Non-Destructive Testing (NDT) Personnel Certification in Malaysia: Historical Evolution, Multi-Scheme Landscape and Industry Workforce Needs

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ABSTRACT

Non-destructive testing (NDT) personnel certification provides employers, regulators and clients with structured evidence that personnel have met defined qualification requirements. This integrative documentary review examines the historical development of Malaysia's national NDT certification system, the central role of the Department of Skills Development (DSD) in administering the Malaysian Skills Certification System for Non-Destructive Testing (SPKM-NDT), the relationship between the national scheme and sector-specific requirements, and the workforce needs evidenced in public sources. It synthesises legislation, standards, DSD and other institutional documents, industry reports and peer-reviewed literature located through targeted searches. The historical analysis traces five phases, from early reliance on overseas expertise to the establishment, institutional consolidation, international recognition and continuing digitalisation of SPKM-NDT. The review finds that SPKM-NDT has become the principal national pathway: DSD administers certification against ISO 9712:2021 and national occupational standards, issues Malaysian Skills Certificates, maintains online application and certification processes, and holds international recognition through the ICNDT Multilateral Recognition Agreement (DSD, 2025; ICNDT, 2024). CIDB-CS-02 and aviation rules address defined sectoral requirements, while their scope should be understood in relation to the national pathway. Workforce evidence identifies demand drivers in oil and gas, construction, aerospace and maintenance, repair and overhaul, advanced manufacturing, power and emerging energy sectors. However, available public indicators do not quantify Malaysia's NDT personnel gap by method, certification level or sector. The review therefore distinguishes documented demand signals from direct estimates of NDT employment and recommends strengthening SPKM-NDT's alignment with employer needs through transparent scheme information, advanced-method and Level 3 development, and a national workforce evidence base. The documentary evidence does not establish the comparative effectiveness of certification routes or the causal effect of certification on employment or inspection quality.

Keywords: NDT personnel certification, ISO 9712, workforce needs, certification schemes

INTRODUCTION

Non-Destructive Testing (NDT), also referred to as non-destructive evaluation (NDE) or inspection (NDI), comprises methods used to detect, characterise and evaluate discontinuities in materials, components and

structures without impairing their future usefulness. Common methods include visual testing (VT), penetrant testing (PT), magnetic testing (MT), radiographic testing (RT), ultrasonic testing (UT) and eddy current testing (ET), together with advanced techniques such as phased array ultrasonic testing (PAUT), time-of-flight diffraction (TOFD), digital radiography (RT-D) and eddy current array (ECA). NDT is used across oil and gas, petrochemical, power generation, aerospace, shipbuilding, railway, manufacturing, and construction, where an undetected flaw may lead to loss of life, environmental damage, and large economic losses (Taheri et al, 2022). Unlike many other measurement activities, the outcome of an NDT inspection depends largely on the person who sets up the equipment, applies the technique, interprets the signal, and makes the accept-or-reject decision. Human factors research has shown that inspection reliability is affected not only by technical skill but also by procedures, organisational pressure, fatigue and decision-making under uncertainty (Bertovic, 2016). For this reason, international codes and standards require NDT to be performed by qualified and certified personnel, and personnel certification has become the primary mechanism by which industry, regulators, and clients gain confidence in inspectors' competence (ICNDT, 2024; ISO, 2021).

Malaysia is an important case for examining how a national NDT certification system can be built and linked to industrial capacity. In the early 1980s, the country relied substantially on overseas expertise and inspection providers; national capacity-building began through international cooperation, including training supported by the IAEA and the Colombo Plan (Abidin, 2025; IAEA, 2018; Plonsky, 2015). The national scheme introduced in 1986 later developed as SPKM-NDT under the administration of DSD. Its subsequent accreditation to MS ISO/IEC 17024, registration under the International Committee Non-Destructive Testing ICNDT Multilateral Recognition Agreement (MRA), and adoption of ISO 9712:2021 demonstrate the institutionalisation and international alignment of the national pathway (Abidin, 2025; DSD, 2025; ICNDT, 2024). The current landscape also includes sector-specific requirements, notably CIDB-CS-02 for construction and EN 4179 requirements for aviation maintenance, which operate alongside the national scheme for their defined scopes (CAAM, 2022; CIDB, 2025).

Despite the safety and economic significance of NDT, published research on personnel certification in Malaysia remains limited and dispersed. Historical accounts, DSD scheme information, standards, regulatory requirements and industry reports describe separate parts of the system. They have rarely been synthesised to explain how SPKM-NDT developed, how DSD governs and administers it, how sector-specific requirements interact with it, and what the available evidence indicates about workforce needs. This review addresses that gap by placing SPKM-NDT and DSD at the centre of an integrative synthesis, while treating other pathways as context for understanding recognition and sectoral acceptance (Abidin, 2025; CAAM, 2022; CIDB, 2025; DSD, 2025). The review addresses three connected questions: how NDT personnel certification in Malaysia evolved from the 1980s to the present; how SPKM-NDT is governed and administered by DSD and how it relates to other national, sectoral and international requirements; and what available industry and labour-market sources indicate about demand for certified NDT personnel and the competencies required. These questions structure the historical account, scheme analysis and workforce synthesis.

The review contributes an integrated account of the institutional development of SPKM-NDT, an analysis of DSD’s responsibilities and the scheme’s relationship with sectoral recognition rules, and a synthesis of industry workforce signals and associated competency needs. By identifying gaps in public workforce data, it also clarifies the limits of current national planning evidence. The analysis informs policy and skills development; it does not rank schemes or estimate the causal effects of certification on employment or inspection performance.

METHODOLOGY

This paper uses an integrative documentary review. This design accommodates a source base that includes peer-reviewed studies, legislation, technical standards, certification rules and institutional reports. The purpose is to synthesise historical and institutional evidence and identify implications for workforce planning; it is not to estimate a pooled effect (Snyder, 2019). Four source groups were examined. The first comprised legislation and regulatory instruments relevant to NDT personnel and inspection bodies, including the Atomic Energy Licensing Act 1984 (Act 304), the Construction Industry Development Board Act 1994 (Act 520), the National

Skills Development Act 2006 (Act 652), Standards Malaysia's MIBAS technical requirements and CAAM's CAD 8704. The second comprised DSD's SPKM-NDT scheme information and related guidelines, CIDB-CS-02 documents, registers and official statements from Standards Malaysia, Atom Malaysia, CAAM, MSNT and relevant international organisations. The third comprised international standards, principally ISO 9712:2021, ISO/IEC 17024:2012, ISO 18490, ISO/TS 25107 and ISO/TS 25108, together with their Malaysian adoptions. The fourth comprised peer-reviewed literature, books and institutional reports on NDT competence, human factors, digital inspection and workforce development (CAAM, 2022; CIDB, 2025; DSD, 2025; ISO, 2021).

