MECHANICS

LEVEL-III

Learning Guide-#58

Unit of Competence: Maintain and Repair Engineering Components

Module Title: Maintain and Repair Engineering Components

Module Code: XXX

LG Code: XXXXX

TTLM Code: XXXXX

LO1*:* Plan maintenance procedures

Instruction Sheet-1	Learning Guide #58

This learning guide is developed to provide trainees the necessary information regarding the following **content coverage** and topics:

- Introducing Maintenance (overview)
- Types of Maintenance /procedures
- Diagnostic Technologies and measuring devices
- Failure Modes and effect analysis (FMEA)

This guide will also assist trainees to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, trainees will be able to**:

- Understand about maintenance and causes of failures
- Test component for desired specifications, mechanical property, tolerance etc.
- Know different maintenance systems and their scopes
- Know different tests used in prediction of failures
- perform Failure Modes and effect analysis (FMEA)
- establish risk priority numbers(RPN)

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 1 to 3
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4”.

Information Sheet-1	Introducing Maintenance (overview)

1.1. Introduction

Maintenance involves fixing any sort of mechanical or electrical device which has become out of order or broken. It also includes performing routine actions which keep device in working order or prevent trouble from arising.

Maintenance is a routine and recurring activity of keeping a particular machine or facility at its normal operating condition so that it can deliver its expected performance or service without causing any loose of time on account of accidental damage or breakdown.

1.2. Objectives of maintenance

The objectives of maintenance should be formulated within the framework of the overall organizational setup so that finally the goals of the organization are accomplished. For this, the maintenance division needs to ensure that:

- The machinery are always in an optimum working condition at the lowest possible cost
- The time schedule of delivering to the customers is not affected
- The performance of the machinery is dependable and reliable.
- The performance of the machinery is kept to minimum to the event of the breakdown.
- The maintenance cost is properly monitored to control overhead costs.
- The life of equipment is prolonged while maintaining the acceptable level of performance to avoid unnecessary replacements.

Maintenance, in general, can be defined as efforts taken to keep the condition and performance of a machine always like the condition and performance of the machine when it is still new.

Maintenance activities can basically be divided into two parts: planned maintenance activities and unplanned maintenance activities.

Planned maintenance is maintenance that is organized and carried out with thought to the future, control and recording in accordance with the plans that have been determined previously.

1.3. Difference between Maintenance and Reliability

Maintenance

- Maintenance is all activities involved in keeping a system's equipment in working order.
- Implementing or improving preventive maintenance
- Increasing repair capability or speed

Reliability

- Reliability is the probability that a machine will function properly for a specified time.
- Improving individual components Providing redundancy

1.4. Maintenance Management

Maintenance management is defined as the process of maintaining a company's assets and resources while controlling time and costs, ensuring maximum efficiency of the manufacturing process.

1. Necessity of Maintenance Management:

Maintenance activities are related with repair, replacement and service of components or some identifiable group of components in a manufacturing plant so that it may continue to operate at a specified 'availability' for a specified period. Thus maintenance management is associated with the direction and organisation of various resources so as to control the availability and performance of the industrial unit to some specified level.

Thus maintenance management may be treated as a restorative function of production management which is entrusted with the task of keeping equipment/machines and plant services ever available in proper operating condition.

The minimization of machine breakdowns and down time has been the main objective of maintenance but the strategies adopted by maintenance management to achieve this aim have undergone great changes in the past.

Maintenance has been considered just to repair the faulty equipment and put them back in order in minimum possible time.

In view of the utilization of mostly general purpose/conventional machines with low production output, the demands on maintenance function were not very high. But with fast developments in the design, development and mechanisms of control such as electronic, NC and CNC in machine tools the manufacturing scenario has changed a lot.

The stringent control of dimensional tolerances and surface finish of the product have increased the tendency to adopt standardization and interchange-ability of parts/components of machines.

In the current production setups even a minor down time leads to serious production problems both technological as well as economical. All this is due to tough competition in the industrial market. Under the present circumstances effective and objectively designed efforts to update maintenance management has become a necessity

2. Importance of Maintenance Management

- Maintenance management is responsible for the smooth and efficient working of the industrial plant and helps in improving the productivity.

- It also helps to keep the machines/equipment in their optimum operating conditions. Thus plant maintenance is an important and inevitable service function of an efficient production system.

- It also helps in maintaining and improving the operational efficiency of the plant facilities and hence contributes towards revenue by decreasing the operating cost and improving the quality and quantity of the product being manufactured.

As a service function it is related with the incurrence of certain costs. The important component of such costs are — employment of maintenance staff, other minor administrative expenses, investment in maintenance equipment and inventory of repair components/ parts and maintenance materials.

Absence of plant maintenance may lead to frequent machine breakdown and failure of certain productive centres/services which in turn would result in stoppages of production activities, idle man and machine time, dislocation of the subsequent operations, poor quality of production, failure to meet delivery dates of product supply, industrial accidents endangering the life of workers/ operators and allied costs etc.

However, the importance of plant maintenance varies with the type of plant and its production but it plays a prominent role in production management because plant breakdown creates problems such as:

(i) Loss of production.
(ii) Rescheduling of production.
(iii) Materials wastage (due to sudden stoppage of process damages in process materials).
(iv) Need for overtimes,

(v) Need for work subcontracting.

(vi) For maximum manpower utilization workers may need alternative work due to temporary work shortages.

Hence, the absence of planned maintenance service proves costlier. So it should be provided in the light of cost benefit analysis. Since plant maintenance is a service function, it should be provided at the least possible cost but it is very important as discussed above.

3. Objectives of maintenance management

The purpose of maintenance management is to optimize the performance of productive facilities of an organization by ensuring that these facilities function regularly and efficiently. This can be achieved by preventing the failures or breakdowns if any, as far as possible and by minimizing the production loss due to failures.

The main objectives of maintenance management are as follows:
(1) Minimizing the loss of productive time because of equipment failure to maximize the availability of plant, equipment and machinery for productive utilization through planned maintenance.

(2) To extend the useful life of the plant, machinery and other facilities by minimizing their wear and tear.

(3) Minimizing the loss due to production stoppages.

