Eddy Current Testing (ET)

Course Curriculum

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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

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What is Eddy Current Testing?

Eddy Current Testing (ET or ECT) is a non-destructive testing (NDT) method that uses electromagnetic induction to detect and characterize surface and near-surface flaws (e.g., cracks, corrosion, pitting) in conductive materials (metals like aluminium, copper, titanium, stainless steel). It also measures thickness, conductivity, coating thickness, and material properties without contact or surface preparation.

The technique involves inducing eddy currents in the test material using a coil carrying alternating current. Changes in the eddy current flow, caused by defects or material variations, are detected and analyzed to assess material integrity.

How It Works:

1. Probe Activation: Alternating current (AC, typically 50 Hz–6 MHz) flows through a test coil in a probe, generating an alternating magnetic field.
2. Eddy Current Induction: When the probe is placed near the conductive material, the magnetic field induces circular eddy currents in the material (per Faraday's law).
3. Disruption Detection: Flaws or property changes alter eddy current paths, causing changes in coil impedance (amplitude and phase shift).
4. Signal Analysis: The instrument displays signals on an impedance plane (X-Y plot: resistance vs. reactance) or time-based waveform. Calibration with reference standards sets baselines.
5. Skin Depth (penetration): $\delta = 1 / \sqrt{(\pi f \mu \sigma)}$ (where f = frequency, μ = permeability, σ = conductivity) → Higher frequency = shallower penetration (surface focus); lower frequency = deeper (up to ~10 mm in low-conductivity materials).

ET is widely used in industries such as aerospace, automotive, power generation, and petrochemical for the inspection of components including aircraft structures, heat exchanger tubes, welds, and surface-critical parts. The method is particularly effective for detecting surface-breaking cracks, corrosion, and material sorting.

Applications:

- Surface flaw detection (cracks in aircraft, welds, rails).
- Tubing inspection (heat exchangers, boilers).
- Corrosion mapping (under paint/coatings).
- Thickness/coating measurement (non-conductive layers on metals).
- Material sorting (conductivity, heat treatment, alloy ID).
- Industries: Aerospace, oil & gas, power generation, automotive, manufacturing.

Advantages:

- Fast and portable (real-time results, no couplant).
- Non-contact (works through coatings up to ~5 mm).
- Versatile (flaws + measurements).

- No radiation or chemicals (safe, clean).
- High-speed scanning (arrays cover large areas quickly).

Limitations:

- Conductive materials only (not plastics/composites).
- Limited penetration (skin effect: ~1–10 mm max).
- Affected by permeability (challenges with ferromagnetic steels unless RFT used).
- Skilled interpretation required (signals from geometry/lift-off can mask flaws).
- Surface roughness or edges may interfere.

About the Course

PCN Level 1

This course is designed to provide participants with a foundational understanding of eddy current testing principles and practical application. The PCN Level 1 ET course covers the theoretical basis of electromagnetic induction, equipment operation, probe selection, and basic defect detection techniques.

Suitable for personnel new to eddy current testing, this course provides comprehensive preparation for the PCN Level 1 examination. Successful candidates will be able to perform eddy current tests under supervision and record results according to written instructions.

PCN Level 2

This advanced course builds upon Level 1 knowledge and provides detailed instruction on selecting appropriate testing techniques, setting up and verifying equipment, interpreting results, and preparing written instructions. The PCN Level 2 ET course covers impedance analysis, probe selection for various applications, evaluation of indications, and report preparation.

Suitable for personnel with existing Level 1 certification or equivalent experience, this course is recognized by PCN and provides excellent preparation for the Level 2 examination. Successful candidates will be able to independently perform and supervise eddy current testing, prepare written instructions, and evaluate results according to applicable standards.

PCN Level 3

This guidance course is aimed at meeting the PCN Level 3 requirements for ET practitioners. The main objective is to make candidates fully aware of the scope of the examination and level of knowledge required across all aspects of eddy current testing, including procedure development, validation, standards interpretation, and personnel qualification.

The course will enable candidates to identify their areas of strength and weakness. Advice will be given on any further study required. Successful Level 3 candidates will be able to establish and validate NDT procedures, designate test methods and techniques, and manage NDT operations within their sector of certification.

