Mechanics Level - II

Based on March 2022, Curriculum Version 1

Module Title:-Maintaining and Repairing Tools, Equipment and mechanical machine drive

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Acronyms

PM Preventive Maintenance

CM Corrective Maintenance

Introduction to the Module

In mechanics filed; Maintain and Repair Tools, Equipment and mechanical machine drive helps us to carrying out compulsory and routine safety and maintenance checks on machines and equipment, calibrate measuring instruments and tools in a manufacturing setting.

This module is designed to meet the industry requirement under the mechanics occupational standard, particularly for the unit of competency**:** Maintain and Repair Tools, Equipment and mechanical machine drive

This module covers the units:

- Maintenance safety `
- Maintenance programmed
- Preventive maintenance
- Inventory tools and equipment

Learning objectives of the Module

- Perform Maintenance safety
- Apply Maintenance programmed
- Apply Preventive maintenance
- Apply Inventory tools and equipment

Module Learning Instructions

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit One: Maintenance Safety

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

- check Tools and machines/equipment
- Safely operational procedures.
- Calibrate measuring instruments
- non-functional tools, instruments and equipment
- Status/report Record

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 And Machines/Equipment
- Apply Safely Operational Procedures
- Check Calibrate measuring instruments
- Segregate Non-Functional Tools, Instruments And Equipment
- Perform Status/Report Record

1.1. Check Tools and Machines/Equipment

1.1.1Definition of Maintenance

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

- Increase availability of a system
- Keep system's equipment in working order

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

Human reliability: The probability of accomplishing a task successfully by humans at any required stage in the system operation with a given minimum time limit (if the time requirement is stated)

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)

Human performance: A measure of human functions and actions under some specified conditions

Active redundancy: A type of redundancy in which all redundant units are functioning simultaneously

1.1.2Types of maintenance

British Standard 3811 classified maintenance as the followings

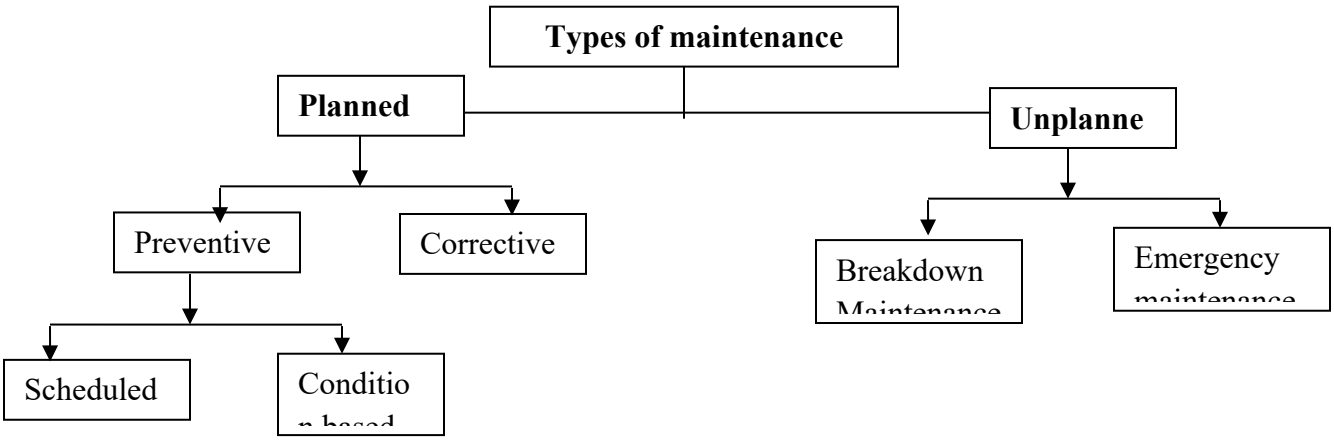


Fig1.1. **Types of maintenance**

- **Unplanned Maintenance**: "The maintenance carried out to no predetermined plan."
  - ✓ **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"
  - ✓ **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
- **Planned Maintenance**: "The maintenance organized and carried out with forethought, control and the use of records to a predetermined plan."
  - ✓ **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.

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

Preventive Maintenance

Preventive maintenance (PM) is an important component of a maintenance activity. Within a maintenance organization it usually accounts for a major proportion of the total maintenance effort. PM may be described as the care and servicing by individuals involved with maintenance to keep equipment/facilities in satisfactory operational state by providing for systematic inspection, detection, and correction of incipient failures either prior to their occurrence or prior to their development into major failure

Elements of Preventive maintenance

Inspection: - Periodically inspecting materials/items to determine their serviceability by comparing their physical, electrical, mechanical, etc., characteristics (as applicable) to expected standards.

Servicing: - Cleaning, lubricating, charging, preservation, etc., of items/materials periodically to prevent the occurrence of incipient failures

Calibration: - Periodically determining the value of characteristics of an item by comparison to a standard; it consists of the comparison of two instruments, one of which is certified standard with known accuracy, to detect and adjust any discrepancy in the accuracy of the material/parameter being compared to the established standard value.

Testing:- Periodically testing or checking out to determine serviceability and detect electrical/mechanical-related degradation.

Alignment: - Making changes to an item's specified variable elements for the purpose of achieving optimum performance.

Adjustment: - Periodically adjusting specified variable elements of material for the purpose of achieving the optimum system performance. Installation:- Periodic replacement of limited-life items or the items experiencing time cycle or wear degradation, to maintain the specified system tolerance.

