



BENG – MANUFACTURING SYSTEMS ENGINEERING

Non-destructive Testing Techniques

Abstract

This report aims to discuss what non-destructive testing is, along with its importance when applied to test a system. The report then discusses in detail three types of non-destructive testing that are used by engineers and tradesmen, along with their applications.

Joshua Evans (P067646)

Jevans.067646@student.uwtsd.ac.uk

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2.0 INTRODUCTION

This report aims to compare and contrast Non-destructive testing methods to traditional test methods, giving examples of each and explaining their use. The report then discusses three different types of NDT techniques, giving an outline of each, covering the advantages and disadvantages along with any sources of error that may be encountered with that technique. Examples of how the selected NDT techniques are applied in real world situations are then given before concluding the importance of how non-destructive testing techniques can be used in relation to the stress analysis of a product.

For this report, interviews were conducted with two highly experienced and respected tradesmen for primary research purposes. The first interviewee was current Ford Motor Company Tinsmith - James Jenkins, who is regarded as a highly skilled welder and fabricator with numerous company 'Reward and Recognition' certificates for his work within Ford. The second interviewee was former Process Pipe Systems General Site Manager - Jeff Nicholas, who was also a very highly skilled welder and fabricator who went on to become site manager in the latter years of his career. Mr Nicholas retired in 2015, bringing an end to a career of almost 50 years. Both men are qualified to conduct various Non-destructive testing techniques and have done so throughout their respected careers.

3.0 TYPES OF TESTING

3.1 NON-DESTRUCTIVE TESTING

Non-destructive testing (NDT) is a generic term for the process that is often applied in civil engineering tasks to ensure the structural safety and performance of infrastructure that is to undergo structural assessment is not affected in the process of testing (Maierhofer, et al., 2010). This means that the system or structure involved in the testing is only affected for the duration of the test and may continue to function as normal once the test has been completed, providing that it passed the inspection.

Due to how NDT causes no damage to the items being tested, it is considered a valuable tool for engineers to use for problem solving and research projects, minimising costs and downtime, providing maximum quality at a low cost (International, 2019). As NDT techniques do not leave tested parts being out of action for long periods of time, they have become an essential tool in industry with aircraft, nuclear facilities, chemical plants, transport systems, electronic devices and other safety-critical installations all being tested regularly, requiring fast and reliable testing technologies. (Maierhofer, et al., 2010).

The following statement is from the American Society for Non-destructive Testing (ASNT) and gives a further definition of what NDT is.

“Non-destructive testing (NDT) is 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.” - (ASNT, 2019)

Test method names often refer to the type of penetrating medium or the equipment used to perform that test. Current NDT methods are:

- Acoustic Emission Testing (AE)
- Electromagnetic Testing (ET)
- Guided Wave Testing (GW)
- Ground Penetrating Radar (GPR)
- Laser Testing Methods (LM)
- Leak Testing (LT)
- Magnetic Flux Leakage (MFL)
- Microwave Testing (MT)
- Liquid Penetrant Testing (PT)
- Magnetic Particle Testing (MP)
- Neutron Radiographic Testing (NR)
- Radiographic Testing (RT)

- Thermal/Infrared Testing (IR),
- Ultrasonic Testing (UT),
- Vibration Analysis (VA)
- Visual Testing (VT).

The six most frequently used NDT methods within industry are MP, PT, RT, UT, ET and VT (Groover, 2010).

3.2 DESTRUCTIVE TESTING

Traditional destructive testing is used to test a specimen to its point of failure, to give a further understanding of its capabilities and structural limitations (Bridges, 2009). This type of test method is commonly used for finding out the properties of the materials used in small parts that are to be mass-produced, due to how the part being tested will be destroyed and rendered useless for its designed purpose. Destructive testing is not practical for anything that is built as a single component e.g. a building, bridge or any other singular structure (Aire & Chimezie, 2016), or for any component that is currently part of a functioning system. Most destructive testing techniques are carried out in a controlled manner with a test piece that has been fabricated for the sole purpose of testing.

3.2.1 Fillet Weld Bend Testing

This type of test consists of breaking open a test fillet weld joint. This broken joint is then examined to find the source of the break, given testers an idea of the forces required to break the joint as well as the location and method they act in. This is achieved by applying a 2mm deep saw cut to a weld on a test specimen, then striking the test specimen with a hammer to cause a fracture (AlcoTec, 2019). This type of destructive testing can be carried out as well as non-destructive testing methods. For example, welders may carry out Magnetic Particle Inspection (MPI) testing to get an idea of the weak spots in a weld. A bend test may then be carried out to show how the weaknesses will react under stress and the required breaking forces can be calculated (Baxter, 2018).

