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The Status of Non-Destructive Testing in Malaysia and Technical Cooperation for Sustainable Development in the Asia-Pacific Region

Dr. Ilham Mukriz Zainal Abidin

Manager & Senior Research Officer, Malaysian Nuclear Agency

Summary

The paper examines the evolution and current status of Non-Destructive Testing (NDT) in Malaysia and its role in sustainable development across the Asia-Pacific. It highlights Malaysia's progress from reliance on foreign expertise in the 1980s to establishing a robust domestic industry with internationally recognized certification, advanced technologies, and strong ties to the International Atomic Energy Agency (IAEA) and Regional Cooperative Agreement (RCA). NDT has become vital in sectors such as oil and gas, power generation, aerospace, and construction, contributing to safety, cost savings, and skilled job creation. However, challenges remain, including fragmented certification systems, regulatory inconsistencies, high costs of advanced technologies, and limited R&D investment. Regional cooperation through RCA and the Asia Pacific Federation for Non-Destructive Testing (APFNDT) has supported workforce training, standardization, and expansion of NDT into civil engineering and disaster response, aligning with Sustainable Development Goals (SDGs) and Industry 4.0. Moving forward, Malaysia and the Asia-Pacific region must harmonize standards, invest in NDT 4.0 technologies, strengthen academia-industry collaboration, and deepen international partnerships to build a resilient, future-ready NDT sector that supports safety, reliability, and sustainability. ✓

CONTENTS

1. Introduction
2. Malaysia's NDT Landscape
3. Challenges in NDT Technical Cooperation
4. Regional Cooperation for NDT and Sustainability
5. Sustainable Development Strategies in the Asia-Pacific Region
6. Conclusion and Future Directions

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1. Introduction

The Role of NDT in Industry and Sustainability

Non-Destructive Testing (NDT) is a technique for inspecting and evaluating materials, components, or structures without causing damage or compromising their usability. It ensures safety, reliability, and cost-effectiveness in industries such as nuclear, oil and gas, aerospace, manufacturing, automotive and construction. By detecting flaws early, NDT helps prevent structural failures, reduce maintenance costs, and extend asset lifespan.

NDT is widely applied in industrial settings at various stages of a system’s lifecycle. During manufacturing and installation, it is used for Pre-Service Inspections (PSI) to verify quality and compliance with standards. During operation, In-Service Inspections (ISI) ensure continued integrity, prevent potential failures, and optimize performance. These inspections enhance operational reliability, product quality, and overall system efficiency.

Beyond industrial applications, NDT also contributes to sustainability by reducing material waste, optimizing resource use, and improving energy efficiency. This is particularly relevant in industrially active regions such as the Asia-Pacific, where infrastructure resilience is essential for economic stability. As industries adopt smarter, greener technologies, NDT is evolving to integrate with automation, artificial intelligence (AI), and digital monitoring asystems, further supporting safety and sustainability goals in the modern industrial era.

NDT Development and Technical Cooperation in Malaysia

Malaysia has made significant progress in NDT, evolving from reliance on foreign expertise to building a strong local industry. This development has been driven by industrial growth, regulatory demands, and international collaboration. Over the years, Malaysia has built a competent workforce, established a national NDT certification scheme, and integrated advanced NDT technologies across various sectors.

The oil and gas sector was an early adopter of NDT in Malaysia, and its use quickly expanded into power generation, aerospace, construction, and manufacturing. Today, NDT is essential for ensuring structural integrity and operational efficiency across industries, contributing to both safety and economic growth. Institutions such as the Malaysian Nuclear Agency, universities, and private training centres have been instrumental in developing the country’s NDT workforce, promoting technical expertise, and advancing research in emerging technologies.

Malaysia has also actively participated in international NDT cooperation, working with organizations such as the International Atomic Energy Agency (IAEA) and the Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology for Asia and the Pacific (RCA). These collaborations have facilitated knowledge transfer, training programs, and technology adoption, strengthening Malaysia’s position in the global NDT landscape.

