# Ultrasonic Testing (UT)

## Course Curriculum

## Table of Contents

## Who we are?

African NDT Centre (Pty) Ltd is an NDT training and service provider organization located in Roodepoort, South Africa, providing complete solutions for NDT training and inspection.

**We conduct training for PCN certification for level 1,2 and 3 in the following methods:**

- PCN - Eddy Current Testing (ET)
- PCN - Ultrasonic Testing (UT)
- PCN - Magnetic Particle Testing (MT)
- PCN - Liquid Penetrant Testing (PT)
- PCN - Radiographic Testing (RT)
- PCN – Radiographic Interpretation (RI)
- PCN – Basic Radiation Safety (BRS)
- PCN – Visual Testing (VT)
- PCN – UT Phased Array (PAUT)
- PCN – UT Time of Flight Diffraction (TOFD)

## How to Book Your Training Course

To book a training course, simply contact us via phone or email and we will be happy to discuss your requirements. If necessary, we can provide advice on which type of training and certification is appropriate for you or your company.

Courses can be booked and paid online on the following links:
ANDTC Constantia Kloof Campus: https://andtc.com/courses-constantia-kloof/
ANDTC Vaal Training Centre: https://andtc.com/courses-vaal/

Training courses are conducted on a regular basis at both our branches, and PCN examinations are run ongoing at our Roodepoort Examination Centre.

## Contact Us

### ANDTC Constantia Kloof

**AFRICAN NDT CENTRE (PTY) LTD**
21 Constantia Boulevard, Constantia Kloof
Roodepoort, 1709, Gauteng

**Phone or WhatsApp:** +27 (0)69 122 9848
**Email:** Bookings@andtc.com
**Web:** www.andtc.com

**PCN ATO Authorization Number: 0838**

### ANDTC Vaal

**AFRICA NDTC VAAL (PTY) LTD**
8 Leeuwenhoek Street, Duncanville,
Vereeniging, 1939, Gauteng

**Phone or WhatsApp :** +27 (0)73 223 1832
**Email:** info@andtc.com
**Web:** www.andtc.com

**PCN ATO Authorization Number: 0837**

## What is Ultrasonic inspection?

Ultrasonic Testing (UT) is a non-destructive testing (NDT) method that uses high-frequency sound waves (ultrasonic waves, typically 0.5–25 MHz) to detect internal flaws, measure material thickness, or evaluate material properties in objects without causing damage.
How It Works:

1. Sound Wave Generation: A piezoelectric transducer (probe) converts electrical energy into ultrasonic waves, which are pulsed into the material.
2. Wave Propagation: The waves travel through the material until they encounter:
    - An interface (e.g., a defect like a crack, void, or inclusion).
    - The opposite surface (back wall).
3. Echo Reflection: Part of the wave reflects back to the transducer as an echo.
4. Signal Analysis: The transducer receives the echo, converts it to an electrical signal, and displays it on a screen (A-scan, B-scan, or C-scan). Key data includes:
    - Time of flight: Time between pulse and echo → determines depth/location.
    - Amplitude: Strength of echo → indicates defect size or type.

Applications:

- Weld inspection (pipelines, pressure vessels).
- Corrosion mapping (thickness measurement in tanks, pipes).
- Aerospace (composite delamination, bond testing).
- Railroad (wheel/axle crack detection).

Advantages:

- Highly sensitive to small defects.
- Portable and real-time results.
- No radiation (unlike radiography).

Limitations:

- Requires skilled operators.

## About the Course

### PCN Level 1&2

This course equips participants with a comprehensive understanding of the theory and practical application of ultrasonic testing for welds. It prepares and qualifies candidates for PCN Level 1 or Level 2 certification in ultrasonic testing.

### PCN Level 2 UT 3.8 & 3.9

This advanced course expands your practical expertise in Ultrasonic Testing within the Welds category, covering Nozzles (3.8) and Nodes (3.9). Achieving Nozzle (3.8) certification also qualifies you to inspect “T” Welds (3.7).

### PCN Level 3

This preparatory guidance course is tailored to the PCN Level 3 requirements for Ultrasonic Testing practitioners. Its primary goal is to familiarise candidates with the scope, content, and expectations of the Level 3 examination.