Sources were located through targeted searches of Google Scholar, Scopus-indexed literature, the IAEA publications database, NDT.net and official agency, standards-body and scheme websites. Search terms combined expressions such as "NDT certification", "ISO 9712", "personnel certification", "SPKM-NDT", "SKM NDT", "CIDB NDT", "Malaysia", "NDE 4.0", "human factors" and "TVET". Sources were included when they documented the history, governance, requirements or recognition of a certification pathway relevant to Malaysia, or provided evidence on workforce, competence, inspection reliability or technology affecting certification. When several versions of a scheme document were available, the latest located version was used; discrepancies were described rather than resolved by assumption. This approach follows the integrative-review purpose of bringing together heterogeneous documentary and scholarly evidence, while the absence of a retained protocol-defined screening log limits reproducibility and exhaustiveness (Snyder, 2019).

The analysis linked the documentary evidence to the review questions through a chronological account of institutional milestones, a comparison of certification governance and scope, and a sector-based synthesis of workforce signals. Scheme information was compared using consistent attributes, including the responsible body, legal context, standard, recognition, scope, levels, methods, validity and sectoral use. Workforce data were classified as direct NDT evidence or as broader indicators, such as occupation listings or total turnaround employment, to avoid treating general employment figures as NDT headcounts. The synthesis then identified implications for DSD, SPKM-NDT and national workforce planning. Because the source base combines evolving scheme documents with grey literature and no protocol-defined screening count was retained, this paper is an integrative review rather than a systematic review; it does not claim exhaustive coverage or provide a PRISMA flow (Snyder, 2019).

CONCEPTUAL FOUNDATIONS OF NDT PERSONNEL CERTIFICATION

Qualification, certification and competence

In the NDT literature, qualification refers to the demonstration of the physical attributes, knowledge, skills, training, and experience required to perform NDT tasks properly, while certification is the procedure used to demonstrate qualification, resulting in a written statement of competence (ISO, 2021). Competence in the wider sense also includes judgement, ethical conduct and the ability to adapt to new situations. Personnel certification therefore functions as a proxy for competence, and its value depends on how well the examinations, experience requirements and surveillance mechanisms actually reflect workplace performance.

Central third-party and employer-based certification

Internationally, two main philosophies exist. The first is central, independent third-party certification, in which an independent certification body, separate from the employer and the training provider, examines and certifies the candidate. ISO 9712 and ISO/IEC 17024 represent this model, and schemes such as the UK Personnel Certification in Non-Destructive Testing (PCN) and the Malaysian SPKM-NDT follow it. The second is employer-based certification, in which the employer certifies its own personnel according to a written practice, as in ASNT Recommended Practice SNT-TC-1A and the standard ANSI/ASNT CP-189 (ASNT, 2026). In aerospace, EN 4179 adopts a similar employer-based approach, with a nominated Level 3 responsible for the written practice (CAAM, 2022).

Both models have strengths and limitations. Central certification provides portability, impartiality, and comparable standards across employers, while employer-based certification can be more closely tailored to specific products and procedures. Malaysia uses both, and the Asia-Pacific region in general has moved toward ISO 9712-based central certification supported by RCA and IAEA projects (Abidin, 2025).

ISO 9712 and ISO/IEC 17024

ISO 9712 specifies requirements for the qualification and certification of personnel performing industrial NDT at three levels. Level 1 personnel perform NDT according to written instructions under supervision; Level 2 personnel set up and calibrate equipment, perform and supervise NDT, interpret and evaluate results, and write instructions; and Level 3 personnel take full responsibility for NDT facilities, establish techniques and procedures, and interpret codes and standards (ISO, 2021). The 2021 edition introduced several important changes compared with the 2012 edition. These include alignment of conformity assessment with ISO/IEC 17024 and stronger impartiality requirements, a documented procedure for employer responsibilities, training expressed in days with the option of distance or self-paced theory but face-to-face practical training, reduced experience requirements with a structured experience programme, vision requirements aligned with ISO 18490, examinations divided into separately assessed "elements", and a structured credit system for renewal and recertification at all levels (ICNDT, 2024).

ISO/IEC 17024:2012 specifies general requirements for bodies operating certification of persons. It focuses on impartiality, examiners' competence, the validity and reliability of assessments, the management of the certification scheme, and the surveillance of certified persons. Accreditation of a certification body to ISO/IEC 17024 by a national accreditation body that is a signatory to international arrangements provides the basis for cross-border recognition. ICNDT uses this as a prerequisite for registration of certification bodies under Schedule 2 of its MRA (ICNDT, 2024).

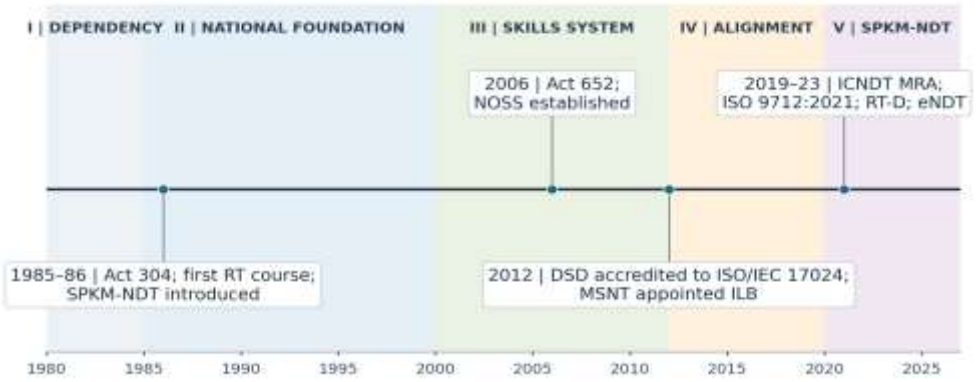
Human capital and signaling theory

Two theoretical lenses are useful to interpret the role of certification. Human capital theory views training and certification as investments that increase worker productivity (Becker, 1964). Signaling theory, on the other hand, argues that credentials are valuable because they communicate unobservable ability to employers in labor markets with information asymmetry (Spence, 1973). Empirical evidence supports the view that occupational certification carries a measurable labour market premium, especially for younger workers (Albert, 2017). In NDT, both mechanisms operate simultaneously: certification is meant to build and verify competence, and it also serves as a market signal that allows clients and regulators to trust inspectors they cannot observe directly. When many schemes coexist with different requirements, the signal becomes noisy, and employers may demand multiple certificates for the same method, thereby increasing costs without necessarily increasing competence (Abidin, 2025). This tension is central to the Malaysian case.