NDT: Ensuring Safety, Reliability, and Sustainability in Industry Applications

Non-Destructive Testing (NDT)

Used to examine materials, components, or structures without causing damage or impacting their functionality

- Safety
- Reliability
- Cost-effectiveness



In Industrial Settings

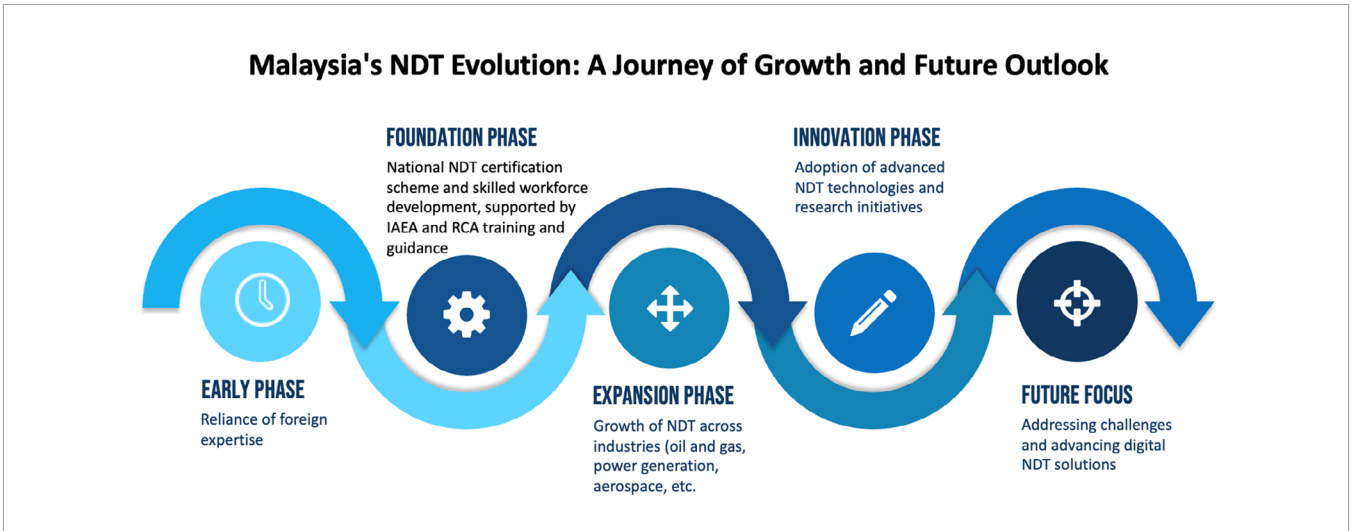
NDT is widely applied at various stages of a system's lifecycle

- Pre-Service Inspection (PSI)**
 During manufacturing and installation
- In-Service Inspection (ISI)**
 During operation and maintenance

Key Role in Sustainability

- Reducing material waste
- Optimizing resource use
- Improving energy efficiency





However, challenges remain, including issues with standardization, skill gaps in advanced NDT techniques, and the need for more investment in research and development (R&D). Moving forward, Malaysia aims to tackle these challenges by adopting digital innovations, strengthening regulatory frameworks, and expanding global partnerships.

its own NDT professionals, reducing dependence on foreign expertise.

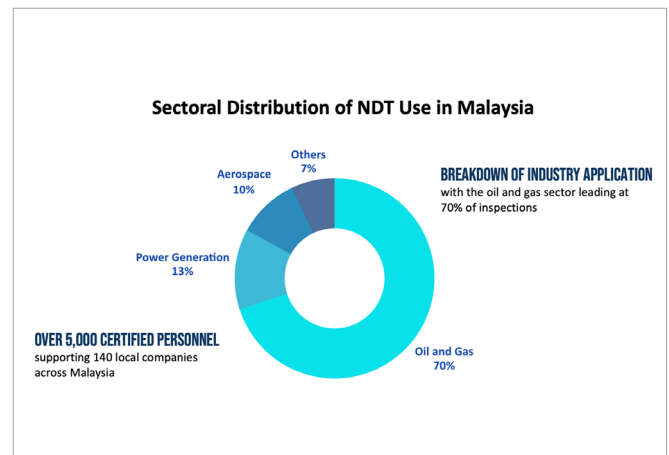
The Department of Skills Development (DSD) implemented the national NDT certification scheme in 1986. Through this scheme, over 10,000 individuals have been trained, with more than 5,000 NDT personnel holding Level 1, Level 2, and Level 3 certifications. These certified individuals support about 140 local NDT companies across industries such as oil and gas, aerospace, power generation, and railways. Notably, the oil and gas sector accounts for 70% of all NDT inspections.