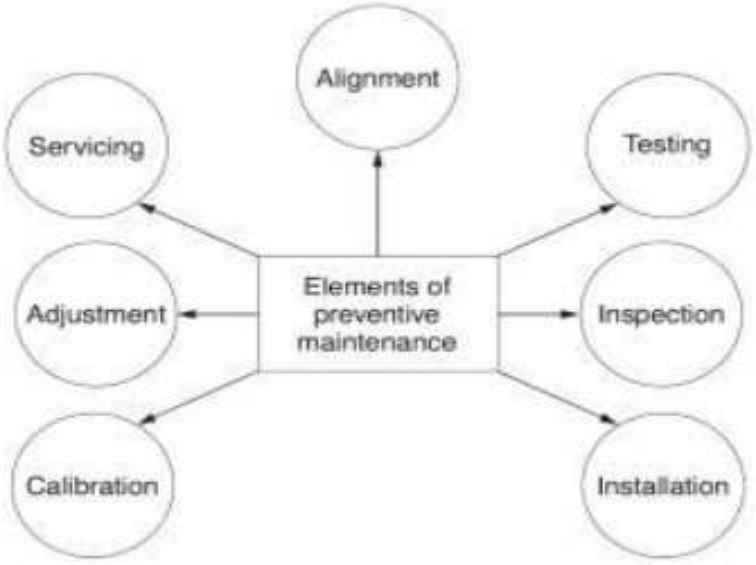


Fig1. 2, Elements of preventive maintenance

1.1.3Tool/ Equipment Inspection Schedule

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 1.1Sample of checking /equipment in the case of lathe

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 daily checks

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.**

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

A. Check before start the motor.

- Clean-up of machine: Dust, chips and other articles 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.

A. 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.

B. 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:

  a. Must stop operation when you leave the machine.

  b. When changing main spindle speed or feeding speed stop running first.

  c. All tools and products are strictly not allowing to be left on sliding surface of bed.

C. 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.

D. 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.

E. 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.

F. 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 spindle and 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.

G. Yearly inspection

- Positioning and levelling: According to the inspection regulation, recheck the positioning and levelling after 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:
  Re-examine the insulating materials and clearance fit & lubrication of all bearings.

- Inspection for appearance:

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

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

Maintenance inspection Checklists

A. Checklists

Checklist can help you identify the hazards related to maintenance of tools/equipment and take the necessary preventive measures. Depending on the power source, different checklists may be necessary

TABLE 1.3 Sample Checklists

General questions	Yes	No
Is there a maintenance plan?		
Are portable tools periodically tested and labelled with the date of test?		
Are instructions and operating manuals available?		
Are damaged tools labelled "do not use"?		
Are maintenance records kept of all tools that are used on the site?		
Are all tools used at the workplace in good condition and clean?		
Are all tools properly lubricated?		
Are blades, bits, and other cutting parts sharp and well fixed, and not worn, cracked or loose?		
Are tools stored in a dry and safe place?		
Are blades removed when tools are being transported, stored or not in use?		
Are maintenance workers trained in safe working procedures?		

Sample 2

The following inspection checklists are only examples. It is always best to design checklists or inspection sheets that are specific to your firm or operation.

Inspections should be divided into two categories:
(1) What to "look at" and
(2) What to "look for".

What to look at:

- Atmospheric surroundings: hazardous conditions of dust, gases, fumes, sprays etc.
- Chemical substances: all liquids and solids that are toxic in nature.
- Containers: all objects for storage of materials, e.g., barrels, boxes, bottles, cans etc.
- Electrical conductors and apparatus: wires, cables etc.; switches, controls, transformers, lamps, batteries, fuses, etc.
- Engines and prime movers: sources of mechanical power.
- Firefighting equipment: all firefighting equipment and early detection systems, plus related structures such as sprinklers, fire plugs etc.
- Guards and safety devices: all removable and fixed guards, and safety devices or attachments, excluding personal protective apparel.
- Hand tools-all kinds: equipment that is held or carried when in use.
- Hoisting equipment: air hoists, hydraulic lifts, jacks, electric hoists, wire ropes, chains.
- Flammables and explosives.
- Machinery and its parts: power equipment that processes or modifies materials, i.e. agitators, grinders, forging presses, pulverizing machines, drilling machines etc.
- Mechanical and power transmission systems: shafts, bearings, gears, pulleys, drums, cables, belts, sprockets, ropes, chains etc., when used to transmit power.
- Overhead structures and equipment: any structural part of equipment that may fall from above.
- Personal protective apparel: goggles, gloves, aprons, leggings, etc.
- Pressure vessels, boilers and pipes: objects subject to internal pressure from compression of liquids or gases.
- Pumps, compressors, blowers and fans: objects that move or compress liquids, air, or gases.
- Shaftways, pits, sumps and floor openings: any type of opening into which a person may stumble or fall.
- Walking or standing surfaces: floors, aisles, stairs, platforms, ramps, roads, scaffolds, ladders etc.
- Warning and signal devices: direct communication systems such as radio, telephones, buzzers, bells, lights etc.
- Vehicles and carrying equipment: trucks, cars, motorized carts, and non motorized equipment for transporting materials.
- Miscellaneous: other potentially hazardous objects or conditions that do not fall into the above categories.

