.

- 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 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