2. Malaysia's NDT Landscape

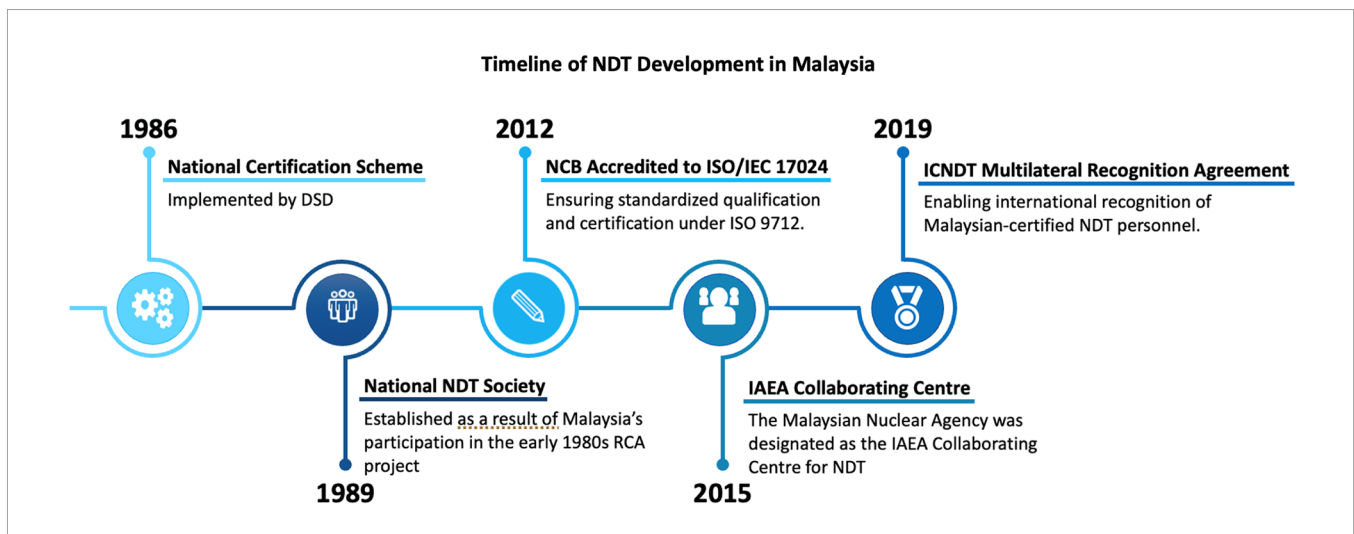
Historical Perspectives

NDT began gaining traction in Malaysia in the 1980s, coinciding with the country's transition from a commodity-based economy to a technology-driven industrial hub. The rapid expansion of sectors like oil and gas, manufacturing, and power generation created a demand for local NDT expertise to ensure safety, compliance, and operational reliability.

Before establishing a domestic NDT industry, Malaysian companies relied on expensive foreign inspection services. Recognizing the need for self-reliance, the government took steps in the early 1980s to develop a trained NDT workforce. Under programs such as the IAEA Technical Cooperation Programme (TCP) and the Colombo Plan, Malaysian personnel were sent abroad for training in France, Pakistan, Singapore, Japan, and Australia. This knowledge transfer enabled Malaysia to train and certify



The Malaysian Society for Non-Destructive Testing (MSNT) was established in 1989 as part of the RCA project, in which Malaysia participated in the early 1980s. One of the key objectives of the project was to establish NDT societies in each Member State. The establishment



of the NDT society provided a platform for professionals to explore and maximize the benefits of NDT technology.

A key milestone was achieved in 2012, when Malaysia became the fourth country in the Asia-Pacific region to obtain accreditation according to ISO/IEC 17024 for its National Certification Body (DSD). This accreditation, enabled the DSD to fulfil the requirements of ISO 9712, for certification of NDT personnel and thereby ensure standardized qualification. This international recognition improved inspection practices, enhancing both safety and industry credibility.