4.0 RADIOGRAPHIC TESTING

4.1 THE SCIENTIFIC PRINCIPLES BEHIND THE TECHNIQUE.

Radiographic Testing (RT) is a type of non-destructive testing (NDT) that can be used to identify any defects or flaws that may be located within the internal structure of manufactured components and machinery (Inspectioneering, 2019). This is achieved by internally examining the structure using radiation in the form of x-rays or gamma rays (TWI, 2019).

In RT, the test-part is placed between the radiation source and detector. The material density and thickness differences of the test-part will reduce the penetrating radiation through interaction processes involving scattering and/or absorption. The differences in absorption are then recorded on the detector, with any discontinuities showing up as dark areas. In industrial radiography there are several imaging methods available, using various techniques to display the final image via film or a digital display method (TWI, 2019).

The most widely used form of RT is film radiography and is described by (Bossi, et al., 2002) as being “the backbone of industrial applications of penetrating radiation”. This method uses a thin layer of silver bromide coated film to display results of the radiography (ASNT, 2019). However, as technology has advanced over the years there have been developments in the field and other methods of radiographic testing were created in which the results of each experiment is displayed digitally (Inspectioneering, 2019). The 4 types of digital radiography are:

- Real Time Radiography (RTR)
- Computed Tomography (CT)
- Digital Radiography (DR)
- Computed Radiography (CR)

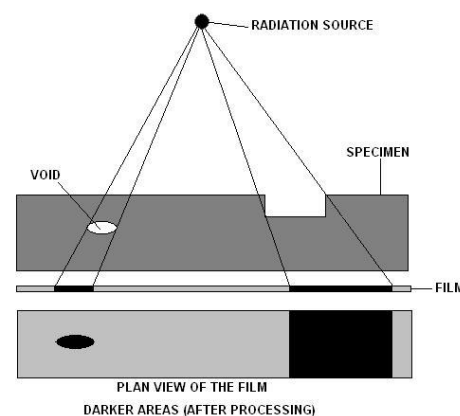


Figure 1 – Overview of how Radiographic testing works (ASNT, 2019).

4.2 ADVANTAGES AND DISADVANTAGES OF THE TECHNIQUE.

TABLE 1. Advantages and Disadvantages of Radiographic Testing

Advantages	Disadvantages
• It is highly reproducible • Can be used on a large selection of materials • Data gathered can be stored for later analysis • Requires very little surface preparation • Portable, allowing them to be used in the field and at elevated positions. • Part can still be used after testing and analysis has been carried out. • Can accurately locate, measure and identify defects. (Inspectioneering, 2019), (Garant, 2019)	• Requires access to both sides of the test specimen • Can be very expensive in terms of downtime due to the long-winded process • The depth of discontinuities is not indicated due to the 2D conversion • Can be hazardous to nearby personnel if exposed to radiation • High level of skill/experience required to diagnose the outcome of tests (Hijazi, 2019), (Bossi, et al., 2002)

4.3 POTENTIAL SOURCES OF ERROR AND ASSUMPTIONS THAT NEED TO BE MADE.

The sources of error when it comes to RT are in relation to the interaction between penetrating radiation and matter, as it is not a simple process. (Hijazi, 2019)

It is also important that personnel working with RT are properly trained to be able to interpret results to ensure that any test specimens are fully repaired (Hijazi, 2019). The importance of this was supported by (Jenkins, 2019), who added how good communication between staff and trade is also essential. This was in relation to a problem he encountered whilst repairing a damaged weld. In this case, a foreman was in possession of the radiography test results and was only willing to pass on information to the welders assigned to the job, as oppose to giving them the X-ray photographs. However, the foreman misread the results and told the tradesman to weld the wrong side of a damaged fillet weld. This led to a repetitive cycle of the weld failing and requiring to be repaired, which occurred three times before the tradesman was finally given access to the test results for him to rectify the fault properly. This combination of miscommunication and misinterpretation meant that the job was unnecessarily extended, causing increased disruption to production and downtime.

