



NZ Non Destructive Testing Association Inc.

C/- HERA, PO Box 76-134 Manukau City, Auckland 2241

COURSE TITLE **ULTRASONIC INSPECTION Level 1 (Welds/Thickness)**

COURSE CODE **UT10A**

Revision **Initial Issue Dated 26 Apr 2021**

Purpose:

The body of technical knowledge required of non-destructive testing (NDT) personnel is essential for maintaining the quality level of all NDT inspections regardless of method or technique. The content and expected outcomes of this course are designed to cover the manual Ultrasonic inspection of product forms (including welds) for evaluation of thickness and internal discontinuities at qualification Level 1 (ISO 9712).

This course is also designed to prepare the trainee for the **Theory** part of the CBIP Ultrasonic certification **UTT1** and **UTW1**

NZNDTA is initially offering this course only as an option to be delivered in conjunction with UT20A (Welds Level 2).

UT20A course duration is 80 hours (10 days). It is anticipated that UTW1 and UTT1 candidates attending this course will benefit from the additional Level of training so that they will be better equipped for progression to Level 2.

Practical training and assessments have been included in this course for demonstration purposes and to confirm the adequacy of the training.

Introduction to specialized inspection techniques such as Phased Array (manual and encoded) and TOFD are included in the training, however additional formal training in these categories will be required before applying for certification in these techniques

Competency Standards:

This course and associated training materials have been designed to comply with the following documents

ISO 9712-2012 -Non-Destructive Testing - Qualification and Certification of NDT Personnel

ISO/TS 25107:2019 - Non-destructive testing — NDT training syllabuses

CBIP PRO-CER-18 - Guidelines for certification General

CBIP PRO-CER-17 - Guidelines for certification Ultrasonic testing



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Learning Outcome:

Trainees will be able to demonstrate knowledge of the ultrasonic inspection process including practical applications at certification Level 1

They should be able to perform the following;

- Set up and verify equipment settings.
- Perform specific manual UT tests in accordance with written instructions
- Report the results of Ultrasonic Inspections when authorized by the employer

A level 1 certified UT person shall work under the supervision, and be guided by a level 2 or 3 certified person.

A level 1 certified person shall not be responsible for the selection of the test procedure nor for the interpretation and evaluation of test results.

For Whom

Personnel involved in the manual UT inspection of all product forms for thickness and defect detection. Personnel seeking UT certification to Level 1 iaw CBIP PRO-CER-17 and ISO 9712.

Prerequisite

Trainees attending this course should have a basic understanding of the Ultrasonic method at an introduction level along with a working knowledge of basic mathematics including trigonometry. Prior knowledge of materials and processes is also required.

Trainees shall also have an understanding of English (written and spoken) to a level of TOEFL 500

Course Duration

The course will be delivered over a **minimum** period of 40 hours covering 5 days as required by CBIP and IOS 9712

A course plan detailing the expected timetable will be issued to the trainee at the start of the course. The course will consist of theory lecturers, practical exercises and assessments as detailed in the course programme and attached syllabi.

The practical content of this course can be delivered in the classroom or at the trainee's workplace.

Instructor

Course instructors shall be accepted by NZNDTA and their adequacy documented. Instructors should be qualified to L3 (or equivalent as determined by NZNDTA) in the Ultrasonic method. Subject Matter experts as determined by the Instructor may be used for specific training modules when required.



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Assessments:

Informal assessments will be allocated to trainees at the end of each day. These will be used for determining training effectiveness. The end of course assessment shall consist of a minimum of 40 questions adapted from the ASNT Recommended Practice SNT-TC-1A question and answer book. To successfully complete this course a minimum pass mark of 70% is required

Resources:

Trainees will be issued with training notes and handouts reflecting the training presentation as identified in the course program.

Course evaluation/feedback forms will also be supplied and upon successful completion of all modules, an NZNTA endorsed completion certificate will be issued.

It is expected that Trainees will supply their own UT units and probes suitable for the practical demonstrations. Trainees will also be provided with a list of training material required along with any Health and Safety requirements prior to commencement.

Course Program and Syllabi

The Course syllabus is designed to comply with CBIP PRO-CER-17 and ISO/TS-25107.

Course content has been derived from a variety of resources including equipment manufacturers and on line education packages.

