NDT Trends

history and future

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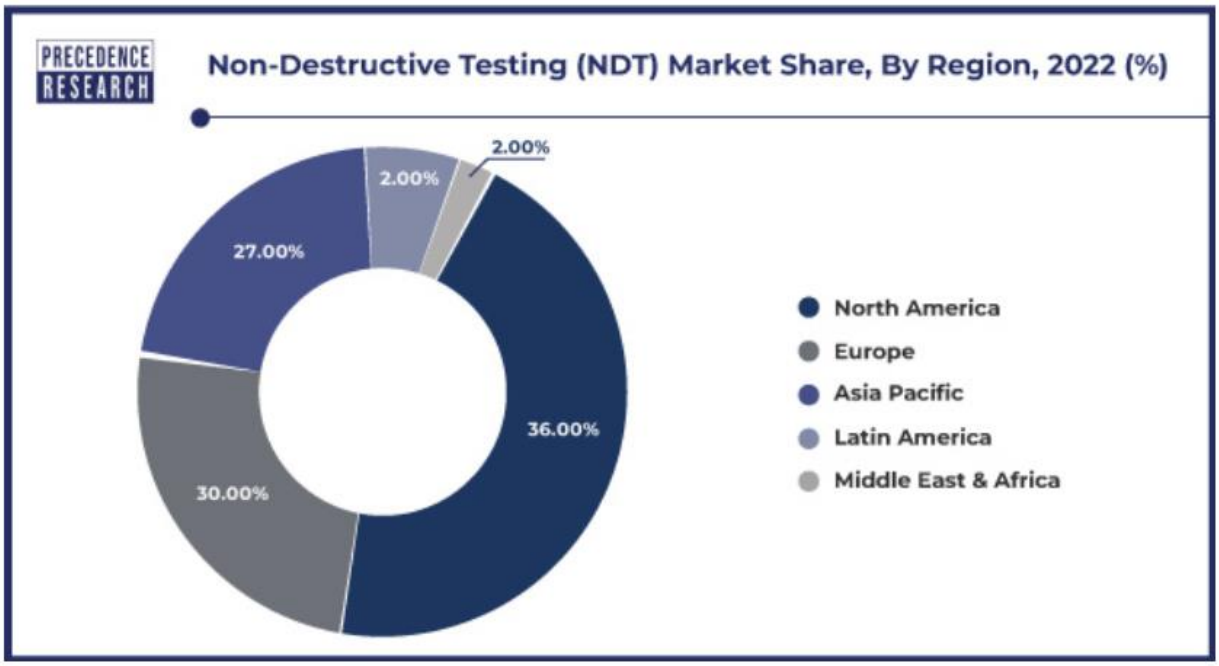

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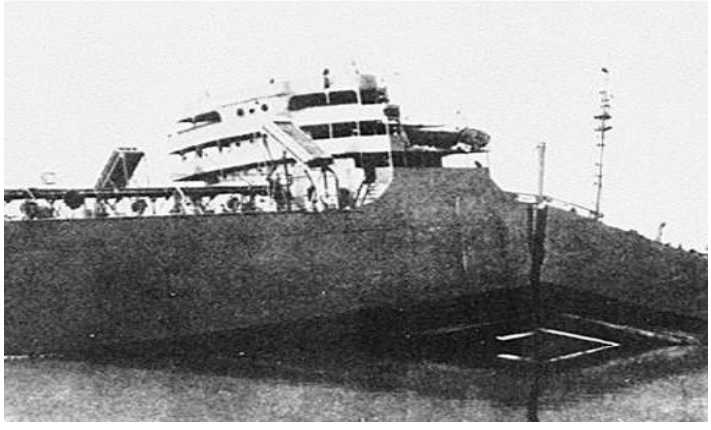

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Introduction

Non-Destructive Testing (NDT)

Non-Destructive Examination (NDE), Non-Destructive Inspection (NDI), and Non-Destructive Evaluation (NDE)

Definition by the American Society *for Nondestructive Testing* (ASNDT):

"…the process of inspecting, testing, or evaluating materials, components or assemblies for discontinuities, or differences in characteristics without destroying the serviceability of the part or system."