Historical Evolution of NDT Personnel Certification in Malaysia

Documentary evidence indicates five broad phases in the development of NDT personnel certification in Malaysia, from early dependence on overseas capacity to the current nationally administered SPKM-NDT system and its sectoral interfaces. The timeline draws on institutional records, historical accounts and scheme documents; it is followed by a comparison of the key milestones and their implications for DSD’s role (Abidin, 2025; IAEA, 2018; Ibrahim, 2001).

Figure 1. Timeline of key milestones in Malaysia's NDT certification system, compiled from historical and DSD records (IAEA, 2018; Abidin, 2025; DSD, 2025; ICNDT, 2024; CIDB, 2025; CAAM, 2022).



Phase I: Dependency on foreign certification before 1985

Before the mid-1980s, Malaysia had no national NDT certification system. Oil and gas operators, power utilities and fabricators depended on foreign NDT service providers, or on local companies that hired operators certified overseas (IAEA, 2018; Plonsky, 2015). This arrangement was expensive and created a dependency on foreign expertise in a field directly related to national energy security. In the early 1980s, the government responded by sending staff abroad for NDT training in France, Pakistan, Singapore, Japan and Australia through the IAEA Technical Cooperation Programme and the Colombo Plan (Abidin, 2025). Malaysia also joined the Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) project on NDT, which aimed to establish national NDT societies and certification systems in Asia-Pacific member states (Abidin, 2025). The nuclear research institution at that time, known as the Nuclear Energy Unit (Unit Tenaga Nuklear, UTN) under the Prime Minister's Department, became the technical focal point for NDT capacity building.

Phase II: National foundation, 1985-1999

The second phase began with two key events. First, the Atomic Energy Licensing Act 1984 (Act 304) established the Atomic Energy Licensing Board (AELB) as the regulator for activities involving ionising radiation, including industrial radiography. Second, in 1986, the Nuclear Energy Unit, with IAEA support and in collaboration with the national skills authority (today's DSD), SIRIM and AELB, conducted the first national NDT training course in radiographic testing (IAEA, 2018). In the same year, the national NDT certification scheme, later known as SPKM-NDT, was introduced (Abidin, 2025; DSD, 2025). An early description of the scheme was presented by Ibrahim (2001) at a national seminar on nuclear techniques in industry, indicating that qualification and certification of NDT personnel was considered a strategic national issue from the beginning.

Institutional support was strengthened with the establishment of the Malaysian Society for Non-Destructive Testing (MSNT) in 1989 as part of the RCA project (Abidin, 2025). A National NDT Certification Board was formed with IAEA assistance, and one of its key founders, a former junior official of the nuclear agency who had attended IAEA training, served the board until his retirement in 2014 (Plonsky, 2015). During this phase the focus was on building a domestic pool of Level 1 and Level 2 personnel in the conventional methods, especially RT, which remained the most widely used method in Malaysia (Plonsky, 2015).

Phase III: Institutional consolidation, 2000-2011

The third phase is characterised by the consolidation of NDT certification within the national skills system. The National Skills Development Act 2006 (Act 652) provided the legal basis for the Malaysian Skills Certificate (Sijil Kemahiran Malaysia, SKM) and the National Occupational Skills Standards (NOSS), which became the reference for NDT competency standards (National Skills Development Act 2006 (Act 652), 2006)(DSD, 2006). The nuclear agency, renamed the Malaysian Institute for Nuclear Technology Research

(MINT) in 1994 and the Malaysian Nuclear Agency (Nuklear Malaysia) in 2006, continued to serve as a key training provider and technical partner. The NDT industry grew steadily, supported mainly by the oil and gas sector, which accounted for about 70% of NDT inspection business (Plonsky, 2015). By the mid-2010s, more than 2,000 certified technicians were employed by over 50 companies, and local inspection was estimated to cost about one-fifth of hiring foreign inspectors and technology (Plonsky, 2015). Malaysia's scheme also became a reference for other countries; for example, Sudan adopted the Malaysian model and trainees from the Philippines, Yemen and Sri Lanka were trained and certified in Malaysia (Plonsky, 2015).

Phase IV: International alignment, 2012-2019

The fourth phase marks Malaysia's move from a nationally recognised scheme to an internationally recognised one. On 3 October 2012, the DSD National Certification Body received accreditation to MS ISO/IEC 17024:2012 from the Department of Standards Malaysia, making Malaysia the fourth country in the Asia-Pacific region with such accreditation for NDT (Abidin, 2025; DSD, 2025). In the same year, MSNT was appointed as the Industry Lead Body (ILB) for NDT, giving industry a formal role in developing standards and assessment (DSD, 2025). In 2014, Standards Malaysia published MS ISO 9712:2014, an identical adoption of ISO 9712:2012, which gave the international standard a formal national status (DSM, 2014).

Regulatory anchoring also increased. From January 2015, AELB required SKM Level 2 in Radiographic Testing for the appointment of radiograph operators (DSD, 2025). This requirement linked a national skills certificate to radiation-safety regulation and created a defined role for SPKM-NDT in the RT pathway. In 2015, the IAEA designated Nuklear Malaysia as an IAEA Collaborating Centre for NDT; its advanced NDT collaboration was extended for 2019–2023 and renewed for 2023–2027 (Abidin, 2025). IAEA project MAL1014 also supported the extension of national NDT capacity to the nuclear sector (IAEA, 2018). In September 2019, DSD was registered as a certification body under Schedule 2 of the ICNDT MRA, adding an international recognition route for SPKM-NDT (DSD, 2022).