What to look for:

Guards

- Missing guards on gears, belts, pulleys and shafts
- Missing guards on power saws

Different parts of equipment must be checked by the manufacturer Manual Example: Adjustments of safety guards, stops, wear pads, tool holders, nipping up glands, scrapers and aprons must be checked

B. Tools must be checked

Before the tool is put into use for the first time After servicing and changing part sat regular intervals appropriate for each tool. The period between inspections can vary, depending on the type of tool, the conditions of use and the environment. Portable equipment, including inspection intervals.

C.Final check

When maintenance is complete workers have to check if the maintenance has left the portable tools in a safe and functioning condition:

Test the functionality of the tool

Replace all guards and safety devices

Record your inspection and actions, sign out and pass the tool to the worker or store it safely.

Scheduled Inspections and Maintenance check

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 1.4Maintenance Service Checks

Date	Equipment	Service Performed	Performed By

1.2. Safely operational procedures.

When servicing equipment, hazards not related to your process operation are likely to be introduced. For this reason, it is important to prepare written servicing procedures that include the following:

1.2.1 Operational procedure

- A clear, step-by-step procedure, in checklist form, for controlling hazardous energy:
  - ✓ Preparing for shutdown
  - ✓ Shutting down machine, process or equipment
  - ✓ Isolating energy to the machine, process or equipment
  - ✓ Applying lockout devices
  - ✓ Controlling stored energy (de-energization)
  - ✓ Verification of isolation
  - ✓ Release from lockout control
- Hazards identification
- Selection and specification of personal protective equipment:
  - ✓ appropriate for the hazard
  - ✓ proper fit
- Selection and specification of tools to be used:
  - ✓ right tool for the job
  - ✓ In good condition

- ✓ Appropriate for the environment (e.g., non-sparking tools in flammable atmospheres)
- ✓ Ergonomic design

- Step-by-step procedure for disassembly
- Step-by-step checklist for inspection of components (to establish a baseline for reliability)
- Identification of hazards associated with sub-procedures:
  - ✓ entering and working in confined spaces
  - ✓ welding in open and confined spaces
  - ✓ removing insulation
  - ✓ cleaning
  - ✓ handling and using solvents
  - ✓ erecting temporary structures
  - ✓ using portable equipment
  - ✓ using ladders
  - ✓ abrasive blasting
  - ✓ painting
- Disassembly of small-scale equipment
- Reassembly of small-scale equipment
- Support and disassembly of large scale equipment
- Support and reassembly of components of large scale equipment
- Use of hoists and mobile working platforms

1.2.3. Training

Maintenance personnel are often involved in a complex and changing set of problems. Therefore, they need more thorough training in accident prevention than regular workers. Serious consequences to maintenance and other workers can result from not following established maintenance procedures (e.g., use of work permits, lockout procedures, confined space entry procedures). Ensure that your maintenance personnel are well trained in, and can demonstrate that they understand, all relevant procedures.

Also provide training in: Hazard identification, Selection, use, and care of equipment, machine tools, personal protective clothing/equipment, etc., required to be used First-aid and life-saving techniques

It is a good practice to call the maintenance crew (team) together at the start of each job, in order to discuss the hazards involved and the method of doing it safely.

In the course of their daily work, members of the maintenance crew travel throughout the plant, becoming familiar with every machine and process. If properly selected and trained, they can do much to identify and correct unsafe conditions

1.3 Calibrate measuring instruments

1.3. 1 General Description of Calibration

Calibration is the comparison of measurement results provided by a device under test with those of a calibration standard of established accuracy in measurement technology and metrology. Known-accuracy measurement equipment, a device that generates the amount to be measured, such as a voltage or a sound tone, or a physical arte-fact, such as a meter ruler, could be used as a standard. The calibration is just a comparison of measurement between the test equipment to the standard equipment. The comparison could lead to following outcome;

1. No significant error is found in test equipment.
2. Significant error found but no adjustment has been made.
3. Significant error found and slight adjustment was made to reduce the error.

1.3.2. Types of Calibration

Calibration of measurement equipment can be done on a variety of instruments in a variety of industries. Let's have a look at some of the most common calibration procedures

A. Electrical Calibration

Electrical calibration is the process of ensuring that any instrument that measures or tests electrical properties such as voltage, current, resistance, inductance, capacitance, time, and frequency is operating properly. Electrical calibration is a high end process which needs the use

of precise instruments or calibrators to assess the performance of important criteria in other devices referred to as units under test.

The following instruments are frequently submitted for electrical calibration:

- Data loggers
- Electric meters
- Multi-meters
- Oscilloscopes
- Frequency counters
- Insulation Testers

Fig**1.3Electrical Calibration**

B. . Mechanical Calibration: (Types of Calibration)

Mechanical instruments are prone to drift as a result of repeated use, mechanical stress, and exposure to fluctuating air conditions etc., and because of such condition the mechanical calibration is the much needed remedy to overcome the error induced in the equipment's. Mass, volume, density, force, torque, dimension, angle, flatness, and vibration are the major properties that are calibrated during mechanical calibration in a temperature-controlled atmosphere.

The following are some of the most commonly tested mechanical calibration instruments:

- Accelerometers
- Scales/Balances
- Force Gauges & Load Cells
- Micrometers, Venire, and height gauges

Fig1.4 **Mechanical Calibration**

C. Pressure Calibration

Pressure calibration is a critical operation performed in a variety of industries where measurement equipment is required to monitor process performance and safety, with gas and hydraulic pressure being the most common measurements. Many businesses are now certified to quality standards such as ISO9000. There is a different procedure that must be followed in order to maintain quality standards, and because many industrial processes depend upon pressure measurement, pressure calibration is a crucial aspect of a company's quality assurance.