(4) To ensure operational readiness of all equipment's needed for emergency purposes at all times such as fire-fighting equipment.

(5) Efficient use of maintenance equipment's and personnel.

(6) To ensure safety of personnel through regular inspection and maintenance of facilities such as boilers, compressors and material handling equipment etc.

(7) To maximize efficiency and economy in production through optimum utilization of available facilities.

(8) To improve the quality of products and to improve the productivity of the plant.

(9) To minimize the total maintenance cost which may consist of cost of repairs, cost of preventive maintenance and inventory costs associated with spare parts/materials required for maintenance.

(10) To improve reliability, availability and maintainability.

4. Functions of maintenance management

The important functions of maintenance can be summarized as follows:

(1)To develop maintenance policies, procedures and standards for the plant maintenance system.

(2) To schedule the maintenance work after due consultation with the concerned production departments.

(7) To carry out and facilitate periodic inspections of equipment and facilities to know their conditions related to their failure and stoppage of production.

(8) To prepare inventory list of spare parts and materials required for maintenance.

(9) To ensure cost effective maintenance.

(10) To forecast the maintenance expenditure and prepare a budget and to ensure that maintenance expenditure is as per planned budget.

(11) To recruit and train personnel to prepare the maintenance workforce for effective and efficient plant maintenance.

(12) To implement safety standards as required for the use of specific equipment or certain categories of equipment such as boilers, overhead cranes and chemical plants etc.

(13) To develop management information systems, to provide information to top management regarding the maintenance activities.

(14) To monitor the equipment condition at regular intervals.

(15) To ensure proper inventory control of spare parts and other materials required.

In terms of plants operations the functions of maintenance are:

(a) The plant must be available as and when required.

(b) The plant must not breakdown during actual operation state.

(c) The plant must operate in an efficient manner at required level of plant operation.

(d) The down time must not interfere with production runs.

(e) The down time due to breakdown should be a minimum.

To accomplish these conditions there must be complete cooperation and mutual understanding between maintenance and production departments. There must be an effective maintenance policy for planning, controlling and directing all maintenance activities.

The plant maintenance department must be well organized, adequately staffed sufficiently experienced and adequate in number to carry out corrective and timely maintenance with the efforts in minimizing breakdowns.

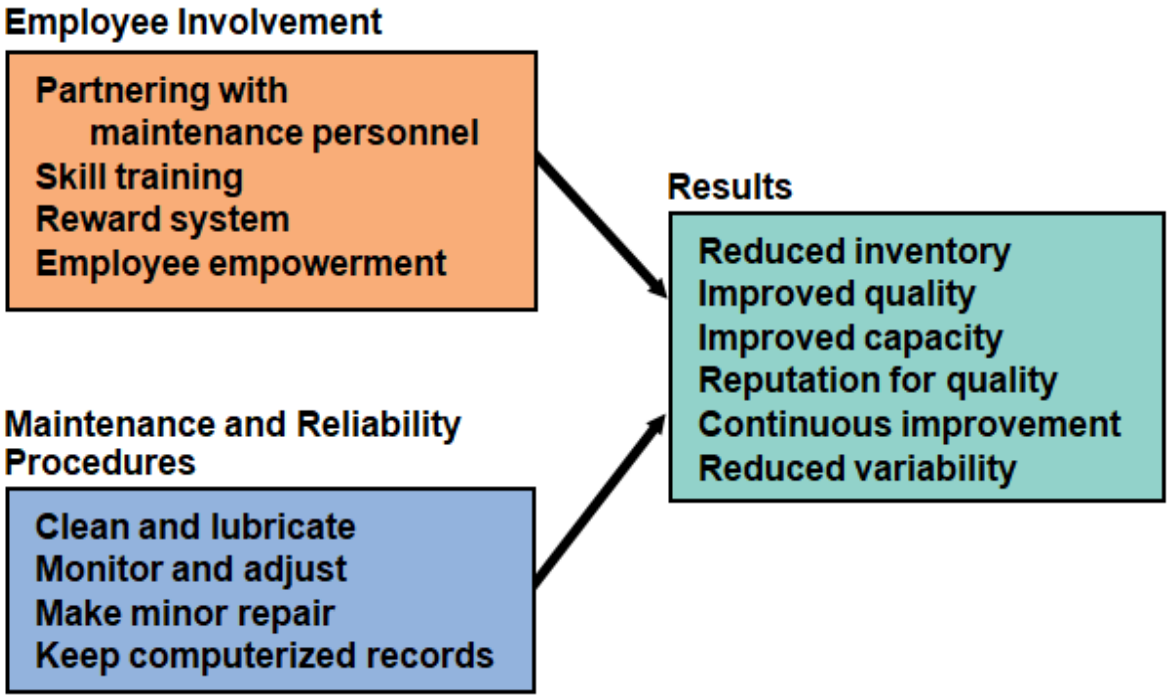


Figure 1: Maintenance management results

Information Sheet-2	Types of Maintenance /procedures

1.5. Types of Maintenance /procedures

The type of maintenance cannot be equated for each types of equipment which depends on the method, cost and critical level.

To make sure that all machineries are performing well, proper maintenance should be utilized. Machine maintenance, to most people, is usually considered to be work done just after any glitch is found in machineries or worse when there are already failures in machineries. Having legit maintenance programs can effectively help prevent machine failures through various steps of preventive measures. There are generally 4 different maintenance programs that can be used in machine maintenance. Each method of every maintenance program will greatly depend on the organizational structures and management philosophies of the company or organization that owns and operates the machineries, or perform machine repairs.

Generally, **four types of maintenance** philosophies can be identified, namely:

- Preventive Maintenance
- Predictive Maintenance
- Corrective Maintenance
- Breakdown Maintenance

1. **Preventive Maintenance:** It is a method for preventing damage to equipment by periodically replacing parts based on time of use and carrying out minor maintenance and inspections to find out the current state of the equipment or machinery. Example:-
    - Cleaning,
    - checking,
    - lubricating,

- bolt tightening
- Periodic inspection
- Periodic and small overhaul restorations (**overhaul**: - machinery or equipment repairs it if necessary).