"…In other words, when the inspection or test is completed the part can still be used."

NDT + Condition Monitoring ⇔ **Safety** of modern societies

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Introduction

The NDT is key in Unified Life-Cycle Engineering concepts, producing a notable amount of information to be shared, with a high level of interactivity, among ALL the teams involved in:

- Total Quality Management system
- Product and Structural Design
- Conventional and Modern Manufacturing
- and Maintenance… i.e. FULL LIFE-CYCLE

NDT data will drive the modern societies enabling increasing reliability and cost-effectiveness of the global digitalized world

Introduction

What are the main industrial application of NDT?

1) **Inspection of the base material (raw material) before being processed;**
   (Detection of defects inherent to the material)
2) **Inspection of the products during their manufacture;**
   (Statistical quality control process)
3) **Inspection of the products after manufacture;**
   (Quality control of the final product - detection of defects arising from the manufacture)
4) **Component inspection service;**
   (Equipment maintenance – detection of the source of defect in service)
5) **Characterization of properties of materials and metrology;**
   (Measurement of electrical conductivity, speed of sound, paint and coating thickness, structural variations and characterization of microstructures)
6) **Other emerging / non-industrial applications**
   (e.g.: in preventing and combating terrorist acts)

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Historical Scope

When and why NDT introduced?

- NDT throughout the history:
- Dawn of civilization:
  - Reverberate clay pots
  - Examination of eggs in the flame light
  - Marking chalk in the metal surface

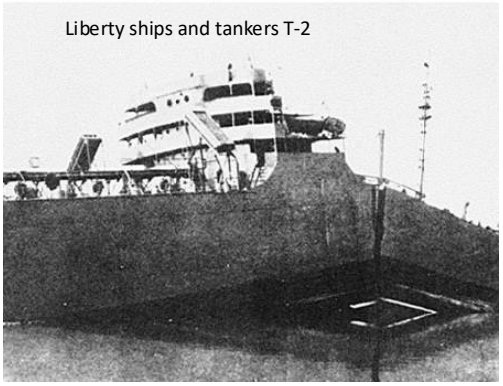
III century BC:

- Archimedes uncovers fraud of golden crown of Hiero II, the king of Syracuse
  (https://www.math.nyu.edu/~crorres/Archimedes/Crown/CrownIntro.html)

World War I: NDT ceaseed to be a “laboratory curosity”

World War II: NDT is an essential tool in industries

Today: established practise in all industrialized countries



During WWII, 12 USA ships, including 3 Liberties built, broke in half without warning. Suspicion fell on the shipyards which had often used inexperienced workers and new welding techniques to produce large numbers of ships in great haste. The Ministry of War Transport borrowed the British-built Empire Duke for testing purposes.

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Defects and their Origins

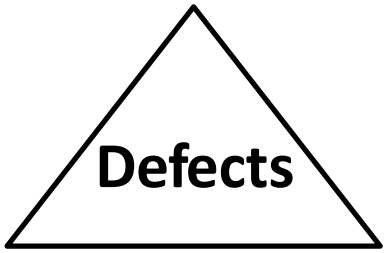
Main Defect Features

Effective application of NDT requires in-depth knowledge of materials and technological processes ⇒ **Engineering skills**

Morphology

Spherical?
Crack?
Delamination?
Physical discontinuity?

Based on these defect features ⇒ Decision to **Accept /Reject** component



Location

Superficial?
Subsuperficial?
Internal?

Dimension

10 cm?
2 mm?
50 µm?