Pressure calibration is carried out using a different pressure balances and calibrators, as well as high-accuracy pressure sensors and pressure gauges.

Fig1.6Pressure Calibration

1.4. Non-functional tools, instruments and equipment

1.4.1Classify non-Functional and functional tools

Tools are very useful to us in our homes especially to our job. But tools that are no longer functional may cause harm.

A. Make an inventory of functional and non-functional tools in your shop.

B. Classify your tools according to their function.

1.4.2. 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.
- **Performanc**e. 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.

1.4.3 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

1.4.4 Non-functional tools and equipment

Are those that are not able 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 jaw

Fig1.6 non-functional tools

- Functional tools and equipment are those that are in good condition and can perform its regular functions. Examples of these are the following Standard screw driver Philips Screw Driver Combination pliers

Fig 1.7 non-functional tools

1.5Record

1.5.1 Introduction

- It will be necessary to record any unsafe actions or conditions observed during your inspection tour.
- A well-written inspection report 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.
- 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.

1.5.2. 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.

How does the ABC rating system work?

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.

"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**.**

"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, e.g.

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.

"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, e.g.

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.

Oxygen and acetylene cylinders stored together, caps on, good ventilation, fireproof surroundings.

Hazard Rating Lists

It may be helpful if the people involved in doing inspections (e.g. employer representatives, worker representatives, health and safety committee members) develop a hazard rating list to use during workplace inspections. If this list is used for all inspections, then hazards will be rated consistently on inspection reports no matter who is inspecting or when inspections are done.

1.5.3. Note all items 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:

Management

Joint health and safety committees

Worker health and safety representatives

Supervisors

Safety coordinator

Maintenance

Others?

1.5.4. Record keeping

The foundation records for preventive maintenance are the equipment files. In a small operation with less than 200 pieces of complex equipment, the records can easily be maintained on paper. The equipment records provide information for purposes other than preventive maintenance. The essential items include:

- **Equipment identification number;**
- **Equipment name;**

- Equipment product/group/class;
- Location;
- Use meter reading;
- PM interval(s)
- Use per day;
- Last PM due;
- Next PM due;
- Cycle time for PM;
- Crafts required, number of persons, and time for each;
- Parts required.

1.5.5 Reports

Keeping inspection records is important. Past inspection records show what has been previously identified. They also show what an earlier inspection team concentrated on and what areas it did not inspect. Do not simply repeat or copy previous inspection results. Use the older inspection reports to help look for issues, and then determine whether recommendations were implemented. Note if the changes have been effective.

1.5.6 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.

1.5.7 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:

A = Major - requires immediate action
B = Serious - requires short-term action
C = Minor - requires 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: _____

Observations								
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: _____

Table1.5 Workplace Inspection Report

1.5.8. 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 rates over time, deterioration based on pH, and record of cleanouts. Other fields may be added, including bacterial and fungal levels, water hardness, conductivity and TDS.

Table **1.6 Daily Coolant Report Cards**

DATE	APPEARANCE	BRIX	pH	GALLONS COOLANT ADDED	GALLONS WATER ADDED	DATE LAST CHANGED	INITIALS

1.5.9Preventive Maintenance Recording Form

Table **1.6 Preventive Maintenance**

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.

1.5.8. Preventive Maintenance Recording Form

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.

Fig 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	

Maintenance Schedule Matrix

Vehicle license Number	Year/Model	Schedule Number	Who does maintenance

Schedule number

1 Daily, 2. Weekly

Self check-1

Part -I choice

Directions: select the correct answer for the give choice.

1. Which one of the following is not an action of maintenance?

A. Servicing & Repair
B. Modification& Overhaul
C. Inspection and Condition verification
D. None

2. Which one of the following is not Unplanned Maintenance?

A. Emergency maintenance
B. Breakdown maintenance
C. Preventive maintenance
D. All

3. Which one of the following is not Planned Maintenance?

A. Preventive Maintenance (PM)
B. Corrective Maintenance (CM)
C. Breakdown maintenance
D. All

4. Which one of the following is not preventive Maintenance Activity?

A. Inspection
B. lubrication
C. Repair
D. Overhaul of equipments
E. All

5. The main objectives of maintenance is

A. Improve and ensure maximum utilization of maintenance facilities
B. Reduce the amount and frequency of maintenance
C. Improve maintenance operation
D. All

6. Which one of the following is not Advantage of preventive maintenance?

A. Avoid major break downs
B. Increased production
C. Less down time of plant
D. Increase life of plant
E. None

Part II: True or False

Directions: Say True or False

1. Functional tools and equipment are those that are in good condition and can perform its regular functions.
2. Tools are very useful to us in our homes especially to our job. But tools that are no longer functional may cause harm.
3. It will be necessary to record any unsafe actions or conditions observed during your inspection tour
4. A well-written inspection report will establish the location of the condition or action observed
5. Visual inspection is refers to the visual observation of an expert on the appearance of the tools and equipment

Part III: Short answer writing

Direction: Give short answer to the following questions

1. What is maintenance?
2. What is the difference between?
3. Write the main objectives of maintenance?
4. Define preventive maintenance (pm)?