Based on Malaysia's outstanding achievements in NDT, the IAEA has designated the Malaysian Nuclear Agency as an IAEA Collaborating Centre for NDT from 2015 to 2019. This prestigious recognition strengthened the close and highly productive cooperation between Malaysia and the IAEA, supporting a wide range of initiatives, including research, development, and training activities. In 2019, the IAEA further acknowledged the contributions of the Malaysian Nuclear Agency by extending its designation as the IAEA Collaborating Centre for Advanced NDT from 2019 to 2023. This recognition was renewed for an additional period, from 2023 to 2027, reflecting the continued success and growth of the Malaysian Nuclear Agency's NDT programs.

Another major achievement came in 2019, when the DSD successfully met all eligibility criteria for registration under the International Committee for Non-Destructive Testing (ICNDT) Multilateral Recognition Agreement

(MRA). This recognition further elevated Malaysia's NDT certification scheme to global standards, facilitating international acceptance of Malaysian-certified NDT personnel.

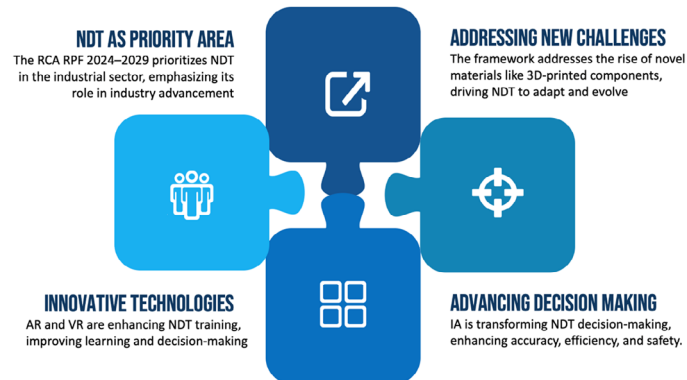
NDT has also enhanced employment opportunities particularly for graduates and non-graduates, while significantly reducing costs. Local inspections cost only one-fifth of hiring foreign expertise. Additionally, the growth of the NDT industry has elevated Malaysia's socio-economic landscape by creating high-skilled jobs, supporting local businesses, and attracting investment in industrial sectors. Today, Malaysia has successfully built a self-sufficient, globally competitive NDT sector, contributing to national development and industrial efficiency.

Technological Advancements

Malaysia's NDT landscape has evolved significantly, driven by advancements in technology, digitalization, and industry demands. Over the years, the adoption of modern inspection methods and techniques, innovative systems, and data-driven solutions has enhanced the efficiency, accuracy, and reliability of NDT applications across various sectors.

One of the most significant advancements in Malaysia's NDT sector is the transition from conventional to advanced inspection techniques. While traditional methods such as radiographic testing (RT), ultrasonic testing (UT), and eddy current testing (ET) remain essential,

Transforming NDT: The RCA Regional Programme Framework 2024–2029



industries are increasingly adopting radiographic testing - digital (RT-D), phased array ultrasonic testing (PAUT), and pulsed eddy current (PEC) for greater reliability and efficiency. These advanced techniques enhance the overall inspection capabilities, reduce exposure to radiation, and improve defect detection particularly in complex structures.

The integration of automation and robotics has further revolutionized Malaysia's NDT sector. Technologies such as automated scanning systems, robotic crawlers, and drones are now deployed to inspect hazardous and hard-to-reach areas, like offshore platforms, pipelines, and power plants. These technologies enhance safety by minimizing human exposure to risks while reducing downtime and operational costs.

The ongoing evolution of NDT in Malaysia is paving the way for NDT 4.0, integrating smart technologies, automation, and real-time data processing. Industries are increasingly leveraging AI, Internet of Things (IoT), and digital twins, into NDT practices. This aligns with the RCA Regional Programme Framework (RPF) 2024–2029, which identifies NDT as a priority area under the industrial sector. The framework also addresses new challenges, such as the increasing use of novel materials in manufacturing and construction, including additive manufacturing (3D printing). The integration of augmented reality (AR) and virtual reality (VR) in training, along with intelligent augmentation (IA) for NDT decision-making, is expected to transform the industry. As Malaysia continues its transition toward NDT 4.0, these

advancements will strengthen safety, sustainability, and cost-effectiveness, positioning the country as a leader in next-generation NDT applications.

