Machining Level-II

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Acronyms

- C.A = Corrective Action
- C.M = Corrective Maintenance
- P.M = Preventive maintenance

Introduction of the Module

Equipment maintenance is any process used to keep a business's equipment in reliable working order. It may include routine upkeep as well as corrective repair work. Equipment may include mechanical assets, tools, heavy off-road vehicles, and computer systems. It is very important to have proper equipment maintenance to increases equipment up-time, enhances efficiency when running, reduces overall costs, improves the lifespan of the equipment and maintains the value of the equipment

This Module deals with the knowledge, skills and attitudes required in carrying out compulsory and routine safety and maintenance checks on machines and equipment, measuring instruments and tools in a manufacturing setting. It is designed to meet the industry requirement under the machining occupational standard, particularly for the unit of competency **Maintaining Tools and Equipment**

Module units

- Program Safety and maintenance
- Basic program maintenance
- Basic preventive maintenance of tools
- Inventory tools and equipment.

Learning objectives of the Module Or LEARNING OUTCOMES

At the end of the module the trainee will be able to:

- Undertake program safety and maintenance
- Undertake basic program maintenance
- Perform basic preventive maintenance of tools
- Perform Inventory tools and equipment

Module Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below.
- Read the information written in the information Sheets
- Accomplish the Self-checks
- Perform Operation Sheets
- Do the “LAP test”

Unit one: Program Safety and maintenance

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

- Tools and machines/equipment
- Operational procedures
- Calibrate measuring instruments
- Non-functional tools, instruments and equipment.
- Status/report on pro-forma or report orally

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Inspect and/or check tools and machines/equipment.
- Undertake checks safely and prescribes operational procedures.
- Calibrate measuring instruments
- Label Non-functional tools, instruments and equipment.
- Record Status/report on pro-forma or reporting orally.

1: Program Safety and Maintenance

1.1. Introduction

Maintenance is a set of organised activities that are carried out in order to keep an item in its best operational condition with minimum cost acquired (British Standard Glossary of terms3811:1993).

1.1.1. Terms of maintenance

Many terms and definitions are used in maintenance engineering work. The section presents some of the frequently used terms and definitions in these areas taken from various sources:

Maintainability: The probability that a failed item will be restored to its satisfactory operational state

Maintenance: All actions necessary for retaining an item or equipment in, or restoring it to, a specified condition

Reliability: The probability that an item will perform its assigned mission satisfactorily for the stated time period when used according to the specified conditions.

Availability: The probability that an item is available for use when required

Mission time: The time during which the item is carrying out its assigned mission

Downtime: The total time during which the item is not in satisfactory operating state

Logistic time: The portion of downtime occupied by the wait for a required part or tool

Failure: The inability of an item to operate within the defined guidelines

Serviceability: The degree of ease or difficulty with which an item can be restored to its working condition

Redundancy: The existence of more than one means for accomplishing a stated function

Failure mode: The abnormality of an item's performance that causes the item to be considered to have failed

Useful life: The length of time a product operates within a tolerable level of failure rate.

Maintenance concept: A statement of the overall concept of the product specification or policy that controls the type of maintenance action to be taken for the product under consideration.

Corrective maintenance: The repair or unscheduled maintenance to return items or equipment to a specified state, performed because maintenance personnel or others perceived deficiencies or failures

Continuous task: A task that involves some kind of tracking activity (e.g., monitoring a changing situation)

Active repair time: The period of downtime when repair personnel are active to affect a repair

Inspection: The qualitative observation of an item's condition or performance

Overhaul: A comprehensive inspection and restoration of a piece of equipment or an item to an acceptable level at a durability time or usage limit

1.1.2. Types of maintenance

British Standard 3811 classified maintenance as the followings

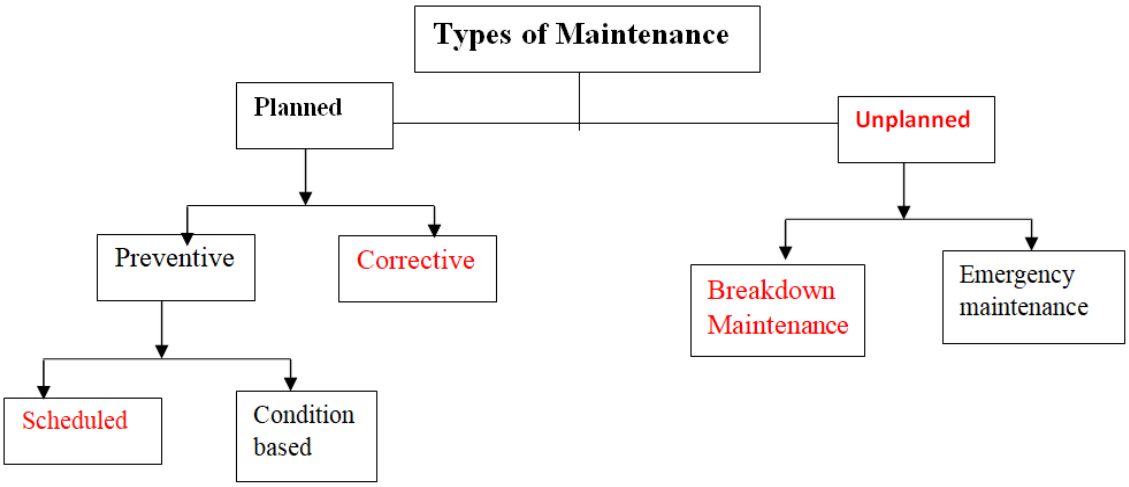


Figure 1:1 Types of maintenance

1) **Unplanned Maintenance**: "The maintenance carried out to no predetermined plan." These are also two types :

a) **Emergency maintenance***:* it is carried out as fast as possible in order to bring a failed machine or facility to a safe and operationally efficient condition. "The maintenance which it is necessary to put in hand immediately to avoid serious consequences"

b) **Breakdown maintenance:** it is performed after the occurrence of an advanced considered failure for which advanced provision has been made in the form of repair method, spares, materials, labour and equipment. Repair is undertaken only after failure of system. Equipment is allowed to run till it fails. Lubricating and minor adjustments are done during the period. Small factories where equipment is very small and doesn't use special tools Isn't suitable for big industries

2) **Planned Maintenance**: "The maintenance organized and carried out with forethought, control and the use of records to a predetermined plan." These are also two types :

a) **Preventive Maintenance (PM)** Condition-based **(Predictive)** Maintenance: "The preventive maintenance initiated as a result of knowledge of the condition of an item from routine or

continuous monitoring." In predictive maintenance, machinery conditions are periodically monitored and this enables the maintenance team to take timely actions, such as machine adjustment, repair or overhaul.

i. **Scheduled Maintenance:** "The preventive maintenance carried out to a predetermined interval of time, number of operations, etc.

ii. **Condition Based Maintenance:**

b) **Corrective Maintenance (CM)** Corrective Maintenance: "The maintenance carried out after a failure has occurred and intended to restore an item to a state in which it can perform its required function."In this type, actions such as repair, replacement, or restore will be carried out after the occurrence of a failure in order to eliminate the source of this failure or reduce the frequency of its occurrence.

1.1.3. Purpose and objective of maintenance

The main purpose of maintenance in all industrial perspective is to reduce the business risks. In general, operation and maintenance is synonymous with high level of availability, reliability and assets operability linking directly with production capacity, productivity and business profit.

- **The main objectives of maintenance are:**
  - ✓ Improve and ensure maximum utilization of maintenance facilities
  - ✓ To obtain plants and equipments at its maximum operating efficiency, reducing downtimes and ensuring operational safety.
  - ✓ To safeguard instruments by minimizing rate of deterioration and achieving this at optimum cost through budgeting and controls.
  - ✓ To help management in taking decisions on replacements or new investments and actively participate in specification preparation, equipment selection, its correction commissioning etc.
  - ✓ Help in implementation of suitable procedures for procurement, storage and consumption of spares, tools and consumables etc.
  - ✓ Standardization of spares and consumables, in conformity with plant, national and international standards and help in adoption of this standard by all users in the plant.
  - ✓ Running of centralized sciences like steam generation and distribution, water supply, air supply and fuel supply etc.
  - ✓ Running of captive workshops for repairs and conditioning and also for making some new spares.

- ✓ Reduce the amount and frequency of maintenance
- ✓ Improve maintenance operation

- **Advantage of preventive maintenance**

  List of different maintenance work is already given in which preventive maintenance is an important function with which, an efficient plant maintenance programmed, good per work system, work planning and scheduling, training, work measurement, control report and good shop tools, may be achieved.

  There are so many advantages followed by adoption of well preventive maintenance programmed.

  - ✓ Avoid major break downs
  - ✓ Increased production
  - ✓ Less down time of plant
  - ✓ Increase life of plant
  - ✓ Fewer number of spares maintaining
  - ✓ Better man power control
  - ✓ Less overhaul maintenance cost
  - ✓ Prevention of accidents-grater safety
  - ✓ Less damage of machine

1.2. Tools and machines/equipment inspection.

According to the classic view, the role of maintenance is to find broken items. Taking such a narrow perspective, maintenance activities will be confined to the reactive tasks of repair actions or item replacement triggered by failures. Thus, this approach is known as reactive maintenance, breakdown maintenance, or corrective maintenance.

Therefore maintenance is a set of organized activities that are carried out in order to keep an item in its best operational condition with minimum cost acquired (British Standard Glossary of terms3811:1993)

All actions necessary for retaining an item, or restoring to it, a serviceable condition, include servicing, repair, modification, overhaul, inspection and condition verification.

a) Tools used to be inspect are:
   - ✓ Increase availability of a system
   - ✓ Keep system's equipment in working order
   - ✓ Cutting tools - hacksaw, crosscut saw, rip saw

- ✓ Boring tools - auger, brace, gimlet, hand drill
- ✓ Holding tools - vice grip, C-clamp, bench vice
- ✓ Threading tools - die and stock, taps
- ✓ Measuring instruments-
- ✓ Hand tools-allen key hammer plaires

b) Machine to be inspected are

- ✓ Manual operating machine ,
- ✓ semi-automatic and
- ✓ automatic machines

1.3. Prescribed operational procedures

1) Occupational health and safety (OHS).

Safety in maintenance is basically the freedom from danger or risk from harm during the process of carrying out maintenance procedures. Ensuring safety during the process of conducting maintenance works is important as it also contributes to the prevention of costs such as; worker's compensation, health insurance claims, regulatory fines, lawsuits and so many more.

These includes:-

- **Personal safety**
  - ✓ Always wear appropriate closes
  - ✓ Stop machine before making maintenance activity
  - ✓ Do not attempt to dismantle the machine unless you switch off the electric power
  - ✓ Remove your watch, rings etc before performing maintenance activity.
- **Machine safety**
  - ✓ Never attempt to dismantle the machine until you have been instructed properly.
  - ✓ switch off the electric power before dismantling the machine.
  - ✓ use proper hand tools to dismantle the machine.
  - ✓ clean the machine parts before and after dismantling .
  - ✓ place the dismantled machine parts in proper sequence and easy for assembly
  - ✓ never attempt to carry heavy machine parts alone.
- **Workplace safety**
  - ✓ keep all tools clear of a work table .
  - ✓ change coolant fluid before it become contaminated.
  - ✓ Wipe up all spilled coolants from the floor around the machine right away.

2) Personal protective equipment (PPE)

The hazards and risks already present on maintenance shape , such as slips, trips, falls, noise, moving vehicles, and the specific risks related to the maintenance of portable tools frequently require the use of personal protective equipment. For example, safety helmets must be worn in areas where overhead hazards exist. Hand protection and gloves must be worn where workers have to work with sharp tools. Use of e.g. lubricants, hydraulic fluids or cleaning agents (solvents) may cause eye or skin injuries and requires protection. Ear protection may be necessary when working with or near noisy machines or equipment.

3) Hazards and Risk in Maintenance

a) Hazard :- A hazard is any source of potential damage, harm or adverse health effects on something or someone.Basically, a hazard is the potential for harm or an adverse effect (for example, to people as health effects, to organizations as property or equipment losses, or to the environment).

The hazards associated with maintenance activities can be classified as follows:

- Safety Hazards
  - ✓ Mechanical-equipment, tools
  - ✓ Electrical-– live equipment
  - ✓ Pneumatic ,Hydraulic & Thermal
- Health Hazards
  - ✓ Chemical Agents -Process chemicals, Cleaning solvents, Unexpected reaction products
  - ✓ Physical Agents- noise, vibration
  - ✓ Ergonomic Hazards
  - ✓ Biomechanical- lifting, pushing, pulling (manual handling), stretching, ending (to reach hard to access areas)
  - ✓ Work/process design- poorly designed tools, hard to access work locations, complex procedures, poorly fitting personal protective equipment

Many of these hazards are interrelated. Examine your process, the layout of your process area, and the process equipment used, to determine the exact nature of the hazards likely to be encountered during your maintenance activities.

For example, maintenance work carried out in confined spaces carries a greater risk of critical injuries and acute exposures to chemical and physical agents. These risks are associated with

equipment and materials in the space itself and from nearby operations. Fatalities (wounded) are quite common.

b) Risk is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard. It may also apply to situations with property or equipment loss, or harmful effects on the environment.

- ✓ Harm – physical injury or damage to health.
- ✓ Hazard – a potential source of harm to a work
- ✓ Risk - expose (someone or something valued) to danger, harm, or loss:

1.3.1. Inspection Maintenance checks

All equipment is to be inspected and maintained according to the following Equipment Inspection Schedule as a minimum. Records of all inspections and maintenance are completed and maintained for review and approval. Maintenance of equipment, release of lubrication fluids, etc., is performed only in approved areas. Spills and leaks from equipment are cleaned up promptly.

✓ Table 1.1 Sample of inspection :-

Type of tool	Type of Inspection	Schedule
Cutting tool Boring tool Holding tool Treading tool Measuring tool Hand tools	Complete inspection and certification	Before put to work and annually
	Critical items, controls, overall functioning	Daily
	Safety device, electrical	Monthly
	Complete inspection	Every 3 months
	Repair	When failure occurs
	Preventative maintenance	Manufacturer's recommendation

Table 1.2 . **Sample of checking machine/equipment in the case of lathe**

	Daily Checks
1	Check that all moving parts are well **lubricated**.
2	**Clean** the surface of the spindle, the turret and the body of the machine.
3	Check **that there are no objects / tools near the moving parts.**
4	Check the **operation of the manually operated handwheels**.
5	Check the **wear of the guide rails.**

1.3.2. Preventive maintenance inspection

a) Daly inspection

Inspection of lathe is carried out on basis of each shift. The inspection work accords to the following item .

- **Check before start the motor.**

✓ Clean-up of machine: Dust, chips and other atticles should be removed from sliding surface of machine to make the rotating or sliding parts performing easy and smoothly. All other static parts are often also cleaned to avoid the corrosion.

✓ Gearing and oiling: Regular oiling should be done every day (see lubrication plan sheet) to keep the machine properly lubricated.

✓ Check all the running parts not too tight, or loose. Bearings of headstock, longitudinal and cross feed, tool holders etc would be examined and adjusted by hand to proper fitness.

