Engineering L2

– Fault Finding and Maintenance

# 1 of 21 – Welcome

Welcome to this second session on fault finding and maintenance.

By the end of this session, you will be able to:

* Describe different causes of engineering equipment failure
* Describe the effect of equipment failures
* Explain the different between planned and unplanned maintenance
* Explain the six-step fault-finding process

# 2 of 21 – The importance of maintenance

All equipment will experience wear and tear in their day-to-day use. This will have been considered by the manufacturer when they give an estimate of the life of the product, by which we mean the length of time it will be functional for.

Many products develop faults within their estimated life-span, either due to accidents, part failure or operator error. Maintenance is important to diagnose and fix these issues so that the product can continue to be used.

Regular maintenance of products is also important to maximise product life, as often issues are easier and less costly to fix if they are spotted early on. Regular tasks such as applying lubricant or recalibrating parts can even prevent some malfunctions from happening at all.

# 3 of 21 – Common causes of equipment failure

Equipment can experience faults and failures for many reasons, some avoidable and some not.

* Age – All products have an expected life-time. When they go beyond this, malfunction becomes more likely as materials to not perform as expected, such as rubber losing its elasticity.
* Wear – When parts rub against one another friction slowly erodes the surface. This can cause parts to not fit together as they should, or even to break apart altogether.
* Vibration – Many machines produce vibrations in their usual operation. These vibrations shake the machine and can work lose screws or fixings, as well as creating additional friction points between components.
* Corrosion – Chemicals used inside a machine can cause corrosion inside the machine, however external influences in the environment where the machine is located such as saltwater or acidic rainfall can corrode the machinery on the outside too.
* Fouling – Undesirable substances such as mould or waste products can gather on surfaces inside or outside of machinery that can in turn cause corrosion, or simply impede the normal function of the machinery.
* Environment – Environmental conditions in the location of the machinery can affect how a machine performs, such as extreme heat making components swell up, jamming the machinery or causing extra friction.
* Lack of maintenance – Some parts need regular servicing to ensure their continued operation, through replacing parts that are used up in the process or resupplying lubricant to the system. Without this regular maintenance the machine will fail.
* Malicious damage – Machinery can be damaged by employees through improper use, or vandalised intentionally by external individuals or groups.

# 4 of 21 – Effects of equipment failure

Aside from the immediate inconvenience, equipment failures can have a range of wider negative effects on production and the organisation as a whole.

Failed machinery creates downtime for production, which in turn increases costs. These usually cannot easily be passed onto the consumer, meaning that the business will have to absorb them. Downtime can cause delays in manufacture too, which could lead to loss of goodwill, or even fines or fees from others further down the supply chain.

Sometimes equipment malfunctions are not immediately noticed, and a machine continues to operate whilst broken. This can cause damage to other components or machines in the wider system.

In extreme circumstances, machinery malfunctions can lead to injuries to employees or even loss of life.

# 5 of 21 – Regularly scheduled maintenance

Maintenance is either regularly scheduled and planned or unplanned, in response to a problem.

Regularly scheduled or planned maintenance can take a variety of forms. Routine maintenance – regular inspections or part replacement done to a set schedule

* Preventative maintenance – regularly checking machinery and replacing parts that show signs of wear and tear before they fail
* Condition monitoring – a component of preventative maintenance, monitoring a particular condition such as vibration or temperature within a machine to identify significant changes that may cause other problems
* Front-line maintenance – the people who use the machines making checks and repairs to the machines as they use them as part of their job
* Servicing – regular activities performed to ensure the expected lifetime of a machine, such as replacing lubricants

# 6 of 21 – Routine maintenance activities

Lots of activities can be carried out as part of routine maintenance. What is required will vary depending on the equipment being maintained, however below is a list of some of the processes that may be carried out.

* Leak detection
* Checks for wear, chafing, overheating, corrosion or fouling
* Security of part attachment checks
* Replenishments
* Adjustments
* Replacements
* Repair

An important aspect of routine maintenance activities is documenting whatever has been checked, fixed or replaced. This is done through a range of reports and documentation, such as scheduled maintenance reports, corrective maintenance reports, other company-specific reports, job cards and maintenance logs.

# 7 of 21 – Unplanned maintenance

Unplanned maintenance takes place in response to a problem being discovered. This could be at the point when a piece of equipment stops working, or it could be because someone has noticed an issue that will occur soon, such as a loose part or corrosion that will soon lead to part failure.