Phase V: Diversification and digitalisation, 2020 to the present

The current phase is marked by the continued development of SPKM-NDT alongside more explicit sectoral requirements. In February 2022, CAAM issued CAD 8704, which requires aviation-maintenance NDT personnel to be qualified under EN 4179 and specifies the accepted qualifications for nominated Level 3 personnel (CAAM, 2022). Standards Malaysia also revised MTR 2 for NDT inspection bodies, defining the personnel certification routes accepted for accreditation and requiring DSD Level 2 or Level 3 personnel to serve as approved radiographic-testing signatories (DSM, 2022). In November 2022, AELB was renamed the Department of Atomic Energy Malaysia (Atom Malaysia), while continuing to administer Act 304 (MOSTI, 2022). These requirements show that national certification remains closely connected to regulatory acceptance, while sectoral rules specify additional conditions for particular work.

CIDB introduced CIDB-CS-02 for NDT of welded joints in construction, and reports that its Construction Skills Competency Certificates (SKKP), including NDT, received ISO/IEC 17024 recognition from Standards Malaysia in November 2023 (CIDB, 2025). This development adds a sector-specific route for construction personnel, while SPKM-NDT continues to administer the national scheme. The two pathways differ in scope, occupational context and the standards referenced in their current scheme documents (DSD, 2025; CIDB, 2025).

DSD has continued to modernise SPKM-NDT. With effect from 1 June 2023, the national scheme adopted ISO 9712:2021, added Digital Radiographic Testing, and enabled applications, renewal and recertification through eNDT and MySPIKE (DSD, 2025). Abidin (2025) reports that by 2025 more than 10,000 people had received NDT training, more than 5,000 personnel had been certified across Levels 1 to 3, and approximately 140 local NDT companies employed certified personnel. These are cumulative or aggregate indicators of system scale; they do not show the number of currently active certificate holders by method, level, location or sector. They therefore support the case for maintaining current, disaggregated data within national workforce planning.

Table 1. Phases in the development of NDT personnel certification in Malaysia

Phase	Period	Key characteristics	Representative milestones
I. Dependency	Before 1985	Reliance on foreign service providers and overseas-certified operators	Overseas training via IAEA and Colombo Plan; Malaysia joins RCA NDT project
II. Foundation	1985-1999	Creation of regulator, national scheme and professional society	Act 304 and AELB (1985); first RT course and SPKM-NDT (1986); Ibrahim (2001); MSNT (1989)
III. Consolidation	2000-2011	Integration into national skills system; growth of local industry	Act 652 (2006); NOSS-based SKM NDT; MINT becomes Nuklear Malaysia (2006)
IV. International alignment	2012-2019	Accreditation, standard adoption and regulatory anchoring	DSD ISO/IEC 17024 accreditation (2012); MSNT as ILB (2012); MS ISO 9712:2014; AELB SKM RT L2 rule (2015); IAEA Collaborating Centre (2015); ICNDT MRA (2019)
V. Diversification and digitalisation	2020-present	National scheme updates and sectoral rules	CAAM CAD 8704 and MTR 2 Issue 3 (2022); CIDB-CS-02; Atom Malaysia; ISO 9712:2021 adopted in SPKM-NDT (2023); RT-D; eNDT and MySPIKE

NDT Personnel Certification Schemes in Malaysia

National scheme SPKM-NDT and SKM NDT

SPKM-NDT is Malaysia's national certification scheme for NDT personnel, administered by DSD under the Ministry of Human Resources. Introduced in 1986, it is aligned with ISO 9712:2021 and the National Occupational Skills Standards (NOSS), which specify the competencies required for NDT work. Successful candidates receive the Malaysian Skills Certificate (Sijil Kemahiran Malaysia, SKM), which serves as a nationally administered record of qualification (DSD, 2025; Abidin, 2025). This institutional arrangement distinguishes the certification authority from accredited training agencies and examination centres that deliver training or assessment within the scheme's requirements.

DSD's responsibilities extend across scheme governance and certification administration. The Department identifies the applicable standards, maintains the NOSS basis for occupational competence, sets the examination and certification procedures, and is accountable for impartial certification decisions. The published scheme information describes stakeholder participation through the Skills Development Advisory Committee and states that personnel and committee members sign impartiality undertakings. DSD also identifies MSNT as the Industry Lead Body for NDT, contributing industry input to NOSS development and promoting SPKM-NDT to practitioners and employers (DSD, 2025). This division of responsibilities gives SPKM-NDT a national governance structure that connects public certification authority with industry advice and technical delivery.

The SPKM-NDT programme listed by DSD covers Radiographic Testing, Radiographic Interpretation, Digital Radiographic Testing, Ultrasonic Testing, Magnetic Particle Testing, Penetrant Testing and Eddy Current Testing. Candidates progress through the scheme's training, industrial-experience and theoretical and practical assessment requirements, while centres and examination personnel are subject to DSD accreditation and appointment procedures (DSD, 2025). The scheme states that certificates are valid for a maximum of five

years, with renewal required before expiry; recertification and verification processes are also administered through eNDT. MySPIKE supports related registration and program-management functions (DSD, 2025). These arrangements make the national pathway relevant not only as a credential but also as a system of training standards, assessment, renewal and records management.

SPKM-NDT's institutional position is supported by DSD's accreditation to MS ISO/IEC 17024, registration under Schedule 2 of the ICNDT MRA, recognition of SKM Level 2 Radiographic Testing for radiograph-operator appointments, and explicit reference to DSD-certified personnel in MIBAS requirements (DSD, 2022; DSM, 2022; ICNDT, 2024). Its connection to the national skills system also provides routes for recognising prior learning and integrating NDT competencies with other SKM pathways, subject to the relevant DSD guidelines (DSD, 2021). DSD describes itself as the national certification body for NDT in Malaysia, while other sectoral requirements determine the qualifications accepted for particular work. The scheme's national reach and international recognition make transparency about its scope, currency and operational performance important for employers and certificate holders.

Sectoral scheme CIDB-CS-02

CIDB is a statutory body under the Ministry of Works, established under Act 520. Its CIDB-CS-02 certification scheme covers NDT Level 2 for welded joints made by fusion welding in the construction sector, for five methods: Magnetic Testing (MT), Penetrant Testing (PT), Ultrasonic Thickness Measurement (UTTM), Ultrasonic Testing of welds (UT) and Radiographic Interpretation (RI) (CIDB, 2025). Certification is structured into general, sector-specific and job-specific parts, with the job-specific part carried out by or for the employer.