✓ Check the sensitivity & reliability of all manual control levers: To try the speed change rate function of headstock feeds and apron in gear box and inspect their starting, stopping and forward & reverse action whether they are sensitive at1d reliable or not.

✓ Fixture and fig of headstock, tailstock and tool holder Tight clamping between tailstock and bed surface, close running fit of spindle in tailstock, clamp bolts of tool holder, and figs on headstock.

- **Check after start the motor**

✓ To check electrical control system: Try to put "on" and "off' button and examine the sensitiveness of starting, stopping and pilot lamp strictly.

✓ The sensitivity and reliability of mechanical control device: Control levers for forward and reverse main spindle, automatic feeds and threads change should be sensitive and reliable.

Automatic control devices for longitudinal and cross feed, gear change threads change, carriage, and spindle direction change should be accurate also.

- ✓ Limitation of noise and vibration: When starting max speed of headstock spindle on no loading basis, check the noise and vibration whether they are over specified limit or not
- ✓ Coolant system: Check the quantity of coolant oil and start the oil pump for inspecting its function and leakage.
- ✓ Lubricating system: Examine all Lubricating system carefully and ensure all flowing line without obstacle.

- **Caution during operation**

- ✓ Temperature of bearings. Touch the main bearing by hand and feel the temperature is nom1ally or not.
- ✓ Temperature of motor: Feel the temperature of motor bearing at the case of full load.
- ✓ Noise and vibration: If you find the noise and vibration of the machine are abnormal or irregular. Stop the machine immediately for inspection and adjustment.
- ✓ Quality of products: If you discover the quality of products is out of limit. stop the machine at once for finding the causes of defects.
- ✓ Safety affairs:

1) Must stop operation when you leave the machine.
2) When changing main spindle speed or feeding speed stop running first.
3) All tools and products are strictly not allowing to be left on sliding surface of bed.

- **Check after operation**

- ✓ Cleaning and collection of all tools: All tools should be kept clean first then put back to original position (tool cabinet).
- ✓ Proper position of tailstock, carriage & tool holder: Tailstock, carriage & tool holder should be placed to proper position.
- ✓ Clean-up of machine: All of the oily matters, chips etc, on the machine should be removed completely and put a thin lubricating oil on the sliding surface of machine to prevent the corrosion.

b) Weakly inspection

- Lubricating system: Clean up the whole lubricating system and replenish with fresh lubricating oil.
- Cooling system: Clean up the whole cooling system and replenish with new cooling oil.

- Transmission system: Check the damage of rubber V-belt and readjust the tensile strength of V-belt.

c) Monthly inspection

- Dismantle and clean all the dust, chips and foreign matter from moving parts.
- Electrical system: Carefully examine the connection of all electrical wires, terminals and switches, which occasionally have been damaged by chips or other.

d) Semi Yearly inspection

- Change oil in gearbox: Remove the used oil from gearbox of headstock, feed and replenish with fresh oil.
- Check the wear and tear of all gears and packing: Inspect the damage of all gears in various box. spindle and bearings, and packing. Repair or replace it if necessary.
- Check the clearance fit of complicated feed mechanism: Check the clearance fit between feeding screw lever and nut and main screw spindleand nut whether they are right or not.
- The stability of machine body: Tighten up the foundation bolts of machine body to the ground and make the body stable.

e) Yearly inspection

- Positioning and leveling: According to the inspection regulation, recheck the positioning and leveling after a year service.
- Inspection for accuracy: According to the regulation. Inspection work for accuracy should be rechecked. If the accuracy is over specified limit, the adjustment or alignment will be done accordingly.
- Bearing inspection: Reexamine the insulating materials and clearance fit & lubrication of all bearings.

Inspection for appearance:

a) If paints are peeled off, repaint it with the same color.

b) Check the exposed parts whether they have been damaged, corroded, or deformed. repair or replace them if necessary

1.4. Calibration of measuring instruments

What is calibration?

There are as many definitions of calibration as there are methods. According to ISA's The Automation, Systems, and Instrumentation Dictionary, the word calibration is defined as "a

test during which known values of measured are applied to the transducer and corresponding output readings are recorded under specified conditions."

The definition includes the capability to adjust the instrument to zero and to set the desired span. An interpretation of the definition would say that a calibration is a comparison of measuring equipment against a standard instrument of higher accuracy to detect, correlate, adjust, rectify and document the accuracy of the instrument being compared.

Typically, calibration of an instrument is checked at several points throughout the calibration range of the instrument. The calibration range is defined as "the region between the limits within which a quantity is measured, received or transmitted, expressed by stating the lower and upper range values." The limits are defined by the zero and span values. The zero value is the lower end of the range. Span is defined as the algebraic difference between the upper and lower range values.

The calibration range may differ from the instrument range, which refers to the capability of the instrument. For example, an electronic pressure transmitter may have a nameplate instrument range of 0–750 pounds per square inch, gauge (psig) and output of 4-to-20 milliamps (mA). However, the engineer has determined the instrument will be calibrated for 0-to-300 psig = 4-to-20 mA. Therefore, the calibration range would be specified as 0-to-300 psig = 4-to-20 mA. In this example, the zero input value is 0 psig and zero output value is 4 mA. The input span is 300 psig and the output span is 16 mA. Different terms may be used at your facility. Just be careful not to confuse the range the instrument is capable of with the range for which the instrument has been calibrated.

What are the characteristics of a calibration?

- **Calibration Tolerance**: Every calibration should be performed to a specified tolerance. The terms tolerance and accuracy are often used incorrectly. In ISA's The Automation, Systems, and Instrumentation Dictionary, the definitions for each are as follows:
- **Accuracy**: The ratio of the error to the full scale output or the ratio of the error to the output, expressed in percent span or percent reading, respectively.
- **Tolerance:** Permissible deviation from a specified value; may be expressed in measurement units, percent of span, or percent of reading. As you can see from the definitions, there are subtle differences between the terms. It is recommended that the tolerance, specified in measurement units, is used for the calibration requirements performed at your facility. By

specifying an actual value, mistakes caused by calculating percentages of span or reading are eliminated. Also, tolerances should be specified in the units measured for the calibration.

For example, you are assigned to perform the calibration of the previously mentioned 0-to-300 psig pressure transmitter with a specified calibration tolerance of ±2 psig. The output tolerance would be:

$$\begin{array}{r} 2 \text{ psig} \\ \div\ 300 \text{ psig} \\ \times\ \ 16 \text{ mA} \\ \hline 0.1067 \text{ mA} \end{array}$$

The calculated tolerance is rounded down to 0.10 mA, because rounding to 0.11 mA would exceed the calculated tolerance. It is recommended that both ±2 psig and ±0.10 mA tolerances appear on the calibration data sheet if the remote indications and output milliamp signal are recorded. Note the manufacturer's specified accuracy for this instrument may be 0.25% full scale (FS). Calibration tolerances should not be assigned based on the manufacturer's specification only.

Calibration tolerances should be determined from a combination of factors. These factors include:

- ✓ Requirements of the process
- ✓ Capability of available test equipment
- ✓ Consistency with similar instruments at your facility
- ✓ Manufacturer's specified tolerance

Requirement of calibration

- ✓ It makes sense that calibration is required for a new instrument. We want to make sure the instrument is providing accurate indication or output signal when it is installed. But why can't we just leave it alone as long as the instrument is operating properly and continues to provide the indication we expect?
- ✓ Instrument error can occur due to a variety of factors: drift, environment, electrical supply, addition of components to the output loop, process changes, etc. Since a calibration is performed by comparing or applying a known signal to the instrument under test, errors are detected by performing a calibration. An error is the algebraic difference between the indication and the actual value of the measured variable

Purpose Of Calibrating Measuring Instruments

- ✓ To ensure the products designed are within the process and measuring instruments capabilities available in the plant.
- ✓ To minimize the cost of inspection by effective use of available facilities, and to reduce the cost of rejects and rework through application of Statistical Process Control techniques.
- ✓ .Standardization of measuring methods. This is achieved by laying down the inspection methods for any product right at the time when the production technology is prepared.
- ✓ Maintenance of the measuring instruments used in the plant.
- ✓ To ensure that the part to be measured conforms to the established standard.
- ✓ To meet the interchangeability of manufacture.
- ✓ To provide customer satisfaction by ensuring that no faulty product reaches the customers.
- ✓ To coordinate the functions of quality control, production, procurement & other departments of the organization.

Rules to follow checking and calibrating Measuring instruments

- Establish realistic calibration intervals;
- List all measurement standards
- List all environmental conditions for calibration;
- Ensure the use of calibration procedures for all equipment and standards;
- Coordinate the calibration system with all users

Assure that equipment is frequently checked by periodic system or cross-checks in order to detect damage, inoperative instruments, erratic readings, and other performance degrading factors that cannot be anticipated or provided for by calibration intervals;

- . Provide for timely and positive correction action;
- Establish decals, reject tags, and records for calibration labeling;
- Maintain formal records to assure proper controls.

Any equipment that does not have specific calibration intervals should be

- Examined at least every six months, and
- Calibrated at intervals of no longer than one year.

Adjustments or assignment of calibration intervals should be done in such a way that a minimum of 95% of equipment, or standards of the same type, is within tolerance when submitted for regularly scheduled recalibration. In other words, if more than 5%

of a particular type of equipment is out of tolerance at the end of its interval, then the interval should be reduced until less than 5% is defective when checked.

Calibration record system

- **A record system should be kept on every instrument, including:**
  - ✓ History of use;
  - ✓ Accuracy;
  - ✓ Present location; 4 Calibration interval and when due;
  - ✓ Calibration procedures and necessary controls;
  - ✓ Actual values of latest calibration;
  - ✓ History of maintenance and repairs.

Test equipment and measurement standards should be labeled to indicate the date of last calibration, by whom it was calibrated, and when the next calibration is due. When the size of the equipment limits the application of labels, an identifying code should be applied to reflect the serviceability and due date for the next calibration. This provides a visual indication of the calibration serviceability status. Both the headquarters calibration organization and the instrument user should maintain a two-way check on calibration. A simple means of doing this is to have a small form for each instrument with a calendar of weeks or months (depending on the interval required) across the top, which can be punched and noticed to indicate the calibration due date.

- **Common Measuring instrument for Visual inspection are**
  - ✓ Audio gage
  - ✓ Vibration analyzer
  - ✓ Amplitude meter
  - ✓ Pressure gage
  - ✓ Strain gage

- **Table 1.3 Calibration Card**

Defects found (if any)	Errors / Defects After repairs (if any)	Details of repairs carried out	Calibrated by	Place of use	Next calibration due on	Calibration lab in charge	Remarks

1.4.1. Non-functional tools, instruments and equipment

Non-functional tools and equipment are those that are notable to perform its regular function because of impaired and damage part. Examples of these are the following: Hammer with a broken handle Screw driver with a broken handle Long Nose Pliers with damage jaws. But functional tools and equipment are those that are in good condition and can perform its regular functions without any difficulties.



Figure 1.1 Nonfunctional Tools.

1.4.2. Separate and label Non-functional tools, instruments and equipment

a) Method of identifying non-functional tools and equipment

- *Visual inspection.* It refers to the visual observation of an expert on the appearance of the tools and equipment.
- *Functionality.* Vibration or extra noise from the operation means problems on parts and accessories started to develop.
- *Performance.* When there is something wrong with the performance of either hand tools or equipment they need an immediate repair or maintenance.
- *Power supply (for electrically operated only).* Failure to meet the required power supply, malfunction will occurs in the part of hand tools or equipment.
- *Person's involved*. It refers to the technical person who has the knowledge and skills about the technology.

b) Classifications of tools and equipment according to their uses:

- ✓ Measuring tools
- ✓ Holding tools
- ✓ Cutting tools
- ✓ Driving tools
- ✓ Boring tools
- ✓ Electrical equipment
- ✓ Miscellaneous tools/instrument/equipment

1.5. Record status and Report .

The followings are important points to consider in recoding and reporting inspection orally or in pro-forma form.

- Record any unsafe actions or conditions observed during your inspection tour.
- Use a well-written inspection report which will establish the location of the condition or action observed.
- Give it a hazard rating.
- Provide some guidelines regarding action taken by the inspection team.
- Recommend corrective action and assign accountability for ensuring corrective action by a certain date.
- Use well-written inspection reports communicate to management, supervision and the safety committee.
- They will be used to make records, plot trends and develop statistics on the hazards found in the workplace.

Hazard Ratings:-

Classify each item that you observe and record during your inspection tour. This hazard rating establishes priorities for corrective action and also highlights the level of severity or seriousness of the hazards.

ABC rating system: The A, B, C rating method is used to rate items observed during a safety inspection. The reason for this system is to highlight the degree of severity of those hazards and to assist both the inspectors and the employer in carrying out corrective actions. The following examples can be used as guidelines.

1) **"A" Hazard**

✓ Any condition or practice that has potential for causing loss of life, body part and/or extensive loss of structure, equipment or material.

- ✓ Generally this means that immediate corrective action is required. Activity should be discontinued until the hazard is corrected, e.g.

  A window washer is seen working on the third floor level without any safety belt, hanging on with one hand and leaning out to work.

  Workers are seen in a ditch, about six feet in depth, vertical sides, no shoring, sloping or other means of protection.

  Bricklayers are observed up on scaffolding, 15 ft. high, without handrails or safety belts.

2) **"B" Hazard**

- ✓ Any condition or practice with the potential for causing a serious injury, illness or property damage.
- ✓ Urgent situation. Requires attention as soon as possible,

  For example :-

- ✓ *Forklift trucks are rounding a blind corner into a loading area without stopping.*
- ✓ *Someone has spilled lube oil on the main floor, leading to the areas where workers must gain access.*
- ✓ *Workers observed smoking in a flammable storage area.*

3) **"C" Hazard**

- ✓ Any condition or practice with a probable potential for causing a non-disabling injury or non-disruptive property damage.
- ✓ These types of hazards should be eliminated without delay, but the situation is not an emergency,

  For example:-

- ✓ Worker using a hammer with a loose head, in use on a daily basis for odd jobs.
- ✓ Worker using a heavy file without file handle.

N.B all items must be observed

Record any items that are not up to your predetermined checklist standards. Do not eliminate any condition or action because you had it corrected during the inspection. Remember that you are developing a record of what you found during that inspection. Any items from previous inspections should be noted as "repeat" items.

Copies of inspection reports must be sent to:

1) Management
2) Joint health and safety committees
3) Worker health and safety representatives
4) Supervisors

5) Safety coordinator
6) Maintenance
7) Others?

Types of inspection reports

The following describes three other types of inspection reports:

- **ongoing inspections** as part of their job responsibilities. Such inspections identify hazardous conditions and either correct them immediately or report them for corrective action. The frequency of these inspections varies with the amount and conditions of equipment use. Daily checks by users assure that the equipment meets minimum acceptable safety requirements.
- **Pre-operation** checks involve inspections of new or modified equipment or processes. Often these are done after workplace shutdowns.
- **Periodic inspections** are regular, planned inspections of the critical components of equipment or systems that have a high potential for causing serious injury or illness. The inspections are often part of preventive maintenance procedures or hazard control programs. Laws and regulations may specify that qualified or competent persons must inspect certain types of equipment, such as elevators, boilers, pressure vessels, scaffolding, and fire extinguishers at determined points in the work process and at regular intervals.

