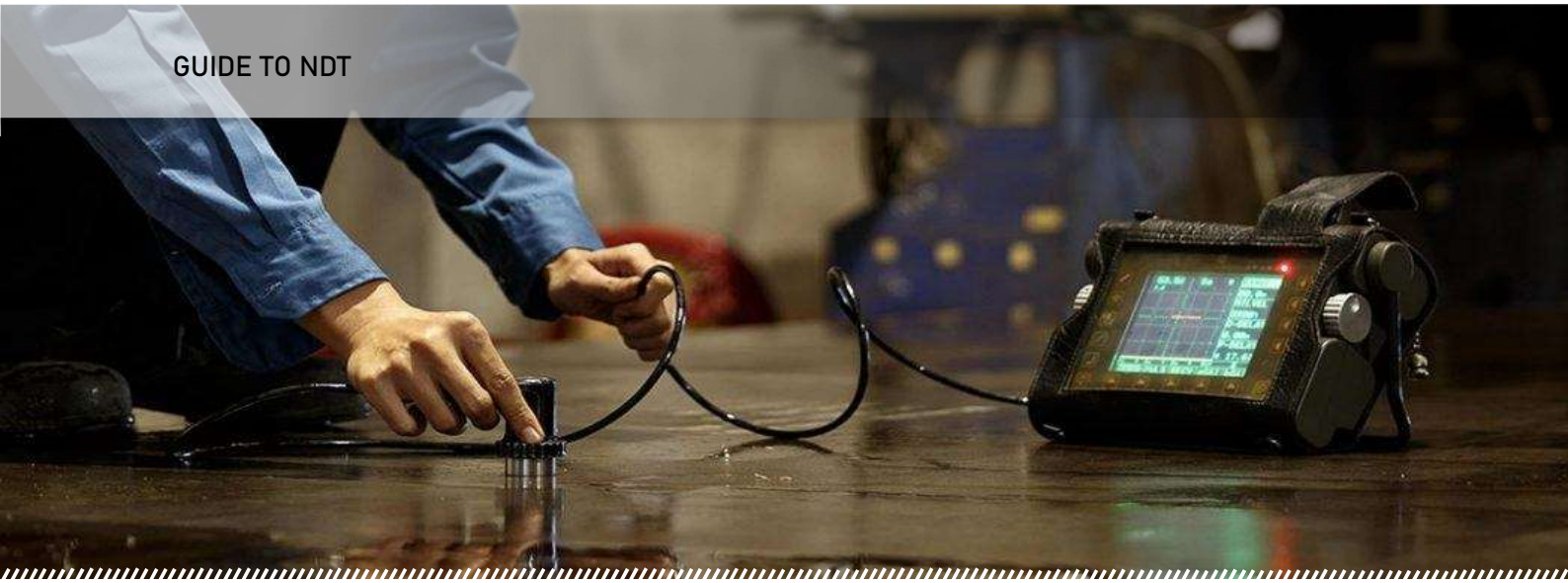


An Introduction to NON-DESTRUCTIVE TESTING

A Comprehensive Guide to NDT

We are surrounded by large structures, dependent on complex machines. Lives are inextricably linked to the proper function of our infrastructure and machinery. For this to be safely possible, we must have absolute confidence in the technologies we rely on. Nondestructive testing provides that confidence.

Collecting data about different materials required testing methods that resulted in damage to the material under study. **Non-destructive testing** (NDT) gives inspectors a chance to learn about materials without damaging side effects.

You can learn more about these processes, the best ways to apply them, and the equipment used in NDT in this article. If you have any questions after you finish this article, feel free to contact our team at NDT Corner.

In many industries around the world, NDT is required by law. Where it is not, it remains a compelling and convincing best practice. Mastering this complex subject takes decades. It demands significant training and practical experience across a wide range of scenarios. Even after 30 years of testing, it's still possible to see something entirely new.

Company or government managers must often still make decisions regarding their nondestructive testing programs. To make smart choices, it's important to have a sound understanding of the purpose, applications, requirements, and different methods of nondestructive testing.