A plaque penetrometer is tool used in radiographic testing to determine that the quality of a test procedure is of a suitable level for viewing. This tool is simply a metal plaque with holes, made out of a variety of radiation absorbing materials that are selected depending on the material being tested, to indicate the quality of the test result image. In some cases, multiple penetrometers must be used to indicate the sensitivity of an image (ATSM-E9400, 2000). It was mentioned by (Jenkins, 2019) that it is important that this tool is not mistaken for a tool that is used to gauge the size of any discontinuities. This is supported by (Bossi, et al., 2002) which states that “penetrameters are used to indicate the quality and sensitivity of radiographic images and are not to be used to provide measurements of the size of minimum discontinuities”.

4.4 TYPICAL APPLICATIONS THAT USE THIS TECHNIQUE.

Radiographic testing is one of the most common types of NDT methods used in industry due to its ability to inspect, quantify and qualify failures and defects within a system. Thus, making it popular with a large variety of industries including aerospace, marine and offshore (Garant, 2019).

4.4.1 Inspecting Welds

The quality of welds can often be determined via a visual inspection, however some minor discontinuities that may be present within the weld will not be picked up. The use of radiographic testing will help identify the precise nature of any discontinuities that may be present within a weld e.g. porosity (TWI, 2019). Porosity is a void that results from gas being entrapped as the weld metal solidifies. Linear and clustered porosity can cause serious failure if located in large quantities within a weld as the presence of it suggests that the welding process has gone wrong, meaning that the weld is not as strong as first thought (Bossi, et al., 2002).

RT can be used to check for equal penetration and uniform thickness of the weld during the root weld, as it is key to forming a strong weld. A root run is the first run that goes into any sort of weld fillet or butt weld and acts as the foundation run for the entire weld (Jenkins, 2019).

Another problem that occurs with welds and requires the use of radiographic testing is slag inclusion. This is when the leftover material 'slag' from any magnetic flux on the welding rod gets trapped within the weld and solidifies. This can occur from welding too fast and is a frequent occurrence in fabrication during the root run of a weld (Jenkins, 2019). The slag can often be picked up visually and broken off but can lay deeper within the weld or become trapped between weld layers (Foundry, 2019).

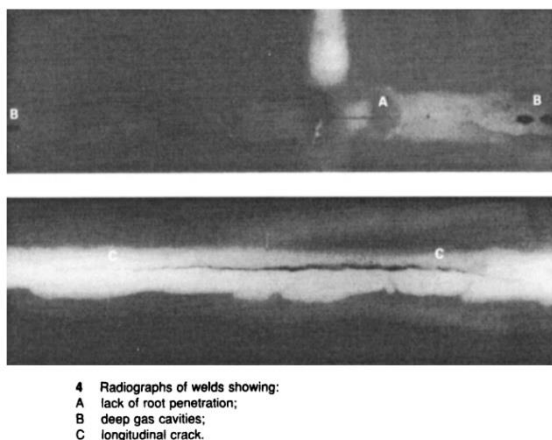


Figure 2 – Example of the radiographic testing of a weld (Bossi, et al., 2002).

4.4.2 Inspecting Metal Castings

The major goal of radiographic testing castings is to ensure a high quality of product and to help control the production process. Problems associated with casting are down to either the mould or complications in relation to the heating of the molten metal, leading to porosity within the casting (Bossi, et al., 2002). Some gas bubbles located in the mould are visible and can be picked up during a visual inspection, but most gas porosity bubbles will be distributed throughout the core of the cast (See Figure 3). These can prove a problem to the structural integrity of a metal casting as clusters of solidified gas bubbles could weaken the casting internally, depending on the area they are located. A radiographic inspection will pick up this type of defect in a part, rendering it an essential tool in industry (CFS, 2018).

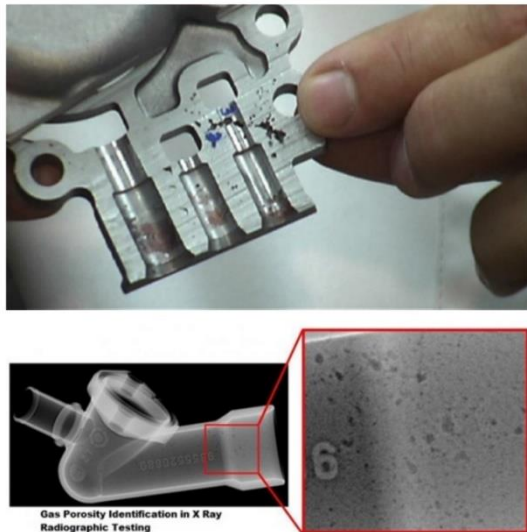


Figure 3 – Example of porosity picked up during RT (Bossi, et al., 2002)

4.4.3 Consumer Goods

Radiography has been reportedly used in the food industry by (Schmitt, 2002) which states that it can test condiment jars for uniform fill and foreign objects e.g. glass splinters. The system has also been used to count the slices of pepperoni on a frozen pizza. With the use of X-ray sensors, any anomalous items are picked up by the program and will be rejected from production.