Preventive Maintenance

Preventive maintenance is a type of maintenance program that involves routine inspections of machineries in certain days of the year or during certain operating hours. Through preventive maintenance, wear and tear on a certain machine will be easily identified since inspection follows a predetermined schedule. Any signs of degradation or minor damage of the machine should be scheduled for machine repair as soon as possible, to prevent worsening of the damage thus causing a total breakdown. Of all the 4 types of machine maintenance programs, preventive maintenance is the least-costly form, since failure of machines can be prevented. Expensive spare parts replacement and high hourly labor costs for machine repairmen can be prevented.

[**Based on scholars definition**]

2. **Predictive Maintenance: It** is a method for doing maintenance by replacing parts based on **predictions using a tool**. The point is if the **preventive** method is only **based on the schedule**, then the **predictive** method is based on the **results of the measurement**. This method can also use the **five senses**, for example in **bearing inspection** can be distinguished from the **sound produced**. Or **checking temperature**, by touching it we can feel the difference or abnormality of the equipment. Examples: **Tachometer**, to measure the rotation **Thermometer**, to measure the temperature of the **Ampere meter**, to measure amperage. **Tachometer** is an instrument which measures the working speed of an engine in revolutions per minute.

Predictive Maintenance
When talking about one of the most efficient machine maintenance program and not costly at the same time, then predictive maintenance may be it. Predictive maintenance makes use of repair methods only as the conditions warrant. For example, if risks of machine damage surfaces due to certain environmental conditions, such as high temperature, vibration, warning lights, etc., then the machine will be shut off before the machine is damaged. By following predictive maintenance, machines should be closely monitored to help prevent machine failure, thus needing machine repair and may end up spending more for the repair.

[**Based on scholars definition**]

3. **Corrective Maintenance:** It is a method intended to **improve the reliability of equipment/machines** by improvising. In addition to equipment, it is also intended for parts that have a short life cycle (reduce the frequency of damage) and speed up repair time. Example: The operator has difficulty checking the oil volume of the generator engine, so improvisation is done by making a measuring cup equipped with a scale.
4. **Breakdown Maintenance:** It is a method where inspection and replacement of parts are not carried out, so with this method we leave the equipment damaged and then we fix it or replace it Usually this method is applied to equipment / machines with consideration:
   - Equipment is only optional (additional) so that if it is damaged it does not interfere with production
   - The cost of repairing / replacing cheap parts
   - Insignificant damage
   - Easy and fast repair

DIFFERENCE BETWEEN PREVENTIVE AND CORRECTIVE MAINTANANCE

- While preventive maintenance is generally considered to be worthwhile, there are risks such as equipment failure or human error involved when performing preventive maintenance, just as in any maintenance operation.
- Preventive maintenance as scheduled overhaul or scheduled replacement provides two of the three proactive failure management policies available to the maintenance engineer.

Information Sheet-3	Diagnostic Technologies and measuring devices

3.1. Diagnostic Technologies and measuring devices

Causes of faults are detected using appropriate engineering principles, techniques, procedures, tools and equipment

Training for large machinery operator

Equipment/machines should be inspected as soon as it is purchased. Operator training is usually done at that point, but training needs to be kept up. Employees come and go, skills become rusty and poor operation leads to breakdowns.

The knowledge you learn about how to maintain your equipment can become quite valuable – be sure to best leverage this important knowledge and use it at every applicable location.

Add and test lubricants frequently

Lubricants reduce friction around any moving part. A schedule of good lubrication maintenance extends the life of large machinery equipment and parts.

Lubrication is one of the first and most important of maintenance checks.

- Look for signs of excess oil or grease build-up on pistons.
- Check for leaks around oil seals.
- Be sure to use the right lubricant.

There are specific kinds of oil and grease for every component.

Check the manufacturer's recommendations.

Getting the lubricants checked is a good way to diagnose problems with large machinery.

Check for signs of wear

Vibration, shock, high temperatures, friction and age all contribute to the breakdown of parts in heavy machinery.

- Vibration can come from gears and belts that are out of alignment
- Shock can come from accidents and from poor operator technique
- High temperatures can come from extended use, friction, poor lubrication and worn parts.
- Age affects many key components.

❖ Over time:-

❖ Belts will warp.

❖ Seals will dry and crack.

❖ Bolts will loosen and stretch out of shape. Age is a factor to monitor in equipment.

Should you discover wear and tear on any moving parts within your heavy equipment, be sure to quickly perform the necessary replacement of any worn parts.

Keep machinery clean, and maintain a clean environment

There are many seals and filters in place on heavy machinery to keep working parts clean and free of contamination.

- Seals should be inspected regularly to make sure they're in good condition.
- Filters should be inspected and changed regularly.
- The electronics in the cab are susceptible to breakdown if contaminated
- Large machinery should be stored in a shed or other building if at all possible.
- Exposure to wind and weather can lead to rust and rot. (decay)
- The machinery should be run periodically if it is not in use.

Have maintenance and repair schedule, and keep good records

Fluids, tires, tracks and electrical systems are among the components that have to be checked regularly for preventive maintenance. Know what needs to be inspected and when. Here are some examples.

- Power transmissions have many moving parts that need to be maintained in top condition. Gearboxes need to be checked for lubrication, vibration and damage to parts.
- Friction materials, seals, gaskets and bearings all need to be inspected for wear and replaced. Gears and shafts usually last a long time and don't need to be replaced often, if at all.
- Drive train components need constant monitoring. Check **pulleys and v-belts on CVT transmissions for alignment and wear**. Check **sprockets for correct meshing with chains** and for breaks. (**CVT**- **continuously variable transmission**)
- Test the oil to diagnose problems. Change filters frequently.
- Bearings keep great amounts of force running smoothly and are **vital to large machinery** performance. Check bearing lubrication often. Maintaining bearings well extends their life.
- Lubricate gears frequently.
- Do a seal check to prevent bearing raceway (shaft) contamination.
- Run torque checks on the bolts. Bolts can elongate and creep over time.

Information Sheet-4	Failure Modes and effect analysis (FMEA)

4.1. Failure Modes

Failure modes" means the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the customer, and can be potential or actual. "Effects analysis" refers to studying the consequences of those failures.