The scheme sets minimum training hours (MT 40, PT 40, UTTM 60, UT 120 and RI 56 hours) and minimum industrial experience (UT 12 months, UTTM and RI 6 months, MT and PT 4 months), with reductions for multi-method candidates. Examinations include general and specific written papers and a practical examination, with a 70% pass mark for each part. Certificates are valid for a maximum of five years, with renewal based on evidence of continuous work activity and a vision test, and recertification every ten years including a full practical assessment (CIDB, 2025). The scheme states that it complies "as a minimum" with ISO 9712:2012. Training is delivered through CIDB's Akademi Binaan Malaysia (ABM) and CIDB Technologies, including subsidised programmes for youth and construction personnel, which lowers the cost barrier for new entrants (Akademi Binaan Malaysia, 2026). In November 2023, CIDB received ISO/IEC 17024 recognition from the Department of Standards Malaysia for its Construction Skills Competency Certificates (Sijil Kemahiran Kompetensi Pembinaan, SKKP) in welding, NDT, and blasting and painting (CIDB, 2025).

CIDB-CS-02 extends personnel certification to construction work involving welded joints and connects certification with CIDB's construction personnel registration arrangements. Its scope remains narrower than SPKM-NDT because it addresses Level 2 and a defined set of methods, while its scheme document continues to refer to ISO 9712:2012 rather than the 2021 edition. This illustrates why DSD's national pathway and sector schemes should be compared based on their specific occupational purpose, level, and acceptance conditions rather than treated as equivalent credentials (CIDB, 2025; DSD, 2025).

Sectoral regulatory requirements

Personnel certification and regulatory acceptance are related but distinct. A certification body assesses and certifies an individual's qualification against a scheme, whereas a regulator or accreditation programme determines whether that credential satisfies the requirements for a particular activity, licence or inspection-body scope. This distinction is especially important in Malaysia because SPKM-NDT is administered nationally by DSD, while radiation safety, inspection body accreditation, and aviation maintenance are governed by separate regulatory instruments (DSD, 2025; DSM, 2022; CAAM, 2022).

Atom Malaysia (formerly AELB) regulates industrial radiography under Act 304. Organisations using ionising radiation must hold a licence, appoint a Radiation Protection Officer (RPO) and a person responsible for the

licence (Orang Bertanggungjawab Terhadap Lesen, OBTL), and use radiation workers recognised by the regulator (Department of Standards Malaysia, 2022). Since 2015, SKM Level 2 RT has been required for radiograph operators (DSD, 2025b). Radiation protection training follows international guidance, such as the IAEA syllabus for RPOs in industrial radiography (IAEA, 2025).

Standards Malaysia, through MIBAS and MTR 2, sets the requirements for accreditation of NDT inspection bodies under MS ISO/IEC 17020. MTR 2 recognises three routes for personnel certification: SPKM-NDT; another independent certification body that is demonstrably equivalent to ISO 9712; or an employer scheme such as SNT-TC-1A that is independently assessed and approved by an ISO 9712 Level 3. For RT, only DSD Level 2 or Level 3 holders can be approved signatories (DSM, 2022).

CAAM regulates NDT in aircraft maintenance through CAD 8704, which replaced Airworthiness Notice 52 and requires personnel to be qualified under EN 4179 through an organisation's written practice. The directive also places technical control with a nominated Level 3 and defines the qualifications accepted for that role. This means that aviation maintenance follows a sector-specific qualification pathway alongside the national SPKM-NDT scheme, and the accepted credential must be interpreted in the context of the maintenance organisation's approval and task scope (CAAM, 2022).

International certification pathways

International certification and sectoral requirements remain relevant in Malaysia, particularly where multinational projects, offshore work, export services or aviation maintenance specify them. PCN is a central certification scheme administered by BINDT and aligned with ISO 9712, while ASNT SNT-TC-1A and CP-189 use employer-based qualification and certification approaches. Aviation maintenance applies EN 4179 through an organisation's written practice and nominated Level 3 oversight. These requirements shape acceptance for defined work but do not replace the national role of DSD in administering SPKM-NDT (ICNDT, 2024; ASNT, 2026; CAAM, 2022).

Comparison of certification pathways

Table 2 compares SPKM-NDT with CIDB-CS-02 and other international or sectoral requirements. The comparison foregrounds DSD's national responsibility while showing how the sectoral and international requirements relate to defined work scopes. It is intended as a documentary comparison of published scheme and regulatory provisions; it does not infer equivalence between certificates or measure how employers apply the requirements in practice (DSD, 2025; CIDB, 2025; CAAM, 2022; DSM, 2022).

Table 2. Comparison of NDT personnel certification pathways in Malaysia

Attribute	SPKM-NDT (DSD)	CIDB-CS-02 (CIDB)	International (PCN / ASNT / EN 4179)
Type of body	Government department (MOHR)	Statutory body (Ministry of Works)	Foreign professional bodies / employers
Legal basis	Act 652	Act 520	Foreign; contractual or regulatory acceptance
Reference standard	ISO 9712:2021 (since 1 June 2023)	ISO 9712:2012 (minimum compliance)	ISO 9712 (PCN); SNT-TC-1A / CP-189 (ASNT); EN 4179

Accreditation / recognition	MS ISO/IEC 17024 (2012); ICNDT MRA Schedule 2 (2019)	ISO/IEC 17024 recognition by Standards Malaysia (2023)	UKAS / ICNDT MRA (PCN); employer-based (ASNT)
Levels	1, 2, 3	Level 2 only	1, 2, 3
Methods	RT, RI, RT-D, UT, MT, PT, ET	MT, PT, UTTM, UT, RI (welds)	Broad, including advanced methods
Main sector	Multi-sector; oil and gas; power	Construction (welded joints)	Offshore, multinational, aerospace
Regulatory anchoring	Atom Malaysia (RT operators); MIBAS RT signatories	CIDB personnel registration	MIBAS (with conditions); CAAM CAD 8704
Validity	Max. 5 years; renewal	Max. 5 years; recertification at 10 years	5 years (ISO 9712); employer-defined (ASNT)

Sources: DSD (2025); CIDB (2025); ICNDT (2024); DSM (2022); CAAM (2022); ASNT (2026).