TABLE 2. Applications of radiographic testing to online inspection of consumer products (Bossi, et al., 2002).

Category	Problem
Foreign objects	• Stones • Metals • Plastics • Bone fragments • Glass
Anomalous products	• Deformed products • Clod formations • Size errors • Waterlogged products • Defrosted frozen products
Missing items	• Missing constituents • Missing packages • Product missing from carton bag • Box missing from case

4.5 EXPLAIN HOW THE RESULTS OF THIS NDT CAN BE USED TO IMPROVE STRESS ANALYSIS

External porosity is considered more critical to welds than internal porosity due to the stress concentration effects. “Stress concentration is the increased level of applied stress that develops at abrupt changes in section such as sharp transitions, abrupt changes in weld profile, sharp corners, notches, and cracks.” (Singh, 2016)

The inclusion of porosity on a casting or weld is not considered a critical discontinuity unless any of the following conditions are present:

- Porosity bubbles are present in large quantities. Greater than 5% porosity in a radiograph length is considered unacceptable (Singh, 2016).
- The concentration in a short distance exceeds X amount
- It contains sharp tails
- Bubbles are aligned excessively in a short distance

(Bossi, et al., 2002)

Levels of porosity can be calculated using the following equation:

$$\text{Porosity} = (\text{Volume of Voids} / \text{Total Volume}) \times 100\%$$

(Study, 2018)

In metal castings, high concentrations of internal porosity can lead to the failure of a component over time as it is structurally weaker than it should be. Exposure to excessive vibration will also accelerate the failure, which would be catastrophic.

The location of any concentration of porosity is also key as it may be high but be situated in a non-relevant area. In other cases, the percentage of porosity may be around the tolerance level, but could be in an area that has more of an effect on the structural strength of the material (Nicholas, 2019).

5.0 MAGNETIC PARTICLE TESTING

5.1 THE SCIENTIFIC PRINCIPLES BEHIND THE TECHNIQUE.

This type of NDT is used to detect cracks in ferromagnetic materials that reach the surface of the material. In some cases, with favourable conditions, cracks slightly beneath the surface can also be detected (Halmshaw, 2006).

Test piece is magnetised, depending on the type of MPI being used this could be achieved indirectly between two magnetic poles or directly by applying current to create an electromagnetic field (Pries, 2009). It. Once the magnetic properties of the material have been changed, ferrous particles are added in dry or liquid form and are attracted to the areas of the test piece that have experienced disruption in the flux due to the presence of a defect. This is indicated when the magnetic particles gather around the defect excessively, mapping it out and making it visible to the human eye for examination purposes, an ultraviolet light can be used to improve the visibility. Any cracks or defects will disrupt the flow of current/magnetic flux and cause MP liquid to build up in that area to emphasise the defect, this is called flux leakage (see Figure 4) (Inspectioneering, 2019). It is important that the test specimen is cleaned to remove any non-magnetic contaminants like loose paint or rust as it may disrupt the process and lead to inaccurate results (Halmshaw, 2006).

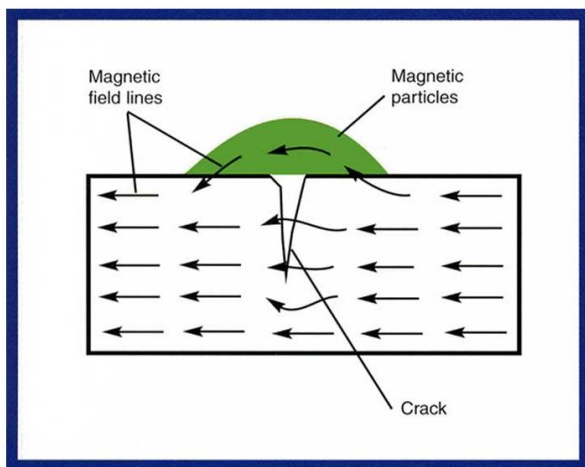


Figure 4 – How the magnetic line of flux help detects defects (LCEN, 2019).