Some **types** of mechanical **failure** mechanisms are: excessive deflection, buckling, ductile fracture, brittle fracture, impact, creep, relaxation, thermal shock, wear, corrosion, stress corrosion cracking, and **various types** of fatigue.

Steps to identify failure

1. Step 1: Identify potential failures and effects. The first FMEA step is to analyze functional requirements and their effects to identify all failure modes.
2. Step 2: Determine severity. Severity is the seriousness of failure consequences of failure.
3. Step 3: Gauge likelihood of occurrence.
4. Step 4: Failure detection.

Causes of machine failures

Machines fail for a variety of reasons. The term "machinery **failure**" or "malfunction" usually implies that the **machine** has stopped functioning the way in which it was intended or designed. This is referred to as “loss of usefulness” of the **machine** or component.

Take a look at the following main causes of industrial machinery failure.

- Accidents. ...
- Inadequate maintenance. ...
- Corrosion. ...

- Misalignment. ...
- Bearing **failure**. ...
- Metal fatigue. ...
- For quality and efficient industrial component repair services, get in touch with YB Components.
- Poor Self-Esteem

✓ Poor self-esteem is a lack of self-respect and self-worth. People with low self-confidence are constantly trying to find themselves rather than creating the person they want to be. Don't label yourself. You might have **failed**, but you're not a **failure** until you stop trying.

Types of failure:

Failures can be divided into three types namely,

- Preventable failures.
- Unavoidable failures.
- Intelligent failures.

Causes of machinery breakdowns

The most common problems on machinery that can lead to breakdowns in the Manufacturing machinery or Equipment: and Information on how you can prevent these problems from happening in the first place is listed below.

Not reading the operator's manual.

Owner's manuals cover everything from maintenance checklists to calibration instructions.

Most issues are addressed in the troubleshooting section so operators can fix the problems themselves without having to wait for a technician.

Improper maintenance

Skipping daily maintenance is another mistake that can cause downtime. it is important to grease all lube points daily and check engine oil and fluids such as transmission fluid.

Operators or maintenance worker also should regularly replace fuel filters and check chains, gearboxes and belts for wear and replace when wear is excessive.

Poor electrical connections

This problem is hard to prevent and is becoming more usual as more machinery is electronically controlled, however, cleaning away dust and dirt around the connectors can help. When cleaning, use compressed air instead of water to keep moisture away from the wires.

Overrunning machines

Constantly pushing machines to run at maximum performance or at the top of the engineering curve can strain joints and cause equipment to die prematurely. Push the machines too hard for too long and try and force them to do things they weren't designed for is not required, operators run machines just under the intended maximum performance level at most times to avoid too much stress and prevent premature wear.

Not replacing worn parts

When a part on a machine breaks, some customers will replace only that part and not check or replace other parts that may have caused the initial failure. Examples include replacing a drive chain when the sprocket was shot or replacing a belt when the pulley was bad.

Replacing only the parts that are broken is a temporary fix that can cost money in downtime. When owners don't replace all the things we recommend need replacing, will come back with bigger problems.

Misaligned tightening

Tightening with the belt or chain in relation to the main drives can put tension on the belt or chain, causing it to break or wear excessively. It's important to replace worn bushings in the tightened pivot that may be pushing the belt or chain sideways.

Make sure that belts are running straight and those chains and belts are at the proper tension so that they don't slip or breaks also make sure that the shafts are running at the right speed."

Ignoring warning signals

Warning lights on screens are there for a reason, often signaling issues that need to be addressed, such as low hydraulic pressure, high engine temperature or a shaft that isn't turning. However, too often those signals are ignored, resulting in machinery failure.

Untrained operators

Manufacturing campaniles have to hire outside help that may not be trained to operate machinery. Lack of training can result in abused machinery and costly breakdowns. Time invested in training can make your machinery last longer.

Advantages of proper equipment maintenance

- Increases equipment up-time
- Enhances efficiency when running
- Reduces overall costs
- Improves the lifespan of the equipment

MECHANICS

LEVEL-III

Learning Guide-#59

Unit of Competence: Maintain and Repair Engineering Components

Module Title: Maintain and Repair Engineering Components

Module Code: XXX

LG Code: XXXXX

TTLM Code: XXXXX

LO2*:* Assess System maintenance requirements

Instruction Sheet-2	Learning Guide #59

This learning guide is developed to provide trainees the necessary information regarding the following **content coverage** and topics:

- Maintenance plan and schedule (MPS)
- Belt drives and chains
- Plain Bearing and rollers bearing
- Electrical system
- Repairing the mechanical parts.

This guide will also assist trainees to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, trainees will be able to**:

- Prepare the maintenance plan and schedule for weekly basis
- Collect data for PM for electrical, mechanical, break down maintenance, predictive and other planned maintenance activity
- Make service the belt and chain drives
- Maintain the bearings
- Repair the mechanical parts for wear, crack and so on..

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 3 to 6
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4”.

Information Sheet-1	Maintenance plan and schedule (MPS)

4.2. Maintenance plan and schedule (MPS)

Maintenance scheduling refers to the timing of **planned** work, when the work should be done and who should perform it. It offers details of "when" and "who." **Scheduling** is meant to: **Schedule** the maximum amount of work with the available resources. **Schedule** according to the highest priority work orders.

Plant/machine/ assemblies is/are serviced according to Maintenance Plan and Schedule

In the maintenance world, planning and scheduling are two different functions that work together to create a maintenance program. Planning is the process of planning, while scheduling is the process of reconfiguring workloads in a production/manufacturing process.

Planning decides what, how and time estimate for a job. **Scheduling decides** when and who will do the job. Planning of a job should be done before Scheduling a job.

Planning is the process by which the elements required to perform a task are determined in advance of the job start.

It comprises all the functions related to the preparation of:

1. The work order
2. Bill of material
3. Purchase requisition
4. Necessary drawings
5. Labor planning sheet including standard times
6. All data needed prior to scheduling and releasing the work order.

Planning Procedures

- Determine the job content.
- Develop work plan. This entails the sequence of the activities in the job and establishing the best methods and procedures to accomplish the job.