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	Level 3
5 Days	6 Days	6 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	Level 3
45 Days	135 Days	450 Days

Note 1: For Level 2 certification, work experience should consist of time as a Level 1. If qualifying directly to Level 2 with no time at Level 1, the experience shall consist of the sum of times required for Level 1 and Level 2. No reduction in the period of experience shall be allowed.

Note 2: For Level 1 and 2, industrial NDT experience in the appropriate sector may be acquired either prior to or following success in the qualification examination.

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
- One government-approved identity document (Passport/ID Card/Driver's License)

Course Content

PCN Level 1

- Terminology and history of eddy current testing
- Physical principles: electricity, magnetism, and electromagnetism
- Depth of penetration and standard depth of penetration
- Impedance concepts and basic impedance plane diagrams
- Product knowledge and material properties
- ET equipment: instruments, probes, and reference blocks
- Testing parameters and equipment setup
- Practical testing techniques
- Working to written instructions
- Recording and reporting results
- Relevant standards and PCN documentation

PCN Level 2

- Advanced electromagnetic theory
- Complex impedance plane representation and analysis
- Advanced probe selection and design
- ET techniques: single frequency, multi-frequency, multi-parameter
- Equipment calibration and verification
- Applications: material characterization, defect detection, coating thickness
- Evaluation and characterization of indications
- Preparation of written instructions
- Acceptance criteria and reporting
- Codes, standards, and specifications
- Supervision and quality control

PCN Level 3

- Alternative ET techniques (pulsed eddy current, remote field, ACFM)
- Analytical calculation and simulation of eddy current tests
- Development and validation of procedures
- Interpretation of codes, standards, and specifications
- Personnel qualification and authorization
- Quality systems and ISO 9712
- Advanced developments in eddy current technology
- Traceability and reliability of measurements
- Technical review and approval of procedures and instructions

Learning Outcomes

PCN Level 1

Successful candidates will be able to:

- Set up equipment and perform eddy current tests under supervision
- Record and classify test results according to written criteria
- Report the results of eddy current testing
- Understand Basic Electromagnetic Principles
- Operate ECT Equipment Safely & Correctly
- Perform Calibration & Verification
- Conduct Testing Under Direct Supervision
- Interpret Basic Impedance Plane Signals
- Follow Written Instructions & Complete Reports

PCN Level 2

Successful candidates will be able to:

- Select appropriate ET techniques for specific applications
- Define the limitations of eddy current testing
- Translate NDT codes and specifications into NDT instructions
- Set up and verify equipment settings
- Perform and supervise eddy current tests
- Interpret and evaluate results according to applicable standards
- Prepare written instructions for eddy current testing
- Supervise all tasks at or below Level 2
- Provide guidance for personnel at or below Level 2

PCN Level 3

Successful candidates will be able to:

- Establish, review, and validate NDT instructions and procedures
- Designate particular test methods, techniques, and procedures
- Interpret and apply codes, standards, and specifications
- Within the scope of certification, carry out all tasks at all levels
- Assess the qualification and authorization of NDT personnel
- Master ECT Physics & Mathematics
- Supervise, Audit & Train Level 1&2 Personnel
- Interpret Complex Signals & Resolve Ambiguities
- Lead Quality & Compliance Programs
- Select & Integrate Complementary NDT Methods
- Prepare for PCN Level 3 Examination

Equipment and Training Materials

African NDT Centre is equipped with modern eddy current testing equipment to provide comprehensive hands-on training. Our facilities include:

ET Equipment Available

- Single Frequency Impedance Plane Display Digital Instrument
- Analogue Meter Display Instrument
- Weld Probe
- Shielded Pencil Probe
- Conductivity Probe
- Calibration Block - Steel
- Calibration Block - Aluminium
- Non-conductive Coating Shims
- Various test specimens and reference standards

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-ET, Issue 3, dated 14/10/2025 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

Syllabus reference number	Title	Module subcontent	Eddy current testing (ET)		
1	Terminology and history of ET		Level 1	Level 2	Level 3
1.0	History of ET	History of eddy current testing	X	X	X
1.1	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
1.2	Purpose of ET	Definition: • Electromagnetic interaction between a sensor and a test object conducting electricity	X		
		• Providing information on physical characteristics of the test object	X		
		Applicability and limitations	X		
1.3	Terminology	Please refer to PCN24 standards document	X	X	X

