



Overview of Ultrasonic Testing

An Online Continuing Education Course for Engineers

Course Number: MA-1008
Credit: 1 Hour / 1 PDH / 1 CPD

Overview of Ultrasonic Testing (UT)

Introduction

Every person responsibly involved in the manufacturing of a quality product worries until they have evidence that its quality is up to snuff. Part of the discontent these days stems from the fact that the product costs so much that the traditional technique of testing a few samples to destruction would soon put the company out of business. What is needed is a method of scientifically "thunking," squeezing, smelling, and looking at the melon to see if it's ripe without having to cut it apart to find out.

In what has come to be called nondestructive testing (NDT), there is a family of techniques for doing just this. By exploiting a variety of physical effects, it is possible to evaluate a product at almost any stage of its manufacture to seek evidence of its integrity (or lack of it) without impairing its usefulness in the process.

Whatever the requirement, there is some physically-based method of interrogating the "subject." The problem is to choose the right method, to apply it with sophistication, and to use the results with discrimination.

All branches of Engineering are intimately concerned with materials and products, especially those engineers dealing with the design of structures and machines.

There are many tests for the determination of a material's soundness. The most desirable test is a nondestructive test

It is important for engineers to have a general understanding of the common methods of nondestructive testing for appraisal and use of the test results and to design for inspectability.

Nondestructive Testing – NDT

Nondestructive Evaluation – NDE

Nondestructive Inspection – NDI

They all mean the same thing. The classic definition of NDT is:

“Testing to detect surface and internal defects in materials, or the physical properties of materials, using techniques that do not damage or destroy the items being tested”

Another way to express NDT is:

The development and application of technical methods to examine materials or components in ways that **do not impair future usefulness and serviceability** in order to detect, locate, measure and evaluate flaws; to assess integrity, properties and composition; and to measure geometrical characteristics

Here are some common terms used in NDT

- **Indication** – The response or evidence from a nondestructive examination
- **Discontinuity** – An intentional or unintentional interruption in the physical structure or configuration of a material or component
- **Flaw** – An imperfection or discontinuity that may be detectable by nondestructive testing and is not necessarily rejectable
- **Defect** – One or more flaws whose aggregate size, shape, orientation, location, or properties do not meet specified acceptance criteria and are rejectable. Engineering judgment determines whether a discontinuity is a defect or not. These judgments are usually expressed as Codes or Specifications.

Discontinuities affect the soundness of materials. A **discontinuity** is judged to be a **defect** when the decreased soundness interferes with the usefulness of the part.

Engineers make judgments as to how serious a discontinuity must be to become a defect. This judgment is made the same way that design judgments are made – to include some uncertainty in the material properties.

Engineering considerations that allow for uncertainty of the material properties in the design of a part include safety factor, proof testing, statistical sampling, and nondestructive testing. The particular design situation will dictate which NDT method or combination of NDT methods is most suitable.

Considerations for selection of which NDT methods will be used include:

Safety – how reliable the part or system must be

Economic – what the incentives based on cost versus reliability improvement are

Test Constraints – what type of tests can physically be made

Advantages and Disadvantages – which method will work most effectively for a given material and location

When NDT tests can be made, they are used to locate, identify, and size discontinuities in the specimen. The engineer then decides on the usefulness of the specimen for the design application.

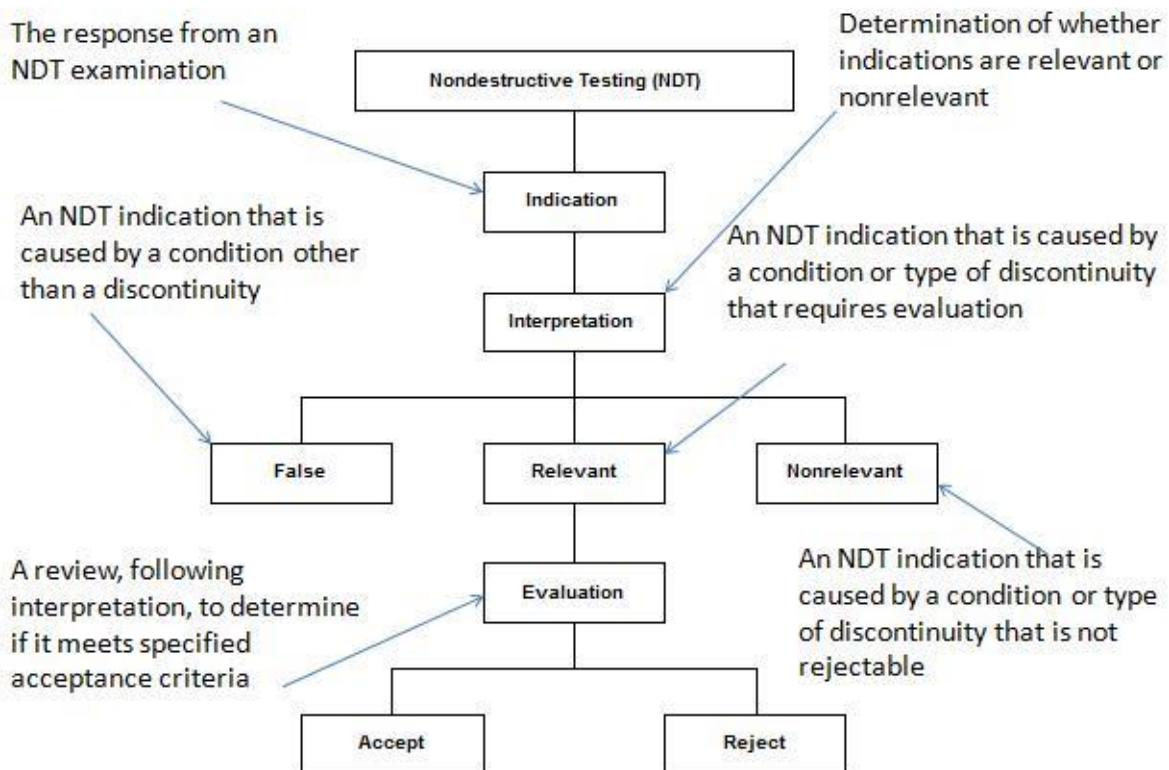
Engineering judgments are often presented as codes or design specifications.

