NDT LABS

Course Outline

Course Name: CGSB Ultrasonic Testing (UT) Level 1

Course Description

The CGSB Ultrasonic Testing (UT) Level 1 course is an introductory course designed to teach technicians the principles and methods, calibration and performance checks, weld inspection, specifications, and result interpretation through lectures and hands-on labs. The course covers inspections of various samples, including welds, castings, forgings, and rolled products, and provides both theoretical and practical training to meet NRCan and CAN/CGSB-48.9712 requirements. Completion of this course prepares students for the UT Level 1 CGSB certification exams. ***Before enrollment, students must complete the Math requirement and pass the Materials and Processes examination.***

Course Duration

Total 64 hours (60% Theory + 40% Practical)

Delivery Method

Training takes place at A. I NDT Labs Training Facility, located at #3120-580 Nicola Avenue, Port Coquitlam.

Course Curriculum

Section	Subject
1.Introduction	1.1 History and Discovery of Non-destructive Testing and Ultrasonic Testing 1.2 Purpose of Ultrasonic Testing ● At what stage of the life of a “product” is NDT performed? ● How does it add value? ● Responsibilities of each level of certification. ● NRCan NDTCB Code of Conduct 1.3 Basic principles of UT 1.4 Capabilities and limitations of UT 1.5 Terminology associated with UT
2.Introduction to Sound Waves	2.1 Definition of Ultrasonic Vibrations 2.2 Frequency, velocity, and wavelength 2.3 Modes and forms of waves ● Compressional waves ● Shear waves ● Rayleigh waves ● Lamb waves 2.4 Composite (pulse) and standing (continuous waves) ● Nominal frequency ● Fundamental frequency ● Harmonic frequency ● Resonance 2.5 Basic waves physics of sound beam ● Fresnel and Fraunhofer zones ● Effects of D and A on beam spread 2.6 General applications of ultrasonic vibrations
3.Principles of Sound Wave Propagation	3.1 Snell’s law of refraction ● Refraction ● Reflection ● Mode conversion ● Critical angles ● Acoustic pressure transmitted through and reflected from boundaries 3.2 Perpendicular incidence of sound wave on single, plane interfaces ● Acoustic impedance ● Acoustic pressure transmitted through and reflected from boundaries

	3.3 Perpendicular incidence of a sound wave on multiple interfaces ● Sound transmitted through thin plates and thin gaps ● Sound reflected from thin plates and thin gaps 3.4 Curved interfaces as reflectors and lenses 3.5 Reflection in a right-angled edge and in a corner 3.6 Phase reversal of sound waves 3.7 Diffraction, dispersion, and attenuation
4.Piezoelectric Methods of Generating and Receiving Ultrasonic Waves	4.1 Piezoelectricity, types and properties of piezoelectric materials ● Lead zirconate-titanate (PZT) ● Barium titanate (Ba tIO3) ● Lead metaniobate (PbNb2O6) ● Lithium sulphate (LiSO4) ● Quartz (SiO2) ● Lithium niobate (LiNbO3) ● Polyvinylidene fluoride (PVDF) polymer 4.2 Construction of ultrasonic search units 4.3 Characteristics of search units ● Frequency-crystal thickness relationships ● Conversion efficiencies of various piezoelectric materials ● Damping, resolution, and sensitivity ● Beam divergence ● Nominal frequency, bandwidth, and Q factor ● Lenses and focusing ● High temperature and radiation effects 4.4 Types and configurations of ultrasonic search units ● Straight beam and angle beam search units ● Dual element search units ● Mechanically focused search units ● Electronically focused search units ● Linear and annular array search units ● Creeping wave search units 4.5 Care of ultrasonic search units
5.Other Methods of Generating and Receiving Ultrasonic Waves	5.1 Electromagnetic-acoustic transducers (EMATS) 5.2 Magnetostrictive transducers 5.3 Laser-excited transducers
6.Ultrasonic Testing Methods	6.1 Description of contact testing ● Straight beam ● Angle beam ● Rayleigh waves ● Lamb waves

	• Through transmissions 6.2 Description of immersion testing • Straight beam • Angle beam • Through transmission 6.3 Modified immersion testing • Tests employing special devices 6.4 Diffraction techniques 6.5 EMATS

7.Ultrasonic Testing Equipment: Description and Operation	7.1 Basic analogue pulse-echo instrument with A-scan
	
	• Time-base (synchronizer) circuit
	• Pulser circuit
	• Receiver or echo-amplifier circuit
	• A-scan display circuit
	• Purpose and adjustment of external controls
	