## Qualification Requirements

### Prerequisites

- Matric (Grade 12) with Mathematics and/or Science
- Basic understanding of physics principles (recommended)
- For Level 3: Previous PCN certification as required by PCN standards

### Training Hours

| Level 1& Level 2 combined | Level 3 |
|---|---|
| 18 Days | 5 Days |

**Note:** Direct access to Level 2 or 3 requires the total days shown in the table for Levels 1 and 2, or Levels 1, 2 and 3 respectively.

### Product Sector

**Multi Sector -** This course prepares candidates for certification across multiple product sectors as defined by PCN standards.

### Experience Requirements

| Level 1& Level 2 combined | Level 3 |
|---|---|
| 180 Days | 450 Days |

**Note:** Experience may be acquired either prior to (for Level 1 and 2 entry only) or following success in the qualification examination. However, the chances of success in a PCN examination may be significantly reduced if candidates have little or no current experience in the application of the NDT method in the sector concerned.

### Documents to be Submitted for Examination

- PSL 57-A Initial Examination Application
- PSL 30 - Log of Experience
- PSL 44 - Vision Requirements
- CP-27 Code of Ethics
- PCN ID (wallet or e-certificate) -only for existing PCN certificate holders
- Proof of either holding PCN certification or successful completion of BINDT PCN Online Product Technology- cert with QR code
- One government-approved identity document (Passport/ID Card/Driver's License)
- Note: Blank PSL and CP forms can be collected from ANDTC offices during course or downloaded from BINDT website.

## Learning Outcomes

### PCN Level 1

Upon completion, the candidate shall be able to:

1. Understand UT Principles
2. Operate UT Equipment Safely & Correctly
3. Perform Basic Calibration
4. Conduct Testing Under Supervision
5. Interpret Basic A-Scan Signals
6. Follow Written Instructions & Report Findings

### PCN Level 2

Upon completion, the candidate shall be able to:

1. Apply Advanced UT Theory
2. Develop & Approve Written Instructions
3. Perform Full Calibration & Sensitivity Setting
4. Independently Detect, Evaluate & Size Defects
5. Inspect Complex Geometries
6. Interpret Codes, Standards & Specifications
7. Produce Detailed Technical Reports

### PCN Level 2 - UT 3.8 & 3.9 (Nozzles & Nodes) – Additional Outcomes

Upon completion, the candidate shall be able to:

- Inspect set-through and set-on nozzles (3.8) and nodal joints (3.9) using appropriate probe angles and scanning patterns.
- Account for complex sound paths due to geometry (e.g., branch-to-run interfaces).
- Plot beam paths and interpret multiple echo patterns in nozzle welds.
- Automatically gain 3.7 (T-weld) certification upon passing 3.8.

### PCN Level 3

Upon completion, the candidate shall be able to:

1. Master UT Theory & Physics
2. Design & Validate NDT Procedures
3. Conduct Audits & Supervision
4. Interpret & Apply International Standards
5. Perform Risk-Based Inspections (RBI)
6. Prepare for PCN Level 3 Examination

## What to Bring?

- Own PPE (coveralls or lab coat, safety boots)
- PCN wallet card or other form of photographic identification

## Special Notes

- African NDT Centre reserves the right to disqualify participants from the certification program when personnel are found not to meet PCN requirements
- Participants are not allowed to use their own equipment during training and examination. African NDT Centre provides all necessary ET equipment and accessories
- Professional dress code must be followed during the entire training and examination period
- Once enrolled, joining instructions will be sent via email with all necessary information communicated telephonically

## Training and Examination Information

The training program comprises daily assessments after completion of each chapter, and participants are required to achieve above 70% marks. Based on daily assessment performance, candidates are awarded successful completion of training.

Participants are then required to undergo PCN examination which consists of:

- Theory examination
- Practical examination
- NDT instruction writing (Level 2 only)

Candidates must obtain a minimum of 70% in each examination element to achieve PCN certification as Level 1, 2, or 3.

PCN certification is valid for 5 years from the date of certification. The certificate must be renewed according to PCN requirements.

## Syllabus Reference

This curriculum is aligned with the PCN examination syllabus as published in **PCN24/GEN/Appendix Z1 - NDT Examination Syllabi, Issue 1, February 2024**.