Operation sheet-1

- **Operation:** Title: non-functional tools, instruments and equipment
- **Purpose:** identify non-functional tools, instruments and equipment
- **Instruction:** use visual inspection method identify non-functional tools, instruments and equipment
- **Required tools and equipment**

Personal protective equipment (PPE)

Precautions: Identifying Maintenance Hazards

Procedures:

Step 1- Conduct an inventory of tool and equipment.

Step 2-Wear. Personal Protective Equipment

Step 3-use visual inspection method identify non-functional tools

Step 4 -Record the number of non-functional tool and equipment

Step 5-Segregate tool that are serviceable or unserviceable.

Step 6-Report the number of tool and equipment that are non-functional but subject for repair.

Step 7-Label tool and equipment which are condemnable.

Step 9-Return tools and equipment in the tool cabinet as per operating procedures

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 3 hours.

Task 1: non-functional tools, instruments and equipment

Unit TOW: Maintenance Programmed

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

- Clean machines/equipment
- Consumable components.
- fluids and lubricants
- minor machine repairs
- machine moving parts

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:

- Cleaned and lubricant machines/equipment
- Remove /replaced consumable components
- Replace fluids and lubricants
- Perform minor machine repairs
- Adjust machine moving parts

2.1 Clean machines/equipment

2.1.1. Introduction

Cleaning of equipments, 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 decaling of big tube-nests, heat-exchangers and condensers etc. Steam cleaning is also used often for many components. Magnetizers have been developed (using permanent magnets or electromagnets), which can be clamped on the pipelines. The rust in water line or sludge in fuel lines get ionized and detached from the inner surface of the pipe lines and remain suspended or floating moving as long as magnetic field exists. By placing number of such magnetizers on the pipe length, the rust and sludge can be taken to the tank and removed. 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.

- **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. Then the machine would be useless as a production tool. All of us in the plant have an important role to play in an effective lubrication program. The foreman and machine operator can be sure of 'getting out the goods' only if the lubrication service man has properly lubricated the machine. In turn, the lubrication service man can lubricate his machines properly only if the engineer has properly designed the machine and specified the right lubricant for it. And in turn, the maintenance mechanic depends upon proper lubrication to keep the machines running. It is a programmed in which all of us have an important role to play.

2.1.2. Kinds of friction

Friction can be 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. Now to compare **fluid friction** with **solid friction**, if a film of oil is introduced between the same two surfaces, the peaks and valleys are filled up by the particles of oil. When a sufficient number of these particles of oil are placed between the two surfaces to produce a thick strong film, then the peaks and valleys slide by each other without inter-loading. When such surfaces either flat, curved or spherical, are kept apart by a fluid film, we have what we call fluid friction and these surfaces are

said to be lubricated. Therefore, in lubrication we actually reduce friction to a minimum by substituting **fluid friction** for **solid friction**.

Friction is governed by following two laws:

- ✓ The frictional force is proportional to normal loads.
- ✓ Friction is independent of the size of bodies.

- **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:

- ✓ Adhesive
- ✓ Abrasive
- ✓ Corrosive
- ✓ Fatigue

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

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.

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

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. VISCOSITY

Viscosity is defined as the internal frictional resistance offered by a fluid to change its shape or relative motion of its parts. An oil film placed between two parallel plates is shown in Fig. The lower plate is stationary while the upper plate is moved with a velocity v by means of a force P. The molecules of oil are visualized as small balls which roll in layers between two plates.

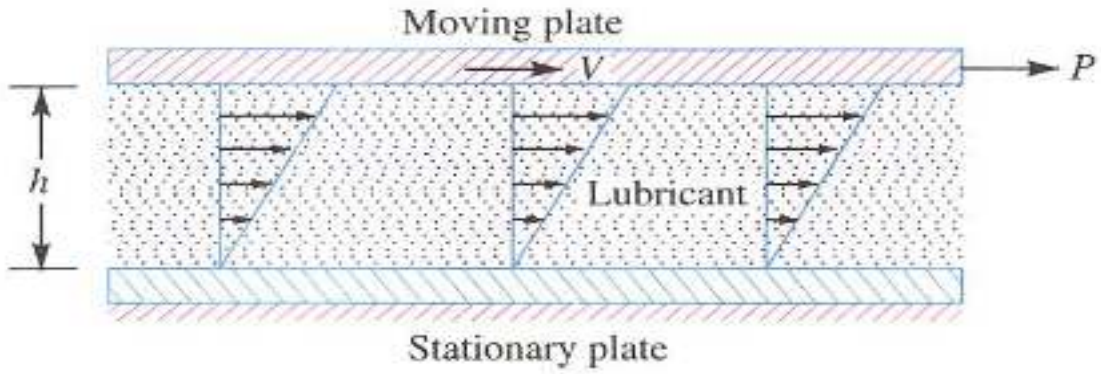


Fig.2.1

The oil will stick to both the surfaces, and therefore the layer of molecules in contact with the stationary plate has zero velocity. Similarly, the layer of molecules in contact with the upper plate will move with a velocity v. The intermediate layers will move with velocities which are proportional to their distance from the Stationary plate.

Note

- A low viscosity oil is thin and flows easily
- High viscosity oil is thick and flows slowly.
- As oil heats up it becomes more viscous (Becomes thin)
- If the oil is too thin (has very low *viscosity)* it will be forced out from between the moving parts, resulting in rapid wear.
- If the oil is too thick (*has very high viscosity)* it will flow very slowly to engine parts, especially when the engine and the oil are cold, resulting in rapid wear.