- Establish crew size for the job.
- Plan and order parts and material.
- Check if special tools and equipment are needed and obtain them.
- Assign workers with appropriate skills
- Review safety procedures.
- Set priorities for all maintenance work.
- Assign cost accounts.
- Complete the work order.
- Review the backlog and develop plans for controlling it.
- Predict the maintenance load using effective forecasting technique.

Scheduling

Is the process by which jobs are matched with resources and sequenced to be executed at a certain points in time? Scheduling deals with the specific time and phasing of planned jobs together with the orders to perform the work, monitoring the work, controlling it, and reporting on job progress.

Successful planning needs a feedback from scheduling.

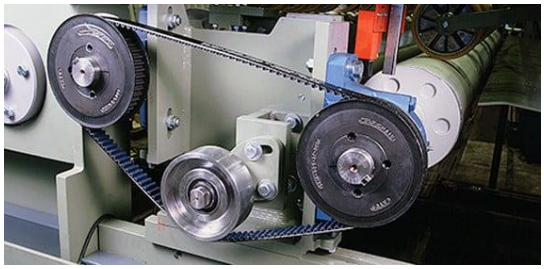
Effective planning and scheduling contribute significantly to the following:

- Reduced maintenance cost.
- Improved utilization of the maintenance workforce by reducing delays and interruptions.
- Improved quality of maintenance work by adopting the best methods and procedures and assigning the most qualified workers for the job.
- Minimizing the idle time of maintenance workers.
- Maximizing the efficient use of work time, material, and equipment.
- Maintaining the operating equipment at a responsive level to the need of production in terms of delivery schedule and quality.

4.3. Inspection of Belt drives and chains

Belts and drives are inspected and replaced according to MPS. A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel.

Belts are the cheapest utility for power transmission between shafts that may not be axially aligned. Power transmission is achieved by specially designed belts and pulleys. Power transmitted between a belt and a pulley is expressed as the product of difference of tension and belt velocity:




Types of belt drives

Flat belts

Flat belts are the purest form of friction drive while V-belts have a friction multiplying effect because of wedging action on the pulley.

Positive drive

Positive drive or synchronous belts rely on the engagement of teeth on the belt with grooves on the pulley. There is no slip with this belt except for ratcheting or tooth jumping.

Round belts

Round belts are generally made of rubber. This type of belt is generally used for light loads, such as in a sewing machine or a vacuum cleaner.

V belts

V belts are arguably the most widely used belts in industry. V belts have a V shaped cross-section, which rests against the side of V pulley under tension. The V shaped cross-section prevents belt from slipping off.

In the above figure types of belt Flat, belts Positive belts, Round belts, and **V belts** respectively

Proper Belt Drive Maintenance

Preventive maintenance provides increased life of belt and drive components.

Belt drives are a cost-effective, reliable means of transmitting power between shafts. That is why they are found all over, pump jacks, compressors, injection pumps, accumulator units.

A misaligned or improperly tensioned drive invites downtime.

Begin thinking PM—preventive maintenance. The benefits will be:

- Longer service life
- Trouble-free operation
- Improved uptime and productivity
- Energy conservation
- More efficient power transmission
- Longer component life

Basic PM Programs include:

- A safe working environment
- Regular drive inspections
- Proper drive installation
- Proper belt storage and handling

Safety First

When working around and with belts and drives, begin with a safe working environment. Wear proper clothing (not loose-fitting), eye and hearing protection, safety shoes and gloves. Keep the area clean and uncluttered for easy access. Be careful to keep hands and fingers out of pinch points as the belt enters the sheave, and keep drives properly guarded from weather, debris and damage.

Regular Inspections

As part of the normal routine, look, listen, feel and smell. Look for a loose, damaged or dirty guard. Listen for unusual noise and use your nose to detect any unusual smells, like burned rubber. Feel the drive to make sure the motor and drive mountings are tight.
Occasionally (every three to six months) schedule a complete shutdown and systematic inspection. The frequency depends on several factors:

- Drive operating cycle
- Drive operating speeds
- Environmental factors
- Temperature extremes
- Drive history

Belt Inspection

How do you inspect a belt, and for what should you be looking? First, remove the belt drive guard and mark a point on the belt. Work around the belt and look for cracks, frayed spots, cuts, missing teeth (if it's a synchronous belt) or unusual wear.
Check the belt for signs of exposure to excessive heat. High heat is a belt killer. Rubber belts will harden, develop cracks and "chunk out" in pieces. The upper ambient

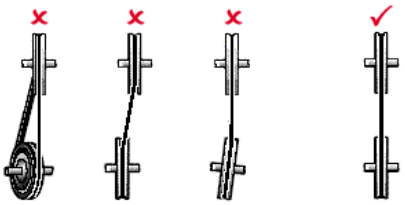
temperature limit for a V-belt is 160 degrees F). Synchronous belts have an upper limit of 185 degrees F

Belt Alignment

Misalignment between the belt and sheaves (or sprockets) can wear out belts quickly. Misalignment can be angular or parallel. You can use one of several methods to check alignment:

- Straight edge
- String
- Laser alignment tool

Ensure that the misalignment is not caused by sheaves or sprockets that are tilted on the shaft due to incorrect installation of the bushings.



Belt Tension

Over- or under-tensioned belts can also cause premature wear and early failure.

Under-tensioned V-belts slip against the sheave sidewalls and overheat. The teeth of synchronous belts jump or skip over the sprocket teeth, or they experience “hook” wear.

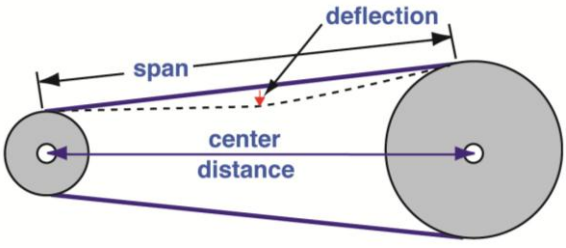
Over-tensioned belts can damage the bearings as well as the belt itself.

There are three common methods of measuring belt tension:

- Force/deflection method
- Span vibration method
- belt tension measuring device

The force/deflection method relies on measuring deflection force with a pencil gauge or spring scale. The span vibration method uses a sonic tension meter. Both techniques should only be performed while the belt is at rest or when the drive is off.