The detailed syllabus breakdown covering all topics for Level 1, 2, and 3 is available in our comprehensive course documentation (Document No: CC-UT, Issue 4, dated 16/10/2025 noted as Annexure A)

African NDT Centre regularly reviews and updates the curriculum in line with scientific, industrial, and technological developments in eddy current testing, as well as any changes to PCN certification requirements.

ANNEXURE A

## Ultrasonic testing (UT)

| Syllabus reference number | Title | Module subcontent | Ultrasonic testing (UT) | | |
|---|---|---|---|---|---|
| **1** | **Terminology and history of UT** | | **Level 1** | **Level 2** | **Level 3** |
| 1.1 | History of UT | History of ultrasonic testing | X | X | X |
| 1.2 | Purpose of NDT | What is testing? | X | X | X |
| | | What is the purpose of NDT? | X | X | X |
| | | At what stage of life is NDT performed on a product? | X | X | X |
| | | How does it add value? | X | X | X |
| | | Who may carry out NDT? | X | X | X |
| | | Main NDT methods | X | X | X |
| 1.3 | Terminology of NDT | Please refer to PCN24 standards document | X | X | X |
| 1.4 | Terminology of UT | Please refer to PCN24 standards document | X | X | X |
| **2** | **Physical principles and associated knowledge** | | **Level 1** | **Level 2** | **Level 3** |
| 2.0 | Relevant standards | Please refer to PCN24 standards document | X | X | X |
| 2.1 | Review of mathematical basics | Algebra | X | X | |
| | | Trigonometry | X | X | |
| | | Logarithms | X | X | |
| 2.2 | Physical definitions and typical parameters | Sinusoidal movement | X | X | |
| | | Amplitude | X | X | |
| | | Period | X | X | |
| | | Frequency | X | X | |
| | | Velocity | X | X | |
| | | Acoustic impedance | X | X | |
| | | Acoustic pressure | X | X | |
| | | Factors of reflection and transmission (normal beam only) | X | X | |
| | | Isotropic materials | X | | X |
| | | Anisotropic materials | | X | X |
| 2.3 | Waves | Sinusoidal movement | X | | |
| | | Amplitude | X | | |
| | | Frequency | X | | |
| | | Wavelength | X | | |
| | | Propagation velocity | X | | |
| | | Longitudinal | X | X | |

| | | | | | |
|---|---|---|---|---|---|
| 2.3 *(continued)* | | Transverse | X | X | |
| | | Rayleigh waves (surface waves) | X | X | X |
| | | Creeping waves | | | X |
| | | Guided waves | | | X |
| 2.4 | Transmission and reflection | Effects at interfaces at normal incidence: | X | X | |
| | | • Transmission | X | X | |
| | | • Reflection | X | X | |
| | | • Interference | | X | |
| | | • Dispersion | X | X | X |
| | | Snell's Law | X | X | |
| | | Relation between velocity and elastic properties | | | X |
| | | Effects at interfaces at oblique incidence: | X | X | |
| | | • Transmission | X | X | |
| | | • Reflection | X | X | |
| | | • Refraction | X | X | |
| | | Corner reflectors: | X | X | |
| | | • Reflection | X | X | |
| | | • Mode conversion | X | X | |
| | | Electrostriction | | | X |
| | | Magnetostriction | | | X |
| | | Electrodynamic generation | | | X |
| | | Generation by laser | | | X |
| | | Piezoelectric effect | X | X | |
| | | Reverse piezoelectric effect | X | X | |
| 2.5 | Transducer characteristics | Material | X | X | |
| | | Dimensions | X | X | |
| | | Frequency | X | X | |
| | | Piezoelectric constants | X | X | |
| 2.6 | Sound fields of disc-shaped transducers | Near field (Fresnel zone) | X | X | |
| | | Far field (Fraunhofer zone) | X | X | |
| | | Beam divergence | X | X | |
| | | Influence of transducer frequency and diameter | X | X | |
| **3** | **Product knowledge and capabilities** | | **Level 1** | **Level 2** | **Level 3** |
| 3.1 | General defects | Casting | X | X | |
| | | Welding | X | X | |
| | | Wrought products (including forgings, tubes and pipes) | X | X | |
| | | Composite material | X | X | |
| 3.2 | Implementation of the testing techniques | According to products | X | X | |
| | | According to expected discontinuities | X | X | |
| | | Standards, specifications and codes | | X | |
| 3.3 | Overall properties of the specimen | Influence of surface conditions | X | X | |
| | | Geometry (additional echoes due to grazing incidence and radial straight beam incidence) | X | X | |
| | | Structure (sound attenuation) | X | X | |
| | | Selection of probe:<br>Inspection-oriented design of specimen | | X | X |

