

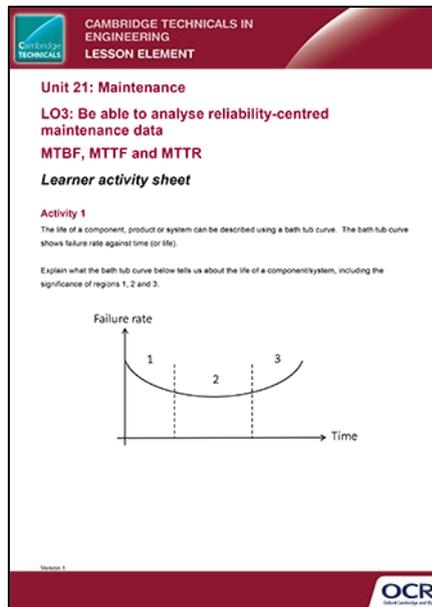
## Unit 21: Maintenance

### LO3: Be able to analyse reliability-centred maintenance data

### MTBF, MTTF and MTTR

### *Instructions and answers for teachers*

*These instructions should accompany the OCR resource 'MTBF, MTTF and MTTR' activity which supports Cambridge Technicals in Engineering Level 3.*



#### **The Activity:**

For Activity 1, learners should explain what the bath tub curve represents.

For Activity 2, learners have been tasked to define Mean Time Between Failures (MTBF), Mean Time To Failure (MTTF) and Mean Time To Repair (MTTR).



*This activity offers an opportunity for English skills development.*



*This activity offers an opportunity for maths skills development.*

#### **Suggested timings:**

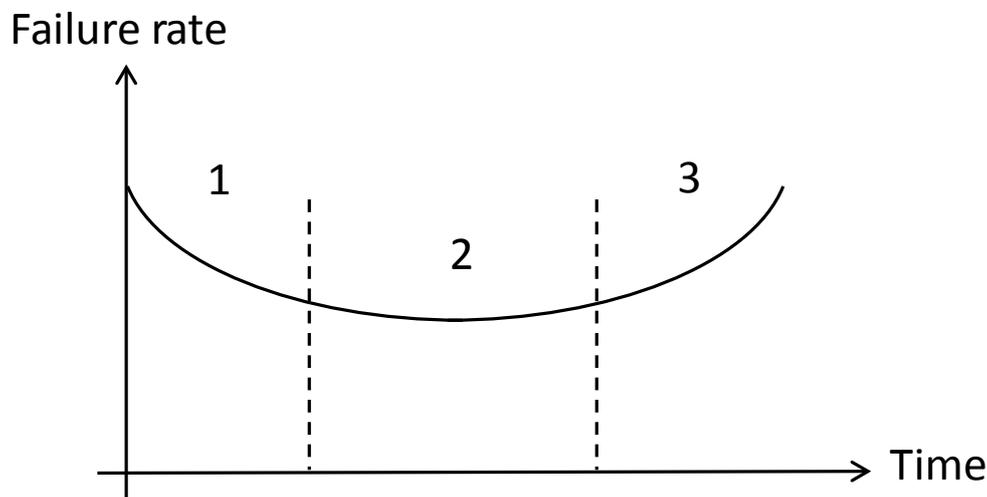
1 hour

### Activity 1

For Activity 1, learners should explain what the bath tub curve represents including the significance of the regions 1, 2 and 3.

The bath tub curve (as shown) represents the life of a population of components, devices or systems. It is a representation of reliability – which may have been determined through component/system testing or through data collected from working components or systems.

It is sometimes referred to as the ‘cradle to grave’ failure rate, and shows failure rate against time. This type of curve is typical for most components, devices and systems.



It has three distinct regions:

1	This represents the start of the life where weaker components/systems fail more rapidly, but with a decreasing failure rate. It is termed the region of infant mortality.
2	In this region, components and systems fail at a roughly constant rate. This is the normal (or useful) region of life.
3	In region 3 components and systems are beginning to reach the end of their useful life – wearing out. This region represents increasing end-of-life wear out.

The bathtub curve is important to understanding the reliability of a component or system with time, as this will affect maintenance strategies.

## Activity 2

For Activity 2, learners have been tasked to define Mean Time Between Failures (MTBF), Mean Time To Failure (MTTF) and Mean Time To Repair (MTTR) including giving a formula by which they can be calculated. A typical solution is given below.

Term	Definition	Formula
MTBF	MTBF (Mean Time Between Failures) is a measure of how reliable a component, product or system is. It represents the mean time between failures for items that are <b>repairable</b> .	$\theta = T/R$ $\theta = \text{MTBF}$ T = total operating time R = number of failures
MTTF	MTTF (Mean Time To Failure) is similar to MTBF but represents the mean time to failure for items that are <b>not repairable</b> .	$\gamma = T/N$ $\gamma = \text{MTTF}$ T = total operating time N = number of units under test
MTTR	MTTR (Mean Time To Repair) is a measure of the maintainability of an item that can be repaired. It represents the average time required to repair a failed component or device.	$\text{MTTR} = \text{total down time/number of repairs}$

Learners may find alternative definitions or formula.

## Activity 3

Solution to Problem 1

$$\theta = T/R = (10 \text{ compressors} \times 500 \text{ hours}) / 2 \text{ failures} = \mathbf{2500 \text{ hours / failure}}$$

Solution to Problem 2

$$\gamma = T/N = (10 \text{ sensors} \times 500 \text{ hours}) / 10 \text{ sensors under test} = \mathbf{500 \text{ hours / failure}}$$

The two cases are different as in Problem 1 the compressor is a repairable system, and in Problem 2 it is expected that the sensor is non-repairable.

For this reason, the failure rate for the compressor in Problem 1 is lower than that for the failure rate for the sensor in Problem 2.

It is therefore important to know the MTTF for components or items in critical systems, as this will have some impact on maintenance strategies.

Teachers might develop further problems for learners to solve for MTBF, MTTF and MTTR.

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