The TRUMMETER is an electronic **measuring** instrument that consists of a **measuring** probe and a microprocessor and is used for **measuring** the **belt tension** and checking the strand force of a **belt** drive. The **measurement** result is displayed either in hertz, Newton's or pound force.



How to Install V Belts Installation of V-Belts

1. Checking Pulleys: Before installation, check the pulleys for wear and other foreign material. Worn out pulleys must be replaced to ensure good contact between the pulley and the belt. Worn out pulleys, if not replaced may lead to the following problems.

Worn-out pulley reduces the belt life It may result into the slippage of belt It reduces the power transmission of the drive May lead to vibrations, especially when the sides of the pulleys are broken

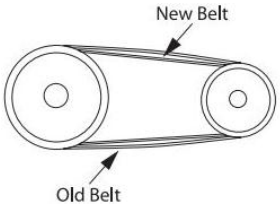
Always check the following before installation

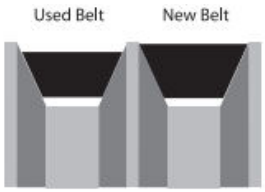
Check the pulley groove with pulley gauge. If the new pulley is to be installed, always check the surface finish of the groove. A rough surface of the groove rapidly wears the belt surface, reducing the life.

2. Checking pulley groove, key and shaft: Whenever the worn-out belts are to be replaced, check the pulley fit with the shaft. If there is any play between the shaft and the pulley, check for the wear of the pulley groove, key and shaft. Improper fit leads to jerks during start of the drive and further wearing leads to the breakdown of the drive.

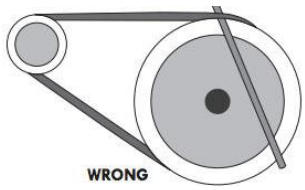
3. Do not mix old and new belts: Never use a set of belts having new as well as used belts. This may lead to the following problems - Non uniform tensioning Reduction in power transmission of the drive

Reduction in the working life of the new belts Slippage of used belts, always use a set with all new belts and same brand.





4. Installing belts: Never use a lever to install the belt; it may lead to breakage of tensile cords of the belt. Use of a lever invariably develops permanent twisting of belts leading to turning of belts in the pulley groove while running. The best way to install the V-Belts is to reduce the centre distance of the pulleys so much that the belts can be installed loosely. For this installation take-up allowances must be provided to the drive. There should be a provision for adjusting the centre distance so that it can be varied sufficiently for easy installation.



5. Checking Alignment: Proper alignment of the installed belts should be done for the smooth running of the belts. Furthermore a good alignment gives longer life of the belt and pulley.

6. Re-tensioning: Check the belt tension during the first two days of operation. Re-tension if the tension of the belt reduces.

7. Drive Guard: Guard the drive properly after installation.

Runners, rollers and transport systems of plant are serviced and/or replaced according to MPS

Material handling involves short-distance movement within the confines of a building or between a building and a transportation vehicle.

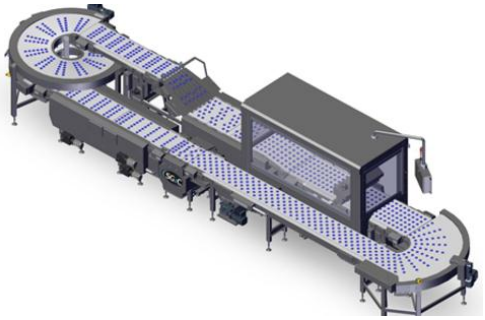
It uses a wide range of manual, semi-automated, and automated equipment and includes consideration of the protection, storage, and control of materials throughout their manufacturing, warehousing, distribution, and disposal.

Material handling can be used to create time and place utility through the handling, storage, and control of material, as distinct from manufacturing, which creates form utility by changing the shape, form, and makeup of material

Conveyor Systems are mechanical devices or assemblies that transport material with minimal effort

Roller Conveyors

Roller Conveyor is a type of Conveyors with a series of rollers supported in a frame over which objects are advanced manually, by gravity, or by power. A roller conveyor is a conveyor that consists of a series of parallel rotating bars that move goods along to their end destination. Roller conveyors are used in environments like warehouses and manufacturing facilities. These conveyors are containing sprocket at one terminal and a bearing housing at other



Care and maintenance of conveyor systems

A conveyor system is often the lifeline to a company's ability to effectively move its product in a timely fashion. The steps that a company can take to ensure that it performs at peak capacity, include regular inspections and system audits, close monitoring of motors and reducers, keeping key parts in stock, and proper training of personnel.

Increasing the service life of a conveyor system involves: choosing the right conveyor type, the right system design and paying attention to regular maintenance practices.

Information Sheet-3	Plain Bearing and rollers bearing

4.4. Plain Bearing and rollers bearing

Maintenance Instructions for bearings

1. Keep your bearings dirt-free, moisture free, and lubricated.
2. Clean your bearings when they become dirty or noisy with the most environmentally friendly cleaner you can find that is suitable for dissolving oil, grease, and removing dirt from the steel, plastic and rubber surfaces.
3. If you use a solvent cleaner, please wear appropriate rubber gloves and work in a safe well ventilated area. When you are finished, please remember to dispose of your solvent in a safe, ecologically sound manner.
4. Do not add oil to dirty bearings. It will not clean the bearing, but merely flush the existing dirt further into the bearing.

i. Bearing repair

Small areas of damage on bearing races, and on the contact surface of the rolling elements, can sometimes be repaired by grinding out the loose metal. Any raised or rough areas should be smoothed flat with grinding and polishing tools. Light rust or corrosion should be removed with emery paper (240 – 320 # grit) as much of the damage should be removed as possible to prevent it from contaminating the bearing when it is returned to service.

ii. Damaged bearings

Despite taking proper precautions, bearings may become damaged either through improper storage and handling or through normal wear in use. Bearings that have been damaged or are no longer within specifications may still be returned to service after repair. Some bearings can be refurbished more than once. If a bearing is damaged or worn beyond repair sooner than expected, do not discard it. The nature of the damage

can provide valuable clues that can help analyze and identify possible causes, leading to corrective actions that will help ensure longer bearing life in the replacement bearing.