Final report:- To make a report, first copy all unfinished items from the previous report on the new report. Then write down the observed unsafe condition and recommended methods of control. Enter the department or area inspected, the date and the inspection team's names and titles on top of the page. Number each item consecutively, followed by a hazard classification of items according to the chosen scheme.

State exactly what has been detected and accurately identify its location. Instead of stating "machine unguarded," state "guard missing on upper pulley #6 lathe in North Building." Assign a priority level to the hazards observed to indicate the urgency of the corrective action required. For example:

Table 1.4 Hazard Report Form

Hazard type	Condition	Requirement	Remark
A	Major	immediate action	
B	Serious	short-term action	
C	Minor	long-term action	

Report issues in a concise, factual way. Management should be able to understand and evaluate the problems, assign priorities and quickly reach decisions. After each listed hazard,

specify the recommended corrective action and establish a definite correction date if possible and appropriate. Each inspection team member should review for accuracy, clarity and thoroughness.

Example of Workplace Inspection Report

Inspection Location: _____ Date of Inspection: _____

Department/Areas Covered: _____ Time of Inspection: _____

Table 1.5: Observations Check list

Observations Check list							
Item and Location	Hazard(s) Observed	Repeat Item Y/N	Priority A/B/C	Recommended Action	Responsible Person	Action Taken	Date

Copies to: _____ Inspected by: _____

a) **Daily Coolant Report Card**

Here is a sample machine check sheet which can be used to track the condition of a particular machine or system in regards to evaporation ratesover time, deterioration based on pH, and record of cleanouts. Otherfields may be added, including bacterial and fungal levels, water hardness,conductivity and TDS.

Table 1.6: **Daily Coolant Report Card**

Date	Appearance	Brix	PH	Gallons Coolant Added	Gallons Coolant Added	Date of Last change	Initials

b) Preventive Maintenance Recording Form

Records: Maintenance Recording Form Maintenance Schedule Matrix	
Approval signature:	[signature]
Document to be posted?	[Yes/No]
Distribution to:	[distribution]

Important Reminder: It is a requirement that this information is documented for all equipment in the workplace, examples include (but not limited to) production, maintenance, and transportation equipment.

The assigned maintenance personnel must complete this form. The original submitted to the Head of Maintenance at the end of every week. A copy will kept in the maintenance files.

Table 1.7:- Preventive Maintenance Recording Form

Item	Information
List of items (parts to be inspected)	
Description of work performed	
Reporting any deficiencies	
Recommendations for correcting deficiencies identified	
Action taken(who, what, when)	
Inspector name	
Inspector signature	
Date of inspection	

Table:1.8 - Maintenance Schedule Matrix

Vehicle license Number	Year/Model	Schedule Number	Who does maintenance

Schedule number

1 Daily, 2. Weekly, 3.As per manufacturer's requirements

Self-check:1

Directions:1 Answer all the questions listed below.

I. Say True For Correct and False For Incorrect Sentences

1. Calibration is a comparison of measuring equipment against a standard
2. In the Direct method of measurement the value of a quantity is obtained directly by comparing the unknown with the standard.
3. Non Functional tools and equipment are those that are in good condition and can perform its regular functions.
4. The calibration range may differ from the instrument range, which refers to the capability of the instrument.
5. A well-written inspection report will establish the location of the condition or action observed

II. Matching Column A with B

Column A	Column B
1) **Unplanned Maintenance**:	A. it is performed after the occurrence of failure .
2) **Emergency maintenance***:*	B. it is carried out as fast as possible in order to bring a failed machine or facility to a safe
3) **Breakdown maintenance:**	C. "The maintenance carried out to no predetermined plan."
4) **Planned Maintenance**:	D. It carried out with forethought, control and the use of records to a predetermined plan.
5) Preventive Maintenance	E. It is carried out after a failure has occurred
6) Corrective Maintenance	**F.** It Is Condition-based **(Predictive)** Maintenance

III. Choose The Best Answer For The following questions

1. Which one of the following is not characteristics of a calibration

   A. Tolerance B. Accuracy C. A and B D. None

2. Which one of the following is not method of identifying non-functional tools and equipment

   A. *Visual inspection.* B. *Functionality* *C. Performance* *D.* None

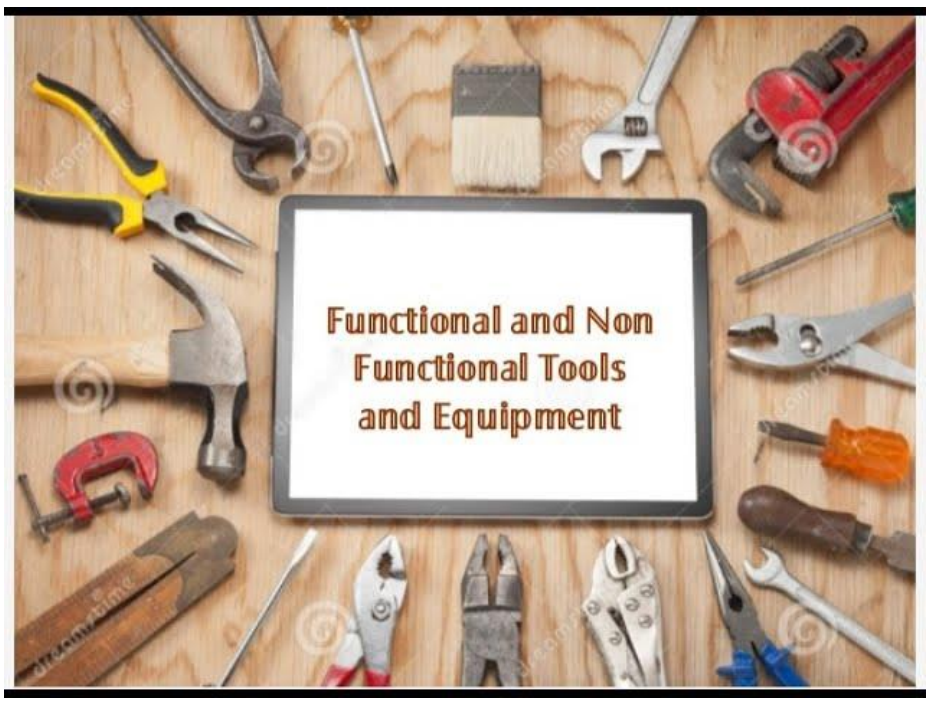
3. One of the following is Measuring instrument for inspection

   B. Visual inspection A. Vibration analyzer

   C. Audio gage B. All

Operation Sheet 1:

- Operation Title: Segregating and labeling nonfunctional tool and equipment
- Purpose: To Segregating and labeling nonfunctional tool and equipment from functional
- Instruction: Take your work shop tool room material and identify them according to their functionality Non functionally .
- **Tools and requirement:**
    1. Vernier caliper
    2. Micrometer,
    3. Steel rule.
    4. Metered
- **Procedures/ Steps in doing the task**
    1. Conduct an inventory of tool and equipment.
    2. -Record the number of nonfunctional tool and equipment
    3. Segregate tool that are serviceable or unserviceable.
    4. Report the number of tool and equipment that are nonfunctional but subject for repair.
    5. Label tool and equipment which are condemnable.
    6. Return tools and equipment in the tool cabinet as per operating procedures.
- **Quality Criteria:** Use there prediction number
- **Precautions:** Use PPE.



LAP Test 1: Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 hour.

Task 1. Segregate and label nonfunctional tool and equipment

Unit Two: Basic Program Maintenance

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

- Cleaning and Lubricating Machines Equipment.
- Consumable Components.
- Fluids and Lubricants.
- Performing minor machine repairs.
- Adjusting machine moving parts.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Clean and lubricate machines equipment.
- Undertake removal/replacement of consumable components.
- Replace fluids and lubricants.
- Perform minor machine repairs.
- Adjust machine moving parts.

2. Basic Program Maintenance

2.1. Cleaning and Lubricating Machines Equipment.

2.1.1. Cleaning of machine parts:-

Cleaning of equipment, components, working tools, hands or working gloves and workplace etc, before taking repairs, during and after repairs is of prime importance, but is often not given due consideration. Cleaning is often considered “donkey’s job” and is left to some unskilled worker to decide and do. But the type and extent of cleaning is purely a technical requirement, depending on the subsequent jobs to be done. Cleaning of components is, normally, assisted by kerosene, petrol, carbon-tetra-chloride (CTC) and many other solvents.

In hydraulic system, dirt and dust are the biggest enemy for sophisticated valves, pumps and control equipments/ items, which calls for proper covering and sealing of tanks, use of suitable filters during oil changing and repair of components to be done in dust-free room/ enclosure. For cleaning of rust, sediments and deposits from water-cooled components (furnace doors, heat shields), heat exchangers and tube-nests etc, suitable chemicals and solvents are used which soften and loosen the deposits so that the deposits come out by water or air force. Very often, high pressure water jets (pressure over 160 bar) are used for descaling of big tube-nests, heat-exchangers and condensers etc. Steam cleaning is also used often for many components.

Scrubbing, etching, skinning, burnishing, vacuum cleaning, extractors and many other such techniques are used for cleaning as per need. Many customized cleaning equipments are available and also many brands and types of cleaning fluids are available in market. You have to select the fluid, techniques and cleaning equipments as per specific requirement for job.

- Cleaning the Machine proper procedures for care and feeding

The entire machine must be cleaned after every use. If another user needs the machine, immediately after you, make sure you discuss who will leave the machine clean. The process is simple and should not take more than 10 minutes. Make sure you are aware of clock to leave enough time to finish clean-up.

2.1.2. Lubricating machines equipment

✓ Lubrication is a process which reduces the friction and wear between two moving solid surfaces with a film of solid, liquid or gaseous lubricant material without causing any damage

to the surfaces. Both friction and abrasion are very complex processes, which depend on bulk and surface properties of the material.

✓ Lubrication is the process or technique of using a lubricant to reduce friction and wear and tear in a contact between two surfaces.

Lubrication can be considered as vital part of a machine as any of the working parts. Of course the various bearings, gears and cams which make up any machine today must be carefully designed and precision made of the best materials to meet the demands of modern high speed production. But without proper lubrication, these same working parts would soon develop rapid wear and eventual failure.

Lubrication Equipment: are used for timely lubrication of different parts of the machine. These systems ensure that each part of application on the machine is supplied with adequate lubricant, in order to facilitate its smooth & persistent performance.

- **Primary purpose or Function of lubrication are**

The primary purpose of lubrication is to reduce wear and heat between contacting surfaces in relative motion. While wear and heat cannot be completely eliminated, they can be reduced to negligible or acceptable levels. Or

The primary functions of a lubricant are to:

- ✓ Reduce friction: R**educing friction is a key objective of lubrication**
- ✓ Prevent wear
- ✓ Protect the equipment from corrosion
- ✓ Control temperature (dissipate heat)
- ✓ Control contamination (carry contaminants to a filter or sump)
- ✓ Transmit power (hydraulics)
- ✓ Provide a fluid seal: Lubricants will occupy the clearance between moving parts through the capillary force, thus sealing the clearance. This effect can be used to seal pistons and shafts.

Classification of lubricants

All lubricants are classified into the following three groups: These are fluid, solid, or plastic substance.

a) **Liquid lubricants** are usually used in bearings are mineral oils and synthetic oils. The mineral oils are most commonly used because of their cheapness and stability. The liquid lubricants are usually preferred where they may be retained.

b) **Semi-liquid (or grease) lubricant** is a lubricant with higher viscosity than oils. The greases are employed where slow speed and heavy pressure exist and where oil drip from the bearing is undesirable.

c) **Solid lubricants** are useful in reducing friction where oil films cannot be maintained because of pressures or temperatures. They should be softer than materials being lubricated. A **graphite** is the most common of the solid lubricants either alone or mixed with oil or grease.

Types of Lubrication methods:-

There are three different types of lubrication: boundary, mixed and full film. Each type is different, but they all rely on a lubricant and the additives within the oils to protect against wear.

1) Full-film lubrication can be broken down into two forms: hydrodynamic and elasto hydrodynamic.

- Hydrodynamic lubrication occurs when two surfaces in sliding motion (relative to each other) are fully separated by a film of fluid.
- Elasto-hydrodynamic lubrication is similar but occurs when the surfaces are in a rolling motion (relative to each other).

Even on the most polished and smooth surfaces, irregularities are present. They stick out of the surface forming peaks and valleys at a microscopic level. These peaks are called asperities. In order for full-film conditions to be met, the lubricating film must be thicker than the length of the asperities. This type of lubrication protects surfaces the most effectively and is the most desired.

2) Boundary lubrication is found where there are frequent starts and stops, and where shock-loading conditions are present. Some oils have extreme-pressure (EP) or anti-wear (AW) additives to help protect surfaces in the event that full films cannot be achieved due to speed, load or other factors.

These additives cling to metal surfaces and form a sacrificial layer that protects the metal from wear. Boundary lubrication occurs when the two surfaces are contacting in such a way that only the EP or AW layer is all that is protecting them. This is not ideal, as it causes high friction, heat and other undesirable effects.

3) **Mixed lubrication** is a cross between boundary and hydrodynamic lubrication. While the bulk of the surfaces are separated by a lubricating layer, the asperities still make contact with

each other. This is where the additives again come into play.With a better understanding of this process, it should be easier to define what lubrication actually is. It is a process of either separating surfaces or protecting them in a manner to reduce friction, heat, wear and energy consumption. This can be accomplished by using oils, greases, gases or other fluids. So the next time you change the oil in your car or grease a bearing, realize there is more going on than meets the eye.

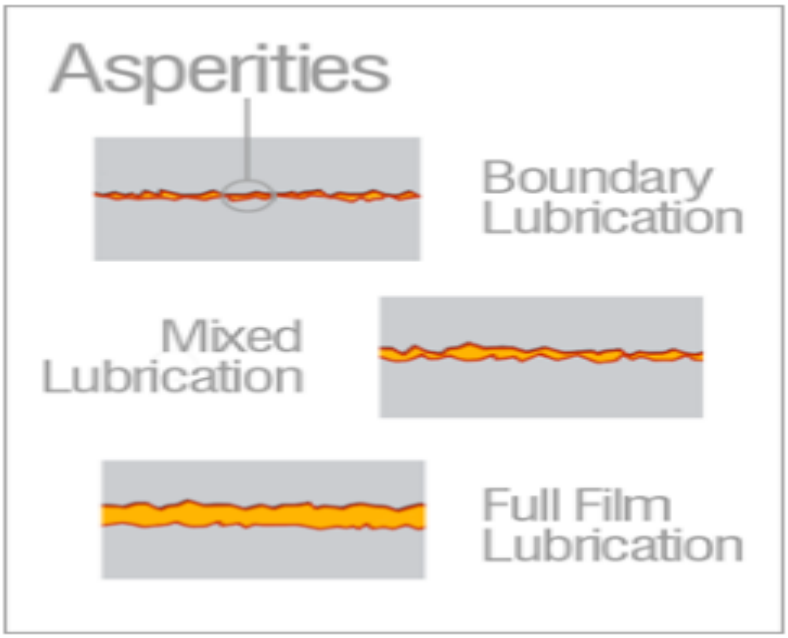


Fig. 2.1 Types of Lubrication

Lubrication actually used to reduce friction and wear to a minimum by substituting fluid friction for solid friction.