Main variants of NDT

Possible classification of NDT based on their physical principle:

Electromagnetic radiation
- X ray
- Gamma ray
- Microwaves
- Thermography
- Infrared flash thermography
- Holographic interferometry

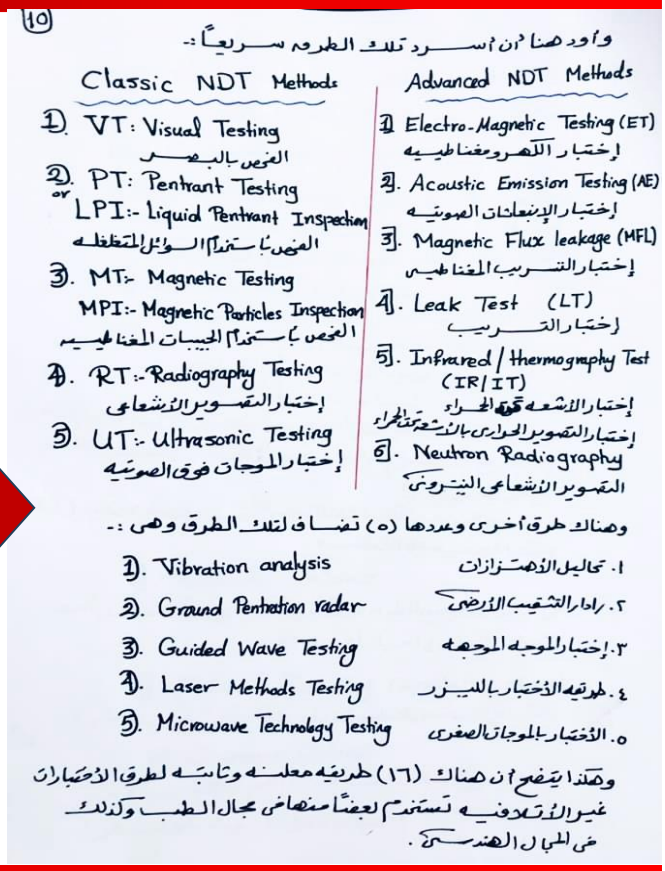
Others (absorption, capillarity, vibrations)
- Visual Inspection
- Liquid penetrant (die penetrant)
- Reverberation

Electromagnetism
- Magnetic particles
- Eddy currents
- Eddy currents arrays

Ultrasonic
- Ultrasonic conventional
- Laser ultrasonic
- Termosonics
- ToFD
- Phased arrays
- EMAT
- Guided waves

General procedure in NDT:

1) Application of a test energy to the material (e.g. radiation, ultrasonic, ...)
2) Physical and/or chemical interaction of the energy with the material and imperfections
3) Detection of energy modifications using a suitable detector (probe)
4) Interpretation of obtained information (signals)



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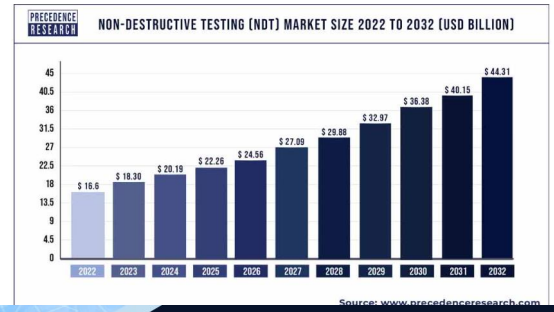
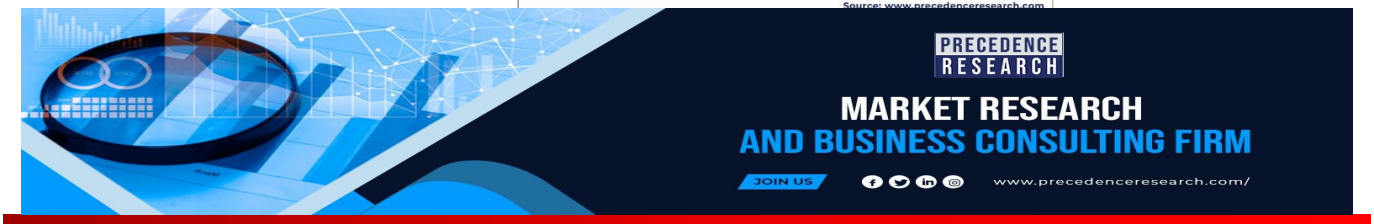
Reliability Assessment of NDT results





Precedence Research is a Canada/India based company and one of the leading providers of strategic market insights. They offer executive-level **blueprints** of markets and solutions beyond flagship surveys.