The comparison indicates that SPKM-NDT is the national certification pathway administered by DSD, while CIDB-CS-02 and aviation requirements address defined sectoral scopes and international schemes may be specified by employers, regulators or clients. These routes should therefore be interpreted in accordance with the applicable work and acceptance rules rather than treated as interchangeable credentials. The documents reviewed do not quantify how often personnel hold duplicate certificates, the resulting cost, or how employers compare qualifications in practice; these remain questions for empirical study (DSD, 2025; CIDB, 2025; CAAM, 2022; DSM, 2022).

Industry Workforce Needs and Competency Demand

The public indicators of where NDT inspection work is required and which competencies are relevant, with SPKM-NDT serving as the national reference point for personnel certification. The reviewed sources describe activity across several industrial sectors, but they do not provide a national count of NDT vacancies or a forecast of demand by method and certification level. Accordingly, broader sector employment figures are used only to explain the context in which inspection work occurs and are not treated as direct estimates of NDT workforce requirements (Abidin, 2025; DSD, 2025; CSC, 2021).

The economic role of NDT in Malaysia

NDT in Malaysia grew out of the national nuclear science and technology (NST) programme, and it remains one of the most economically important industrial applications of NST. Rashid et al. (2020) identify NDT, together with radiation gauges, radiotracer technology and sealed-source technology, as the main industrial uses of NST in oil and gas, conventional power generation, process plants, transportation, aerospace and manufacturing, and map these applications to Sustainable Development Goal 9 (industry, innovation and infrastructure). The same study reports that the share of nuclear technology in national GDP rose from 0.024% in 2006 to 0.032% in 2008, and that licence holders for non-medical activities, a category that includes industrial radiography, increased between 2009 and 2016 (Rashid et al., 2020). Within this broader NST economy, Abidin (2025) reports that oil and gas accounts for about 70% of NDT inspections, about 140 local NDT companies operate with certified personnel, and local inspection costs about one-fifth of hiring foreign experts. These figures indicate the sector's relevance but do not isolate NDT's contribution to national productivity or GDP.

Sectoral drivers of inspection work

Oil, gas and petrochemicals. This sector remains a major user of NDT, with demand driven by asset integrity, turnarounds, shutdowns, and decommissioning. A study of Malaysian offshore structures reported that 65% of 191 platforms had exceeded their design life by 2014, and that more than 300 shallow-water fixed platforms had operated for over 20 years, with 48% beyond their 25-year design life (Zulkifli et al., 2022). These figures describe the asset base covered by that study and are not a current condition survey. PETRONAS identifies NDT as an associated service in installation and maintenance, construction and modification work, which requires substantial annual man-hours (PETRONAS., 2023). News reports citing PETRONAS projected approximately 25,000 workers across turnaround, shutdown and related activities during peak quarters in 2026 and 2027 (DayakDaily., 2025; NST, 2025). That figure refers to the broader project workforce, not NDT personnel. It signals possible peaks in inspection workload but cannot be converted into an NDT headcount without sector-specific data.

Construction and civil infrastructure. CIDB-CS-02 provides a certification route for NDT of welded joints in construction (CIDB, 2025). The IAEA has also issued training-syllabus guidance for NDT in civil engineering (IAEA, 2025). These sources indicate distinct inspection applications but do not quantify the number of certified personnel required in Malaysia.

Aerospace and maintenance, repair and overhaul. Bernama reported that Malaysia's aerospace, MRO and manufacturing sectors employed more than 35,000 highly skilled workers in 2025 and exceeded the Malaysian Aerospace Industry Blueprint 2030 employment target (Bernama., 2026). This is an industry-wide figure, not a count of NDT personnel. CAAM's CAD 8704 requires aviation-maintenance NDT personnel to meet EN 4179 requirements under an organisation's written practice and nominated Level 3 oversight (CAAM, 2022), creating a specialised certification pathway.

Advanced manufacturing and semiconductors. Malaysia's National Semiconductor Strategy includes a plan to train and upskill 60,000 engineers (MIDA, 2024). That target is not an NDT workforce estimate. Growth in precision manufacturing can increase the relevance of radiographic, computed-tomography and ultrasonic inspection, which requires suitable imaging, data-handling and interpretation skills (Taheri et al, 2022).

Energy transition. The National Energy Transition Roadmap covers hydrogen, carbon capture and storage, solar and other low-carbon technologies (MITI, 2023). These sectors may create inspection requirements for new materials, pressure systems and service conditions. The review found no Malaysian workforce forecast that quantifies the resulting NDT demand; implications for certification scope should be treated as emerging rather than established.

Labor-market signals and their limits

Labor-market sources provide signals about the recognition of NDT occupations, but they do not establish the current size of a skills shortage. The Critical Occupations List included "Non-Destructive Testing (NDT) Inspector" under MASCO 3122 in its 2019/2020 and 2020/2021 editions (CSC, 2021). MyMahir lists roles including NDT Engineer, Inspector, Manager Level 3, Operator, Specialist and Technician (MyMahir., 2026). These sources support the relevance of NDT occupations; neither provides a current vacancy count or a method- and level-specific workforce gap.

Competencies associated with sector demand

Table 3 shows the sectoral demand drivers, inspection methods and certification or regulatory provisions documented in the reviewed sources. It relates those sectoral signals to SPKM-NDT and the relevant sector requirements, but it does not forecast headcounts or establish a shortage. The table should therefore be read as a structured summary of published evidence rather than a direct measure of employer demand (DSD, 2025; CIDB, 2025; CAAM, 2022; Abidin, 2025).