Properties of a good lubricant are:

- It should give rise to low friction.
- It should adhere to the surface and reduce the wear.
- It should protect the system from corrosion.
- It should have good cleaning effect on the surface.
- It should carry away as much heat from the surface as possible.

Lubricant application methods

The methods for lubricating tools/machine can be divided into following categories.

a) **Manual Devices**

Lubricating methods may require human action in one form or another. The term manual lubrication applies to methods in which the operator is directly responsible for quantity of lubricant and interval of lubrication. Although the initial cost of manual lubrication is low, the maintenance costs can be high. Reliability may be owing to considerable dependence on human action. The lubricant is quite prone in contamination.

Generally speaking, manual lubrication is satisfactory only for lightly loaded or low speed bearings, typical applications include open gears, chains, wire rope, etc.

b) **Drop-feed Devices :**

Drop feed devices are gravity-flow lubricators. They are employed to deliver lubricant drop-by-drop to individual bearings and other machine elements. They give the best advantage when lubricant points are readily accessible. Their cost is relatively low. Maintenance cost depends on type of service and location.

Depending on the lubricator, lubricant flow may or may not be stopped and started automatically. Automatic operation increase reliability. Typical service applications include journal and roller bearings, gears, chains, engine guides, pumps and compressors.

c) **Splash or Bath Lubrication :**

This type of lubrication is commonly used for machinery having high speed moving parts. These dip into oil and splash it on to the bearings or other machine elements. The splash system requires enclosing the mechanism to be lubricated.

Initial cost of splash system depends on the expense incurred in enclosing the mechanism. Maintenance costs are low. A splash system is reliable, prevents contamination. Typical applications include internal-combustion engines, chain drives and enclosed gear sets.

- ## Friction and wear:

The word friction comes from the Latin "friction", which means rubbing. This term is used to describe all those dissipative phenomena, capable of producing heat and of opposing the relative motion between two surfaces. Therefore friction is the **force that keeps a surface sliding with another surface.**

Friction is caused due to the **irregularities on the two surfaces in contact**. Even the smoothest surfaces have minute irregularities in them and these irregularities of the two surfaces interlock into each other and create friction. Larger the irregularities more is the friction.

According to states of motion there are two main types of friction:

a) Static friction: Which occurs between surfaces in a fixed state, or relatively stationary.

b) Dynamic friction: Which occurs between surfaces in relative motion.

Friction can be also classified into two types;

- Solid friction which may be either sliding or rolling, and fluid friction.
- Sliding friction occurs when two surfaces slide over each other without lubrication as in a plain bearing or between a piston and a cylinder.
- Rolling friction occurs when a cylindrical or spherical body rolls over another surface without lubrication as in the modern ball and roller bearings. We require less force to overcome rolling friction than sliding friction. Hence solid friction essentially occurs when there is no lubrication.

- Wear:

Wear can be defined as undesired removal of material due to mechanical action. It is poorly understood in the scientific sense. By a conventional method wear is divided into following main types:

a) **Adhesive wear** means damage resulting when two metallic bodies rub together without the deliberate presence of an abrasive agent.

b) **Abrasive wear** is characterized by damage to a surface by harder material introduced between two rubbing surfaces from outside. The severity of abrasive wear depends on size and angularity of abrasive particles and also the ratio between hardness of metal and the abrasive particles, more the tendency to wear.

c) **Fatigue wear** occurs due to cyclic stresses in rolling and sliding contacts as in gears and rolling bearings.

d) **Corrosive wear** occurs due to corrosion. Rusting is a well known example. The presence of moisture, oxygen availability and dusty conditions accelerate corrosive wear.

2.1.3. Replacing fluids and lubricants.

Functions of metalworking fluids

Metalworking fluids or coolants play a critical role in most machining processes. The main functions of a metalworking fluid are:

- ✓ Cooling: To reduce and remove heat build-up in the cutting zone and in the work piece.
- ✓ Lubricate: and thereby reduce friction between the tool and the chips being removed.
- ✓ Chip removal: Flush chips away from cutting zone, carrying them back to the sump.
- ✓ Protect against corrosion: of machine work piece and tools

Advantages and disadvantage of different type of oil (Fluid & lubrication)

- **Soluble Oil Advantages**
  - ✓ More economical than straight or neat oils; dilution with water lowers cost without sacrificing a great deal of tooling effectiveness.
  - ✓ Soluble oils cool 2 to 3 times better than straight oils.
  - ✓ Emulsions of soluble oils are very versatile and can be used in most machining and grinding applications on a wide variety of materials.
  - ✓ Soluble oils have better health and safety aspects with respect to the shop environment vs. straight oils; no fire hazard, reduced oil misting and fogging.
  - ✓ Of all the water extendible metal removal fluids soluble oils are the most forgiving of concentration fluctuations and poor management
  - ✓ Residues created by soluble oils are generally oily and not sticky.
- **Soluble Oil Disadvantages**
  - ✓ Higher disposal costs due to high percentage of oil versus synthetics or semi-synthetics.
  - ✓ Emulsions are milky; therefore the workpiece is not visible through fluid.
  - ✓ Less cooling in high-speed applications vs. synthetics or semisynthetics.
  - ✓ May tend to pick up tramp oils due to partial mechanical emulsification from circulation through the coolant pump.

Replace or cleanout machine Fluid sump procedure

- ✓ If the system is severely contaminated or rancid, an appropriate amount of conditioner approved for use in coolants should be added and allowed to circulate per manufacturer's instructions before initiating cleanout procedure.
- ✓ Drain sump or system as far as possible.
- ✓ Remove any solids from sump or system.
- ✓ Add 1 gallon of ASTRO-CLEAN A machine cleaner for each 20 gallons of coolant capacity.
- ✓ Fill the sump with tap water up to the normal operating level and allow the fluid to circulate for at least 4 hours.

- ✓ While the fluid is circulating, use a rag or brush to remove stubborn deposits on machine surfaces and troughs. Allow the fluid to wash the material into the machine sump.
- ✓ Remove the fluid from the sump.
- ✓ Remove any further solids from the sump.
- ✓ Fill the sump to normal operating level with water, add 1 gallon of **ASTRO-CLEAN A** to each 100 gallons of water and allow the fluid to circulate for at least 1/2 hour as a final rinse.
- ✓ Drain this solution from the machine sump.

Top up or charging machine Fluid sump procedure

For best coolant life and successful coolant management program follow these methods to recharge a freshly cleaned machine with Monroe metalworking fluid:

- ✓ When mixing coolant, it is best to use an automatic proportioned which accurately and thoroughly mixes coolant.
- ✓ Always replenish the coolant with a mixture of coolant and water, not just coolant or water. Never add coolant concentrate directly to the sump.
- ✓ Add the mix to the sump to the proper level.
- ✓ Start the pump and allow the fluid to circulate for at least 1/2 hour.
- ✓ Check concentration with refractometer and make necessary corrections before machining.

2.2. Replacement of consumable components.

Consumables are those which are not replaced or which are finished during the process. For ex. Oil, Hand Gloves, Coolant etc. Spares are those which are replaced and doesn't vanishes from the machine during process.

A consumable is a part that needs to be replaced at a certain interval of time, or at a specified number of clicks. The Consumables List includes each part's item number, company, and description; the date you installed the part; and how many clicks a part yields before requiring replacement.

Consumable Spares are those which are replaced and doesn't vanishes from the machine during process. Consumable Spares means items that are designed to be discarded when worn, on reaching a predetermined condition, routinely or on failure.

Eg. Mechanical Consumables all spare parts :

Nuts, Bolts, Screw , Plain Washer , Spring Washer , Stud Bolts, Threaded Rods , Eye Bolts , Cap Nuts , U Bolts , J Bolts , Mushroom Head , Square , Neck Bolts, CSK Philips , Allen Bolts , Square Nuts

- Removing /replacing practice of gaskets

There are a number of general factors that should be considered when removing or installing gaskets.

- ✓ It is advisable to have the new gasket cut or fabricated and ready to install before breaking a joint.
- ✓ Do not, if possible, make the gasket by hammering on the flange face. This can damage both the material and the flange.
- ✓ Use a thin gasket as possible for the joint conditions.
- ✓ For full face gaskets the bolt holes should be the same size as the holes in the flange.
- ✓ The gasket inner diameter should be larger than the inside bore of the joint face to prevent the gasket interfering with the fluids contained. The amount will depend on the material. For example, rubber will swell more than CAF and hence greater clearance will be required.
- ✓ If a joint has to be broken regularly then a coating of graphite or similar dry lubricant on one or both surfaces may make the gasket easier to remove. If a lubricant is used then a check should be made to make sure it is compatible with the contents of the machine, vessel or pipeline.
- ✓ Gaskets on doors and lids that have to be opened frequently can be cemented on one side and smeared with lubricant on the other. The cement chosen must be able to stand up to the operating conditions

Disassembling a joint

- ✓ Before starting make sure the joint is isolated and that all valves are closed. Drain any residual liquid from the joint and purge any gas if necessary.
- ✓ For piping flanges, loosen and remove all bolts if the gasket is full-faced. For ring type gaskets, loosen all bolts but only remove enough to remove the gasket.
- ✓ In equipment flanges it is recommended that all bolts be removed.
- ✓ Where necessary, spring flanges apart using flange spreaders. If wedges are used care must be taken not to damage the flanges.
- ✓ When the gasket has been removed, clean the joint faces and remove all traces of the old gasket and any jointing compound used.

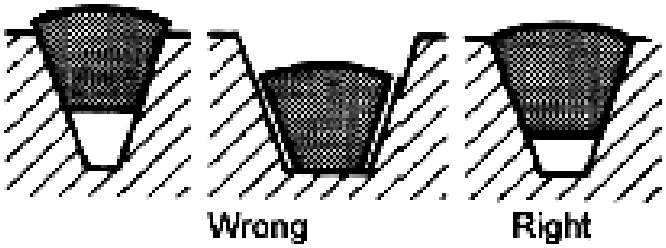
- ✓ Examine the joint faces for any evidence of scratching, corrosion, erosion or distortion of any kind.
- ✓ Installing the gasket and assembling a joint
- ✓ Ensure that joint facings are clean and free from burrs.
- ✓ Bolt or stud threads should be clean and lubricated and spot facings on the back of flanges should also be clean.
- ✓ Insert enough bolts in one flange to locate the gasket and make sure it lines up evenly all the way around the inside.
- ✓ With the gasket in place on one flange, bring up the mating flange. Every effort should be made to ensure the flanges remain parallel as they are brought together.
- ✓ Vertical heavy flanges such as those on vessels and heat exchangers should be jockeyed into position using a crane or hoist. These should be positioned on four bolts at an angle of 90° to each other that can be pulled up evenly to allow the flange to find its seat.
- ✓ Insert the remaining bolts and pull them up in the correct sequence as shown in Do not snug up bolts on the first go round as this can tilt flanges out of parallel. If using an impact wrench, set for about half final torque on the first go round. Ensure that final tightening is uniform.
- ✓ For the best performance in high temperature service make sure that bolts are retightened after 24 hours and then again after one week.

Considerations of O-ring replacement

- ✓ The most important concern when handling O-rings is to protect them from damage and to ensure that the correct loading is applied. The following general considerations should be taken into account.
- ✓ Ensure that the correct size of seal ring is used in relation to the size of groove.
- ✓ Make sure that grooves and recesses are clean and free from sharp edges and burrs.
- ✓ Care should be taken to ensure that the ring sits correctly in the groove and cannot get pinched between the flange faces.
- ✓ Flange faces should be pulled down evenly and to the correct pre-load recommended by the manufacturer.

Replacing practice of V-belt drive

- ✓ Check if the V-belt will fit to the pulley. Only a fitting belt can transform the full transmission load.



Figure;-2.2 V- belt Driv

✓ Align the two pulleys carefully using a straightedge. Misaligned drives can damage the bearing and the belt itself. Especially when installing multiple belt drives it is extremely important to align properly, because otherwise not all of the belts will carry the same load. The vertical misalignment should not exceed 0.5 degree.

2.3. Performing minor machine repairs.

- Record-keeping for repair

Record-keeping : In order for an eye care unit to manage its equipment effectively, it needs good maintenance and repair records. It is very difficult to manage the unknown!

A **central maintenance and repair record** will help you to keep track of the maintenance and repair work done. Ideally, this system should correspond to the eye unit's equipment inventory (mentioned on page 34); this means that you will have maintenance and repair records for each of the items listed in the inventory.

- Record-keeping for maintenance

The preventative maintenance schedule for users can be accompanied by a weekly or monthly ‘tick sheet’ near the item of equipment, with a space for each day so that users can date and sign it, thereby showing that they have carried out the required tasks. This may include a space for users to indicate what spare parts, such as bulbs, were used. On a regular basis, the list of spare parts used should be noted in the central maintenance and repair record so that more spare parts can be ordered.

The central maintenance and repair record can be used to keep track of all other maintenance, including maintenance done by the in-house team, by vendors, or by service agents. The information captured should include the date, the equipment reference number, what was done, who did the work, and when next maintenance is due.

- Record-keeping for repair

Table shows what information about repairs should be recorded in the central maintenance and repair record, and what useful information this can provide.

2.4. Adjusting machine moving parts.

1) Adjustment on Spindle Bearing:

The front and the intel111ediatesection of spindle roller bearing. For high accuracy and to meet the request of operation function, you may be asked to adjust the appropriate pressure on bearing. After a long period of operation. nut "G" probably will get loose and result the "wave trace" on cutting surface. You need to adjust it at this moment. Use a hexagon socket wrench to remove the setscrew and install back with the fixing nut again properly. Only an appropriate pressure is enough. Never have it too tight. as it will lead to the bearing to O\"er-heated or damage the rolling surface of bearing and lessen its dynamics. Make sure to fix the setscrew completely after adjustment ad illustrated.

- **Adjustment for the loosely Half Nut Engaged Lever** After long period of operation. the Half Nut Engaged Lever will get loose. please adjust as per following steps:

✓ Remover Thread Dial Indicator, there is four adjustment screws can be seen.

✓ Adjust those four screws to proper pressure as soon as to push the lever.

✓ Install Thread Dial Indicator back.

- **Adjustment on Spindle Alignment**

When the spindle rotates off-axis or if particularly heavy machining operations must be carried out, make an adjustment to the bearings.

The bearing that supports the spindle is tapered, to carry out the adjustment, proceed as follows (see Figure 23):

1. Loosen the bearing lock nut;
2. Tighten the bearing adjustment nut;
3. Test the spindle by turning it, and make sure it rotates perfectly, with the use of a comparator (see point 4, Chapter 10);
4. Tighten again the bearing lock nut.