This overview is intended to serve as a guide to the subject, providing foundational information on each aspect of nondestructive testing.

Nondestructive testing (NDT), as it is commonly understood, refers to any means of determining the integrity of an object without destroying the object.

Other labels, such as nondestructive inspection (NDI), nondestructive evaluation (NDE), and nondestructive examination (NDE), are used interchangeably. Different labels are used more commonly in different geographical areas, or by different manufacturers.

Non-Destructive Testing (NDT) is the practice of looking for flaws or differences in a material, component without damaging the part's or system's capacity to function.

What is the Difference between **Destructive** & **Non-Destructive**?

These forms of testing both play a role in equipment maintenance. Testing allows professionals to fully assess the condition of mechanical components by focusing on their: Materials, Design and Structure

DESTRUCTIVE testing methods destroy or damage parts, where a component or product is bent, altered, stretch and de-forms its shape to test its strength and load-bearing capacity, where deformation of product is needed, known as Destructive testing.

Types of DESTRUCTIVE testing

- Corrosion Testing
- Facture and Mechanical Testing
- Fatigue Testing
- Hydrogen Testing
- Pressure Testing
- Residual Stress Measurement

Examples of Destructive Testing

- **3-Point Bend Testing**: Assessing the flexibility of a material. The test requires technicians to bend the material at three distinct points.
- **Macro Sectioning**: Testing welded material. Extract a section of the material, often etching it during the examination process.
- **Tensile Testing:** Failure point or find out how the material would respond to certain conditions. In this situation, they may perform tensile testing using the application of controlled tension.

NON-DESTRUCTIVE **testing** does not cause damage to tested equipment.

Why Use NDT?

NDT has its various benefits in terms of uses, Here are some points to consider while thinking about why use NDT

- **ASSESS THE QUALITIES (REASSURANCE)**
  NDT gives reassurance on the product because when the product is inspected through the preferred NDT method, it gives clarity about Product quality and reliability. The underlying reason for doing that is risk management. While nondestructive testing does not eliminate risk, it can significantly reduce or mitigate it.

- **FAILURE PREVENTION**
  NDT reduces the chance of failure due to its process of Inspection, where you don't need to break the component or move anyway (if not possible to move), this gives flexibility and reduces the chances of any horrible condition to happen. Technicians perform nondestructive testing in the field to ascertain how close an object is to reaching those limits. If an object is too close to the limit, NDT allows it to be safely repaired or replaced before any harm is done.

- **ENHANCE PRODUCT RELIABILITY**
  While casting or manufacturing the product, various types of defects may come like Slag, porosity, and so on, which downgrade the quality of component and if gone without inspection, thus can cause some serious issues in the future, So Technician or Authorized person inspect the component to know, if there is any defects or discontinuity is present or not, this tells about product quality and if there is any discontinuity is present, then component or product is further sent to repair. This can increase product reliability and increase quality.

- **COST-EFFICIENT**
  NDT relies on Third-party inspection, so the organization doesn't need to be equipped with NDT equipment. They need to call an NDT company to inspect their products, which saves the various costs of equipment and manpower cost. Although, NDT tells you the quality and reliability of the product, hence its saves any further expenses in the long run.

Where Use NDT?

Nondestructive testing is widely used across many important global industries. Any industry with large physical equipment or infrastructure is likely to use some kind of nondestructive testing. Additionally, within each industry, several methods of NDT are commonly practiced.

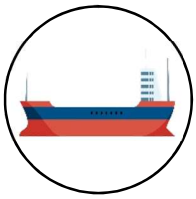
Aviation

Aerospace manufacturers, airlines, and repair services are all required by law to perform a variety of periodic NDT inspections. Nearly every aspect of an airplane or helicopter must be inspected at a specified interval. Many different NDT techniques are used in aviation and aerospace. Ex. use ultrasonic to examine turbine fan blades and eddy current to search for surface or subsurface flaws in multilayer structures.