2.1.4. Lubricant properties

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.
- It should have thermal and oxidative stability.
- It should have good thermal durability.
- It should have antifoaming ability.
- It should be compatible with seal materials.
- It should be cheap and available in plenty.

2.1.5. Lubricant application methods

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

- **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.

- **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

- **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.

- **Ring, Chain, Oilers :**

These lubricators are applicable to horizontal rotating shafts. The ring or chain oiler encircles the shaft and turns freely on it. Each provides an automatic oiling system by bringing oil to the bearing clearance from the oil reservoir.

Initial cost depends on housing for the bearing that must be built to contain these lubricators. Maintenance cost is usually low.

Typical applications include electric motors, fans, blowers, compressors, and line shaft bearings.

- **Pad-and Waste-type Devices :**

These lubricators use the oil-retaining properties of felt pads and waste packing to provide the lubricant to a bearing. Oil is lifted from the reservoir by capillary action in the wicking material. This system requires an appropriate housing, which accounts for a large initial cost. Maintenance cost generally depends on the environment in which they are used. They are generally low. This is often used for rail, road and traction motor bearings.

- **Positive Force feed Lubricators :**

It consists of one or more plunger-type adjustable-stroke pumps mounted on a common reservoir. The pumps are driven from a rotating shaft through a mechanical linkage. It may have a separate drive motor.

Initial cost is high, but maintenance cost is low. The lubricant is free from contamination.

Typical applications include steam cylinders, bearings for diesel and gas engines, oil-drilling rigs, etc.

- **Air-oil Devices :**

Air-oil devices operate by injecting or pumping oil drop-by-drop into an air stream. The oil is drawn by the aspiratory action of compressed air passing through an orifice or control valve.

The initial-cost is very high. However, maintenance costs are low and efficiency of the devices is high. These are well suited for high speed bearings, enclosed gears, slides and table ways.

- **Pressure Circulating Systems:**

Pressure circulating systems employ either gravity or pumps to develop the operating pressures necessary. Generally these are designed to lubricate a number of parts on the machine. Since oil is recalculated maximum economy is possible. Pressure circulating systems are built into the machine. Therefore initial cost is high. Maintenance costs are very low. Typical applications include steam-turbine bearings, reduction gears, steel-mill gear drives, mill bearings, paper-machine bearings and gears and internal-combustion engine

- **Centralized Lubrication Systems:**

Centralized Systems can be designed for oil or grease. A typical centralized system requires centrally located reservoir and pump, and permanently installed piping and distribution valves. These deliver measures quantities of lubricant at desired points. It can be either operated manually or automatically.

The piping and intricate dispensing valves make initial cost very high, but maintenance costs are very low. Initial cost is offset by dependability, durability, safety and resistance of system to contamination.

Centralized Systems are ideally suited for steel and paper mills, machine tools etc.

- **Built-in-Lubrication :**

Built-in lubrication refers to materials or components that do not require any external lubricating device. Materials such as oil saturated porous metals, graphite materials, poly-tetra-fluoro-ethylene (PTFE), nylon can rub together without a lubricant. These materials may be used for sleeve bearings, gears etc.

2.1.6 Classification of lubricants

All lubricants are classified into the following three groups:

- **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.
- **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.
- **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.

2.1.6.Functions of lubricant

- Separate moving materials from each other in order to prevent wear, scoring, and seizure;
- Reduce heat;
- Keep out contaminants;
- Protect against corrosion;
- Wash away worn materials.

Good lubrication requires two conditions: sound technical design for lubrication and a management program to assure that every item of equipment is properly lubricated.

2.1.8 Best Maintenance Lubrication Practices

When using a grease hand gun: always clean the end of the grease gun and the grease fitting with a clean rag or towel. When using a grease hand gun: always know the amount of grease required and the frequency. Ask a vendor's lubrication engineer to assist in this area. Check and mark your grease gun to ensure the amount of grease is known and can be visualized for each type of grease gun one uses.

- Always take oil samples when changing oil in a gearbox.
- When installing a new gearbox, replace the oil 24 hours after installation to remove any contamination that may have been washed from the gearbox cavity and gears.
- Always add hydraulic fluid into a reservoir using a filter cart
- Never touch a hydraulic filter with your hand during installation. By touching the filter you will introduce contamination to the hydraulic system.
- Never accept leaks on any type of lubrication line or bearing. Identify the true problem and make a permanent repair.
- Ensure maintenance personnel performing lubrication practices score at least a 90% on the lubrication assessment
- ALWAYS read and follow lubrication instructions from an equipment manufacturer. If you must change the instructions, contact the manufacturer first for comments. In conclusion, lubrication can cause up to 80% of your equipment problems if not performed in a disciplined manner.

2.1.9Lubrication Program Development

Information for developing lubrication specifications can come from four main sources:

- Equipment manufacturers
- Lubricant vendors
- Other equipment users

- Individuals' own experience.