Refer to appendix A for course content/syllabi and Instructors time table

Course Delivery

The course may be delivered by one (or a combination) of the following

- A. **Computer based interactive webinar.-** This will be confined to specific theory modules that do not include any practical content or where trainees are required to have only minimal participation. Trainees will have the ability to communicate with the instructor and other participants. Learning outcomes and training effectiveness will be evaluated by written assessments delivered at the end of each module
- C. **Classroom.-** Interactive classroom training where the trainee has access training material, equipment and test pieces.
- B. **Home study.** Trainees will be given written assessments that require them to review and interpret the training material at the end of each day/module
- D. **Workplace Practical Exercises** – Trainees will be given written practical exercises that can be completed at their normal place of work. This will enable trainees to access additional equipment and resources to complement their training. These will be supervised by the instructor or delegated representative to confirm and supervise the effectiveness of the training. The delegated representative will be approved by the instructor and NZNTA and will be at least UT Level 2 and IANZ signatory. This may be the trainees employer/supervisor. Training effectiveness will be evaluated by specific checks documented at each stage of the exercise.



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Appendix A

The course syllabi and instructor guide (appendix A) will detail the acceptable delivery system(s) and timing for each module.

Practical exercises are documented at the end of appendix A along with itemised practical training samples required for each exercise.

Minimum requirements for the UT equipment and probes to be supplied by the candidates for the practical exercises are also included.

Documentation Control

Course documentation will be approved, controlled and owned by NZNDTA.

Course APPROVAL:

NZNDTA Rep _____

UT Level 3 _____

DRAFT



Appendix A

Course UT10A Ultrasonic Inspection Level 1 Course Syllabi and Instructor Time Table

The following referenced material has been used to develop the structure and content of this Ultrasonic course UT20A

- CBIP PRO-CER-17 and 18 Training Guidelines
- ISO/TS 25107 Non-destructive testing — NDT training syllabus
- ANSI/ASNT CP-105 Qualification outlines
- ASNT Training handbook – Volume 7 Ultrasonic testing
- NDE/NDT Resource Center
- OEM supplied equipment training material

Module 1	
Introduction to terminology and history of Ultrasonic Testing (UT)	
Content	Timeframe and notes
Course introduction	Notes Ref UT20A
Basic Mathematics – Algebra, Trigonometry and Logs	
Introduction to NDT and Certification (ISO9712)	
Certification Responsibilities	
Certification Examination overview	
Terminology and Definitions	
Ultrasonic Inspection overview - Applications and capabilities	
History and current state of Ultrasonic Testing (UT)	
Confirmation of training effectiveness - Module 1	<ul style="list-style-type: none"> • Basic Maths questions and formula exercises • Review questions



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Module 2		
Physical principles and associated knowledge		
Section	Content	Timeframe and notes
Sound Waves	Ultrasonic Vibrations	Notes Ref UT20A
	Wave propagation	
	Sound Energy	
	Waveforms – Sine, Intensity, Pressure, Amplitude and Period	
	Wavelength	
	Wave Modes - Longitudinal	
	Transverse / Shear waves	
	Rayleigh waves (surface waves)	
	Lamb, Plate, Guided and Creeping	
	Frequency	
	Sound wave Velocities	
Wave Propagation	Transmission Reflection and Refraction	Notes Ref UT20A
	Snell's law	
	Critical angles	
	Relative Wave mode Amplitudes	
	Distance and Amplitude	
	Sensitivity and Resolution	
	Diffraction – Anisotropic materials	
	Scattering and Absorption	
	Acoustic Impedance	
	Interaction and Interference	
Sound Beams	Beamspread	Notes Ref UT20A
	Sound Beam Zones - Dead Zone	
	Near field	
	Far field (Fraunhofer zone)	
	Focal length	
	Beam Diameter	
	Side Lobes	
	Mode conversion	
Influence of test specimen	Shape and Contour of test specimen	
	Orientation and depth of Discontinuity	
	Signal-to-Noise Ratio	
Confirmation of training effectiveness - Module 2		<ul style="list-style-type: none"> • Review questions • Formula exercises



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Module 3 Transducers		
Section	Content	Timeframe and notes
Probes	Piezoelectricity and crystal planes	<ul style="list-style-type: none"> • Notes • Sample probes Ref UT20A
	Natural and Ceramic crystals	
	Transducer Construction	
	Contact Straight Beam Transducers	
	Dual Element	
	Immersion Transducers	
	Angle Beam Transducers	
	Probe shoes	
	Phased Array (PA) Transducers	
	Focused Transducers	
	Transducer Characteristics	
	Sensitivity and Resolution	
Pulse Length		
Waveform Spectrum and "Q" factor		
Couplant		
Confirmation of training effectiveness - Module 3		Review questions

