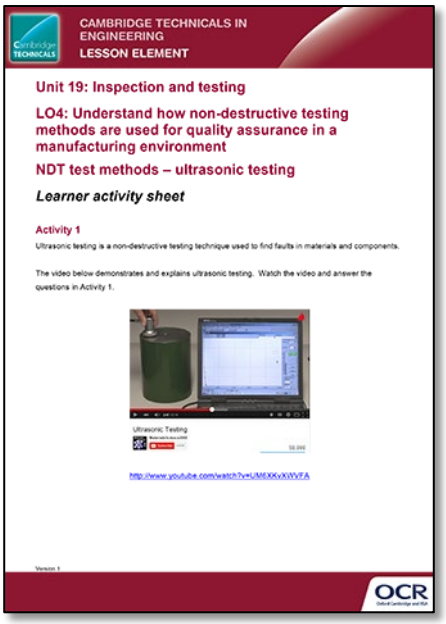
Unit 19: Inspection and testing

LO4: Understand how non-destructive testing methods are used for quality assurance in a manufacturing environment

NDT test methods – ultrasonic testing

Instructions and answers for teachers

These instructions should accompany the OCR resource 'NDT test methods – ultrasonic testing' *activity which supports Cambridge Technicals in Engineering Level 3.*



The Activity:

In Activity 1 learners are to watch a video showing ultrasonic testing.

In Activity 2 learners are tasked to complete and explain a diagram representing ultrasonic detection of a crack.

In Activity 3 learners should investigate two further types of ultrasonic testing.

Suggested timings:

1 hour

Activity 1

In Activity 1 learners are to watch a video showing ultrasonic testing. The video explains the principle by which ultrasonic testing works, demonstrates ultrasonic testing in the laborattory and shows testing being performed on tram bogeys.

http://www.youtube.com/watch?v=UM6XKvXWVFA

This activity could be used as a class-based teaching resource.

Learners are are tasked to answer the following questions.

Answers to questions

1. What is the basic principle of operation of ultrasonic testing?
   The basic principle of ultrasonic testing is the propagation and reflection of sound waves. These are in the ultrasonic range of the spectrum.

2. What is 'free end reflection'?
   Free end reflection is when the sound wave reaches the free end of the material being tested and is reflected back towards the receiver. The wave is even reflected again and travels for several times.

3. What is the 'free end' usually called?
   In ultrasonic testing the free end is usually termed the 'back wall'.

4. At what speed does an ultrasonic wave travel?
   The ultrasonic sound wave travels at the speed of sound.

5. What are 'pulse echo mode' and 'through transmission mode'?
   The pulse echo mode is the echo caused by a defect in a material. The through transmission mode is the phenomenon that hardly any sound waves pass through an imperfection. Pulse echo mode is commonly used where the transducer contains both the sound generator and the receiver.

6. What signals are usually present in a specimen free from defects?
   In a specimen free from defects the signals present will be those from the back wall only, although it is possible that usual features can cause echoes. The monitor will show the transmission pulse and the echo pulse from the back wall.

7. What signals are usually present in a specimen with defects?
   In a specimen with defects, then echo signals will be present caused by the defects. The defect creates an additional echo, or just an echo from the defect itself.

8. What function does a piezo-electric disc perform?
   The piezo-electric disc is a transducer that can both generate and receive ultrasonic waves. It works on the piezo-electric effect (learners could investigate this in more detail).

9. Why is a couplant gel required?
   A couplant gel is required to improve the contact area of the ultrasonic probe with the work piece. Without the gel, then poor signal reflection occurs. The couplant gel allows for better surface contact allowing ultrasonic waves to enter the work piece and to be reflected back to the probe.