Malaysia's NDT industry has become an essential component of industrial safety and reliability, driven by technological advancements and strategic collaborations. As industries continue to modernize, Malaysia's commitment to innovation, workforce development, and international cooperation will ensure its continued growth as a regional leader in NDT, supporting both economic progress and sustainability in the Asia-Pacific.

3. Challenges in NDT Technical Cooperation

Regulatory Inconsistencies

In Malaysia, regulatory inconsistencies present significant challenges in standardizing NDT practices, particularly in personnel certification. There are two main certification routes: the central certification scheme based on ISO 9712 and in-company certification, where individual companies establish their own qualification systems. While ISO 9712 offers an internationally recognized and standardized framework, its implementation by multiple local and foreign certification bodies leads to variability in certification practices. This fragmentation often results in NDT personnel needing multiple certifications for the same methods to

meet varying employer or industry requirements, creating unnecessary costs and administrative burdens.



Fig. 1: Inconsistencies in NDT – Variations in standards, regulations, and accreditation affect reliability

In addition to certification, discrepancies in regulatory enforcement and inspection standards exist. Different industries operate under varying codes, standards, and regulatory expectations, leading to inconsistent NDT application and acceptance criteria. While high-regulation sectors like oil and gas or power generation enforce stringent standards, other industries may lack clear guidelines, resulting in inconsistencies in inspection quality and safety compliance. Differences in adopting international standards such as ASME, API, and ISO further complicate standardization efforts.

Additionally, the regulatory framework for accrediting NDT service providers is not uniformly enforced. Some industries require service providers to obtain accreditation under ISO/IEC 17025 for testing laboratories or ISO/IEC 17020 for inspection bodies, while others operate with less stringent oversight. This uneven implementation affects the credibility and reliability of NDT services across sectors.

Moreover, the accreditation of NDT service providers is inconsistently applied. While certain industries require accreditation under ISO/IEC 17025 for testing laboratories or ISO/IEC 17020 for inspection bodies, others operate with minimal oversight. This inconsistency undermines the credibility and reliability of NDT services across sectors.

Addressing these challenges requires greater harmonization of certification schemes, standardization of regulatory enforcement, and a unified approach to industry-wide compliance. Strengthening regulatory oversight, ensuring consistent application of standards across sectors, and improving coordination among relevant authorities will help create a cost-effective, standardized, and internationally recognized NDT framework in Malaysia.

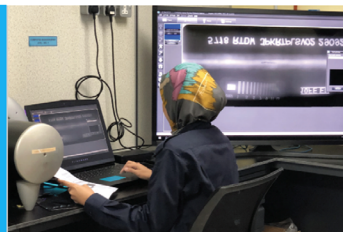
Resource Constraints and Industry-Academia Gaps

Another challenge for Malaysia’s NDT sector is the limited financial resources for adopting advanced inspection technologies and supporting workforce development. Basic methods such as magnetic testing (MT) and penetrant testing (PT) are relatively affordable, but advanced techniques like RT-D and PAUT require substantial investments in digital systems, software integration, and skilled personnel. Beyond initial costs, ongoing expenses for calibration, maintenance, software

Key Drivers for Advancing Malaysia’s NDT Sector

FINANCIAL RESOURCES

Substantial investment is required in high-end digital systems, software integration, and skilled personnel



R&D ECOSYSTEM

A stronger research ecosystem will keep Malaysia at the forefront of innovative NDT solutions



updates, and continuous training are additional burdens. These constraints hinder the ability of NDT service providers, training centres, and research institutions to embrace cutting-edge technologies, limiting Malaysia's ability to compete globally.

Compounding this issue is the gap between industry needs and academic research. While industry leaders such as PETRONAS have strengthened NDT research through academic collaborations, overall large-scale NDT R&D in Malaysia remains underfunded. To overcome this, closer industry-academia collaboration is vital, along with increased support from policymakers and key stakeholders, such as the Ministry of Science, Technology and Innovation (MOSTI) and the Ministry of Higher Education (MOHE). Strategic funding and national-level research grants are necessary to drive innovation and ensure Malaysia remains competitive in the evolving NDT landscape.