Module 4 Ultrasonic Instrumentation		
Section	Content	Timeframe and notes
Display	Pulse-Echo A-Scan	<ul style="list-style-type: none"> • Notes • A scan display • DAC preparation Ref UT20A
	B Scan and C scan	
	Digital vs Analogue	
UT Controls	Pulser & Receiver	
	Filters	
	Delay, Range and Velocity	
	Amplifier, Gain and dB	
Alarm and Reject		
DAC		
Confirmation of training effectiveness - Module 4		Review questions



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Module 5 UT Applications		
Section	Content	Timeframe and notes
Information prior to testing	Customer requirements, product form, specification, job access and acceptance criteria	Notes Ref UT20A
General Techniques	Pulse echo contact testing	
	Through Transmission and Tandem	
	Immersion	
	Resonance	
	Phased Array, TOFD and Long Range	
Thickness testing	Single and Multiple Echo	• Notes • Practical exercises Ref UT20A
	Thin materials	
	Dual Transducers	
	Peak vs Flank	
	Measurement Methods AS 2452	
	Laminations and corrosion characteristics	
	Factors affecting results AS 2452	
Estimation of uncertainty – reliability of results		
Defect Sizing	Last Significant Echo	• Notes • Practical exercises Ref UT20A
	20 dB drop	
	6 dB drop	
	Echo Height (DGS)	
	Beam Profile plot	
Special techniques	Crack Tip Diffraction	Notes Ref UT20A
	Automatic scanning	
	Bond Inspection	
	Bolt Inspection	
	EMAT	
	High Temperature Inspection	
Recording and Reporting, job records, reports and Codes/Standards		• Notes • Report writing
Confirmation of training effectiveness - Module 5		• Review questions • Formula exercises • Practical exercises



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Module 6 UT Weld Inspection		
Section	Content	Timeframe and notes
Welding Processes and Terminology	SMAW	Notes Ref UT20A
	GMAW	
	FCAW	
	GTAW	
	SAW	
	Groove and Fillet welds	
	Welding position and joints	
	Electrodes	
Welder Certification	Guided Bend test	
	Fillet Weld break	
	Macro testing	
Weld Inspection	RT, PT, MT and VT	
Welding terms and Definitions	AWS A3.0M/A3.0:2010 - AS 2812	
Ultrasonic Weld Inspection	Choice of Probes	Notes Ref UT20A
	Basic Inspection procedures AS2207	
	Equipment verification and calibration	
	Transfer loss	
	Visual Inspection	
	Compression wave inspection	
	Shear wave root inspection	
	Shear wave weld area inspection	
	Transverse crack inspection	
	Defect Identification, plotting and sizing	
	Setting sensitivity for scanning and evaluation	
	Scanning Terminology and Defect signal behavior	
Formula		
Confirmation of training effectiveness - Module 6		<ul style="list-style-type: none"> • Review questions • Formula exercises • Practical exercises



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Module 6 continued UT Weld Inspection		
Section	Content	Timeframe and notes
Weld Inspection	Review sample questions	1 hour
Thickness and Weld Inspection	Thickness Inspection	Practical exercises Ref UT20A
	DAC and Transfer loss	
	Weld inspection <ul style="list-style-type: none"> • Parent material • Weld root • Weld area 	
	Defect sizing	
	Recording and reporting	

Module 7 Calibration, Verification and Standardisation		
Section	Content	Timeframe and notes
Calibration	Calibration, Verification and Standardisation	Notes Ref UT20A
Calibration blocks	IIW calibration blocks	
	Miniature angle beam	
	AWS Shearwave DSC	
	AWS Resolution	
	Thickness stepwedges	
	Distance and Area Amplitude blocks	
Calibration checks	Vertical Linearity	• Notes • Practical exercises Ref UT20A
	Horizontal linearity	
	Shear wave index and angle checks	
	Range calibration	
	Resolution	
	Dominant frequency, pulse length & dead zone.	
	Overall system gain	
Confirmation of training effectiveness - Module 7		<ul style="list-style-type: none"> • Review questions • Practical exercises



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Module 8 (MF20A)		
Product Knowledge and Manufacturing		
Section	Content	Timeframe and notes
Basic Steel manufacturing and manufacturing defects	Production of steel and fabrication processes.	<ul style="list-style-type: none"> • Practical exercises (Module 7) • Notes Ref UT20A
	Heat Treatment	
	Common defects associated with the processing methods	
	Casting Rolling and Forging (Wrought)	
	Welding and welding defects	
	Tubing, Pipe and Composite	
	Hydrogen Embrittlement	
In-service inspection	Corrosion and cracking	
	Fatigue	
Confirmation of training effectiveness - Module 8		Review questions