Unplanned maintenance is often carried out by front-line workers, who fix machinery as and when it is being used. These repairs are generally what are known as ‘running repairs’ or ‘ongoing maintenance’ and will often include swapping out components with short lifetimes such as light bulbs or screws. It can also include topping up coolants or lubricants, or cleaning machinery so that they function smoothly.

Other times unplanned maintenance will be carried out by external individuals or companies who are brought in to fix more severe problems. This will usually be in response to equipment breakdown. Here engineers may be replacing larger parts or systems to fix problems.

# 8 of 21 – Planning a maintenance activity

When considering carrying out a maintenance activity, the work must be carefully planned. There are three main areas to consider.

* Identification of resources – From the tools to identify and fix the problem to the staff who have the knowledge to do it, the first key area is to identify the resources that will be needed from start to finish in the process. This includes any required management sign-off, spare parts and permits needed to carry out the work.
* Maintenance planning – To enable the work can be carried out efficiently, it must be planned into the other operations that are most likely still occurring around it. The timing of the work should take into account availability of engineers to carry out the work, impact on wider production and any additional costs it creates.
* Maintenance documentation – The engineer will need to gather together all appropriate documentation to complete the repair, including records and logs, instructions or plans for the equipment and any fault-finding guides they need.

# 9 of 21 – Resources for a maintenance activity

There are many resources required for carrying out a maintenance activity.

* Maintenance and production staff – This includes scheduling a skilled member of staff to carry out the maintenance but can also include rescheduling staff who would have been working on the machine to carry out a different task whilst the maintenance is carried out.
* Documentation – This includes permits for work, logs and records to be filled out and any handover documentation for the staff who will resume work on the machinery afterwards.
* Fault-finding aids – This includes diagnostic equipment and any paperwork useful for fault-finding.
* Spares, materials and consumables – This includes parts that need to be replaced, fluids that need topping up and even materials for cleaning up afterwards if the maintenance process creates any mess or waste.
* Test equipment and tools – This includes equipment for fixing the faults and for testing that it works properly once the work has been completed.

# 10 of 21 – Scheduling maintenance activity

Planned maintenance needs to be scheduled so that it is efficient; a good maintenance schedule will improve the efficiency and cost effectiveness of a production line by ensuring the machinery doesn’t fail, not decrease it by interrupting production and disrupting staff.

Different maintenance activities will need to be completed with differing amounts of frequency. For example, lubricants might need to be topped up daily, but key parts only replaced once a year. In order to draw up a schedule, first the process needs to be evaluated entirely and a list made of the maintenance requirements and how frequently they need to happen. Typically, this will be either shift, daily, weekly, monthly or yearly, but other frequencies are possible too.

When scheduling work, environmental and health and safety issues must also be considered; some work may need to take place when minimal staff are present or may require a shutdown of other production areas to prevent harmful waste products from escaping.

# 11 of 21 – Maintenance documentation

Documentation is an essential part of the maintenance process. This includes documentation written for the engineer, such as manuals, diagrams and fault-finding aids, and documentation written by the engineer, such as reports and logs.

Some of the documentation an engineer might use or complete during a maintenance activity are:

* Manufacturers’ manuals or instructions
* Drawings, charts and diagrams
* Planning sheets and schedules
* Maintenance logs
* Machine or process records
* Hand-over documents
* Fault-finding aids
* Permit-to-work
* Maintenance check lists

# 12 of 21 – Identifying faults

When machinery stops working it is usually obvious that something is wrong, however it may not always be obvious what the fault is. For that reason, it is important to have an idea of how to identify a fault so that the machine can be fixed.

There are three main types of faults:

* Intermittent operation – When a machine works sometimes but not other times, or it works but not as expected.
* Part failure – When a component within the machine has broken, such as wire being snapped, which may affect only part of the machine’s process or could affect the whole thing.
* Complete breakdown – When the machine will not work at all.

It is the engineer’s job to use a range of techniques and aids to find the specific problem so that it can be fixed.