2	Physical principles and associated knowledge		Level 1	Level 2	Level 3
2.0	Fundamentals		X	X	X
2.1	Electricity: elements	Direct current:	X	X	X
		• Current	X	X	X
		• Voltage	X	X	X
		• Resistance	X	X	X
		• Conductance	X	X	X
		• Ohm's Law	X	X	X
		• Resistivity	X	X	X
		• Conductivity	X	X	X
		Units:	X	X	X
		• Conductivity values for some metals	X	X	X
		Alternating current:	X	X	X
		• Sinusoidal current	X	X	X
		• Voltage	X	X	X
		• Amplitude	X	X	X

2.1 *(continued)*		• Frequency	X	X	X
		• Period	X	X	X
		• Phase	X	X	X
		• Vector representation		X	X
		Other periodic currents			X
2.2	Magnetism	Magnetic field	X	X	X
		Lines of force		X	X
		Magnetic field strength	X	X	X
		Permeability	X	X	X
		Flux density (induction)	X	X	X
		Flux	X	X	X
		Hysteresis loop	X	X	X
		Units	X	X	X
		Diamagnetism		X	X
		Paramagnetism		X	X
		Ferromagnetism		X	X
		Reluctance		X	X
		Magnetomotive force		X	X

2.3	Electromagnetism	Magnetic field created by a current (wire, coil)	X	X	X
		Electromagnetic induction phenomenon	X	X	X
		Inductance	X	X	X
		Mutual inductance		X	X
		Electromagnetic coupling	X	X	X
		Induced currents	X	X	X
		Secondary field	X	X	X
		Lenz's Law	X	X	X
		Distribution in conducting materials:	X	X	X
		• Planar wave		X	X
		• Depth of penetration	X		
		• Standard depth of penetration		X	X
		• Amplitude	X	X	X
		• Phase	X	X	X
		Cylindrical conductors:	X	X	X
		• Characteristic frequency	X	X	X
		Real (practical) depth of penetration		X	X

		Impedance:	X	X	X
		● Complex plane representation		X	X
		● Impedance plane diagrams		X	X
2.4	Alternative techniques	Pulsed eddy current			X
		Magnetic field sensors			X
		Alternating current field measurements			X
		Remote field eddy currents			X
2.5	Simulation	Analytical calculation of eddy current tests			X
3	**Product knowledge and capabilities**		**Level 1**	**Level 2**	**Level 3**
3.1	Defectology/product technology	Manufacturing-related discontinuities	X	X	X
		Service-induced discontinuities	X	X	X
		Material properties influencing eddy current testing:	X	X	X
		● Conductivity	X	X	X
		● Permeability	X	X	X
		Product characteristics influencing eddy current testing:		X	X
		● Condition (surface, heat treatment, cold working)		X	X

		• Temperature		X	X
		• Shape		X	X
		• Wall thickness		X	X
		• Accessibility		X	X
		Products being tested:		X	
		• Semi-finished products		X	
		• Pipes		X	
		• Heat exchanger tubes		X	
		• Mechanical parts (for example cars, railway and aircraft industry)		X	
		• Welds (for example offshore)		X	
		• Characteristics of flaws affecting detection		X	
		• Width/depth ratio		X	
3.2	Applications of eddy current testing	Material characterisation: conductivity, ferrite content, metal sorting, heat treatment sorting, thickness of thermochemical treatments (case hardening, nitriding), coating thickness (conductive or non-conductive) and derived information (hardness)	X	X	X
		Detection of discontinuities: cracks (SCC, fatigue), wall thinning, corrosion, deposits, etc	X	X	X

3.3	Capabilities	Depth of penetration	X	X	X
		Conductive materials	X	X	X
		Non-contact	X	X	X
		High speed	X	X	X
		High temperature	X	X	X
		Multiplexed arrays	X		
		Mechanised	X	X	X
3.4	Techniques	Single frequency	X	X	X
		Multi-frequency	X	X	X
		Multi-parameter	X	X	X
		Pulsed current		X	X
		Multiplexed arrays		X	X
		Remote field		X	X
		Similarity rules for surface inspection and tube characteristic/ limit frequencies		X	X
3.5	Codes and standards	Please refer to PCN24 standards document		X	X