Module 9	
Examination preparation and sample questions	
Content	Timeframe and notes
Theory and Specific exam review	Ref UT20A
Practical exam preparation	
Ultrasonic Formula	
BINDT CP25 – Procedure and written Instruction preparation	
ASNZS 1554.1	
ASTM E 494 Published material ultrasonic properties	
AS 2452 and AS1710 (Thickness)	
AS 2207 (weld) and AS 4037 (Pressure Equipment testing)	
AS 2083 (Calibration Blocks)	
Review and CBIP examinations	Ref UT20A



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UT20A Practical Exercises – General and Thickness		
Test Piece Description	Identification	Practical Demonstration
IIW V1 Block – Steel SDH = 1.5mm diameter IIW V1 Block – Aluminium SDH 1.5mm diameter	V1 - S/n 0513-99 V1 - S/n 799731	<ul style="list-style-type: none"> • Sensitivity • Range calibration • Angle beam verification • Index point • Resolution • Beam profile • Dead Zone • Pulse Length • Dominant Frequency • System Gain • Linearity
IIW V2 Block - Steel SDH = 1.5mm diameter	V2 S/n 3886	<ul style="list-style-type: none"> • Angle beam calibration • Sensitivity
AWS Distance/Sensitivity Calibration (DSC) Block	DSC S/n 799730	<ul style="list-style-type: none"> • Shear wave sensitivity • Shear wave range calibration
IOW Beam Profile Block Steel	Locally Manufactured	<ul style="list-style-type: none"> • Beam profile • Resolution
ASTM E127 Distance/amplitude Area/amplitude blocks	Locally Manufactured	DAC
Steel and Titanium Step wedges (1 inch)	FE 0.1 – 1.0 TI 0.1 – 0.5	Thickness calibration
Carbon steel discs (20mm)	US022	<ul style="list-style-type: none"> • Thickness calibration • Thickness measurement • Reporting
Carbon steel pipe (corrosion) (10mm)	US023	<ul style="list-style-type: none"> • Thickness measurement • Reporting
Stainless steel pipe (0.100")	S0091-1	Thickness measurement
Forged Aluminum Blocks (75mm) and Plate	US020 and US021	<ul style="list-style-type: none"> • Defect location • Thickness measurement • Datum • Defect Sizing
Cast Iron block	USP	<ul style="list-style-type: none"> • Velocity measurement • Thickness measurement
Steel bolts	USB1-6	<ul style="list-style-type: none"> • Defect location and datum
Various Plate and Pipe samples (FE,AL,SS, SG)	Refer Practical list	<ul style="list-style-type: none"> • Accuracy comparisons • Coatings and scanning



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UT20A Practical Exercises - Weld

Test Piece Description	Identification	Practical Demonstration
Single V Butt Weld Plate 10 mm Carbon steel (5)	3PI-1-14 3PI-2-14 3PI-3-14 3PI-4-14 3PI-5-14	<ul style="list-style-type: none"> • DAC • Transfer Loss • Defect detection • Parent Material scanning • Weld root scanning • Weld area scanning • Defect evaluation • Defect sizing • Datum • Reporting
Single V Butt Weld Plate 16 mm Carbon steel (2)	3PI-6-14 3PI-7-14	
Double V Butt Weld Plate 16 mm Carbon steel	3PI-8-14	
Single V Butt Weld Pipe 12 mm Carbon steel	3PI-G-45	
Single V Butt Weld T 10 mm Carbon steel	3PI T -14	

UT20A Practical Exercises - Equipment

All UT equipment and probes used for the practical thickness exercises shall have an A scan presentation and comply with AS 2452 Section 5.2

All UT equipment and probes used for the practical weld exercises shall comply with AS 2207 Section 2

Ultrasonic testing (UTT1 and UTW1):

A scan ultrasonic test instrument with adjustable repetition rate and pulse length – Freq. 1 to 10 MHz minimum. It shall also be equipped with a stepped gain control in units of 2.0 dB or less and have both send and receive jacks for operation with twin crystal or dual search units.

Cables as applicable to connect probe and instrument;

Angle Probes:

- (i) 45°, 2 to 5 MHz
- (ii) 60°, 2 to 5 MHz
- (iii) 70°, 2 to 5 MHz

Straight beam probes

- (iv) Twin crystal probe (2 to 5 MHz)
- (v) Single crystal (normal) probe (2 to 5 MHz)