5.2 ADVANTAGES AND DISADVANTAGES OF THE TECHNIQUE.

TABLE 3. The advantages and disadvantages of Magnetic Particle Inspection testing (TWI, 2018), (Halmshaw, 2006), (Inspectioneering, 2019).

Advantages	Disadvantages
• It is quick and relatively uncomplicated • It gives immediate indications of defects • Helps identify surface defects and in some cases, defects just below the surface • The method can be adapted for site or workshop use • Cheap to conduct • Large or small objects can be examined • Elaborate pre-cleaning is not necessary	• It is restricted to ferromagnetic materials - usually iron and steel, and cannot be used on non-magnetic materials • It is a messy process • It is sometimes unclear whether the magnetic field is sufficiently strong to give good indications • The method cannot be used if a thick paint coating is present • Spurious, or non-relevant indications, are probable, and thus interpretation is a skilled task • Some of the paints and particle suspension fluids can give a fume or fire problem, particularly in a confined space

5.3 POTENTIAL SOURCES OF ERROR AND ASSUMPTIONS THAT NEED TO BE MADE.

Human error is the main source of error in regards to this type of NDT method. Once a test specimen has been sprayed, it is then up to the person conducting the inspection to be able to correctly scan the test area for any cracks, chips or discontinuities. Failure to pick up on such things could lead to an eventual failure, making the inspection obsolete. It is important that personnel in charge of interpreting the results of an MPI test are fully trained in that field, competent and knows what they are looking for (Jenkins, 2019). It is also important that the test area is cleaned of any excess non-magnetic foreign bodies like rust, paint or grease, as they could interfere with the mapping of particles, leading to inaccurate results or defects going unnoticed (Worman, 2019).

5.4 TYPICAL APPLICATIONS THAT USE THIS TECHNIQUE.

5.4.1 Testing Welds

Magnetic particle testing is commonly used for the testing of existing welds due to its ability to pick up defects that the human eye would not be capable of during a visual inspection. This includes highlighting slag traps that may have formed between weld layers which will reduce the structural strength of a weld and it is basically a hollow spot (Bossi, et al., 2002). If picked up with MPI, welders can 'blow out' these traps and refill the hollowed out weld to safeguard the stability of a weld (Nicholas, 2019).

Another area that MPI is useful for is locating any lack of fusion between the molten metal and the cold metal surface, known as 'cold lap' (Bhatti, 2010). This usually happens when welding two materials of different thickness together and results in the weld not fusing completely to the material, leaving a small gap that will be susceptible to breaking (see Fig). To the naked eye, the weld looks acceptable, however any hard force applied to the material may cause the weld to break (Jenkins, 2019).



Figure 5 – Example of the lack of fusion on a weld called 'Cold lap'.

5.4.2 Testing Materials

Surface cracks can form on materials and will only get larger over time, likely until the material has completely shattered. If implemented correctly, the use of MPI will allow welders to rectify small faults before they can develop into anything serious or even escalate to the point of failure (Maierhofer, et al., 2010).

A real world example given by (Nicholas, 2019) is in the event of a flange connecting a large pipe to a sump pump being reported for displaying signs of damage in the for giving producing loud vibrations, it would be shut down to undergo MPI testing. The system would then be taken apart to undergo a field MPI test to determine if there were any underlying issues. If tested correctly, any cracks or defects will get detected and can be rectified by a welder sooner rather than later. If a fracture is detected, holes can be drilled at either end of a fracture to prevent it from spreading. The holes are then converted to a slot, allowing the welder on the job to insert a weld to replace the area where the crack had formed. This prevents the defect from developing to the point of a catastrophic failure that would have an effect on production, most likely in the form of extensive downtime for the damaged component to be replaced.

5.5 EXPLAIN HOW THE RESULTS OF THIS NDT CAN BE USED TO IMPROVE STRESS ANALYSIS

Surface cracks that may have developed on a component due to fatigue will be susceptible to being effected by stress concentration. Implementing MPI to a surface that is suspected to contain defects early on will display any surface cracks that may be present. If left unattended, these cracks will develop and fracture points will chase out over time until the material completely shears, this process will be accelerated if the material is situated in an environment consisting of excess vibration. MP testing allows trade to take apart machines or systems that are suspected to be faulty and test them for anything that may cause failure. Cracks, porosity, undercut and slag inclusions can lead to fatigue failures if not acted on in time and will all be picked up by MP testing.