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The global non-destructive testing (NDT) market size accounted for USD 16.6 billion in 2022 and it is expected to hit around USD 44.31 billion by 2032, registering a CAGR of 10.32% during the forecast period from 2023 to 2032. The non-destructive testing (NDT) market is a niche industry dedicated to the examination and evaluation of material, component, and structural integrity without causing harm. It employs various techniques like ultrasound, radiography, and magnetic particle testing to achieve non-invasive inspections. The non-destructive testing market serves diverse sectors such as aerospace, manufacturing, construction, and healthcare, ensuring safety, quality control, and regulatory compliance. With an increasing emphasis on safety and quality assurance, the NDT market is experiencing steady growth, driven by technological advancements and stringent industry standards.

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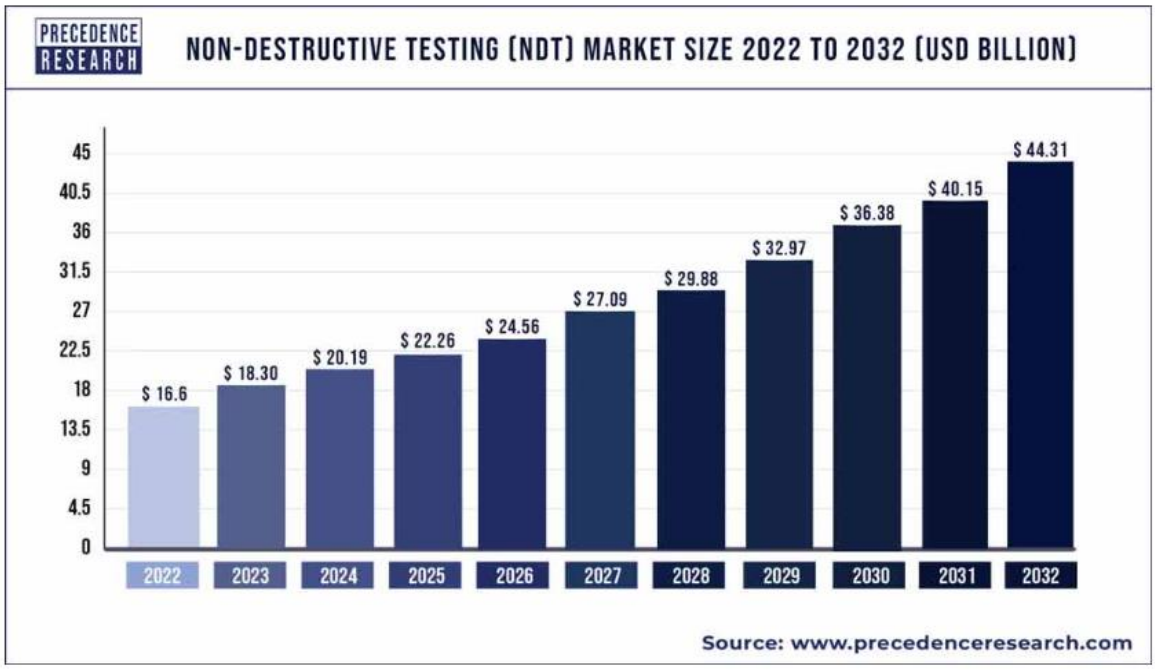