✓ Like most other preventive maintenance elements, initial guidance on lubrication should come from manufacturers. They should have extensive experience with their own equipment both in their test laboratories and in customer locations. They should know what parts wear and are frequently replaced. Therein lies a caution: a manufacturer could, in fact, make short-term profits by selling large numbers of spare parts to replace worn ones. Over the long term, however, that strategy will backfire, and other vendors, whose equipment is less prone to wear and failure, will replace them. Lubricant suppliers can be a valuable source of information. Most major oil companies will invest considerable time and effort in evaluating their customers' equipment to select the best lubricants and intervals for change. Naturally, these vendors hope that the consumer will purchase their lubricants, but the total result can be beneficial to everyone. Lubricant vendors perform a valuable service of communicating and applying knowledge gained from many users to their customers' specific problems and opportunities. Experience gained under similar operating conditions by other users or in your own facilities can be one of the best teachers. Personnel, including operators and mechanics, have a major impact on lubrication programs. A major step in developing the lubrication program is to assign specific responsibility and authority for the lubrication program to a competent maintainability or maintenance engineer.

2.1.10. The primary functions and steps involved in developing the program are to:

- ✓ Identify every piece of equipment that requires lubrication;
- ✓ Assure that all major equipment is uniquely identified, preferably with a prominently displayed number
- ✓ Assure that equipment records are complete for manufacturer and physical location
- ✓ Determine locations on each piece of equipment that needs to be lubricated
- ✓ Identify lubricant to be used

- ✓ Determine the best method of application
- ✓ Establish the frequency or interval of lubrication
- ✓ Determine if the equipment can be safely lubricated while operating, or if it must be shut down
- ✓ Decide who should be responsible for any human involvement
- ✓ Standardize lubrication methods
- ✓ Package the above elements into a lubrication program
- ✓ Establish storage and handling procedures
- ✓ Evaluate new lubricants to take advantage of state of the art
- ✓ Analyze any failures involving lubrication and initiate necessary corrective actions

2.1.11. Preventive maintenance schedule

It is important to have a schedule for preventative maintenance of each item of equipment. This consists of a timetable stating when (and how frequently) maintenance should be done, and a list of maintenance activities for each item. These schedules should provide simple guidelines for all types of equipment, covering the tasks to be undertaken in the following areas:

- Care and cleaning
- Safety checks
- Functional and performance checks
- Maintenance tasks (changing bulbs, lubricating moving parts, etc.)

The best source of this information is usually the manufacturer's user and/or service manual. Schedules need to be developed separately for both users and maintainers. For example, users can perform checks and basic maintenance tasks on a daily basis, whereas the maintenance team can set aside a specific day of the week or month to carry out regular maintenance tasks. More sophisticated maintenance tasks, such as those which need to be carried out by service agents, should be scheduled for a specific day or week in the year.

It is helpful to display maintenance schedules for users on or near the equipment they refer to this can serve as a useful daily reminder of the tasks that should be performed. All Moving parts which subjected to sliding or rolling friction in all case Cleaning and lubrication is must

- Lubrication – is generally considered to be the **heart of** P.M of a machine
- Regular planned preventive maintenance consists of
    - ✓ Miner repair
    - ✓ Lubrication
    - ✓ Medium repair
    - ✓ Major repair

2.1.12. A proper P.M schedule should be followed by

- **Daily check P.M**

The following duties should be performed by the operator

- ✓ To clean the machine
- ✓ To check lubrication oil level
- ✓ check the coolant level
- ✓ Lubricate all moving parts
- ✓ Inform to maintenance department even minor defect noted in the Performance of a machine

- **Weekly check P.M**

The following check should be carried out by maintenance department:-

- ✓ Check all lubrication
- ✓ Check coolant
- ✓ Check all filters
- ✓ Check hydraulic & pneumatic lines

- **Monthly check P.M**

Monthly check should be carried out by maintenance department

- ✓ Check spindle drive belt for wear

- ✓ check hydraulic pumps & hydraulic oil
- ✓ Check movement of oil

- **Six monthly checks**

Six monthly should be carried out by maintained department

- ✓ check machine alignment
- ✓ To replace oil and filters

2.1.13. Activities of P.M

All P.M has some of the basic activates

- Planning
  - ✓ What to do?
  - ✓ How to do?
- . Schedule
  - ✓ When to do?

2.1.14 P.M planning

- Program of P.M of a machine include
  - ✓ Cleaning of all machine parts
  - ✓ Lubrication
  - ✓ Application of protective coating
  - ✓ Repair of crack & other repairable damages
  - ✓ Adjustment
  - ✓ Inspection of state of component
  - ✓ Replacement of worn out component
  - ✓ Cost calculation
- Machine may stopped due to the following reason
  - ✓ Break down maintenance
  - ✓ Preventive maintenance

2.1.14. Use of preventive maintenance

- To prolong the life of the machine
- To reduce an expected break down
- To improve accuracy of the machine
- To insure quality &continuity of production

2.1.15. Lubrication practices in different lathe machine parts

It is good practice to clean the machine, especially the guides, removing all chips produced by the work.

Apply, with a rag or a brush, a thin layer of oil on the guides and on the spindle to prevent corrosion.

The next day, remember to remove the oil before starting the machine.

The perfect efficiency of the lathe is guaranteed over time with the perfect lubrication of its moving parts.