| | | | | | |
|---|---|---|---|---|---|
| *3.3 (continued)* | | Testing technique based on task: | | X | |
| | | • Simulations | | | X |
| **4** | **Equipment** | | **Level 1** | **Level 2** | **Level 3** |
| 4.1 | Ultrasonic instruments | Digital instruments: | X | X | |
| | | • Design | X | X | |
| | | • Function | X | X | |
| | | • Pulse generation | X | X | |
| | | • Reception | X | X | |
| | | • Amplification | X | X | |
| | | • A-scan presentation | X | X | |
| | | • RF-signal | X | X | |
| | | • Rectification | X | X | |
| | | • Peak and flank measurement | X | X | |
| | | Analogue *versus* digital | | X | X |
| | | Ultrasonic thickness gauge | X | X | |
| | | Automated and semi-automated systems | | X | X |
| | | Manual | | | X |
| | | Speed | | | X |
| | | Incrementation | | | X |
| | | Repeatability | | | X |
| | | Sampling rate | | | X |
| 4.2 | Probes | Straight beam: | X | X | |
| | | • Design | X | X | |
| | | • Application | X | X | |
| | | Angle beam: | X | X | |
| | | • Design | X | X | |
| | | • Effects at interface wedge/specimen | X | X | |
| | | • Critical angles | X | X | |
| | | • Typical angles for testing of steel | X | X | |
| | | • Sound fields | X | X | |
| | | • Probe index | X | X | |
| | | • Beam angles | X | X | |
| | | • Change of probe index and beam angle due to abrasion or probe shoes | X | X | |
| | | • Half and full skip | X | X | |
| | | • Application | X | X | |
| | | Dual element: | X | X | |
| | | • Design | X | X | |
| | | • Deviation error | X | X | |
| | | • Sound field | X | X | |
| | | • Adjustment | X | X | |
| | | • Application | X | X | |
| | | Dynamic range | | | X |
| | | Immersion probes (focused, spherical, cylindrical, Fermat surface) | | X | X |
| | | Measurement of pulse length | | X | X |
| | | Practical measurements of directional characteristics | | X | X |
| | | Shoe (delay, curvature) | | X | X |

| | | | | | |
|---|---|---|---|---|---|
| 4.3 | Couplant | | X | X | |
| 4.4 | Connecting cables | Length | | | X |
| | | Impedance | | | X |
| 4.5 | Adjustment reference and transfer blocks | Adjustment block No 1 | X | X | X |
| | | Adjustment block No 2 | X | X | X |
| | | Reference blocks | X | X | X |
| | | Resolution: | X | X | X |
| | | • Near | X | X | X |
| | | • Far | X | X | X |
| **5** | **Information prior to testing** | | **Level 1** | **Level 2** | **Level 3** |
| 5.1 | Information about the test object | Identification or designation material: | X | X | X |
| | | • Object to be tested | X | X | X |
| | | • Kind of manufacture | X | X | X |
| | | • Catalogue of defects | | X | X |
| | | • Extent of test coverage | X | X | X |
| 5.2 | Test conditions and application of standard | Accessibility | | X | X |
| | | Infrastructure | | | X |
| | | Particular test conditions | | X | X |
| | | Application standard | | X | X |
| | | Stage of manufacture or service life when testing is to be carried out | | | X |
| | | Standards assigned to the test object | | X | X |
| | | Requirements of test personnel | | X | X |
| | | Acceptance criteria | | X | X |
| 5.3 | Technique and sequence of performing test | Surface condition | X | X | |
| | | Surface preparation | X | X | |
| | | Post-test documentation | | X | |
| 5.4 | Instructions | Preparation of written procedure | | | X |
| | | Preparation of written instruction | | X | |
| | | Performing inspection in accordance with written instruction | X | | |
| **6** | **Testing** | | **Level 1** | **Level 2** | **Level 3** |
| 6.1 | Techniques | Pulse echo and transmission | X | X | |
| | | Contact | X | X | |
| | | Tandem technique | | X | |
| | | Immersion technique | | X | |
| | | TOFD technique | | X | |
| | | Phased array technique | | X | |
| | | TFM technique | | X | |
| | | Techniques for ultrasonic thickness measurement: | X | X | |
| | | • Reference reflectors (laws of distance and size) | | X | |
| | | Verification of combined equipment: | X | X | |
| | | • DGS techniques | | X | |
| | | • Multiple-probe arrays | | | X |
| | | Electromagnetic acoustic transducer (EMAT) | | X | |
| | | Range setting: | X | X | |
| | | • Single-point adjustment | X | X | |
| | | • Two-point adjustment | X | X | |