Oil & Gas

All divisions of the oil and gas industry rely on NDT to prevent accidents based on thousands of miles and trillions of dollars of infrastructure and equipment to secure their investments. Drill sites, pipelines, and refineries employ NDT teams to constantly perform inspections of welds, pipes, risers, tanks, and large forgings. The sheer volume of the inspections performed by the oil and gas industry rewards efficient NDT tools

Marine

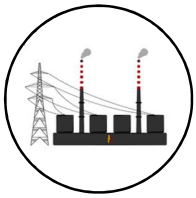


Large and small marine craft depend on NDT to prevent materials failure at sea. Metal and composite hulls are inspected by their manufacturers, and periodically while in service. Propeller blades, turbines, and internal equipment such as holding tanks or boilers must be routinely inspected as well. Nuclear powered ships must test their systems as carefully as with steam generator plants found on land. Due to the difficulties of maritime law, marine NDT regimes are often primarily the purview of ship owners and manufacturers, though informed by international standards

Manufacturing

Heavy manufacturing companies typically use NDT to ensure product quality prior to delivery. Pipe, steel, and tubing manufacturers inspect for material and weld integrity. Manufacturers of turbines, large vessels, and ships likewise trust NDT to determine whether their products meet appropriate specifications. Special composite can detect voids, delamination, density variations, porosity, stress, damage, and foreign materials present in their products. NDT in manufacturing not only guarantees product safety, but also a company's reputation.

Power



Large power plants have zero tolerance for failure and stringent testing requirements. Nuclear plants, in particular, trust their NDT solutions to ensure safe operation. But coal, oil, and gas plants all depend on NDT to detect flaws in their turbines, tubing, and related systems. Renewable power plants including hydropower and wind test their hardware and systems integrity as well

Automotive

While vehicle owners are not required to perform NDT, manufacturers are to prevent material failure on the road, manufacturers must inspect vehicle components for cracks and flaws, issues arising from improper heat treatment, and unacceptable material mixes.

Military

Militaries rely on aerospace, naval, and nuclear technologies, and must diligently inspect the equipment in their charge to ensure mission reliability. Military vehicles, munitions, and installations also commonly require NDT inspections.

Rail

Trains and their tracks require NDT, as does much related intermodal storage and logistics. Train car wheels, axles, brakes, and hydraulic systems must be inspected, as well as the rails and their frogs. Cranes, risers, and holding tanks require periodic safety inspections, particularly holding tanks storing hazardous materials.

Fertilizer, Cement, Mining, Medical and other industries.

All industries uses NDT to make certain their infrastructure remains safe and effective. Regardless of industry, the most common uses of NDT are to test the integrity of structural materials. These materials include metals of varying compositions and thicknesses, composite materials, fibers, and plastics. The need for NDT for a given application is derived from the likelihood and consequences of the application's failure.

SHOULD ALL OBJECTS BE TESTED?

No, Non-destructive testing is worthwhile when the risk of an object failing outweighs the cost of testing it.

High-risk objects are those that endanger the lives of those around them upon failure, such as passenger jets or nuclear reactors. High-risk objects also include those which can cause severe financial or environmental harm, such as oil pipelines. The cost of testing is a function of equipment cost and employee time; employee time includes both training and actual testing.

Fortunately, companies don't have to guess which equipment or infrastructure to test, many nondestructive testing requirements are dictated by national governments.

Governments often base their legal requirements on information published by international standards bodies, such as ASTM or ISO. Thus, a derived, though nonetheless essential, purpose of NDT is ensuring regulatory compliance. Flaunting NDT requirements can quickly become more expensive in fines and penalties than simply following them

Requirements for NON-DESTRUCTIVE TESTING

Certain minimum standards for nondestructive testing are prescribed by law. Different nations or bodies follow different standards, so companies operating in multiple countries may have to meet different testing or reporting requirements for the same application. Companies subject to overlapping restrictions must follow the most stringent of them. Airlines, oil and gas companies, and manufacturers have the most exposure to complex and overlapping regulatory requirements. NDT programs should be developed in consultation with appropriate experts or specialist legal counsel to ensure full compliance. Most governmental standards for NDT are based on the recommendations of independent international organizations, including ISO and ASTM.