	7.2 Basic digital pulse-echo instrument with A-scan presentation
	
	• Data acquisition
	• Data processing and display
	• Data recording
	• Purpose and adjustment of external controls
	
	7.3 B-scan and C-scan displays
	
	7.4 Multi-functional digital flaw detector systems with high-resolution alphanumeric and graphic display
	
	• Data acquisition
	• Data storage
	• Data processing
	  ○ Signal averaging
	  ○ Synthetic aperture focusing techniques (SAFT)
	  ○ Spectrum analysis
	  ○ Others
	• Data display format
	  ○ A-scan
	  ○ B-scan
	  ○ C-scan
	  ○ D-scan
	  ○ Composite
	• Data recording
	
	7.5 Scanning equipment
	
	• Manual scanning
	  ○ Immersion units
	  ○ Portable units
	• Automatic scanning
	  ○ Immersion units
	  ○ Portable units

8.General Ultrasonic Testing	8.1 Selection of ultrasonic testing method

Procedures	• Contact, immersion, or gap testing
	• Manual or automated testing
	• Pulse-echo or through-transmission testing
	• Compressional, transverse, surface, or plate waves
	
	8.2 Determining the performance characteristics of the equipment
	
	• Vertical and horizontal linearity
	• Near and back surface resolution
	• Sensitivity and noise
	• Vertical and horizontal profile of the sound beam
	• Evaluating characteristics of the ultrasonic search unit
	• Frequency spectrum
	• Relative pulse-echo sensitivity
	• Others
	
	8.3 Ultrasonic test standardization-description of reference blocks and calibration techniques
	
	• Distance amplitude blocks
	• Area amplitude blocks
	• Resolution blocks
	• IIW blocks
	• IOW block
	• DSC block
	• Others
	
	8.4 Selection of coupling media, checking of coupling, coupling through intermediate layers
	
	8.5 Selection of ultrasonic testing parameters
	
	• Instrument parameters
	  ○ Sweep delay
	  ○ Sweep range
	  ○ Sensitive level
	  ○ Reject
	  ○ Damping
	  ○ Pulse repetition rate
	  ○ Frequency
	  ○ Others
	• Transducer parameters
	  ○ Type
	  ○ Size
	  ○ Frequency
	• Scanning parameters
	  ○ Motion
	  ○ Speed
	  ○ Index
	
	8.6 Flaw sizing techniques
	
	• By comparing the echo amplitude
	• By using DGS diagrams
	• By dB drop methods
	• By time of flight diffraction (TOFD)
	• Others
	
	8.7 Code requirements
	
	• Inspection procedures serving quality control functions

	• Inspection procedures serving fitness-for-purpose functions 8.8 Test records • Data sheets

9.Variables Affecting Test Results	9.1 Instrument performance variation
	
	9.2 Search unit performance variations
	
	9.3 Inspected part variation
	
	• Entry surface condition
	  ○ Surface roughness
	  ○ Surface coatings
	  ○ Surface curvatures
	• Part size and geometry
	  ○ Sound beam behaviour on approaching boundaries parallel to the beam axis
	  ○ Secondary echoes produced by the split-off transverse waves (64° in aluminum)
	  ○ Screen patterns when testing a plate
	  ○ Interfering surface wave echoes
	• Metallurgical structure
	
	9.4 Discontinuity variations
	
	• size and geometry
	• Distance from entry surface
	• Orientation to the entry surface
	• Type of discontinuity-reflecting characteristics

10.Interpretation and Evaluation of Test Results	10.1 Separating flaw indications from irrelevant indications
	
	• Identifying signals caused by electrical interference
	• Identifying signals caused by external ultrasonic sources
	• Identifying interfering surface wave echoes by damping with an oily finger
	• Identifying mode converted signals by damping with oily finger, and/or distance calculations, and/or nothing their position on the CRT screen
	• Retesting from different directions
	
	10.2 Flaw characterization
	
	• Determining the nature of a flaw on the basis of:
	  ○ Location
	  ○ Echo dynamic patterns
	  ○ Knowledge of material structure and part configuration
	  ○ Past experience with part inspection
	• Size measurements
	• Spectroscopy
	
	10.3 Code requirements
	
	• Evaluation based on fitness for purpose criteria
	• Evaluation based on quality control or workmanship criteria