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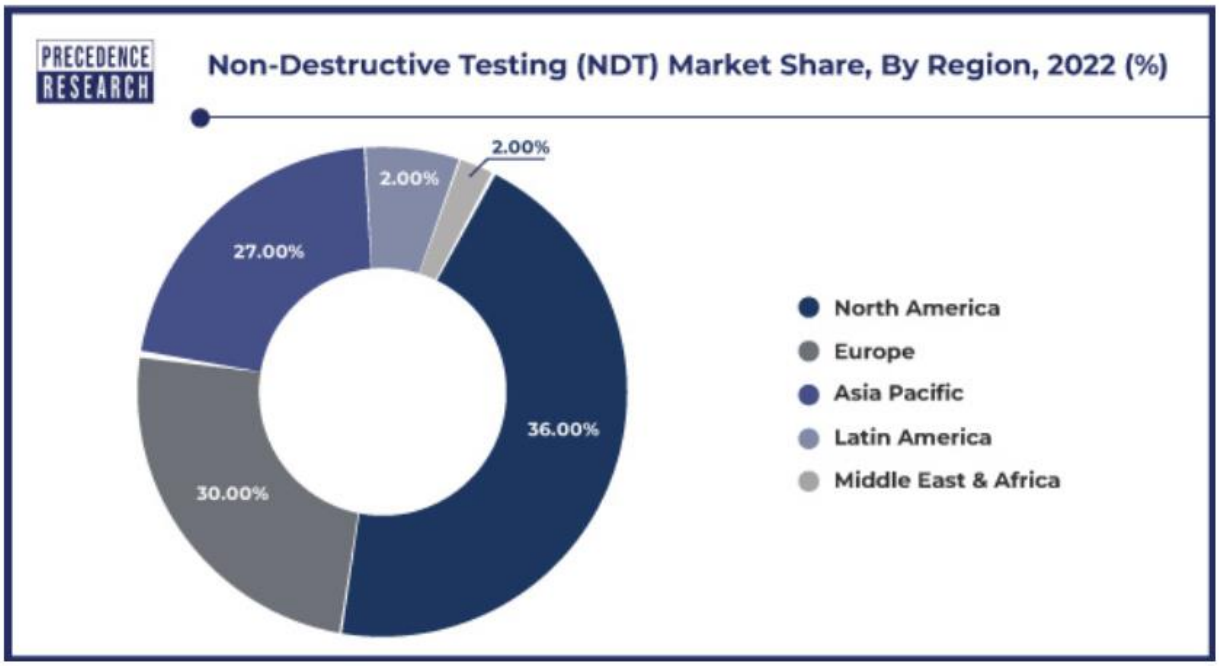

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NDT Vs NDE

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NDT (Non-Destructive Testing) refers to an array of inspection techniques that allow inspectors to collect data about material without damaging it.

NDT stands for Non-Destructive Testing. It refers to an array of inspection methods that allow inspectors to evaluate and collect data about a material, system, or component without permanently altering it.

NDT may also be called:
•NDE (non-destructive examination or evaluation)
•NDI (non-destructive inspection)

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Nondestructive Testing (NDT)

NDT is an umbrella term encompassing a diverse array of testing methods. These techniques examine materials and structures for possible flaws or problems. NDT is carried out in a variety of ways. You might know different ways to check, like looking, using sound waves, electricity, or X-rays.

NDT aims to find and pinpoint flaws in materials, like cracks or voids. This ensures the safety and reliability of the inspected objects.

Nondestructive Evaluation (NDE) Explained

NDE is a more comprehensive approach, transcending mere defect detection. The evaluation doesn't find flaws. It looks at the condition and performance. The aim is to gather more information about a material's strength, durability and function.

This comprehensive approach examines material properties, structural integrity and corrosion resistance. The aim is to ensure that the material retains quality and integrity for a long time.

To simplify it, NDT is like a snapshot of a material's current condition. It focuses on identifying flaws and/or defects. **NDE offers a more long-term assessment.** It evaluates an object's overall performance and future behaviour.

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LPR Global offers AIS series of in-field **nondestructive testing (NDT)** equipment, which utilizes the instrumented indentation technology (IIT) to test material mechanical properties, such as **tensile strength**, **yield stress**, **residual stress**, and **fracture toughness.** It is commonly used for **pipe, tank, rotor, turbine blade, pressure vessel,** and **steel sheet** non-destructive inspections.