2.7. Safety Precautions for the Maintenance of Mechanical Drives

Maintaining drives, like (chain drive, belt drive, gear drive etc.), under disregard of safety rules is a dangerous procedure.

Comply with the following to avoid serious personal injury:

- Use always care to prevent injury

- Wear the personal protective equipment like protective clothing, safety goggles, safety shoes and when necessary safety gloves.
- Guards must be provided to cover the moving parts of mechanical drives
- Before starting to work on a mechanical drive, STOP the machine and LOCK-OUT the power. Let your fellow workers know that you are – or will be – working on it.
- Never strain yourself by lifting or shifting mechanical parts that are too heavy. Use proper lifting devices for handling heavy parts.
- Before starting a test-run clean up the workplace and remove all tools, containers, etc.
- Clean up all grease, solvent and lubricant spills. Wipe the area including the mechanical drive with couplings and the protection cover dry and clean.
- Before you start up the drive, make sure that all fasteners are tight and all guards are in place. Inform all the workers near the mechanical drive that you start the test-run.
- Stay at the beginning of the test-run near the power switch. In case of any unusual sound or vibration, switch off the drive immediately.

Information Sheet-4	Electrical maintenance

4.5. Maintenance of Electrical system

. **Electrical/Electronic systems are tested according to specification. Electrical safety testing** is essential to ensure safe operating standards for any product that uses electricity

Electrical maintenance covers all aspects of testing, monitoring, fixing, and replacing elements of an electrical system. Usually performed by a licensed professional with a complete knowledge of the National Electric Code and local regulations, electrical maintenance covers areas as diverse as:

- Digital communication
- Electrical machines
- Generators
- Hydraulics
- Lighting systems
- Pneumatics
- Surge protection
- Transformers.

With an increased reliance on both data collection and machinery run by computer software, electrical maintenance is more vital than ever. The failure of a single component in the electrical system can cause extensive downtime or data loss.

Preventative Electrical Maintenance

Early identification of problems is a key aspect of electrical maintenance. For instance, should a back-up generator sit idle until needed, it may not start due to a number of factors. Uncharged starting batteries, or start switches left in the wrong mode can all prevent a smooth transition to backup power. These are basic problems, easily identified and addressed through preventative maintenance.

One of the major challenges to electrical maintenance is the nature of electrical wiring. It can be difficult to pinpoint the location of specific problems as the system is built into the

building. Thermal imaging has become increasingly important in the industry for its ability to identify issues with both electrical connection points and equipment operation. By catching such problems early, electrical maintenance helps reduce unexpected power outages and protects equipment from damage.

MECHANICS

LEVEL-III

Learning Guide-#60

Unit of Competence: Maintain and Repair Engineering Components

Module Title: Maintain and Repair Engineering Components

Module Code: XXX

LG Code: XXXXX

TTLM Code: XXXXX

LO3*:* Carry Out Machine maintenance

Instruction Sheet-3	Learning Guide #60

This learning guide is developed to provide trainees the necessary information regarding the following **content coverage** and topics:

- Maintenance repair and operations
- Maintenance of machineries
- Repairing and manufacture spare parts

This guide will also assist trainees to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, trainees will be able to**:

- Repair large installations
- Repair the components
- Manufacture spare parts

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 1to 3
3. Read the information written in the information “Sheet 1 and Sheet 2”.

Information Sheet-1	Maintenance repair and operations

Maintenance repair and operations (MRO)

MRO (maintenance, repair, and operating supply) items are supplies utilized in the production **process** that is not ultimately seen in the end products themselves. Anything used in the manufacturing of, but not employed in, a final product may be considered **MRO**.

MRO items may include:

- Gloves
- Safety equipment
- Computers
- Maintenance processes
- Batteries
- Computer systems
- Sealants
- Office supplies
- Repair tools
- Industrial equipment (valves, compressors, pumps)
- Consumables (cleaning, laboratory, and office supplies)
- Plant upkeep supplies (lubricants, gaskets, repair tools)

The Main Types of Industrial MRO Maintenance

Below are the three main types of maintenance that fall under the MRO umbrella.

1. **Preventive Maintenance.** This type of maintenance is done regularly before issues arise in order to keep equipment and processes running smoothly.

2. **Corrective Maintenance.** This refers to maintenance completed after a problem has occurred, whether dealing with general wear and tear or a complete breakdown.
3. **Predictive Maintenance.** Predictive maintenance is done based on the data obtained from monitoring processes that track historical trends, allowing for reliable failure predictions.

MRO Materials Management

MRO supplies and equipment are typically purchased on a regular basis, so it's important to have an organized system in place to manage and track these supplies. For instance, keeping an on-site inventory of the most commonly used items can reduce downtime, extra expenditures, and the general stress of restocking.

Streamlining MRO management offers many benefits, but MRO, in general, is often overlooked in facility management and organization. Making use of computer systems and **MRO software** to track, manage, and control inventory streamlines processes and ensures key MRO items are on hand as soon as they're needed. Creating a dedicated space for this inventory and tracking maintenance repair and operating supplies simplifies the process and improves organization.

Employing supply chain personnel who are well-versed in supplier relations and have established relationships with MRO partners can also help drive down costs while ensuring the most efficient operations possible.

For some companies, third-party MRO management may be a better option. Vendor-managed inventory (VMI), for instance, which involves the supplier being on site to manage MRO inventory, can provide peace of mind while allowing for volume discounts.

Establishing a set of performance indicators (KPIs) can be very helpful in tracking and monitoring costs, savings, and overall trends. Companies armed with this knowledge

have an upper hand, as they're able to make changes in real-time to MRO inventory and strategies.

The Importance of Developing a Full Understanding of MRO

Although the exact MRO definition may vary from company to company, it's crucial for businesses of all types to develop a full understanding of what their specific MRO needs entail, and how to best monitor and manage MRO inventory, suppliers, costs, and services.

Information Sheet-2	Maintenance of machineries

Maintenance of machineries

Machinery maintenance is the means by which mechanical assets in a facility are kept in working order. Machinery maintenance involves *regular servicing of equipment, routine checks, repair work, and replacement of worn or nonfunctional parts*.