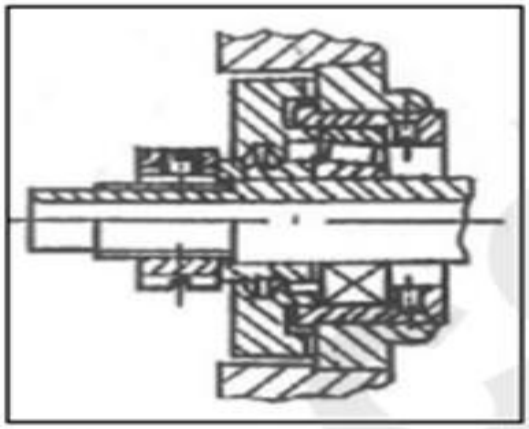


Figure: 2.3 **Spindle Alignment**

- **Adjustment for the loosely Half Nut Engaged Lever** After long period of operation. the Half Nut Engaged Lever will get loose. please adjust as per following steps:
  - ✓ Remover Thread Dial Indicator, there is four adjustment screws can be seen.
  - ✓ Adjust those four screws to proper pressure as soon as to push the lever.
  - ✓ Install Thread Dial Indicator back.
- **Feed load adjustment (cross feed & longitudinal feed):**

  There is a conical clutch "0" in the middle of Apron, which is an overload protector.

  The capacity of safety load is about 12 kg. A hexagon socket screw in the middle of apron can adjust appropriate load. Turn clockwise to increase load: anti-c1ockv,:ise it decrease. A proper load capacity can be tested by pressing hand wheel handle while auto feed operates to see if it will automatically cut-ofT v,hen load is oyer 12 kg.

- **Adjustment of tailstock centering**

✓ To adjust the accuracy of Tailstock. get loose two hexagon socket screws connect the Tailstock body and Bottom Plate, adjustment to be done depends on what you expect it to which direction; if you need it to be in cline front. you must let loose the adjustment screws then correct it to required accuracy minutely. then install the hexagon socket screws and the adjustment screws. Never have it too tight or the Clamping Lever will become heavier, as per illustrated "A".

✓ If you feel the Release Hand wheel is still too heavy although the Tailstock quill has been fixed. This is because the Clamping Block cannot be released freely. You have to push forward thc Clamping lever a bit and it recover in good order again.

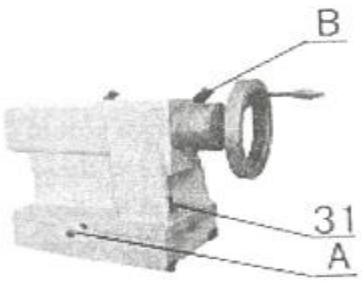


Fig.2.4:- **Feed load adjustment**

When the tailstock is off-axis it is necessary to correct its position, following these instructions:

1. Loosen the locking screw (ref. I in Figure 22);
2. Turn the adjustment screw (ref. II in Figure 22) to align the reference marks on the rear plate (ref. III in Figure 22);
3. Tighten the locking screw, fixing the body of the tailstock onto the guide rails and test the alignment.

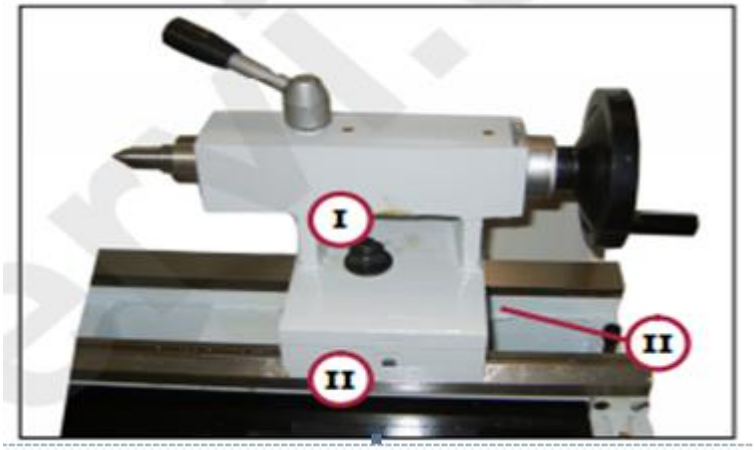


Fig.2.5 :- **Tail stock adjustment**

- **Belt tension adjustment**

1. After long period of working. belts will get slacked. so you need to adjust it for some times. It is as:

   1. Open the cover on rear left side of the lathe.

   2. Release adjustment Nut "A", lower the motor to proper height and bring the helt to certain tension.

   3. Install the Nut tightly.

- **Foot brake belt adjustment**

A brake pad fading may caused the slack of brake hell. Adjust Nut "H \" on Brake belt Open side rear cover remove top nut push bottom nut to appropriate position. then install two nuts to complete adjustment. Install the side rear .

illustration 7-6

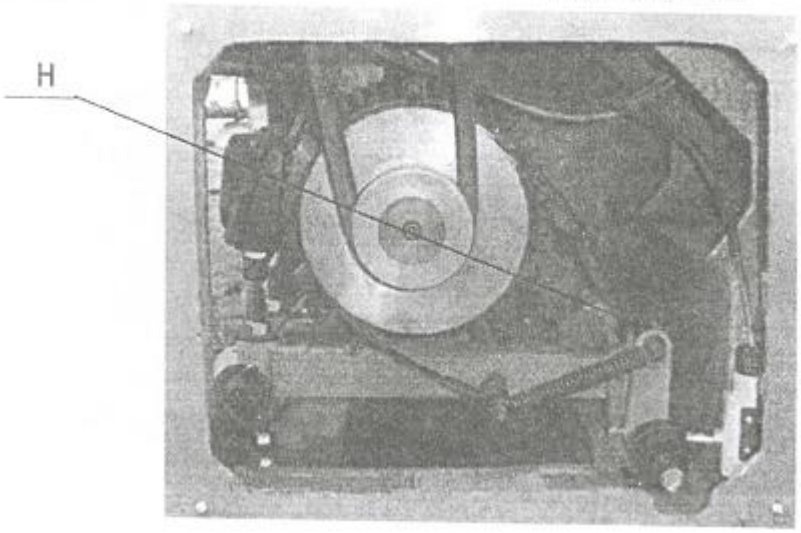


Fig.2:6 - **Foot brake belt adjustment**

- **Brake and micro switch Adjustment**

Foot brake is linked to Micro Switch. It needs to maintain a backlash of 3-5mm from Brake Cam to the touching head of the Micro Switch. Always disconnect the power to break the machine or it will cause the fading of brake pad. After stepping the foot brake, needs to reiterate the spindle control lever to make the spindle revolute again.

illustration 7-7

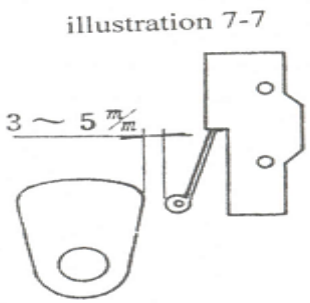


Fig. 2.7:- **Brake and micro switch Adjustment**

- **Adjustment of the back lash lead screw**

Which it happens to some pole-up threads during processing. it is caused by the backlash on Lead screw. Adjust the packing nut appropriately on rear side of the Lead screw. Open the cover on rear side of Lead screw Bracket. turn nut "A" very tight with no backlash left

behind. (To check the result by pushing down Half Nut Handle. turn Apron Hand wheel to rotate. clasp the contact point between Gear Box and Lead screw . Make sure there is no backlash created). Install "A" nut and side cover.

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

I. Say True or False

1. Cleaning is often considered “donkey’s job” and is left to some unskilled worker to decide and do.
2. Lubricant suppliers can be a valuable source of information
3. Lubrication can be considered as vital part of a machine as any of the working parts
4. Always take oil samples when changing oil in a gearbox
5. Repairable are items that are repaired after replacement after which they are *ready-for-use*
6. The condition of a metal part can be determined by visually inspecting the number and length of cracks.

II. Choose the best answer For the following question

7. Which one of the following is Properties of a good lubricant
   A. It should give rise to low friction.
   B. It should adhere to the surface and reduce the wear.
   C. It should protect the system from corrosion.
   D. It should have good cleaning effect on the surface. E. All
8. One of the following is a category of wear.
   A. Adhesive B. Abrasive C. Corrosive D. All
9. . One of the following is discarded after replacement and bought new from a supplier.
   A. Retables B. Repairable C. Consumables D. All

III. Give short Answer

10. List at list three Properties of a good viscosity.

Operation Sheet-2

- Operation Title: **Cleaning and Lubricating the Machine**
- Purpose: To protect the machine from rust and other ingredient materials .
- Instruction: Using the right cleaning material clean any machine you find from your work shop example Power hacksaw
- **Tools and requirement:**
    1. Cleaning oil
    2. Brush
    3. Cleaning Rug .
    4. **Lubricating Oil.**
- **Procedures/ Steps in doing the task**

1. Turn off the machine and remove the tool holder. Brush, blow or wipe it clean.

2. Put away all your hand, set-up and cutting tools. If not sure where they go, ask a supervisor.

3. Use a brush or light blasts of air to remove the chips from the vice, table and ways.

4. Do not blast the chips and fluids across the shop, only use enough force to get the chips to the ground.

5. Brush or vacuum the difficult to reach spots. Wipe the spindle, slides, ways, tool post, chuck, etc.

6. Wipe off ALL cutting fluids and oils from the ENTIRE machine. Top to bottom, machine must be dry.

7. Gently mist the slides, ways, chuck(s) with WD40. Move the carriage and slides to mist all Step 8-Sweep the floor and surrounding areas. Chips are to be placed in chip buckets, not regular trash cans.

8. There should be NO visible chips of any size on the machine. Leave it cleaner than when you found it.

9. Finaly allay lubricant oil when necessary

- **Quality Criteria:** The Given selected machine must be clean well
- **Precautions:** Use PPE .

LAP Test 2	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 hour.

Task 1. Clean and Lubricate the Power hack saw Machine

Unit Three : Basic Preventive Maintenance Of Tools

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

- Check tools for defects/functionality.
- Report defective hand tools for repair or replacement.
- Cleaning hand tools.
- Lubricating and storing tools.
- Accomplishing necessary reports.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Check tools for defects/functionality.
- Report defective hand tools for repair or replacement.
- Clean tools using appropriate cleaning materials.
- Lubricate and store tools.
- Accomplish necessary reports.

3. Basic Preventive Maintenance Of Tools

3.1. Introduction:

Preventive maintenance:- Preventive maintenance is the act of performing regularly scheduled maintenance activities to help prevent unexpected failures in the future. Put simply, it's about fixing things before they break. Also known as preventative maintenance, which includes adjustments, cleaning, lubrication, repairs, and replacements

3.2. Checking tools for defects/functionality.

All tools and equipment used for maintenance should be checked for their proper function which is appropriate for maintenance of the particular machine or parts.

There are many ways of identifying hand tools. One of these is to identify them according to their function. However, awareness of defective and non-defective hand tools is a primordial concern of workers/welders to be effective in their jobs.

Most common used hand tools in the work shop which we must identify for defective and non-defective problems are

- ✓ Cutting tools - hacksaw, crosscut saw, rip saw
- ✓ Boring tools - auger, brace, gimlet, hand drill
- ✓ Holding tools - vice grip, C-clamp, bench vice
- ✓ Threading tools - die and stock, taps
- ✓ Measuring instruments-
- ✓ Hand tools-Allen key ,hammer pairs

Practical way to identify defective and non-defective hand tools

- **Visual inspection:**

Defective tools can easily be distinguished from the functional ones through visual inspection. The physical appearance of tools will describe such characteristics as dullness, sharpness, dismantled parts, and unevenness of the teeth of the cutting tools.

- **Functionality**

Another way is to check the quality of the manufactured tools. Is it already susceptible to wear and tear? Has it already exceeded its service life? Has it passed the manufacturer's quality control test?

A few pieces of the hand tools issued in the shop can be subjected for Condemnation they are no longer serviceable. Some hand tools issued for years in shops and few pieces of these can be subjected for condemnation.

- **Performance:**

Performance of hand tools is determined not only during the actual use but also after use to find out whether the hand tools are still worth using.

- **Service span**

Hand tools are issued to shop teacher at one time. However, this must be recorded to determine when it was received and how long the tools have been kept in the shop. A hand tool which is too old is unsafe for both the students and workers. Such tool should be marked defective and segregated from the good ones.

- ✓ Defective tools can cause serious and painful injuries.
- ✓ If a tool is defective in some way, DON'T USE IT.

Be aware of problems like

- ✓ Chisels and wedges with mushroomed heads
- ✓ Split or cracked handles
- ✓ Chipped or broken drill bits
- ✓ Wrenches with worn out jaws
- ✓ Tools which are not complete, such as files without handles

To ensure safe use of hand tools, remember:

- ✓ Never use a defective tool
- ✓ Double check all tools prior to use ʊ
- ✓ Ensure defective tools are repaired ʊ

Air, gasoline or electric power tools, require skill and complete attention on the part of the user even when they are in good condition. Don't use power tools when they are defective in any way.

Watch for problems like:

- ✓ Broken or inoperative guards
- ✓ Insufficient or improper grounding due to damage on double insulated tools
- ✓ No ground wire (on plug) or cords of standard tools
- ✓ The on/off switch not in good working order
- ✓ Tool blade is cracked

- ✓ The wrong grinder wheel is being used
- ✓ The guard has been wedged back on a power saw

3.3. Reporting defective hand tools for repair.

A. Detective tools can cause serious and painful injuries. If a tool is defective in some way, DO NOT USE IT.

B. Remove all defective tools from the work area and mark, "DEFECTIVE – DO NOT USE."

- Reporting
  - ✓ Any hand tools controlled by DIT found defective should be removed from service and a label attached stating its defect.
  - ✓ The condition / defect of the defective tool should be entered into the Tool Log record.
  - ✓ The tools should be repaired in compliance with the manufacturer's or scraped and a replacement tool if required be purchased.
  - ✓ If the tool is repaired a retest / inspection must be Carrie
- **Documentation**
  - ✓ The Technical staff member in charge of the laboratory /workshop should maintain a Tool Log to record defective tools, their repair or disposal and their replacement.

3.4. Cleaning tools.

Cleaning Solvents:- Solvent is a component of a solution that dissolves solute and is usually present in large proportion or amount. It can be classified as polar and nonpolar. Polar solvents are solvents which dissolve/are soluble in water; while nonpolar solvents are solvents which do not dissolve/are insoluble in water. Solvents are usually used for cleaning in workshops. They are water, gasoline, kerosene, thinner and detergent soap.

Table:3.1 Kinds of cleaning solvent based on their solubility in water:

S/No.	Cleaning solvent	Solubility in water	Polar	Non polar
A	Water	Soluble	x	
B	Gasoline	Insoluble		x
C	Kerosene	Insoluble		x
D	Thinner	Insoluble		x

E	Detergent soap	Soluble	x	

Table 3.2 Use of cleaning solvents:

Cleaning solvent	**uses**
Gasoline	Wash greasy tool/equipment
Kerosene	Remove dust, grease oil, paint, etc
Thinner	Remove spilled paint on the floor, wall and tool
Water	Wash dust in the floor, wall, etc
Detergent soap	Wash/clean benches, table, cabinet, etc

1) **Cleaning Hand-Held Workshop Tools** *(Hammers, wrenches, screw drivers, etc.)*

Whether gardening, fixing a broken pipe, or building a deck, using the proper tools to complete your job is essential. Consequently, it is important to maintain your tools and keep them clean so that they will last and be in good shape for any job you have in mind. These simple tips will help you get the most out of your tools.