LPR Global's NDT equipment is based on the local indentation method (IIT method) and does not require sample preparation or data input prior to testing. It is a **fully automated** NDT machine that generates test results immediately upon inspection completion. In addition to advanced IIT technology, our equipment's **portable size** and **advanced attachment options** allow it to be used on in-service pipelines and complex structures, eliminating asset down-time.

Global companies in the pipeline industry such as PG&E, TransCanada, Husky Energy, as well as pipeline integrity service providers such as TDW, Acuren, XCEL Group, SGS and GE have relied on our NDT equipment for **PHMSA regulation compliance** and on-site testing of material properties and structural integrity.

Please contact us for more information or connect with a product specialist at info@lprglobal.com.

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Non-Destructive IIT Method vs. Destructive Tensile Tests

AIS series equipment uses the **load-depth indentation method** to build a stress-strain curve, and to obtain tensile strength and yield stress data. When compared to destructive test results, our NDT equipment's **in-field accuracy** shows **less than 10% deviation.**

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Challenges and future developments

Opportunities

Predictive maintenance, data analytics, and integration

Predictive maintenance is a powerful driver for the non-destructive testing (NDT) market. As industries increasingly adopt predictive maintenance strategies, NDT plays a pivotal role in identifying potential equipment failures and defects before they escalate.

This proactive approach minimizes downtime, extends asset lifespan, and reduces operational costs.

NDT technologies are essential for monitoring the health of critical machinery and infrastructure, ensuring their reliability and safety.

The growing recognition of NDT as a core component of predictive maintenance programs propels the demand for NDT services and technologies, making it an indispensable asset for industries seeking to optimize operations and reduce disruptions.

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Moreover, Data Analytics and Integration are catalysts for increased market demand in the non-destructive testing (NDT) industry.

By harnessing data from NDT processes and integrating it with other manufacturing and maintenance systems, companies gain deeper insights into their assets' health and performance.

This data-driven approach enhances predictive maintenance capabilities, reduces downtime, and optimizes operational efficiency.

Industries are increasingly recognizing the value of such integrated solutions, spurring demand for NDT services and technologies.

Furthermore, as data analytics and integration continue to evolve, NDT providers have the opportunity to offer innovative, value-added solutions that further fuel market growth.

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Vertical Insights

The Oil & Gas segment held the largest revenue share of 31.9% in 2022. In the Oil & Gas sector, non-destructive testing (NDT) refers to the critical process of inspecting and evaluating the integrity of equipment, pipelines, and infrastructure without causing damage. NDT methods, such as ultrasonic testing, radiography, and magnetic particle testing, play a pivotal role in preventing leaks, ensuring safety, and maintaining operational efficiency. Recent trends in the Oil & Gas NDT market include a growing emphasis on advanced NDT techniques like phased array ultrasonics and computed tomography for enhanced accuracy. Additionally, there's a focus on remote monitoring and robotics to conduct inspections in challenging environments, improving the industry's overall safety and productivity.

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The cyber security sector is anticipated to grow at a significantly faster rate, registering a CAGR of 15.6% over the predicted period. The automotive industry encompasses the entire process of designing, manufacturing, and marketing vehicles. Within the Non-Destructive Testing (NDT) market specific to the automotive sector, the central objective revolves around guaranteeing the quality and safety of critical automotive elements. This includes the assessment of components like welds, engine parts, and vehicle body structures. Trends in the automotive NDT market include the increasing use of advanced NDT techniques like phased array ultrasonic testing for detecting defects more precisely. Additionally, as electric vehicles gain prominence, NDT is vital for assessing the integrity of battery components. Furthermore, automation and robotics are being incorporated to streamline inspection processes, enhancing efficiency and accuracy in the automotive industry's NDT practices.

From cutting-edge technologies to evolving methodologies, here are some key trends that we anticipate shaping the NDT landscape in the coming year.

Advancements in digital radiography (DR)

Integration of artificial intelligence (AI) and machine learning (ML)

Continued growth in advanced ultrasonic testing (UT)

Expansion of robotics and automation

Sustainable NDT practices

Emphasis on training and skill development

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