Any cracks or defects highlighted during testing can be drilled out to halt fatigue process before being repaired by welders. The system can then be put back together and return to function as normal.

(Jenkins, 2019), (Nicholas, 2019)

6.0 ULTRASONIC TESTING

6.1 THE SCIENTIFIC PRINCIPLES BEHIND THE TECHNIQUE.

Ultrasonic testing is another common NDT method that is performed on materials. This method of testing uses sound waves to examine and measure a specific area of testing.

Typically, the UT inspection system includes an ultrasonic transducer probe that acts as a transmitter and a receiver of sound waves, and a display unit. An ultrasonic transducer is an electronic device that produces high voltage electrical pulses to the transducer. When transmitting, the transducer generates high frequency ultrasonic sound energy into the material in the form of sound waves (TWI, 2019). These soundwaves then reflect to the transducer, which now acts as a receiver. The probe is then moved along the full length of the test specimen and the results of the test are displayed on a CRT display screen (see Figure 6). This can help identify any cracks, defects or discontinuities within the system or material that is being tested, providing that the person carrying out the test has undergone the appropriate training to be able to interpret any readings displayed. A common use for ultrasonic testing is testing pipes for thickness or defects (Element, 2019).

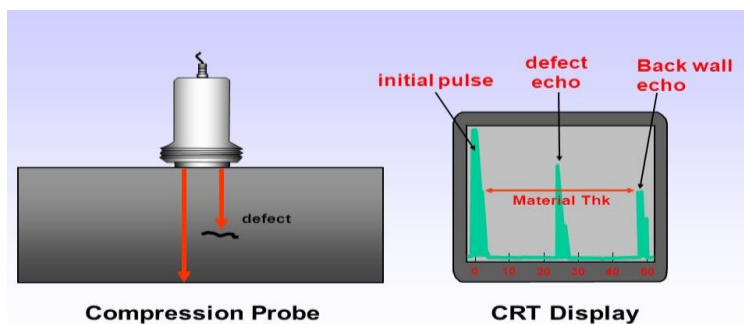


Figure 6 – Overview of UT equipment (TWI, 2019).

Ultrasonic welding is considered by (NDTRC, 2019) as a highly accurate form of testing with “the depth of penetration for flaw detection or measurement being superior to other NDT methods.” This statement was supported by (Jenkins, 2019), who added that ultrasonic testing will pick up more defects than any other form of testing.

(Olympus, 2018) states that sound energy does not travel well through air, meaning that some ultrasonic data could be lost via the small gap between the transducer and the material being tested. To avoid this, an ultrasonic couplant gel is often applied to the surface being tested to create a “bridge” for the soundwaves to travel across the space between the two solids. (Jenkins, 2019) agrees with this procedure and has experienced applying gel during ultrasonic testing to help obtain more accurate results.

6.2 ADVANTAGES AND DISADVANTAGES OF THE TECHNIQUE.

TABLE 4. Advantages and Disadvantages of Ultrasonic testing (Olympus, 2019), (Element, 2019).

Advantages	Disadvantages
• It is sensitive to both surface and subsurface discontinuities. • The depth of penetration for flaw detection or measurement is superior to other NDT methods. • Only requires access to one side of the test specimen • It is highly accurate • Minimal part preparation is required. • Instantaneous results provided via electronic equipment. • Detailed images can be produced with automated systems. • It has other uses, such as thickness measurement, in addition to flaw detection. • No health hazards present like in radiographic testing.	• Surface must be accessible to transmit ultrasound. • Extensive skill and training required to carry out testing • It normally requires a coupling medium to promote the transfer of sound energy into the test specimen. • Materials that are rough, irregular in shape, very small, exceptionally thin or not homogeneous are difficult to inspect. • Struggles to test cast iron as it effects transmissions • Linear defects oriented parallel to the sound beam may go undetected. • Reference standards are required for both equipment calibration and the characterization of flaws.

6.3 POTENTIAL SOURCES OF ERROR AND ASSUMPTIONS THAT NEED TO BE MADE.

Ultrasonic testing is a highly accurate form of NDT with commercial gauges achieving accuracies as high as $\pm 0.001\text{mm}$, with accuracies of $\pm 0.025\text{ mm}$ in most common engineering materials. Surface condition, uniformity of sound velocity the test material, the rate of sound absorption, the and the appropriate calibration of kit are all effecting factors the accuracy of UT results. Careful and attentive calibration will further enhance accuracy (Olympus, 2019).