What You Will Need:

- ✓ Wire scrub brush
- ✓ Commercial cleaner (Pine-Sol, Spic ‘n Span, Lest oil, etc)
- ✓ Large bucket
- ✓ Hot water
- ✓ Several old towels
- ✓ Heavy duty rubber gloves
- ✓ Steel wool
- ✓ Household oil
- ✓ Soft rag

The Cleaning Process:

1. Fill a large bucket with a measured amount of hot water (usually about a gallon or two, depending on the number of tools you are washing) and add the amount of commercial cleaner indicated on the product instructions for the amount of water.
2. Place tools in the bucket of cleaning solution, and let soak for at least 30 minutes.
3. While wearing rubber gloves, use the wire brush to scrub the tools, removing dirt and grease.
4. Remove the tools from the cleaning solution and dry each one thoroughly.
5. If any of your tools have rust on them, use the steel wool to rub the rust off.
6. Many of today’s hand tools are rust resistant, but if any of your tools are susceptible to rust, it is recommended that about once every 6 months, you coat them with a thin coat of household

oil (such as WD-40® or 3-in-1® Household Oil, available at most home improvement and hardware stores) by pouring some on a soft rag and wiping

2) **Cleaning Power Tools** *(Jigsaws, drills, chain saws, etc.)*

What You Will Need:

- ✓ Heavy duty working gloves
- ✓ Can of compressed air (available at most home improvement stores)
- ✓ Cleaning rags
- ✓ Bucket
- ✓ Hot water
- ✓ Commercial cleaner (Pine-Sol, Spic 'n Span, Lestoil, etc)
- ✓ Old towels
- ✓ Steel wool
- ✓ Toothbrush

The Cleaning Process:

1. Make sure you wear heavy duty gloves when handling power tools, especially power tools with sharp cutting edges.
2. ALWAYS check the manufacturer's directions and recommendations for proper cleaning and maintenance of your power tool(s), and follow any such instructions carefully.
3. DISCONNECT all power cords from the tool being cleaned.
4. If you are cleaning a chainsaw, jigsaw, or any other such type of power tool that tends to collect sawdust, using the compressed air, spray out any sawdust and dirt accumulated within the grooves and crevices.
5. Fill a large bucket with a measured amount of hot water (usually about a gallon or two, depending on the number of tools you are washing) and add the amount of commercial cleaner indicated on the product instructions for the amount of water.
6. Wet a cleaning rag with the cleaning solution and wring out thoroughly so that it is just damp, not wet or dripping. Wipe down the surface of the tool. Avoid getting water in or around the power cables or motor casings.
7. Dry thoroughly with an old towel.
8. With a toothbrush, clean around any switches or toggles, making sure to remove any debris or dust that may interfere with the proper operation of any of those switches.
9. With a DRY rag, wipe down the power cord, checking it carefully for any nicks, cuts, fraying or damage. If you do find the cord to be damaged in any way, it should be REPLACED before using the power tool again.

10. Check any exposed metal parts of the tool for rust. If there is any rust, remove it by rubbing briskly with the steel wool.

3) Additional Tips and Advice

- NEVER submerge a power tool in water.
- NEVER attempt to clean a power tool while it is plugged in or operational! You will risk serious injury!
- Avoid oiling power tools unless specifically recommended by the manufacturer.
- Cleaning dirt, dust and debris from your tools after each use will make your job much easier when it comes down to more substantial cleaning.
- Always make sure to dry your tools thoroughly after cleaning. If you store your tools while they are wet, they stand a greater chance of developing rust, which will eventually eat away at the metal.

3.5. Lubricating and storing tools.

✓ Lubricants are identified according to types of equipment.

✓ Tools and equipment are lubricated according to preventive maintenance schedule or manufacturer's specifications.

✓ Measuring instruments are checked and calibrated in accordance with manufacturer's instructions.

✓ Tools are cleaned and lubricated according to standard procedures.

✓ Defective equipment and tools are inspected and replaced according to manufacturer's specification.

✓ Work place is cleaned and kept in safe state in line with OSHC regulations.

A lubricant is a substance introduced to lessen friction between moving surfaces. It may also transport external particles. The property of reducing friction is known as lubricity.

3.5.1. Types and Uses of lubricants

- Anti-rust lubricant spray:
  - ✓ loosen rusted part
  - ✓ drives out moisture
  - ✓ cleans and protect
  - ✓ stops squeaks

- ✓ free sticky mechanisms

- Wire Pulling Lubricant:
  - ✓ does not damage insulation
  - ✓ cling to wire and dries to a slippery film
  - ✓ suitable for use with wire or cable covered with rubber (t, thw, thhn, etc)
- All Purpose Anti Rust Lubricant:
  - ✓ anti-rust
  - ✓ lubricating
  - ✓ rust removal
  - ✓ decontamination
  - ✓ conductance
- Lubricant Oil and Engine Oil
  - ✓ lubricating the gear
  - ✓ cleans and protect
  - ✓ drives out moisture
- Silicon Lubricant:
  - ✓ heat stable
  - ✓ lubricates
  - ✓ protects
  - ✓ reduces friction
  - ✓ water repellent
- **Reminders:** *A good lubricant possesses the following characteristics*:
  - ✓ High boiling point.
  - ✓ Low freezing point.
  - ✓ High viscosity index.
  - ✓ Thermal stability.
  - ✓ Corrosion prevention.
  - ✓ High resistance to oxidation

3.5.2. Lubricating and storing tools

Lubricant is a substance that reduces friction, heat, and wear when introduced as a film between solid surfaces. Using the correct lubricant helps maximize the life of your bearings and machinery, therefore saving money, time, and manpower, thus making operations more efficient and more reliable.

- **Lubricating and storing vice**

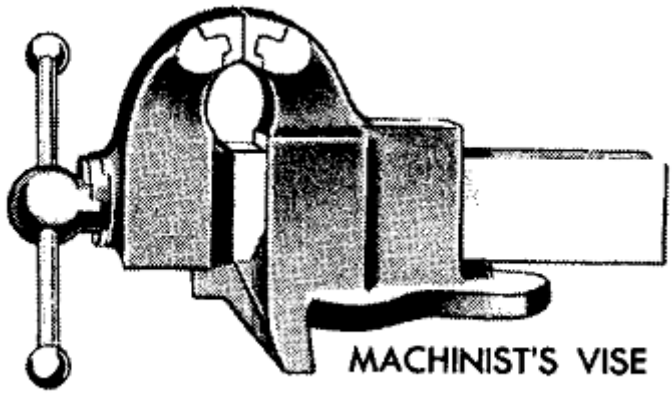


Figure:3.1 **Lubricating and storing vice**

Lubrication: Lubricate slide and worm lightly with preservative lubricating oil (special) or engine oil (SAE 10). Lubricate sparingly; excessive amounts help cause a messy shop.

Storage: Wash lubricants from vise with dry cleaning solvent. Dry vise thoroughly. Coat all surfaces of vise with rust preventive compound (thin film) and store in a dry place. Upon removal from storage, wash off the rust preventive compound with dry cleaning solvent

- **Lubricating and storing taps and dies**

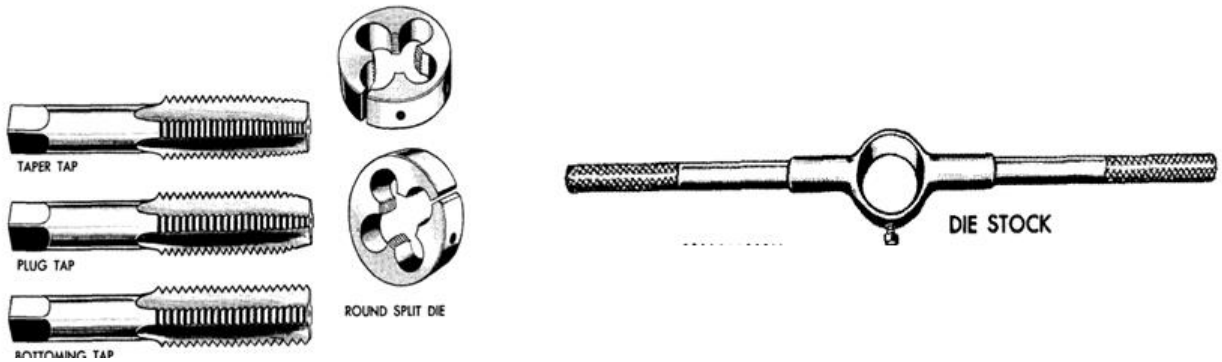


Figure: 3.2 **Lubricating and storing taps and dies**

Storage: Coat all parts with rust preventive compound (thin film) and store in a dry place. Store in racks or divided boxes to protect cutting edges from contact with metal. Upon removing from storage wash with dry cleaning solvent to remove rust preventive compound

- **Lubricating and storing saws**

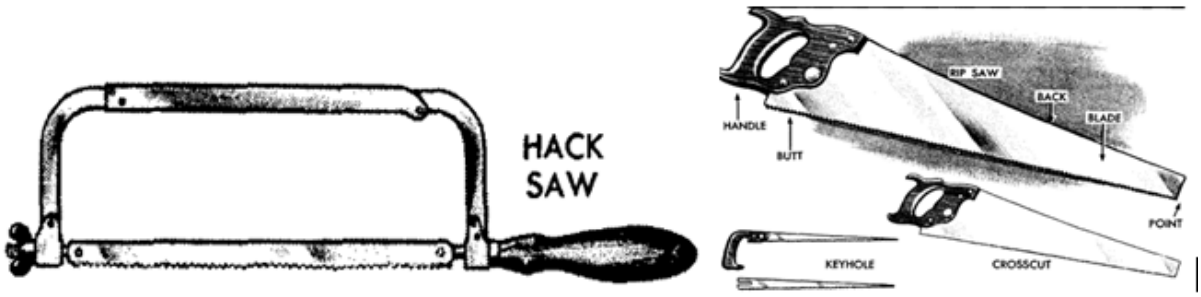


Figure: 3.4 Lubricating and storing saws

Lubrication: Always oil blade with a clean cloth dampened with preservative lubricating oil (special) after using saw. Do not permit blade to rust. Clean off all signs of rust from blade with crocus cloth. Apply oil to blade after cleaning off rust

Storage: Apply rust preventive compound (thin film) to blades to prevent rust, and store so teeth will not be dulled by contact with other tools. Upon removal from storage, wash metal parts with dry cleaning. Solvent to remove compound.

- **Lubricating and storing clamp**

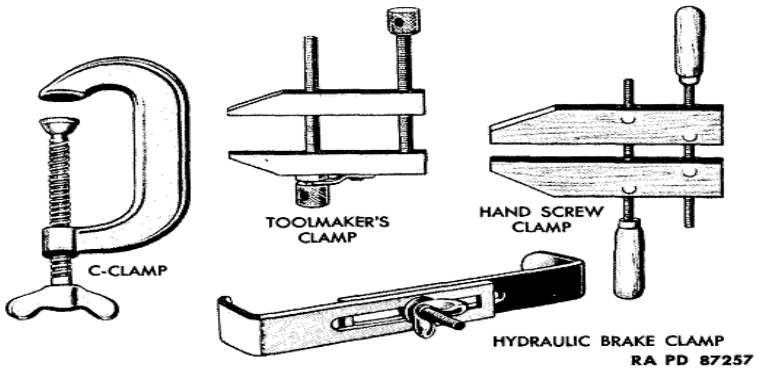


Figure:3.5 Lubricating and storing Clamp

Lubrication: Keep screws lubricated with small quantity of preventive lubricating oil (special) or engine oil (SAE 10). Excessive lubricant interferes with use of tool. Keep metal surfaces free of rust. Scour off rust or corrosion with crocus cloth or aluminum oxide abrasive cloth. Coat surfaces with preservative lubricating oil (special) or engine oil (SAE 10).

Storage (All Clamps): Coat clamps with rust preventive compound (thin film) and store in a dry place. After removal from storage, wash metal parts with dry cleaning solvent to remove rust preventive compound.

- **Lubricating and storing calipers**

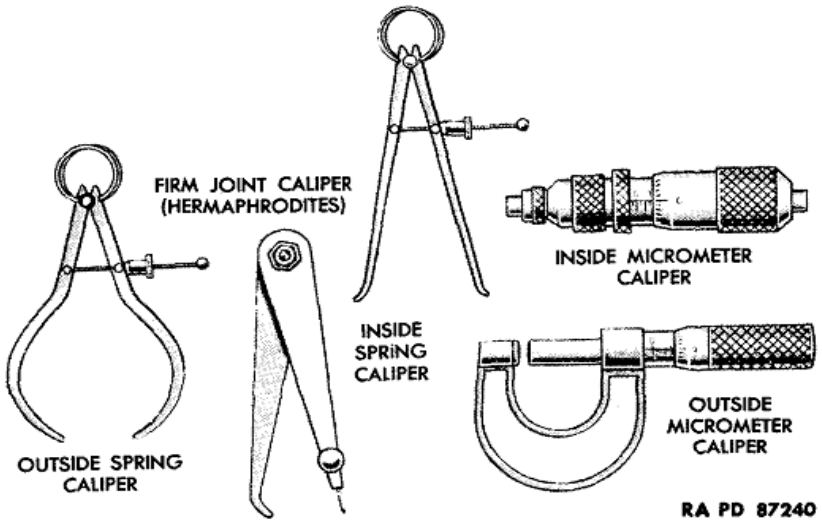


Figure: 3.6 Lubricating and storing saws

Lubrication: Oil threaded and moving parts and friction surfaces (firm joint calipers) with preservative lubricating oil (special). Coat non-operating surfaces with a film of preservative lubricating oil (special).

Storage: Wrap in greaseproof wrapping and enclose in a covered box. Store roughly and apply a film of preservative lubricating oil (medium). Wrap in greaseproof wrapping and enclose in a covered box. Store in a dry place

Self-Check -3	Written Test

Directions: Choose the letter of the word/s that best complete each statement below. Use the Answer sheet provided in the next page:

I. True Or False Items

1- Lubricant is a substance that increase friction

2- Saws teeth will not be dulled by contact with other tools.

3- Lubricant helps to maximize the life of tool

II. Choose The best answers

1. Defective hand tools are kept and _____.
   A) Marked as defective
   B) Mixed together with non-defective tools
   C) Put anywhere in the shop
   D) Sold in the junk shop
2. One way of checking whether hand tools are defective or non-defective the_____.
   A) length of service C. Trade mark of the manufacturer
   B) Physical appearance D. All
3. Which is determined after the operation of a hand tool is tested?
   C) Service span E) Physical appearance
   D) Performance F) Repair Maintenance
4. Service span of a tool pertains to _____.
   G) Maintenance schedule C. Determining when the tool is acquired
   H) Functionality of a tool D. Defectiveness of a tool

III. Give short answers

1. Write use of cleaning solvent
2. Write three type of cleaning solvent

Operation Sheet 3

- Operation Title: **Cleaning Hand-Held Workshop Tools**
- Purpose: To protect the tools from rust and other dust materials.
- Instruction: Using the right cleaning material clean any Hand tool you find from your work shop example .
- **Tools and requirement:**
    5. Cleaning oil
    6. Steel wool
    7. Cleaning Rug .
    8. **Lubricating Oil.**
- **Precautions:** Use PPE
- **Procedures/ Steps in doing the task**

  Step 1- Fill a large bucket with a measured amount of hot water

  Step 2- Place tools in the bucket of cleaning solution, and at least 30 minutes.