4	Equipment		Level 1	Level 2	Level 3
4.1	Eddy current testing system	Instrument	X	X	X
		General-purpose applications – essential functions	X	X	X
		Specific applications:		X	X
		• Pulsed eddy current			X
		• Magnetic field sensors			X
		• Alternating current field measurement			X
4.1 *(continued)*		Mechanised equipment		X	X
		Probes:	X	X	X
		• Combined		X	X
		• Separate transmit – receive		X	X
		• Surface	X	X	X
		• Coaxial	X	X	X
		• Designs		X	X
		• Array probes (description and operating principles)		X	X
		Measurements:	X	X	X
		• Absolute	X	X	X
		• Differential	X	X	X
		• Impedance testing	X	X	X

4.2	Output and signal display	Signal-to-noise ratio	X	X	X
		Distortion/non-linearity	X	X	X
		Filters	X	X	X
4.3	Reference blocks	Material	X	X	X
		Design		X	X
		Production		X	X
		Storage		X	X
4.4	Codes and standards	Please refer to PCN24 standards document		X	X
5	**Information prior to testing**		**Level 1**	**Level 2**	**Level 3**
5.1	Information about the test object	Written instructions	X		
		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
5.2	Test conditions and application of standard	Accessibility		X	X
		Temperature			X
		Humidity			X
		Availability			X
		Unwanted interfering signals			X

		Electric and/or magnetic disturbances			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	
		Surface preparation		X	
		Post-test documentation		X	
		Equipment to be used		X	
		Requirement for recording		X	
5.4	Instructions	Preparation of written procedure			X
		Preparation of written instruction		X	
		Performing inspection in accordance with written instruction	X		

5.4 *(continued)*		Documents			X
		Presentation of the standards, codes and procedures			X
6	**Testing**		**Level 1**	**Level 2**	**Level 3**
6.1	Probe selection as a result of information in **Section 5**	Product:			
		● Grade		X	X
		● Metallurgical condition		X	X
		● Shape		X	X
		● Type of discontinuity sought		X	X
		● Location		X	X
		● Duty of the product		X	X
		● Extent of examination		X	X
6.2	Operating conditions as a result of information in **Section 5**	Temperature		X	X
		Humidity		X	X
		Access		X	X
		Availability		X	X
		Interfering signals		X	X
		Electric and/or magnetic disturbances		X	X
6.3	Parameters	Excitation frequency	X	X	X
		Auxiliary frequencies	X	X	X
		Probe speed	X	X	X

		Probe clearance	X	X	X
		Probe vibration	X	X	X
		Probe centring	X	X	X
6.4	Adjustment curves	Adjustment curves	X	X	X
6.5	Settings	Data acquisition	X	X	X
		Written procedure		X	X
		Written instruction	X	X	
7	**Evaluation and reporting**		**Level 1**	**Level 2**	**Level 3**
7.1	Reporting	Reporting level		X	X
		Examination report	X	X	X
7.2	Evaluation	Characterisation of the indications:		X	X
		• Single-frequency analysis		X	X
		• Multi-frequency analysis		X	X
		• Data analysis		X	X
8	**Assessment**		**Level 1**	**Level 2**	**Level 3**
8.1	Evaluation and confirmation of test reports	Acceptance criteria according to standards, codes and procedures		X	X
		Training of Level 1 and Level 2 of the acceptance criteria			X

9	Quality aspects		Level 1	Level 2	Level 3
9.1	Factors affecting quality of testing	Personnel qualification:	X	X	X
		• ISO 9712	X	X	X
		• Other NDT qualification and certification systems			X
		Format and scope of working procedures			X
		Qualification of NDT procedures			X
		Authorisations (NDT instruction, procedures and personnel)			X
		Developing written instruction		X	
		Working correctly to written instruction	X		
		Traceability of documents		X	X
		Reliability of measurements		X	X

9.2	Knowledge of applicable NDT application and product standards	Correct technique selection		X	
		Use of correct test parameters		X	
		NDT method selection		X	X
		Job-specific training	X	X	X
		Equipment verification	X	X	X
10	**Developments**		**Level 1**	**Level 2**	**Level 3**
10.1	General information	Non-inductive techniques:			X
		• Magneto-optical imaging			X
		• Superconducting quantum interference device (SQUID)			X
		• Giant magnetoresistance			X
		Imaging			X
		Modelling			X