4. Regional Cooperation for NDT and Sustainability

Role of the RCA and International Partnerships

Regional cooperation has significantly enhanced NDT capabilities across the Asia-Pacific region. Initiatives such as the RCA program have strengthened technical expertise, harmonized certification standards, and encouraged collaboration among industries, academia, and regulatory bodies. These efforts contribute to safer industrial operations and sustainable development by reducing material waste, extending asset lifespans, and minimizing inspection downtime.

Capacity building through technology transfer and training has been a key result of regional cooperation. According to the Social and Economic Impact Assessment of the RCA Programme – Non-Destructive Testing Case Study (2022), over 2,500 NDT personnel across RCA Member States have been trained through more than 20 regional training courses and workshops. This has helped bridge skill gaps, enabling local institutions to train their own personnel, thereby promoting self-sufficiency in NDT workforce development.



International partnerships also play a crucial role in advancing NDT across the region. Organizations like the Asia Pacific Federation for Non-Destructive Testing (APFNDT) facilitate cooperation among national NDT societies, industry leaders, and regulatory bodies, contributing to the standardization of certification frameworks and supporting emerging technologies. Its mission aligns closely with the RCA's goals, focusing on promoting regional harmonization of NDT certification frameworks, encouraging knowledge exchange, and facilitating training programs that support emerging technologies and skill development.

Strategic Approach for Sustainability

A sustainable NDT ecosystem relies on a well-established infrastructure that includes national NDT societies, certification bodies, training centres, and regulatory authorities. Many developing countries in the region have struggled to build these foundational components due to resource limitations and technical gaps. Through RCA-supported projects, several member states have received essential assistance in establishing their basic NDT infrastructure, ensuring they have the necessary frameworks to support industrial applications.

Earlier RCA projects on NDT focused on establishing the fundamental NDT infrastructure across Asia-Pacific. These efforts began with providing training in NDT, supporting the formation of national NDT societies, and preparing countries to implement the internationally recognized ISO 9712 certification scheme. This foundational work enabled local certification of personnel, reducing reliance on



Fig. 2: Participants of the regional training course on RT-D Level 2 hosted by Malaysia implemented under RAS1029 with ISO 9712 certification

external expertise and promoting self-sufficiency in NDT development. As a result, these initiatives have contributed to the sustainability of the NDT ecosystem in participating countries, ensuring long-term growth and resilience in the sector.

The recent RCA projects, RAS1022 and RAS1029, have marked a significant milestone by certifying personnel in advanced NDT techniques. For the first time under the RCA platform, training in RT-D and PAUT has been conducted alongside internationally recognized certification aligned with ISO 9712. This initiative enabled participants to achieve Level 2 certification, strengthening technical expertise and accelerating the adoption of advanced NDT across the region. These certified personnel will play a crucial role in expanding existing certification schemes in their respective countries, incorporating advanced NDT techniques and facilitating local certification.

Additionally, the projects have broadened its scope to cover NDT applications to civil engineering, addressing structural inspection needs beyond traditional industrial sectors. This shift is particularly important as the Asia-Pacific region is the most disaster-prone in the world. Natural disasters, including earthquakes, floods, and landslides, have caused widespread damage to critical infrastructure such as hospitals, schools, and cultural heritage sites. To support post-disaster assessment and reconstruction efforts, NDT is essential in evaluating the structural integrity of affected buildings, ensuring they are safe for continued use.

Recognizing the importance of NDT in civil engineering, the IAEA took a significant step in 2024 by publishing a

guideline defining the requirements and training syllabi for NDT methods and techniques in civil engineering. The integration of NDT into civil engineering and disaster response contributes to long-term resilience, safety, and self-sufficiency in the region.

5. Sustainable Development Strategies in the Asia-Pacific Region

NDT's Role in Achieving SDGs

NDT's Contributions to the Sustainable Development Goals (SDGs)



ENSURES ASSET INTEGRITY & SAFETY



ENHANCES INFRASTRUCTURE RESILIENCE



REDUCES WASTE & EXTENDS LIFESPAN

NDT contributes to multiple Sustainable Development Goals (SDGs) by ensuring the longevity and integrity of industrial assets. For SDG 9 (Industry, Innovation, and Infrastructure), NDT helps prevent structural failures and promotes safe, efficient operations. In SDG 11 (Sustainable Cities and Communities), regular inspections enhance the resilience of essential infrastructure in disaster-prone areas. Additionally, NDT supports SDG 12 (Responsible Consumption and Production) by reducing

material waste through predictive maintenance, helping industries extend equipment lifespans, reduce unnecessary replacements, and lower environmental impact.