These organizations base their standards in part on the research of manufacturers and several national and international trade associations. These trade associations include the International Committee for Non-Destructive Testing, the American Society for Nondestructive Testing, and the Nondestructive Testing Management Association. Non-destructive testing regulations can specify parts to be tested, methods to be used, periodicity of testing, minimum acceptability values, and recordkeeping standards. NDT manufacturers use these standards as references when developing inspection equipment and solutions. Standards and equipment evolve together, with more effective solutions rising to meet more stringent requirements as they emerge. Manufacturers should be able to demonstrate how their products meet regulatory requirements for any application they market.

Training and Certification

for Non-destructive Testing

The successful operation of nondestructive testing technology requires adequate training and experience.

There are various training as well as certifications, which certified and trained a person to involve in NDT testing.

We all know that without proper training and required certification, the person is not allowed to operate equipment or involves in any kind of NDT testing.

While there is no one central, ultimate NDT training authority, training options remain nevertheless available. Training courses are provided by **equipment manufacturers, third-party inspection organizations, and employers themselves.** Employers enjoy final discretion in setting requirements for employee NDT training.

NDT training is typically divided into three levels, roughly corresponding to apprentice, journeyman, and master-level understanding. In the industry, these are known as Level I, Level II, and Level III certification.

NDT evaluations require both theoretical and applied knowledge. Experience, also, is an irreplaceable teacher. As part of their certification requirements, NDT technicians should prove proficiency in written and practical examinations, while minimum experience requirements ensure that important inspections are in proven hands.

Basic level, NDT technicians should demonstrate proficiency in one or more limited evaluation types, i.e., ultrasonic flaw detection in welds. They should be able to determine whether an application passes or fails evaluation, and document the results. Technicians should also be able to set up, calibrate, store, and observe safety measures for one or more types of NDT equipment. Level 1 technicians should be supervised by technicians of a higher level.

Intermediate NDT technicians should demonstrate an advanced understanding of the abilities and weaknesses of their NDT methods. They should be familiar with the relationship between test standards and methods as well as internal and external codes and regulations. Level II technicians can set up and calibrate equipment as well as interpret results. They can supervise a team of Level I technicians and compile reports for presentation.

NDT Expert develop the NDT strategies which Level I and II technicians implement. They convert external regulations into internal best practices. They designate test methods and standards and can be responsible for choosing or recommending equipment. In the absence of prescribed standards, Level III technicians should have the means to develop standards of their own. Level III technicians supervise and examine Level I and II technicians.

What to do, How to do, and what will be the criteria of inspection?

Authorized Organizations to create **Codes and Standard** *For **Non-Destructive Testing***

ASTM (The American Society of Non-Destructive Testing)
ASNT (American Society for Testing & Materials)
ASME (American Society for Mechanical Engineers)
API (American Petroleum Institute)
AWS (American Welding Institute)
AIA (Aerospace Industries Association)
NBBI (National Board of Boiler and PV Inspectors)
ISO (International Organization for Standardization)
CEN (European Committee for Standardization)
PED (European Pressure Equipment Directive)

Authorized Organization to guide **Training and Certification** *For **Non-Destructive Testing***

In certain cases, when certification of NDT personnel is required by standards, codes or regulations.

Many certify their personnel in accordance with the international standard ISO 9712. However, as NDT falls under the purview of different regulatory regimes.

Here are some organizations, which offer personnel, various training, and certification in various NDT methods.

American Society of Non-Destructive Testing (ASNT), a globally established organization, which offers NDT persons, a broad level of certification and training including all methods of NDT. ASNT offers, ASNT Level-II, ASNT Level-III.

British Institute of Non-destructive Testing (BINDT), an accredited certification organization that offers a Personnel Certification in Nondestructive Testing (PCN).

International Standards Organization (ISO), ISO 9712 (Non-destructive testing — Qualification and certification of NDT personnel) is a published standard that details the requirements for qualification and certification of personnel that perform NDT.