	11.1 Testing of semi-finished products

11.Applied Ultrasonic Testing of Materials and Establishing of Techniques	11.2 Testing of very thin materials 11.3 Testing of pipes and cylinders 11.4 Testing of tubes 11.5 Testing of forgings 11.6 Testing of castings 11.7 Testing of assemblies (welded, bolted, press-fitted) 11.8 Testing of composite materials 11.9 Testing at high temperatures 11.10 Thickness measurements 11.11 Special testing problems
12.Automation and the Role of Computers	
13.Standards, Codes, Specifications and Reports	13.1 Standards CAN/CGSB 48.9712, Certification Scheme 13.2 Standards, specifications, and codes • Interpretation of standards, specifications, and codes • Defining the scope of the examination • Definition of acceptance criteria • Establishing specifications • Technical evaluation of given specifications 13.3 Reports • Establishing reports • Technical estimation of reports • Technical evaluation of reports • Implementation of corrective actions
14.Specialized Ultrasonic Techniques Advanced UT Methods	• Phased Array crack tip diffraction for the welding industry • Laser ultrasonic inspection specifics for the composite industry, Ultra-thin ultrasonic thickness measurements for the plastics Skwirter systems specifics • General subjects on PA and TOFD advantages/disadvantages, probes, display types, etc
15.Types of Discontinuities Detected by Ultrasonic Testing	15.1 Indications, discontinuities, inherent, processing and service flaws 15.2 General types of flaws most commonly found in wrought, cast and welded products, and their general appearance
16.Human Factors Affecting	16.1 The inspector’s health

Quality of Testing	16.2 The inspector's mental attitude and any fatigue 16.3 Understanding the important role of inspection (e.g. thoroughness, carefulness, and vigilance) 16.4 What influences the inspector's probability of detection 16.5 Understanding the NRCan NDTCB Code of Conduct
17.Industrial Materials and Manufacturing Processes	
18.Other NDT Methods	18.1 Certification and accreditation of NDT facilities
19.Creating a Written Instruction	19.1 Ability to prepare a detailed NDT instruction providing written step-by-step information on the testing of a sample and to prove the instruction by application Overview: • The requirements of test personnel • Safety Precautions Identification or description of test specimen: • Surface condition • Object to be tested • Kind of manufacture • Extent of test coverage Test conditions and application: • Accessibility • Equipment, calibration standards, and accessories • Particular inspection stage Techniques and sequence of performing the test: • Surface preparation • Order of inspection • Report of finding size, location • Post-test operations
20.Creating a Written Procedure	20.1 Ability to prepare a detailed NDT procedure whose content would include the following: • Scope • Reference documents • Definitions • Safety precautions • Personnel qualification and certification • Part/Product identification and datums • Surface preparation • Extent of inspection • Equipment details, calibrations, and checks • Inspection technique

	• Results assessment, flaw characterization, interpretation, and evaluation against acceptance criteria • Noncompliance and disposition • Reporting Tables, figures, appendices

What to bring

Students are required to bring a scientific calculator, pens, pencils, and a ruler to class. For lab sessions, safety shoes (Steel-toed) and long pants are mandatory for safety.

Instructor

Our company has five certified instructors, each holding CGSB/CWB Level 2 and Level 3 certifications and P.Eng. designation in their respective NDT methods. They bring extensive industry experience and practical knowledge to ensure high-quality, professional training.

Entrance requirement

1) Majority

The age of majority requirement comes into effect for the date of certification issuance, not the application submission date.

*All participants must submit a copy of their ID to verify their legal age.

2) English Proficiency

Participants from abroad must demonstrate English proficiency to ensure successful participation in the course. Acceptable proof includes:

- CLB minimum 6, or
- Completion of a high school or post-secondary program in a country where English is the primary language (transcripts may be accepted).

3) Pre-requisites

In order to take the CGSB PT course, all participants must provide evidence of completion for the following subjects;

(1) Math for NDT

Participants shall demonstrate that they have completed Math. This can be achieved by submitting proof of completion using one of the following methods:

- Transcript of Math for NDT exam at AEC or
- Transcript of Math for NDT exam at RTO

(2) Materials & Processes

- Transcript of a minimum of 32 hours of the Materials & Processes course at RTO or
- The transcript shall indicate that they have scored 70% or higher

Student Evaluation

1) Attendance

If a participant does not attend the course at least once, they cannot pass the course even if they receive a passing grade.

2) Quiz

The instructor may administer two quizzes throughout the course.

3) End-of-Course Exam

The end-of-course exam is administered after the completion of the entire course.

4) The Final Grade

The participants must achieve a passing grade (>= 70%) on the final examination for certification.

Remediation policy

- If the students fail the final course exam, he/she may re-take the one-time repeat exam in 2 weeks.

- The students who achieve a failing grade of 60% or above may apply to attempt a repeat exam immediately.