Equipment Maintenance Schedule is essential that practices have a **schedule** for the **maintenance** and monitoring of all their key clinical **equipment**. **Equipment** that requires calibration, or that is electric or battery powered, needs to be serviced regularly to ensure it is, and continues to be, in good working order.

MECHANICS

LEVEL-III

Learning Guide-#61

Unit of Competence: Maintain and Repair Engineering Components

Module Title: Maintain and Repair Engineering Components

Module Code: XXX

LG Code: XXXXX

TTLM Code: XXXXX

LO4*:* Analyze Machine Performance

Instruction Sheet-1	Learning Guide #61

This learning guide is developed to provide trainees the necessary information regarding the following **content coverage** and topics:

- Performance Measurement system
- Maintenance quality control
- Spare parts inventory **Management**

This guide will also assist trainees to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, trainees will be able to**:

- set the performance indicators
- develop problem solving skills
- measure the performance to take action

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 1 to 3
3. Read the information written in the information “Sheet 1, Sheet 2, and Sheet 3”.

Information Sheet-1	Performance Measurement system

Performance Measurement system

Some of the measures of maintenance performances are availability, mean time between failures (MTTF), failure/breakdown frequency, mean time to repair (MTTR) and production rate index.

Maintenance productivity indicators measures the usage of resources, like; labor, materials, contractors, tools and equipment.

Maintenance performance:

Maintenance KPI is measure how well your operation is doing at achieving its **maintenance** goals, like reducing downtime or cutting costs. Although every facility will have different targets, some of the most common **maintenance** KPIs revolve around a few key elements, including: **Efficiency**.

A **maintenance KPI** is a measurement of performance that helps you focus on **maintenance** objectives you want to reach. It is a quantifiable value that shows how effectively an organization is progressing towards achieving its key **maintenance** objectives over time.

Measuring maintenance performance

The maintenance performance measuring metrics are**:**

1. Planned maintenance percentage (PPC): this metrics represents the percentage of time spent on planned maintenance activities against the unplanned.
2. Overall Equipment Effectiveness (OEE)
3. Mean time to repair (MTTR)
4. Mean time between failure (MTBF)
5. Preventive maintenance compliance (PMC)

Information Sheet-2	Maintenance quality control

Maintenance quality control

The development of a sound quality control system for maintenance is essential for ensuring high quality repair, accurate standards, maximum availability, and efficient equipment production rates.

Quality Maintenance is the sixth pillar of TPM and aims to assure zero defect conditions. It does this by understanding and controlling the process interactions between manpower, material, machines and methods that could enable defects to occur.

Quality control in **maintenance** is responsible for ensuring the **quality** objectives for resources, procedures, and standards used in the **maintenance** process are met. In addition, it performs **inspection** of **maintenance** jobs and tests of equipment prior to acceptance or operation.

A quality control **checklist** is basically a written guide for your products' contents, packaging, color, barcodes, appearance, possible defects, functions and special requirements. It's also sometimes called an “inspection criteria sheet” or inspection **checklist**.

Information Sheet-3	Spare parts inventory Management

Spare parts inventory Management

Service parts management is the main component of a complete strategic service management process that companies use to ensure that right spare part and resources are at the right place (where the broken part is) at the right time (Learn how and when to remove this template message).

Generally, inventory types can be grouped into four classifications: raw material, work-in-process, finished goods, and MRO goods.

Here are seven spare parts inventory management best practices for managing parts inventory more effectively:

1. Systematically identify all parts.
2. Utilize and Manage the Bill of Materials (BOM)
3. Streamline the work order process.
4. Adopt security measures.
5. Centralize and consolidate parts.
6. Utilize an Inventory control system.

Five Critical Steps in Spare parts inventory management:

Spare parts inventory management shares many traits with standard inventory management, but requires an extra layer of cost consideration.

Whether a maintenance and repair organization (MRO) is internal to a larger business, or providing maintenance services to an external customer, efficient spare parts inventory management plays a critical role in reducing costs and maximizing customer service.

For this example, we will look at an internal MRO to a production facility. These five steps collect the information you need for executing effective spare parts inventory management.

Step #1: Understanding existing (or projected) consumption

Because repairs happen due to system failures, rather than as part of a production plan, many logistics professionals overlook consumption predictions.

Depending on the age of the MRO, spare parts consumption can be based on either actual historic consumption, or projected based on equipment manufacturer preventative maintenance recommendations and fleet records of other system owners.

Step #2: Calculating system failure costs

In-stock levels and the size of your on-site inventory should be directly linked to costs of system failure or “down time”. Every machine in a production facility plays a role.

Some have redundancy, like the multiple fork lifts in a warehouse, while others act as a single point of failure for the whole building, such as an automated full-building outbound sorter.

Step #3: Estimate soft cost impact of out-of-stocks

It is a picture familiar to many industry professionals: parts hoarded in toolboxes, a spare motor under a desk in the maintenance supervisor’s office, or the "secret stash" closet with thousands of dollars worth of parts.

Reducing inventory dollars on the books as part of spare parts inventory management can lead to an off-books rise in inventory costs. You are guaranteed these behaviors will start when your out-of-stock rate in your frequently requested spare parts inventory reaches 4-5%.

Step #4: Work with vendors for cost-reduction and in-stock improvement

In many instances, leveraging vendor relationships will allow you to reduce your overall inventory dollars and keep better in-stocks.

Rather than using your own time and resources to monitor spare parts usage, establish reorder points, and project parts required for preventative maintenance, the manufacturer can often provide you a starting point for your stocking levels.

In the best cases, you can find vendors willing to provide spare parts inventory management on a consignment bases: you pay only for parts consumed.

Step #5: Calculate costs (hard and soft) of expedited orders

It is sometimes impossible to maintain a spare parts inventory for every contingency. The key is to establish an expedited spare parts ordering process and understand the costs involved. This allows subordinate managers and maintenance person to make good decisions on what to expedite and what to order on standard orders.

These five steps are just the beginning to achieving optimum spare parts inventory management. From these basics, you can measure, evaluate and further stream line your spare parts inventory control processes.

Cost reduction, increased system availability, and improved moral because workers have the tools they need to do their jobs are just some of the benefits you can experience.

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