American Petroleum Institute (API), API offers numerous Individual Certification Programs (ICPs) specific to NDT personnel in the petroleum and petrochemical industries

Natural Resources Canada (NRCan), NRCan manages the Non-Destructive Testing Certification Body (NDTCB) which offers a Canadian General Standards Board (CGSB) certification.

Another organization that can do same; **French Committee for Non-destructive Testing Studies (COFREND)**, **Canadian Standards Association (CSA Group)**, **Canadian General Standards Board (CGSB)**

The exact regulations designed to handle NDT vary by country and industry.

Guide to Techniques & Equipment

*For **Non-Destructive Testing***

Explore **different** non-destructive inspection **techniques** right here. **Depending upon your industry**, you may use one or more of these testing methods.

Unique NDT Applications

NDT focuses on assessing issues with materials or equipment without causing any damage during the process. The unique applications associated with this form of testing provide several applications, including:

Detect External Flaws

Sometimes, equipment or materials have flaws in their exterior casing. However, these flaws may be microscopic, making them hard to identify with only a visual inspection. NDT testing allows technicians to identify these flaws before they become a problem.

Identifying Internal Flaws

Assessing the inside of a part or piece of equipment poses unique challenges, especially if you want the equipment to continue functioning afterward. NDT inspectors have various assessment tools at their disposal to handle these tests.

Testing Untouchable Objects

How do you test for defects on an object underwater or in a high-temperature environment? NDT provides a way to assess the condition of these parts without destroying them, without exposing technicians to dangerous situations in most cases.

Allows for Medical Assessments

We've primarily focused on the industrial uses of NDT. However, these tests play an essential role in most medical testing, as doctors do not want to damage their patients while carrying out tests to assess their health and well-being.

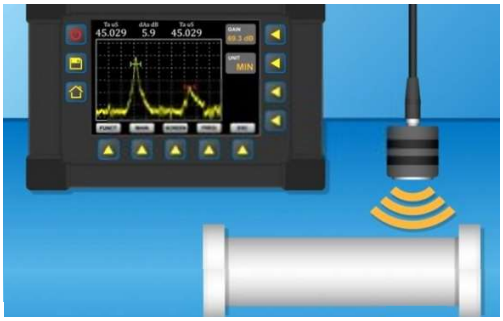
Going for a check-up at the doctor may involve a non-destructive inspection as medical professionals take your pulse, check your blood pressure, and assess your reflexes. In addition, doctors use other NDT technology when they take an X-ray to look at a broken bone or perform a CAT scan to look for other internal injuries.

Determines Machinery's Lifespan

Different machines wear down at different rates, and it can be difficult to tell when a machine is on its last legs. NDT inspections can help determine the rate at which a machine is degrading and how much longer it is likely to be useful before needing to be replaced.

A several Applications of the NDT can be identified,

Monitor, improve, and control manufacturing processes. Inspect for in-service damage. Inspect of raw products. Ensure product integrity and reliability. Maintain uniformity in quality level.



What is NDT equipment?

There are many types of NDT inspections performed in different industries. Therefore, there is no set list of tools used in non-destructive testing.

Inspectors may use everything from their eyes to high-tech machinery to detect defects in various pieces of equipment.

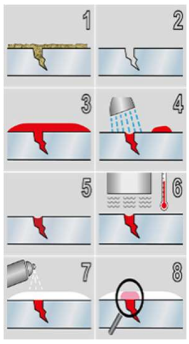
Now, learn more about different forms of testing to learn more about the possible equipment required for testing procedures.

Guide to Most Common Techniques
Of Non-Destructive Testing

Conventional NDT Techniques

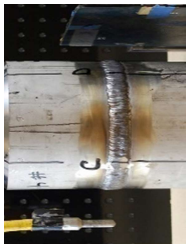
Visual Testing the most basic form of NDT testing. Technicians look at the equipment, material, or asset and notice flaws during visual inspections. They may also use a specialized device to handle a Remote Visual Inspection. Visual testing often provides an excellent place to start assessments, but you may require more in-depth assessments to get definitive results.