There are many NDT methods available for obtaining discontinuity information to fulfill code or specification requirements

This course will be concerned with one of the most widely used and accepted NDT methods - Ultrasonic Testing

NDT methods are classified by the type of discontinuity that can be detected. Surface methods can only detect discontinuities that are open to the surface. Surface/Near Surface methods are primarily used to detect surface discontinuities but also have the ability to detect discontinuities very close to the surface. Volumetric methods are primarily used to detect subsurface discontinuities but also have the ability to detect discontinuities open to the surface, depending on discontinuity location. Ultrasonic testing is a volumetric method. Ultrasound can locate discontinuities on the surface of a part or 20 feet deep into a part.

Flow Chart for a Nondestructive Test



The flow chart above allows you to follow an actual nondestructive test and view the decisions that are made to determine whether a material or component is accepted or rejected. This process is used for any of the six methods that will be discussed in greater detail.

When the test is performed, the first evidence observed is always referred to as an “indication.” This indication is then “interpreted” to determine if it is a “relevant” indication. If the indication is “false” or “non-relevant,” it is either noted for future reference or ignored, depending on the specific procedure followed. If the indication is “relevant,” it is evaluated against a Code or Specification to determine whether it is “accepted” or “rejected.”

Some Technical Societies involved with NDT, Codes, and Specifications

- **ASNT (American Society for Nondestructive Testing)**
SNT-TC-1A
Materials Evaluation
NDT Handbooks
- **ASM (American Society for Metals)**
Metals Handbook, Vol. 11
- **AWS (American Welding Society)**
AWS D1.1
Filler metal specifications
Welding Inspector Certification

The first edition of the *Code for Fusion Welding and Gas Cutting in Building Construction* was published by the American Welding Society (AWS) in 1928. The first bridge welding specification was published separately in 1936. These basic documents have evolved into the *AWS D1.1, Structural Welding Code Steel*, and the *AASHTO/AWS D1.5, Bridge Welding Code*, created to address the specific requirements of state and federal transportation departments.

- **ASTM (American Society for Testing and Materials)**
Standard 03.03

In 1898, the American Society for Testing and Materials (ASTM) created a set of standards that addressed the safe construction and use of industrially significant materials including most metals in various grades, ceramics, chemicals, concrete, graphite, paint, textiles, tires, and wood.

The practices used in nondestructive testing are covered in Volume 03.03 of Section 3, devoted to testing methods and analytical procedures

- **ASQC (American Society for Quality Control)**
Quality magazine
- **ANSI (American National Standards Institute)**
Standards
- **ASME (American Society for Mechanical Engineers)**
B&PV Code

In response to the failures of boilers and pressure vessels, the American Society of Mechanical Engineers (ASME) created the first *ASME Boiler and Pressure Vessel Code* in 1911.

As the importance of material quality became evident, the use of nondestructive testing became a requirement of the ASME B&PV Code.

- **API (American Petroleum Institute)**
API-1104

The American Petroleum Institute (API) developed the API-1104 standard to specify the design and construction of piping and storage tanks. Today, API-1104 is widely used in the oil and gas industry to specify engineering requirements for piping and storage tanks.

- **EPRI (Electric Power Research Institute)**
NUC-MR-1000

And last but not least...

- **US DOD (United States Department of Defense)**
Military Specifications

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Hierarchy of Documentation and Nondestructive Testing

- **Code** – A standard enacted or enforced as a law.
- **Standard** – A document to control and govern practices in an industry or application, applied on a national or international basis and usually produced by consensus.
- **Specification** – A set of instructions or standards invoked by a specific customer to govern the results or performance of a specific set of tasks or products.