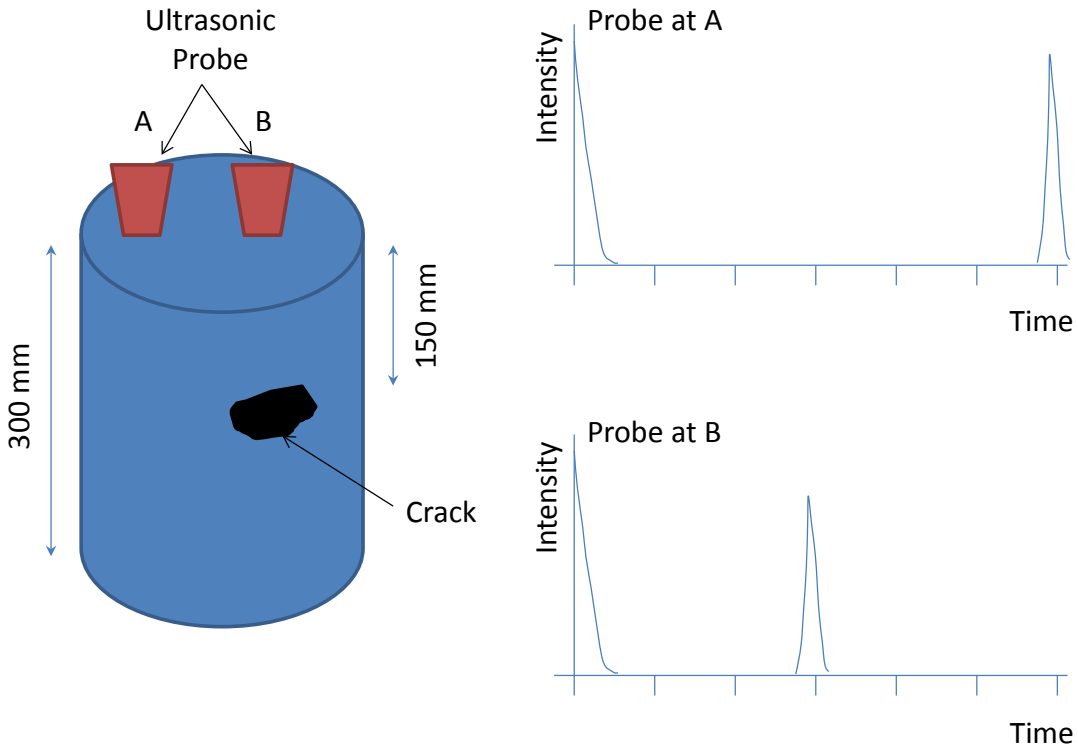
10. How can depth and not reflected signal time be plotted using an ultrasonic tester?
    If the velocity of sound in the material being tested is known then the calculated depth of reflected echo's can be determined. Depth can be shown on the monitor instead of time for the ultrasonic wave to be reflected.

11. Will only abnormalities cause ultrasonic echoes?
    No – it is possible to see reflected signals from normal parts of the geometry of a component such as at shoulders. These are termed contour echoes. Reading and interpreting the ultrasonic signals is a skilled procedure.

Teachers could demonstrate ultrasonic testing practically if access to suitable resources is available.

Activity 2

In Activity 2 learners are tasked to complete and explain the following diagram representing ultrasonic detection of a crack. Learners should be able to use information from the video to complete this activity. Teachers could extend this activity to include different types and location of defect, and to determine depth of the defect in the material. Typical answers are shown below.



1. Explain what is being shown in the plot with the probe at position A:
   At position A the transmission pulse and back wall echo will be seen. The back wall echo intensity will be less that the transmission pulse due to the ultrasonic wave being reduced by losses in the material.

2. Explain what is being shown in the plot with the probe at position B:
   At position B the probe is directly above the defect the transmission pulse and an echo from the defect will be seen. This time position of this will be approximately half way between the transmission pulse and the point where the back wall echo would occur. The intensity is again less that the transmission pulse due to the ultrasonic wave being reduced by losses.

Activity 3

In Activity 3 learners should investigate two further types of ultrasonic testing used in practice.

The following web page from the British Institute of Non-Destructive Testing (BINDT) may be useful:

http://www.bindt.org/What-is-NDT/Ultrasonic-advanced-methods/

Both methods are summarised below:

1. Time-of-Flight Diffraction – TOFD	TOFD is commonly used for detecting defects in welds. In a TOFD system, a pair of ultrasonic probes sits on opposite sides of a weld. One of the probes, the transmitter, emits an ultrasonic pulse that is picked up by the probe on the other side, the receiver. In undamaged specimens, the signals picked up by the receiver probe are from two waves: one that travels along the surface and one that reflects off the back wall. When a crack is present, there is a diffraction of the ultrasonic wave from the tip(s) of the crack. Using the measured time of flight of the pulse, the depth of a crack tip can be calculated automatically by simple trigonometry. This method is even more reliable than traditional pulse echo ultrasonic testing.
2. Phased array	Phased array ultrasonic testing (PA) is an advanced method of ultrasonic testing. The PA probe consists of many small ultrasonic transducers, each of which can be pulsed independently. By varying the timing by pulsing the elements one by one in sequence along a row, a pattern of constructive interference is set up that result in a beam at a set angle. The beam can be steered electronically. The beam is swept like a search-light through the tissue or object being examined, and the data from multiple beams are put together to make a visual image showing a slice through the object.

We'd like to know your view on the resources we produce. By clicking on 'Like' or 'Dislike' you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

If you do not currently offer this OCR qualification but would like to do so, please complete the Expression of Interest Form which can be found here: www.ocr.org.uk/expression-of-interest