Table 3. Industry demand for certified NDT personnel in Malaysia by sector

Sector	Main demand drivers	Key methods in demand	Certification and regulatory requirements	Competency needs identified
Oil, gas and petrochemicals	Ageing offshore platforms; turnarounds and shutdowns; MCM; decommissioning	RT, RT-D, UT, PAUT, TOFD, MT, PT, ECT/IRIS, corrosion mapping	SPKM-NDT; Atomic Energy Malaysia requirements for RT; MIBAS requirements for inspection bodies; client specifications	Advanced UT; RT-D; Level 3; peak-period manpower
Construction and infrastructure	Steel structures; welded joints; bridges and civil assets	MT, PT, UT, UTTM, RI; concrete NDT	CIDB-CS-02 (SKKP); CIDB personnel registration	Concrete and civil NDT; Level 1 and Level 3 routes
Aerospace and MRO	Fleet growth; MRO expansion to 2030	ET, UT, PT, MT, RT, bond testing, composites	CAAM CAD 8704 (EN 4179); nominated Level 3 (EN 4179, PCN/AERO or ASNT)	Composites; aerospace Level 3
Power generation and utilities	Ageing plants; boiler and turbine integrity	UT, PAUT, ECT, RT, MT	SPKM-NDT; Atom Malaysia for RT	Advanced UT; remaining-life assessment
Advanced manufacturing and semiconductors	Quality assurance; precision components	Digital X-ray, CT, UT, VT	Mainly employer-based or customer requirements	Digital imaging; data analysis; AI-assisted interpretation
Energy transition (hydrogen, CCS, renewables)	New pipelines, vessels, wind and solar structures	UT, PAUT, ECT, AE, composites inspection	Not yet specifically defined	New damage mechanisms; composites; standards development

Sources: Abidin (2025); CAAM (2022); CIDB (2025); DSM (2022); DSD (2025); ICNDT (2024); Ekonomi (2023); PETRONAS (2023); Rashid et al. (2020); Zulkifli et al. (2022).

Taken together, the workforce evidence suggests that inspection work spans conventional and advanced methods, while SPKM-NDT's published programme defines the methods and levels currently administered through the national scheme. Aviation and construction also apply sector-specific rules, making clear guidance on how these requirements relate to SPKM-NDT important for personnel and employers. In addition, turnaround activity can create short-term peaks in inspection workload, but published estimates of total project workers do not determine the number of NDT personnel required. National workforce planning should connect project schedules and employer demand to current certification records, disaggregated by method, level, sector, and location (DSD, 2025; CIDB, 2025; CAAM, 2022; NST, 2025).

The need for a national workforce evidence base

The sources provide aggregate certification and training figures and identify occupational roles, but they do not provide a public forecast of Malaysian NDT workforce demand by method, certification level, sector and location. DSD's published information describes scheme scope and cumulative programme indicators, while labour-market sources identify relevant occupations without reporting current vacancies or active certificate holders by method. This limits the ability of DSD, employers and TVET providers to align training intake, advanced-method provision and Level 3 development with quantified demand. A national evidence base could link certification records, employer surveys, project schedules and training capacity while protecting personal data (DSD, 2025; Abidin, 2025; CSC, 2020, 2021; MyMahir, 2026).

Institutional Roles in Malaysian NDT Certification

Professional societies can connect technical communities, industry and international standards bodies. Under the ICNDT MRA, national society participation in Schedule 1 provides a route through which eligible certification bodies may be proposed for Schedule 2 registration (ICNDT, 2024). In Malaysia, this international role sits alongside domestic functions in skills development, technical training and sector regulation.

MSNT was established in 1989 under the RCA project to support national NDT capacity in Asia-Pacific member states. In Malaysia, its documented functions include providing industry input to occupational standards and participating in the international recognition structure. These functions complement DSD's statutory administration of the national certification scheme by maintaining a channel for industry perspectives on occupational competencies and by linking the national system to international NDT coordination (Abidin, 2025; DSD, 2025; ICNDT, 2024). MSNT signed Schedule 1 of the ICNDT MRA in 2012, which provided the national-society route associated with DSD's registration under Schedule 2 in 2019. DSD identifies MSNT as the Industry Lead Body (ILB) for NDT, through which the society contributes industry input to NOSS and assessment requirements. The documentary record also describes cooperation among DSD as certification authority, Nuklear Malaysia as a technical and training institution, Atom Malaysia as regulator, and MSNT as the professional society and industry voice (ICNDT 2024, 2026; DSD, 2025; IAEA, 2018). These roles are institutionally distinct, but the sources reviewed do not evaluate how consistently the coordination operates in practice or how it affects certification outcomes.

Trends Affecting Certification and Workforce Competencies

International recognition relies on the interaction of ISO 9712-based personnel certification, ISO/IEC 17024 accreditation and ICNDT MRA registration. Malaysia's adoption of ISO 9712:2021 in SPKM-NDT in 2023 aligns that national scheme with the current edition and therefore strengthens the international acceptance of Malaysian NDT certificates. Registration under the ICNDT MRA allows the issued certificates to be mutually recognized by other member countries.

Certification requirements extend beyond oil and gas to construction, civil infrastructure, and aviation, while low-carbon industries may create new inspection needs. The IAEA's civil-engineering syllabus guidance and CIDB-CS-02 address construction applications (IAEA, 2025; CIDB, 2025). Malaysia's NETR and NIMP 2030 identify sectors that may create new inspection requirements, including hydrogen, carbon capture, renewable energy and advanced manufacturing (Ministry of Economy, 2023; MITI, 2023). Workforce implications remain prospective until method- and level-specific demand is documented.

Advanced methods include PAUT, TOFD, digital radiography, computed radiography, and eddy-current array. DSD's published program includes Digital Radiographic Testing, while Abidin (2025) describes regional capacity-building and emerging requirements for methods. The reviewed sources do not establish a national shortage for each advanced method, and the available evidence should not be used to infer that a method is absent from all Malaysian practice merely because it is not listed as a separate SPKM-NDT programme (DSD, 2025; Abidin, 2025).

NDE 4.0 describes the integration of NDT with digital twins, connected systems, automation, cloud data and artificial intelligence (Meyendorf et al., 2022; Vrana & Singh, 2021). Machine-learning research examines defect detection and characterisation in ultrasonic and radiographic data (Cantero-Chinchilla et al., 2022). These developments may change inspection tasks and the skills expected of personnel, including data handling and interpretation of algorithm-supported results (Bertovic & Virkkunen, 2021). The review found no evidence that Malaysian certification schemes already assess this full set of competencies.

Certification processes increasingly use digital systems. ISO 9712:2021 permits distance or self-paced theory training under specified conditions, while practical training remains face-to-face (ICNDT, 2024). DSD describes eNDT as supporting online applications, renewals and recertifications (DSD, 2025). Digital records may help verify certificates and support workforce analysis when data quality, access, and privacy are appropriately governed.