Like most NDT methods, the interpretation of results is essential for deriving any defects from reading given for a UT inspection, meaning that anyone carrying out the inspection must be fully trained. Failure to train personnel correctly would likely result in defects going unnoticed and reduce credibility to the ultrasonic test (Element, 2019).

6.4 TYPICAL APPLICATIONS THAT USE THIS TECHNIQUE.

6.4.1 Field Testing - Pipes

Contact ultrasonic testing is often used in field for testing welds and pipes for cracks and fractures (Element, 2019). Contact UT is ideal in situations where only one side of the test specimen is accessible (ESAB, 2018). This method of UT is ideal for field testing in actual use conditions as it causes minimum disruption to the system being tested. A major use of UT is to measure the wall thickness of pipes and tanks that have corroded over time with minimum disruption to operational demands/production (Olympus, 2019). In many cases involving pipes and tanks, radiographic inspection is not possible as these instances, as previously mentioned in the report, require access to both sides of the test specimen. UT can also be used to detect any chips or cracks that are located inside pipes before they are able to develop into larger fractures, resulting in the complete failure of the pipe (Nicholas, 2019).

6.4.2 Controlled Testing - Automotive

Immersion ultrasonic testing is a different variation of UT that is used primarily in controlled laboratory environments. In this type of inspection, the test specimen is submerged in liquid so that soundwaves can travel better (see Figure 8), leading to more accurate results and finding smaller defects (Element, 2019). This method of ultrasonic testing is used in the automotive industry for inspecting small, intricate welds on small components to ensure they have acceptable structural properties. An example of this is the weld joining a sub-shaft to the main tube on prop-shafts (see Fig.). Destructive methods such as bend tests can be used to test the properties of these welds, however that results in the scrapping of the examined components, generating high costs for the manufacturer (Kustroń, et al., 2017).

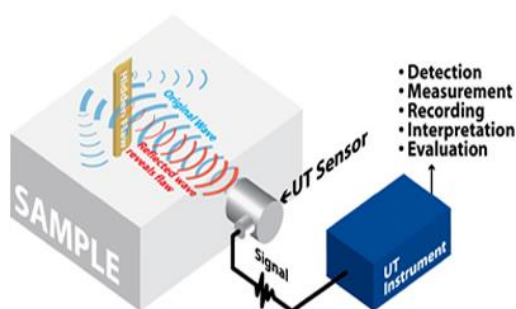


Figure 7 – Overview of Immersion UT equipment (NDTT, 2017).



*Figure 8 – Subshafts used in automotive industry
(Kustroń, et al., 2017)*

6.5 EXPLAIN HOW THE RESULTS OF THIS NDT CAN BE USED TO IMPROVE STRESS ANALYSIS

Ultrasonic testing is commonly used for measuring the wall thickness of pipes that may have corroded over time. As pipes corrode, they will become structurally weaker. If thickness is not monitored then the pipes could corrode to the point of failure which would have serious consequences in certain situations (STI, 2014), (Nicholas, 2019).

Surface defects that lay beneath the surface of a material could cause a failure due to fatigue, especially in environments involving excessive vibration/noise (Jenkins, 2019). Unlike many testing techniques, UT can highlight such defects easily, without damaging or weakening the material being tested. This allows trade to detect any cracks that lay within pipes or beneath the surface of a material early so that they may be amended before any catastrophic damage occurs, resulting in a large-scale replacement that will cause disruption to production (NDT Resouce Centre, 2018).

Radiographic testing is also capable of locating these faults to an extent, however as previously mentioned in the report, that NDT method requires two-sided access to the component. The main benefitting factor of UT is how fast, easy and accurately tests can be carried out as equipment is portable, accurate and requires single sided access to components for usage.

7.0 CONCLUSION

This report has shown that non-destructive testing is an essential tool that is used in industry to attempt to pick up damage and defects to components before they fail. NDT differs to destructive testing as it can be used on components that are currently part of a system to prolong their life, therefor reducing the chance of failure. Destructive testing techniques are limited to components that have been created for the sole purpose of being destroyed for testing purposes and will not be applicable to existing systems.

Non-destructive testing is a vital tool that ensures that materials and components are in the correct working order and display their expected material properties and characteristics.

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