  Step 4-Remove the tools from the cleaning solution and dry each one thoroughly

  Step 4- While wearing rubber gloves, use the wire brush to scrub the tools

  Step 5- if any of your tools have rust on them, use the steel wool to rub the rust off
- **Quality Criteria:** Use there prediction number

LAP Test 3	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 hour.

Task 1 . Clean hand held workshop tool

Unit Four: Inventory tools and equipment

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

- Inventory of tools, instruments and equipment.
- Documenting / recording inventory results.
- Storing tools and equipment.

Storing tools and equipment This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

Perform inventory of tools, instruments and equipment.

- Perform inventory of tools, instruments and equipment
- Document inventory results.
- Store tools and equipment.

4. Inventory Tools and Equipment

4.1. Inventory of tools, instruments and equipment.

4.1.1. Introduction to Inventory

The word inventory simply means the goods and services that businesses hold in stock. There are, however, several different categories or types of inventory.

The first is called materials and components. This usually consists of the essential items needed to create or make a finished product, such as gears for a bicycle, microchips for a computer, or screens and tubes for a television set.

The second type of inventory is called WIP, or work in progress inventory. This refers to items that are partially completed, but are not the entire finished product. They are on their way to becoming whole items but are not quite their yet. The third and most common form of inventory is called finished goods. These are the final products that are ready to be purchased by customers and consumers. Finished goods can range from cakes to furniture to vehicles. Most people think of the finished goods as being part of an inventory stock, but the parts that create them are held accountable in inventory as well.

4.1.2. Classification of inventory

- **Rotable Inventory**

  Rotable inventory is defined as an inventory that can be economically restored to a serviceable condition and, in the normal course of operations, can be repeatedly rehabilitated to a fully serviceable condition over a period approximating the life of the flight equipment to which it is related. Of course there are scrap rates as with all inventory, however, with Rotable inventory the scrap rate is assumed to be very low, perhaps only a few percentage points or even a fraction of a point.

  Examples of Rotables are flaps, transmissions, fuel pumps, hydraulic pumps, etc. Because of their generally high cost, Rotables are economical to repair rather than replace with new purchase upon failure. Rotables are also generally systems made up of series of Repairable and Expendable subcomponents. Rotables are unusual in that the repair cycle causes them to depart from mainstream notions regarding inventory. For example, inventory is typically considered consumed upon installation, sale or other activity. In the case of a Rotable, the inventory is generally tracked, both financially and from a compliance aspect for its entire life. Rotables are typically held on a firm's books, and depreciated on a schedule that may range from 5-7 yearsto 20-25 years, depending on the firm's goals and mode of business.

- **Repairable Inventory**

  Repairable Inventory generally follows the same conventions of Rotable inventory with one important distinction: Repairable inventory has a higher scrap rate than Rotable inventory. For example, a part may be of the same asset value and lifespan as a comparable Rotable; however the repair process may have a 25% scrap rate.

- **Expendable Inventory**

  Expendable inventory is by definition, inventory with 100% scrap rate and therefore 100% replacement for every use. Expendable inventory often meets the criteria most laymen and financial professionals think of when they consider inventory. Expendables range from common fasteners to filters to items which are scrapped upon use and removal. Cost-wise, Expendables can be as expensive or more expensive than inventory assets in the Rotable or Repairable class. Their main distinction is the 100% scrap rate. Financially, Expendables are *usually* expensed at the time of use or issue, depending on the financial dictums of the operator. Bulk items are often expensed at the time of issue to a station or maintenance base, and this practice can induce problems that mask the true inventory levels in the operation, particularly if there are not robust systems for inventory tracking and audit. If station visibility is lost, often planners are induced to over order their Expendable levels, driving up Expendable balances due to the lost visibility at stations.

  Recoverable Inventory

  Recoverable inventory may be a classification not commonly known or utilized. Sometimes they are referred to as Recoverable-Expendables or similar name. An example may be a filter that has a 100% scrap rate, but there may be a simple shop procedure which will restore the filter to serviceability on 4 in 10 filters. The logical line between Recoverables and Expendables is generally an individual airline designation.

  Recoverables can offset new purchase of Expendable items substantially via the shop reconditioning processes, however the results can be highly variable. Recoverables can be controversial since generally shop production of a recoverable can result in a net credit to shop operations. It is recommended that each operator make individual Recoverable classification decisions based on sound economic analysis.

- **Raw Material Inventory:**

Raw materials are the basic materials that a manufacturing company buys from its suppliers and that are used by the former to convert them into the final products by applying a set of manufacturing processes. For example, aluminum scrap is the raw material for a company that produces aluminum ingots. Flour is the raw material for a company that produces bread or pizza. Similarly, metal parts and ingots are the raw materials bought by a company that manufactures cars and crude oil is the raw material for an oil refinery.

- **Work in Progress (WIP) Inventory**

  Work in progress inventory can also be called semi-finished goods. They are the raw materials that have been taken out of the raw materials store and are now undergoing the process of their conversion into the final products. These are the partly processed raw materials lying on the production floor. And they have also not reached the stage where they have been converted into the final product.

- **Finished Goods Inventory**

  Finished goods are indeed the final products obtained after the application of the manufacturing processes on the raw materials and the semi-finished goods discussed above in the article. They are saleable and their sale contributes fully to the revenue from the core operations of the company.

4.1.3. PROCEDURE OF INVENTORY

1. District personnel whose position requires tool and equipment assignment will complete at "Tool and Equipment Inventory Form" (attached) for these assigned tools and equipment. The inventory list will identify all assigned storage area related tools and equipment for which the individual is responsible.
2. Tool inventories will be standardized wherever possible so that inventory equipment can be easily and readily assessed and accessed by all appropriate or authorized users. No additional stock shall be maintained in the appropriate tool and temporary materials or equipment to be utilized for a specific job or project.
3. Department Managers will assign to first line supervisors the responsibility for review and approval of completed inventory lists or changes to inventory items or quantities for all employees assigned district tools and equipment.

4. All District personnel assigned or utilizing District tools and equipment will be responsible for assuring their safe and proper use and will closely monitor their own assigned District tools and equipment on an on-going basis, making sure all lost or stolen equipment is reported to their supervisor for replacement.
5. Employees will submit to Supervisors a District "Tool Replacement Form" prior to requisitioning for replacement of worn, damaged, lost or stolen tools and equipment Worn or damaged tools and equipment will be sent to Stores for replacement.
6. The employee and their supervisor will conduct a full physical inventory twice a year. A full inventory requires that all tools and equipment be counted and verified and inventory forms completed and submitted for department head review. Department heads will submit a copy of inventory reports and a departmental inventory summary to the Purchasing Officer within 30 days of completion of bi-annual inventory.
7. Those items, which meet the District's capitalization criteria will be verified with the District's fixed asset records.
8. The purchasing officer will submit copies of bi-annual inventory reports to the General Manager twice a year.
9. Supervisors shall maintain inventory information for a minimum of two years. After this period, departments at their discretion may dispose of inventory records.
10. Upon termination of employment, all District tools and equipment will be accounted for and returned prior to receiving the final wage payment.

4.1.4. Benefits of inventory control

It is an established fact that through the practice of scientific inventory control, following are the benefit of inventory control:

1. Improvement in customer’s relationship because of timely delivery of good and service.
2. Smooth and uninterrupted production and hence no stock out.
3. Efficiency utilization of working capital. Helps in minimizing loss due to deterioration,
4. Obsolescence damage and pilferage.
5. Economy in purchasing.

6. Eliminates the possibility of duplicate ordering.

- **Responsibility**

It is the responsibility of each department head, or designee, to conduct and document an accurate inventory of all appropriate tools and equipment and maintain an inventory list or file by employee, location or appropriate identifiable storage area or cabinet.

- ***Equipment Labeling and Marking***

Prior to being placed into the equipment inventory, all equipment covered under this procedure will be inventoried and labeled with a unique SESD identification number. The identification number will be assigned only to the identified equipment and will not be reused if the meter is excised or disposed. Equipment that is no longer used or cannot be repaired will be removed from the inventory. Equipment received after the effective date of this procedure will be assigned a number that includes the date the equipment was received followed by a sequential number starting at 01 (e.g., 031407-01, 031407-02, etc.). BFEMS will ensure that duplicate SESD ID Numbers are not assigned to equipment.

Equipment received before the effective date of this operating procedure will be assigned a number that will incorporate all or part of the serial number or other manufacturer number as the unique SESD ID number.

- **Real Property Inventory**

✓ Real Property Inventory is conducted through use of a standardized database that collects basic information on all fixed assets with a replacement cost of $5,000 or more.

✓ These fixed assets include such items as buildings, roads, bridges, levees, water management structures, raceways, boardwalks, fences, and other structures and facilities. Data is collected annually and reported to the General Services Administration.

✓ A key feature of this data collection effort is the estimating of the replacement cost of each individual property item.

✓ The Real Property Inventory (RPI) database is posted to the Service's intranet, and authorized personnel may update records throughout the year**.**

✓ **However, a comprehensive review is required followed by update during preset time (say September of each year). The Director annually provides guidance for conducting the required inventory update in a memorandum to all Regional Directors.**

Purpose of inventory

To establish a formal method of strengthening controls and safeguarding tools and equipment most vulnerable to theft and loss by identifying inventory units, assigning responsibility for and frequency of verification and documenting loss.

Objectives: to ensure that controls are in place for safeguarding District tools and equipment inventory.

An inventory of tools and equipment will be maintained and updated on a regular basis. These inventories will include hand tools, power tools, pneumatic and hydraulic tools and equipment, measuring and testing equipment, portable generators, compressors, electric and electronic tools and equipment and TV, video and camera equipment.

4.2. Documenting / recording inventory results.

4.2.1. Introduction to Maintenance Documentation

Maintenance documentation is a small, but very important, part of the total capital equipment procurement effort. In order to avoid the problems caused by inadequate documentation, it is important to understand the end user needs and what information is contained in an effective documentation package.

This article provides an overview of the needs of the operators and maintenance technicians, and a checklist of specific information that should be covered in an effective documentation package.

A maintenance technician needs to:

- ✓ Understand the nuts and bolts of how each machine operates,
- ✓ Understand the control system that ties the machines together,
- ✓ Know how to effectively troubleshoot the process,
- ✓ Know how to effectively troubleshoot and repair the individual machines,
- ✓ Perform routine maintenance, and
- ✓ Perform setups and changeovers.

- **Operator Level Documentation Checklist**

The ten most important features of an effective operator level documentation package are listed.

- ✓ Accurate safety information - should provide a list of all the hazards associated with the process, identify e-stop locations and zones, identify electrical disconnects, and identify air shutoffs.
- ✓ Basic process flow descriptions - should provide a process overview flow diagram that identifies the function of each component.
- ✓ Plant specific component operation descriptions - should provide descriptions of each component at the level that supports the understanding of task specific information provided in the SOPs (Standard Operating Procedures) and changeover instructions.
- ✓ Clear and concise descriptions of all operator controls - should locate each control panel and describe the controls. Where touch screens panels are used, it is useful to have screen hierarchy diagrams and a description of the functions that are performed at each screen.
- ✓ Symptom-based troubleshooting and tips - should locate and describe the process alarm annunciates. It should also provide tables listing possible alarm messages with guidance for responding to each alarm.

- Quality task list - should identify the quality tasks and reference the documents needed to perform each task.
  - ✓ Operator maintenance SOPs and job aides
  - ✓ Critical process control settings SOPs and job aides
  - ✓ Line cleaning SOPs and job aides
  - ✓ Changeover SOPs and job aides

4.2.2. Maintenance Level Documentation

Maintenance documentation builds on the operator documentation.

The ten most important features of an effective maintenance level documentation package are listed.

- Detailed component operation descriptions - should identify the major components for each machine, and describe the function and operation of each component at a level that supports troubleshooting.
- Clear and concise descriptions of all maintenance controls - should locate each control panel and describe the controls.

- Process control information, such as:
  - ✓ Control program sequence and architecture
  - ✓ Control device identification and function
- Detailed electrical, pneumatic, and hydraulic circuits
- Process level symptom-based troubleshooting and tips - should include basic troubleshooting approaches, information on what triggers annunciated faults, and guidance for responding to each alarm.
- Preventive maintenance activities and intervals
- Recommended lubricants and lubrication frequencies
- Recommended spare parts and quantities
- Changeover instructions and settings
- An OEM documentation library and index

Applied Performance Strategies supports OEMs and customers in the design and development of user documentation and training courses. We can assist you with OEM documentation specifications, job task analysis, plant specific training manuals, SOP and job aide development, training course design and presentation

4.2.3. Record maintenance

✓ Identify purpose(s) of records to be maintained in relation to customer requirements, quality system or production requirements.

✓ Identify requirements for completion of workplace records in accordance with workplace procedures.

✓ Record and collate information ensuring appropriate information and any samples are included in an appropriate manner.

✓ Orally reporting routine information

The 4 basic rules for record keeping are:

✓ Useful — don't waste your time keeping records you will never use.

✓ Easy to use — Simple and neat to encourage you to use the system.

✓ Accurate — Bad records can lead to poor decisions.

- ✓ Compulsory – These are the records you are required to keep by law e.g. financial records for tax returns.

Sample project report

It is a general problem that 'How the maintenance record may be maintained? Most of the persons follow their own system. Here one project report with details is mainly applicable.

SI. No	Machine No .given by maintenance section	Name of the machine/parts	Manufacture's machine No. make & type/No.	Store DSR No.	Person holding the change of machine/equip.
1	2	3	4	5	6

Instruction for form

Column No.1:-

Serial number as usual 1, 2, 3…should be noted. Start these entries from drilling machine, bench grinder, lathe, milling .planer…etc.

Column No.2:-

This column is more important for the purpose of maintenance activity. Here maintenance section has to denote the code number of the machine which will be used as further reference number. This code should be given in following forms.

i. writes abbreviation (letter symbol)of the machine

ii. Next the serial No. (In continuation) of the particular category of the machine

Example: - LAC/12 Here LA is an abbreviation for lathe. Then letter C stands for center lathe.12 are the serial No. for the lathe.

Column No.3:- Write the name of the machine or equipment with its sub category.

Column No.4:- Name of the manufacturer of that machine

ii. Their machine No.

iii. Type of the machine/Equipment or code used by manufacturer

Column No.5:- Write the store DSR No. with date

Column No.6:- Keep more space for this column.

Write the name (initial) of the person (Instructor) who holds the physical charge of that machine. At the beginning the first person name should be written in ink. Subsequently, the charge may be changed. Write these names by pencil.

- Stock Records

Stock records provide a very useful way of monitoring stock in your store. Like other inventory management tools there are many systems being used. The aim is to provide up to date information about each product within the store.