| | | | | | |
|---|---|---|---|---|---|
| 6.1 *(continued)* | | Sensitivity setting: | X | X | |
| | | • Reference reflectors (BW, SDH, DSR) | X | X | |
| | | • Single-reflector technique (reference height) | X | X | |
| | | • Air-coupled ultrasonic testing | | | X |
| | | • Guided waves | | X | X |
| | | • Testing at higher temperatures | | X | X |
| | | Different sizing techniques: | | X | |
| | | • Principles | | X | |
| | | • Limitations | | X | |
| | | • Requirements for reference blocks | X | X | |
| | | • DAC technique | X | X | |
| | | • Transfer correction | X | X | |
| | | • Recording gain (testing level) | X | X | |
| | | • Errors at echo height evaluation | X | X | |
| | | Laser UT | | | X |
| | | Verification of procedures and instructions for their efficiency | | | X |
| **7** | **Evaluation and reporting** | | **Level 1** | **Level 2** | **Level 3** |
| 7.1 | Interpretation | Relevant standards | | | X |
| | | Relevant specifications | | | X |
| | | Relevant codes | | | X |
| | | Evaluation (conventional or computer-aided methods, for example echo tomography, synthetic aperture focusing technique (SAFT)) | | | X |
| | | Data storage process (for example ALOK) | | | X |
| 7.2 | Detecting, locating and sizing techniques | Detecting | X | X | |
| | | Distinction between defect and geometry echo | X | X | |
| | | Locating (calculation, trigonometrical rules) | X | X | |
| | | Interpretation | | X | |
| | | Evaluation | | X | |
| | | A-scan presentation | X | X | X |
| | | B-scan presentation | | X | X |
| | | C-scan presentation | | X | X |
| | | D-scan presentation | | | X |
| | | E-scan presentation | | | X |
| | | F-scan presentation | | | X |
| | | P-scan presentation | | | X |
| | | S-scan presentation | | | X |
| | | Recording results | X | X | |
| | | Classifying results | X | X | |
| | | Acceptance levels | X | X | |
| | | Echo height evaluation with distance gain size (DGS) method | | X | |
| | | Sizing and half-amplitude technique | X | | |
| | | Sizing using the fixed-amplitude-level technique | | X | |
| | | Echo height evaluation with single-reflector technique and DAC method | X | X | |
| | | Reporting | X | X | |
| | | Checking content and matching of test reports, instructions and procedures | | | X |

| 8 | Assessment | | Level 1 | Level 2 | Level 3 |
|---|---|---|---|---|---|
| 8.1 | Evaluation and confirmation of test reports | Application of the acceptance criteria according to standards, codes and procedures | | X | |
| **9** | **Quality aspects** | | **Level 1** | **Level 2** | **Level 3** |
| 9.1 | Personnel qualification | ISO 9712 | X | X | X |
| | | Other NDT qualification and certification systems | | X | X |
| 9.2 | Documentation | Traceability of documents | | X | X |
| | | Equipment verification | | X | X |
| | | Reliability of measurements | | X | X |
| | | Format of working procedures | | | X |
| **10** | **Developments** | | **Level 1** | **Level 2** | **Level 3** |
| 10.1 | Newest developments for industrial and scientific applications of UT | Phased array | X | X | X |
| | | Time-of-flight diffraction | X | X | X |
| | | Long range | X | X | X |
| | | Computer modelling | | | X |
| | | TFM technique | | X | X |