# 13 of 21 – Fault-finding aids

To locate the fault, an engineer has many tools available to them, such as the following:

* Troubleshooting or functional charts – A series of questions you can follow to identify the point where a problem is occurring
* Wiring or schematic diagrams – Drawings showing how machinery should be put together
* Instruments – Equipment that can give readings, such as multimeters or pressure monitors
* Dial test indicators – Equipment for measuring products made on a lathe
* Torque measuring devices – Equipment the measure twisting forces
* Flow meters – Equipment to measure amount and pressure of gasses or liquids
* Alignment devices – Equipment to check alignment of parts or components
* Pressure or force indicators – Equipment to measure pressure or force on components
* Component data sheets – Documents that summarise the performance and characteristics of a part or product
* Software-based records and data – Digital documentation or information about the characteristics or performance of a part or product

# 14 of 21 – Fault-finding instruments

Choosing the right fault-finding instrument is an important part of accurately identifying faults. Most instruments are designed to read a certain type of information, so they need to be used correctly. For example, there is no point trying to measure light levels with a multimeter or insulation resistance with a signal tracer.

Let’s explore some common fault-finding instruments and what they measure.

* Multimeter – Measures current, resistance and voltage
* Signal generator – Generates signals with amplitude, frequency and wavelength, often used to test electronic or electroacoustic devices
* Oscilloscope – Graphically displays waveforms to show how electrical or other signals vary with time
* Insulation resistance tester – Tests insulation resistance in electrical installations
* Logic probe – Measures the logic state of any node within a circuit
* Signal tracer – Measures signals in radio and electronic circuitry
* Continuity tester – Determines if an electrical path can be made between two points
* Light meter – Measures light levels
* Earth loop impedance tester – Checks if enough current is flowing in a system to operate a fuse or circuit breaker in case of fault

# 15 of 21 – Fault-finding techniques

Engineers can use many techniques to locate the faults in their equipment.

Some of the most common include:

* Half split – Testing half the parts at first, then half of those, and so on, in order to locate the faulty part
* Input to output – Testing parts in the sequence they are encountered during the machine’s process
* Unit substitution – Swapping out a part or process to see if it makes the whole machine work
* Emergent sequence – Starting with testing things that have been changed recently
* Visual examination – Looking at the machine to see if anything appears to be broken or out of place
* Six-point fault finding – A six step process to follow to find and fix problems

# 16 of 21 – Six-point fault finding

The six-point system is a commonly used process for finding and fixing faults.

There are six steps in the process. If the machinery doesn’t work after the sixth step, then there is probably an additional fault, so the process can be followed through again until the machinery is operational.

Step 1 – Collect the evidence

Focus on evidence that is relevant to the problem. Use senses and diagnostic equipment to collect the evidence.

Step 2 – Analyse evidence

Study the evidence – does it point to a particular area?

Step 3 – Locate fault

Check the most likely place for the fault as shown by your analysis and verify if there is a fault there

Step 4 – Determine and remove cause

If something has caused the fault, remove it so that it cannot happen again. Failure to do this will result in the fault reoccurring.

Step 5 – Rectify fault

Fix or replace the broken part, as required by your current findings.

Step 6 – Check system

Check the system and if possible, run it to make sure that it works well again. If not, return to the first step and start again.

# 17 of 21 – Maintaining computerised equipment

Computerised equipment has an additional level of maintenance required beyond that of the physical hardware. Software must be kept up to date or patched or ensure that it is not vulnerable to outside security attacks.

Software updates will also ensure ongoing compatibility with new formats and provide fixes for any problems that have been identified in earlier versions.

Updates for computerised equipment will usually be available from the manufacturer, either directly or via their website.

# 18 of 21 – Question 1

Indicate if the following statement is true or false.

Unplanned maintenance takes place in response to a problem being discovered.

Answer: The correct answer is **true**.

# 19 of 21 – Question 2

Which of the following is a type of maintenance documentation?

1. Skilled staff to carry out the repair
2. Maintenance log
3. Fluids that need topping up
4. A multimeter

Answer: The **maintenance log** is a type of maintenance documentation.

# 20 of 21 – Question 3

Which of the following is the first step in the six-step fault finding process?

1. Locate fault
2. Collect the evidence
3. Analyse evidence
4. Rectify fault
5. Determine and remove cause
6. Check system

Answer: The correct answer is **b**, **collect the evidence**.

# 21 of 21 – End

Well done, you have completed this session on fault finding and maintenance.

You should now be able to:

* Describe different causes of engineering equipment failure
* Describe the effect of equipment failures
* Explain the different between planned and unplanned maintenance
* Explain the six-step fault-finding process