Magnetic Particle Testing looking for the flaws in ferromagnetic materials by assessing any disruptions in the flow of their magnetic field. Inspectors perform these tests by inducing a magnetic field and introducing iron particles to the material's surface. Inspectors observe the movement of the magnetic particles to look for imperfections. Assessing the magnetic field in this way allows technicians to check on the state of equipment without damaging the material. MT should not cause any health risks to inspectors.

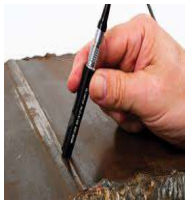


Liquid Penetrant Testing indicate breaks or defects in the surface of pieces of equipment. Technicians perform liquid penetrant testing by applying a liquid that contains either a visible dye or a fluorescent dye to the surface of an object. The inspectors rub away excess liquid; any liquid that remains behind indicates a defect. Once crews notice the flaws, they examine them in greater detail with ultraviolet (UV) lights if they use a fluorescent dye. PT works very well to identify defects, and technicians can easily clean up after the process by washing away the dye.

Ultrasonic Testing use high-frequency sound waves during UT. They transmit the sound waves at the material or asset under inspection and look for any property changes. Many forms of UT use pulse echoes, which involve looking for surface imperfections based on the echoes reflected off of an item.



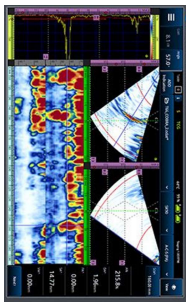
Radiographic Testing use radiation to complete RT. Often, crews use x-rays if they're dealing with thin materials. However, they may choose gamma radiation instead if they need to assess a dense or thick material, requiring a thickness measurement before beginning the assessment. Experts use a variety of processes to report the results of RT. For example, they may use computed tomography, computed radiography, digital.



Eddy Current Testing electromagnetic testing. This process allows crews to measure the magnetic field of a material based on its eddy currents (or electrical currents). Eddy current testing generally works best on non-ferrous materials. It used for surface and near surface cracks, used on metal, welds and tubes.

Advanced NDT Techniques

Magnetic flux leakage (MFL) testing utilizes a strong magnet, which creates a magnetic field that crews use when assessing structures made of steel. Use sensors to track any changes in the magnetic flux lines or density, which may indicate issues like: Pitting, Erosion, Corrosion. Monitoring the magnetic field allows crews to assess issues with large structures without causing any damage. Technicians often spend a significant amount of time studying magnetic field science and magnetic flux density before completing these tests.



Phased Array Ultrasonic Testing (PAUT) serves as a variation of traditional UT. This kind of test uses an array that can create independent pulses. Technicians control how each element fires, allowing them to steer or focus the sound beams. They can move the beam to various depths and angles, easily generating cross-section views of equipment or materials. Some examples of PAUT used a virtual probe to gather additional information in this NDT method.

Guided Wave Testing (GWT) Leak Testing use this NDT inspection to test pipes that stretch across long distances. The tests use ultrasonic waveforms to detect any issues in the walls of the line. Guided wave testing returns the results to a computer, allowing crews to look for possible problems. Companies can order either guided wave medium-range ultrasonic testing (GW MRUT) or guided wave long-range ultrasonic testing (GW LRUT). You may assess areas hundreds of feet away from the starting location with GW LRUT testing.

EC Tube Inspection is a key NDT practice in the Power Generation/Heat Exchanger sector and Eddy Current is one of the best methods of measuring wall thickness and circumferential cracks. Tubes may be inspected using ECT from the outer diameter (OD) at the time of manufacture and from the inner diameter (ID) for in-service inspection. Tube inspection equipment has a multi-channel to use different probes (ET, MFL, IRIS, RFT, NFT, and ECA). These all probes go inside the tube for Wall Loss, Corrosion, Cracks, etc. either (ID) or (OD) detection.

Acoustic Emission Testing use to look for defects and imperfections with this NDT testing method. First, they monitor acoustic energy bursts, focusing on the location of the burst, its intensity, and its arrival time. Acoustic emission testing works well for companies operating in many different industries.