NOSS, Recognition of Prior Achievement and work-based learning provide mechanisms that could connect prior experience, training and certification within Malaysia's skills system (DSD, 2021). Effective NDT workforce planning requires addressing three interdependent dimensions: evolving employer demand driven by an aging workforce and digital transformation, operational training pipeline capacity, and clear candidate progression across the qualification framework (Gilbert, 2023; Saboonchi et al., 2021).

Issues in the Malaysian Certification Landscape

Malaysia's national, sectoral and international requirements differ in scope, governing authority and recognition. SPKM-NDT provides the DSD-administered national route, CIDB-CS-02 addresses a defined construction scope, and aviation maintenance applies EN 4179 requirements through organisational written practices and nominated Level 3 oversight. These differences make it important to publish clear information about the relevant credential for each work activity and the rules that govern its acceptance. Current evidence does not quantify duplicate certification or its cost, so those effects require employer and personnel research rather than assumption (DSD, 2025; CIDB, 2025; CAAM, 2022; DSM, 2022).

SPKM-NDT adopted ISO 9712:2021, whereas the CIDB-CS-02 document specifies ISO 9712:2012 as a minimum requirement (DSD, 2025; CIDB, 2025). Differences between editions include training, experience, examination and renewal provisions. Until scheme documents are aligned or their differences are mapped, users may find it difficult to compare requirements across pathways. Since these elements are the main basis for judging whether a person is competent, a change in any of them can affect how equivalent the certificates issued under each pathway really are (Jovanović, 2024).

The DSD programme list includes conventional methods and Digital Radiographic Testing but does not identify PAUT, TOFD or ECA as separate SPKM-NDT programme areas in the source reviewed. CIDB-CS-02 covers Level 2 certification within its construction scope, while international and employer requirements may specify additional methods or levels. Level 3 personnel remain important for procedure development and technical oversight, including the execution of nominated Level 3 responsibilities under aviation requirements.

Training, examination, travel and recertification can create access costs, particularly when candidates need specialised methods or must travel to an accredited training or examination centre (Eley et al., 2025). However, the documents reviewed do not provide comparable fee data, centre-level capacity or a national map of training availability, so the scale and geographical distribution of these barriers remain unestablished. DSD publishes programme and centre information, but further data is needed to assess whether access varies by method, region or candidate background (DSD, 2025; CIDB, 2025).

Certification examinations assess performance under specified conditions, while field inspections may involve time pressure, restricted access, fatigue and organisational influences. Human-factors research has linked such conditions to inspection decisions and probability of detection (Bertovic, 2016; Bertovic & Virkkunen, 2021; Bato et al., 2019).

Inspection technologies are changing, but the documents reviewed do not consistently demonstrate how competencies in data management, automated scanning, and AI-assisted interpretation are incorporated into Malaysian NOSS and scheme syllabi. DSD's published SPKM-NDT programme information and the reviewed NOSS-related materials provide the national reference for current scope, while research on NDE 4.0 and AI-assisted inspection indicates emerging technical tasks that merit consideration in future revisions (DSD, 2025; Meyendorf et al., 2022; Vrana & Singh, 2021; Cantero-Chinchilla et al., 2022; Taheri et al., 2022). Periodic reviews with employers and training centers could determine which of these competencies should be reflected in training and assessment, rather than assuming that all emerging technologies require a new certification method.

Public data are limited on certified NDT personnel by method and level, examination outcomes, renewal, employment and sector demand. DSD and industry sources report aggregate system information, whereas occupational lists identify NDT roles but do not provide current vacancies or active certificate-holder counts by specialty. These indicators cannot establish whether personnel supply matches demand for particular work. This evidence gap constrains workforce planning and assessment of how well SPKM-NDT's training and certification capacity responds to industry needs (DSD, 2025; Abidin, 2025; CSC, 2021; MyMahir, 2026).

LIMITATIONS

This review relies on peer-reviewed literature, government documents, scheme materials, institutional reports and media reporting. Some scheme details come from issuing organisations' own publications and were not independently audited against accreditation-body records. The review documentation did not retain protocol-defined search dates, database-specific retrieval counts or a screening log; the findings should therefore be read as an integrative synthesis of located evidence, not an exhaustive census. Public data were insufficient to estimate the NDT workforce gap by sector, method or level, and broader employment projections cannot substitute for such estimates. The study includes no interviews, employer survey or direct assessment of scheme outcomes.

CONCLUSION

NDT personnel certification in Malaysia has evolved from an early reliance on overseas expertise to a nationally administered system centered on SPKM-NDT under DSD. The historical record traces the scheme from its introduction in 1986 through consolidation within the national skills system, accreditation to MS ISO/IEC 17024, recognition under the ICNDT MRA, adoption of ISO 9712:2021 and digital administration through eNDT and MySPIKE (IAEA, 2018; Abidin, 2025; DSD, 2025; ICNDT, 2024). CIDB-CS-02 and aviation requirements impose specific sectoral conditions, but they do not diminish the importance of DSD's national role in setting and administering SPKM-NDT (CIDB, 2025; CAAM, 2022).

Evidence from oil and gas, construction, aerospace and MRO, advanced manufacturing, power and emerging energy sectors indicates varied inspection applications and competency requirements. However, the available sources do not establish a current national shortage or quantify NDT personnel demand by method and level. Sector workforce figures, occupation listings and aggregate certification totals should therefore not be presented as direct measures of an NDT skills gap (Abidin, 2025; DSD, 2025; CSC, 2021; MyMahir, 2026; CAAM, 2022; CIDB, 2025).

For workforce planning, Malaysia needs clearer information on how SPKM-NDT's methods, levels, and certification cycle align with current employer demand, alongside reliable national data on active certificate holders and workforce needs. Periodic review of standards, training capacity and Level 3 development should be grounded in sector evidence. Further research should examine how the national scheme is implemented across training and examination centres and how certification relates to competence, mobility, employability and inspection quality (DSD, 2025; Abidin, 2025).

Declarations

Ethics approval: Not applicable. This documentary review did not involve human participants or animals.

Conflict of interest: The authors declare that there is no conflict of interest regarding the publication of this article.

Data availability: No original dataset was generated for this review. Documentary sources are cited in the reference list.

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