By strengthening NDT adoption, countries in the Asia-Pacific region can enhance industrial sustainability while ensuring safety, reliability, and resource efficiency. Expanding training and certification programs will be key to scaling up NDT applications and supporting a sustainable approach to infrastructure development and maintenance.

Integration of NDT into Industry 4.0

Safety and efficiency have always driven the evolution of NDT, ensuring the reliability of industrial assets. With the rise of Industry 4.0, NDT has entered a new phase, NDT 4.0, where AI, AR, big data analytics, and real-time data management enhance inspection accuracy and productivity. AI-driven algorithms enable real-time defect detection with higher precision, AR and VR facilitate immersive training and remote inspections, and cloud-based data management systems improve traceability and analysis. These advancements optimize maintenance strategies, reduce downtime, and increase safety in critical infrastructure.

While other regions have integrated automation and AI-powered analytics into their inspection frameworks, many countries in Asia and the Pacific remain in the early stages of implementing digital NDT techniques. This disparity limits their ability to meet modern industrial standards, ensure asset integrity, and remain competitive in the

global market. Bridging this gap will require investments in NDT 4.0 technologies, training programs, and industry collaboration to create a future-ready NDT ecosystem.

6. Conclusion and Future Directions

Final Thoughts: Strengthening NDT for a Sustainable Future

Malaysia has made significant progress in the field of NDT, evolving from an early dependence on foreign expertise to establishing a robust local industry. Over the years, Malaysia has built a skilled workforce, developed internationally recognized certification schemes, and adopted advanced NDT technologies across various sectors, particularly in oil and gas, power generation, aerospace, and construction. This growth has been supported by strong government initiatives, industrial collaborations, and technical cooperation with international organizations such as the IAEA and the RCA.

However, challenges remain, such as regulatory inconsistencies, skill gaps in advanced NDT techniques, and limited investment in R&D. Fragmented certification systems and industry-specific standards create inefficiencies, while resource constraints hinder the adoption of advanced technologies. Addressing these issues is critical for ensuring Malaysia's continued growth as a regional NDT leader.

Transforming the Future of NDT: Embracing Tomorrow's Technology



At the regional level, cooperation under initiatives like the RCA and APFNDDT has enhanced NDT capabilities through workforce development, technology transfer, and standardization efforts. The integration of NDT into civil engineering and disaster response highlights the increasing importance of NDT in ensuring the safety and sustainability of infrastructure across the region.

Shaping the Future of NDT in Malaysia and Beyond

Moving forward, Malaysia and the broader Asia-Pacific region should focus on several key areas to enhance NDT capabilities and ensure long-term sustainability:

1. Strengthening Regulatory Frameworks and Standardization

- Harmonizing certification systems to reduce multi-certification requirements.
- Enhancing regulatory enforcement for uniform compliance across sectors.
- Alignment with global standards to improve the international mobility of certified NDT professionals.

2. Advancing NDT Technology and Digital Transformation

- Promoting NDT 4.0 by integrating AI, automation, and digital monitoring systems.
- Investing in robotics and drones for safer and efficient inspections in hazardous environments.
- Developing cloud-based systems for real-time decision-making and data management.

3. Bridging the Industry-Academia Gap

- Increasing government and industry funding for NDT-related R&D.
- Strengthening university-industry collaborations for technology transfer.
- Expanding technical training programs to equip the workforce with emerging technologies

4. Enhancing Regional and International Cooperation

- Continuing active participation in RCA projects and strengthening collaborations with the IAEA and APFNDDT to facilitate knowledge exchange and training.
- Supporting the expansion of certification programs for self-sufficient NDT workforce.
- Promoting NDT applications in civil engineering to improve infrastructure safety.

By addressing these priorities, Malaysia and countries in the Asia-Pacific can establish a resilient, technologically advanced NDT sector, ready to meet the challenges of tomorrow while ensuring safety, reliability, and sustainability. ✓

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