A typical stock record system includes the product:

1) Name 2) Number 3) Size

In addition the stock record would include:

1) Amount on hand
2) Minimum stock level
3) Amount on order
4) Retail price
5) Cost price

These systems can be manual or electronic. The more sophisticated electronic systems may also include an automatic reorder function. Like any documentation accuracy and regularly updating information is the key to its usefulness.

Table :4.1 *Sample stock record sheet*

Product Name	Product number	Size	Qty on hand	Min. stock level	Qty on order	Retail price	Cost price
Breeze powder	30387623	250gm	45	30	12	45.95	28.90
Dymo liquid	92837402	175ml	32	15	6	23.75	10.50
Placid capsules	38263014	275gm	12	6	3	12.45	5.98

. Documentation

Your inventory control system and the outcomes of the stock take provide a range of useful and up to date information. These documents help you to identify the current state of the store's inventory with regard to:

- ✓ Fast and slow moving stock
- ✓ Stock turn
- ✓ Damaged stock

4.3. Storing tools and equipment.

4.3.1. Introduction

If you're like most people, you probably have a wide variety of tools stored in various places around the house. Maybe you have random screwdrivers and hammers stored in the basement, garden tools like rakes and hoes in the garage, and power tools stuffed in the tops of closets. If you aren't storing these tools properly, it's possible they could get damaged and break- or even just simply lost! What's worse than not being able to find a screwdriver when you need one?

You have to work with the space you have. Maybe you hang tool on pegboards, maybe you store them in boxes, bags, or chests, or maybe you keep them in drawers or on shelves in your shop. Whatever works for you is best.

- **Functions of stores: The functions of stores can be classified as follows:**

1. To receive raw materials, components, tools, equipment's and other items and account for them.
2. To provide adequate and proper storage and preservation to the various items.
3. To meet the demands of the consuming departments by proper issues and account for the consumption.
4. To minimize obsolescence, surplus and scrap through proper codification, preservation and handling.
5. To highlight stock accumulation, discrepancies and abnormal consumption and effect control measures.
6. To ensure good housekeeping so that material handling, material preservation, stocking, receipt and issue can be done adequately.
7. To assist in verification and provide supporting information for effective purchase action.

4.3.2. Tool Storage Ideas and Tips

By taking proper care of your tools, you'll ensure that they'll remain in good working order and will be ready for use when you need them. No matter what kind of tools currently in your possession, it's important to take some time organizing your collection so you're protecting your investment. You'll want them in good condition when it's time to start that next DIY project!

Regardless of where you choose to store your tools, there are a few basic tool storage ideas and tips to keep in mind before you put them away.

- **Follow the instructions.** Some manufacturers will have specific instructions for how to store tools, so consult your manual first and foremost. It's important to follow these instructions, especially for larger power tools like saws or drills, so they remain in good working condition.
- Clean them off. Tools should be cleaned each time you use them. Wipe them down with a damp rag or towel to get rid of any dirt, dust, grease or debris. Make sure garden tools are free of mud and grime. Everything should be completely dry before placing it in storage to avoid rust developing.
- Use original cases: Power tools usually come in hard, plastic cases, and it's recommended to keep these cases for storage whenever possible. These cases will keep your power tools in storage safe from extreme conditions, plus all the parts can be stored right alongside them in the case. No more lost power cords or chargers!
- Invest in sturdy storage containers. If you don't have the original container, or you're storing smaller hand tools, invest in some sturdy containers. This will not only keep your tools organized, but also allows them to be easily transportable to your next project area.
- Store in a safe, dry place.: Along with having the right containers, another way to protect your tools is to ensure that area you're storing them in is safe and dry. Water or humidity can cause damage to tools, especially power tools.
- Go vertical. Tools should never be stored on the ground. Invest in some shelving for smaller tools, or hang pegboard along your workbench or on a wall in your garage. You'll be able to hang things like wrenches, hammers, box cutters, garden equipment and many other tools so they'll be easy to access at any time.

How to Store Tools & Equipment

- Zip those home projects out in no time with well-organized and properly stored tools and other home maintenance equipment. Garden supplies, vehicle implements and liquids and home tools such as hammers, saws, nails and power equipment all benefit from proper care and storage. These items organized efficiently make home projects easy, and make clean up even easier.
- You have to work with the space you have. Maybe you hang them on pegboards, maybe you store them in boxes, bags, or chests, or maybe you keep them in drawers or on shelves in your shop. Whatever works for you is best. Pegboards make a great storage system for tools. They let you see all your tools at a glance and they can make use of wall space in a pretty efficient way. If you don't have enough wall space, though, you can still take advantage of pegboards by building a hinged system, a rolling pegboard, or even a portable pegboard storage system.

  The most important purpose served by the stores is to provide uninterrupted service to the maintenance and repair divisions. Further, stores are often equated directly with money, as money is locked up in the stores.

  Steps to Prepare and Store Tools

  1. To keep tools tidy, it should be cleaned after use and wiped down with a rag or towel to be sure that they are free of dirt, grease and debris.
  2. After cleaning, damage or defects should be checked. If the tool cannot be repaired, it should be thrown to away.
  3. Any soil and dirt should be scraped away from the metal surfaces with an approved solution. Before placing in storage it should be dried with a towel or rag.
  4. The metal parts of the tools should be coated with a lubricant protector spray.
  5. Tools is does not directly stored on the ground both small hand and power tools should be Placed on shelving.
  6. Short-handled tools should be stored in a plastic bin or box. All surfaces of Power tools should be cleaned and completely dry before storage and Spraying lubricants

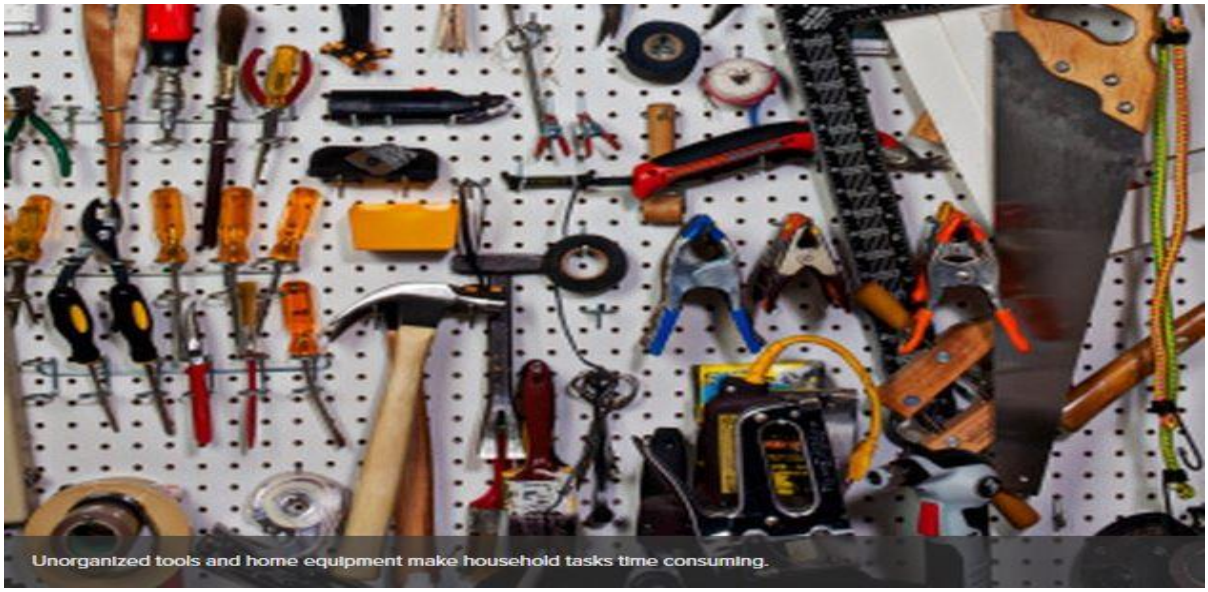


Figure 4.1 Stored Tools need to be Prepare

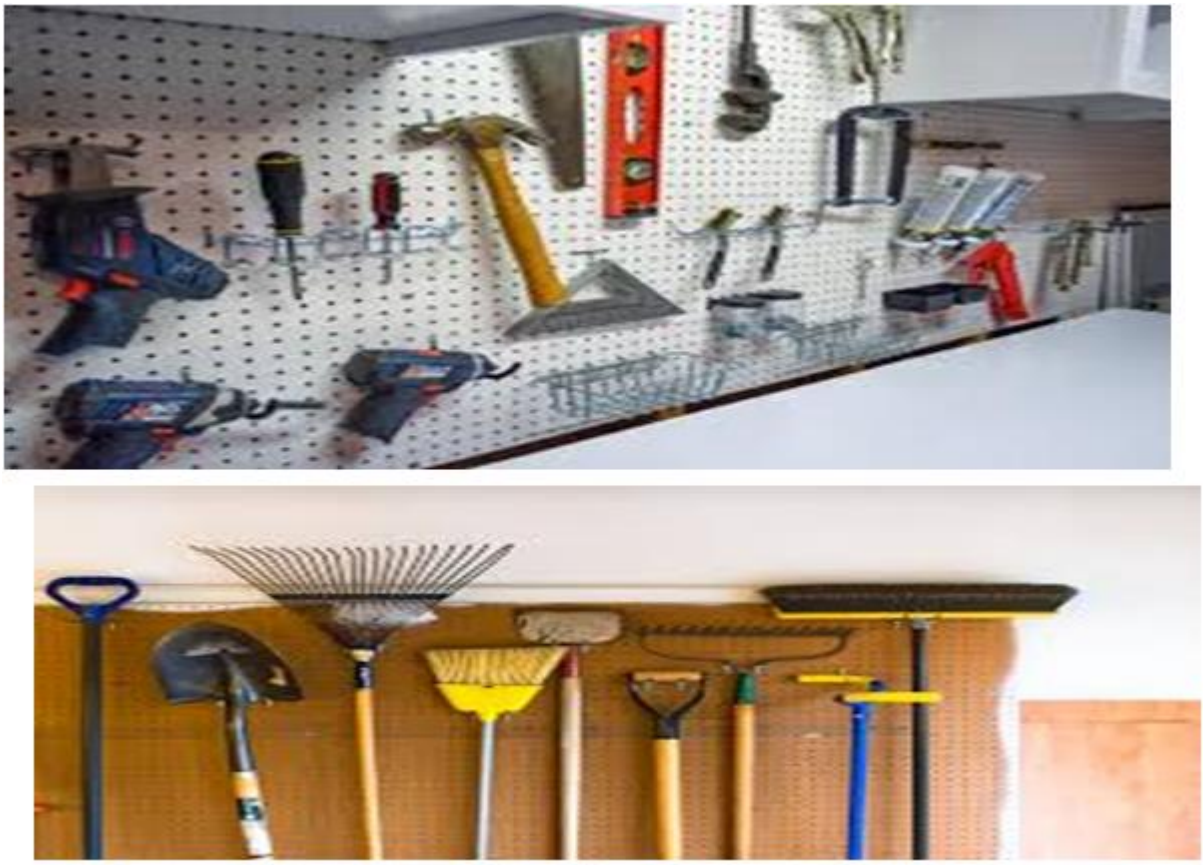


Figure 4.2 How to Prepare and Store Tools

- **Functions of stores**: The functions of stores can be classified as follows:

- ✓ To receive raw materials, components, tools, equipment's and other items and account for them.
- ✓ To provide adequate and proper storage and preservation to the various items.
- ✓ To meet the demands of the consuming departments by proper issues and account for the consumption.
- ✓ To minimize obsolescence, surplus and scrap through proper codification, preservation and handling.
- ✓ To highlight stock accumulation, discrepancies and abnormal consumption and effect control measures.
- ✓ To ensure good housekeeping so that material handling, material
- ✓ preservation, stocking, receipt and issue can be done adequately.
- ✓ To assist in verification and provide supporting information for
- ✓ effective purchase action.

Self-Check -4: Written Test

Directions: Answer all the questions listed below. **True or False Item**

1. The metal parts of the tools should be coated with a lubricant protector spray.

2. Keeping tools properly storing, cleaning, and maintaining does not saves time and money.

3. Provide adequate and proper storage is preserve various items.

I. Choose The Best answer

1. Which one is the principle of tool Storage mechanism .

   a. Follow the instructions c. Clean them off

   b. Use original cases C. Bread Store in a safe, dry place e. all. Refined oil

2. Work in progress inventory

   a. Raw material C. Final product

   b. Semi-finished product d. All

3. Which of the following is benefits of inventory control

   a. Economy in purchasing. b. Eliminates the possibility of duplicate ordering

   b. Improvement in customer's relationship C, all e. None

4. which one is false about procedure of inventory

   a. Tool inventories will be standardized

   b. The inventory list will identify all assigned storage area related tools and equipment

   c. The employee and their supervisor will conduct a full physical inventory twice a year.

   d. Supervisors shall maintain inventory information for a minimum of one years e. none

II. Give Short Answer

1. Write 4 basic rules for record keeping?

2. What is inventory

3. What is the aim of Stock Records?

Operation Sheet-4

1. **Operation Title: Inventory tools and equipment**
2. **Instruction: Select one of the work shop tool room and follow the rule to make an inventory of hand tool .**
3. **Purpose: To calculate the new value of equipment stock (using up-to-date prices) which will be used for calculating budgets and By using check-in and check-out features, we can reserve the equipment that we need in the future instead of scrambling to look for the assets.**
4. **Required tools and equipment:**
   - ✓ **A4 Paper**
   - ✓ **Pencil / pen**
   - ✓ **Computer**
   - ✓ **Ladder**
5. **Precautions: Use Proper PPE For tool and Materials**
6. **Procedure for the task**
   - ✓ **Step 1: Follow 5s Rule**
   - ✓ **Step 2: List tools in the right balanced form**
   - ✓ **Step 3: Make inventory**
   - ✓ **Step 3: Make Identification card for each Items.**
   - ✓ **Step5: Store in a safe, dry place.**
7. **Quality Criteria: the given geometrical shape is measured with 1mm accuracy**
8. **Precautions: Keep tools from damaging or broken out during inventory .**

LAP Test 4: Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 hour.

Task1. Make an Inventory of tools and equipment on your mini tool room in Manufacturing work shop and store them in a well-defined area..

Reference Materials

- B.S Dhillon (maintainability, maintenance, and Reliability for Engineers)
- Ricky Smith and Keith Mobley (Industrial machinery Repair: Best maintenance practices pocket guide)
- Lindley R.Higgins, P.E, R.Keith Mobley (Maintenance Engineering Hand Book) Mc Graw-Hill standard Hand Book
- Maintenance engineering handbook, Lindley R. Higgins, P.E, Sixth Edition, New York Chicago San Francisco Lisbon London.
- Ricky Smith and Keith Mobley (Industrial machinery Repair: Best maintenance practices pocket guide)
- https://www.researchgate.net/publication/315465348_Safety_in_Maintenance_An_Improvement_Framework
- https://wwwSafe Maintenance | Health and Safety Executive Northern Ireland (hseni.gov.uk)
- https://www12 Safe Maintenance Rules - Dietsmann
- https://wwwHazard and Risk : OSH Answers (ccohs.ca)

Profile of Participants on TTLM Development

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