- **Point on the machine to be lubricate**

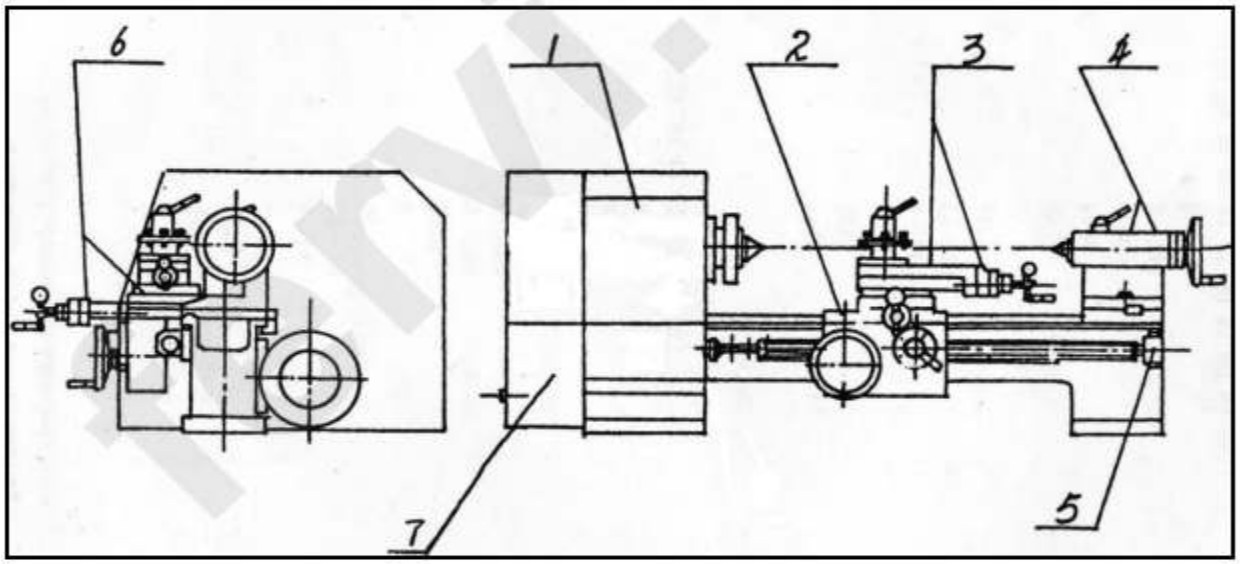


Fig 2.1 Lubrication lathe

Ref.	Parts of the machine	Lubrication point	Lubrication method	Frequency
1	Spindle head box	Spindle head bearings	Spray	After 10 days of commissioning, and thereafter every 60 days.
2	Tool holder carriage	Longitudinal guides	Oiler	Daily
3	Longitudinal slide	Screw and longitudinal guides	Oiler	Daily
4	Tailstock	Screw and quill guides	Oiler	Daily
5	Lead screw supports	Lead screw	Oiler	Daily
6	Transverse slide	Screw and transverse guides	Oiler	Daily
7	Threading gears	Gears	Oiler	Daily

Type of oil recommended
Mobil Vectra n° 2
Shell – Tonna – T68/TX68
Chevron – Vistac – 68X
Esso – Febis – K68

- **Lubrication in Headstock**

An oil-splash feed is utilized in the lubrication system of Headstock. On top of the Headstock there grooves surrounded providing lubricant flow into the spindle bearing along the groove then finally flow down on the bottom of the box. When supplying the lubricant, remove the cap of oil sight glass. To drain the waste oils away, a drainer whole located in the right side downward of the Headstock. Please take good care of checking whether the Headstock has been filled up with lubricant or not when you purchase the machine. If negative. Use as show in the figure (2-2) lubricating oil. We request you to change the lubricant at first month and then do once every two months so to assure the gears are working in the best conditions

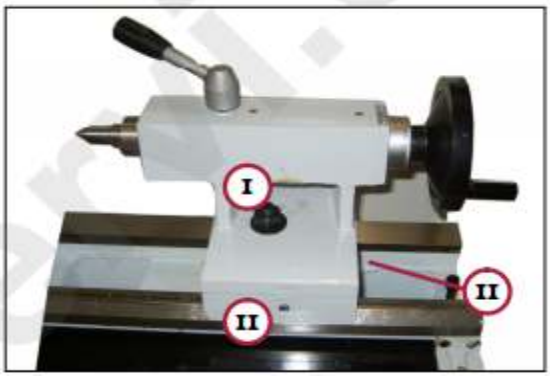


Fig 2.2Lubrication in Headstock

- **Lubrication in Gear Box and Apron**
  - ✓ Gear Box is oil-bath lubricated to insure the lifetime of gears and bearing. It is recommended the lubricant to be changed every six months.
  - ✓ Apron is also oil-bathed. If the oil quantity in Apron is lower than center level of oil sight glass. Then it is time to add up some oil to standard level.

Table 2.1ubricating of lathe machine

No.	Location	How	How many	For how long to fill-up	Oil exchange time
1	Headstock	Remove the screws of filler hole on left side up	L	Once a month	One month.then every two month
2	Gear Box	Open top cover remove the screws of filler hole	L	Once a month	Every half year
3	Apron	Remove the screws of filler hole	L	everyday	
4	Compound Rest	By oilcan	approp.	everyday	
5	Auto Feed lever	By oilcan	approp.	everyday	
6	Tailstock	By oilcan	approp.	everyday	
7	Leadscrew	By oilcan	approp.	everyday	
8	Bracket of Three Rods	Remove the screw of filler hole	approp.	everyday	
9	Bedway	Press the manual oil pump	approp.	everyday	

- **Useful reference lubricating table for other mechanism**
- **Headstock**
  - ✓ **Prevent from oil leakage from top cover of Headstock:**

    Before covering the top cover of Headstock, whenever it is removed, please wipe to clean the contact surface and apply some grease on it. Make sure it is tightly securing by setscrews.

  - ✓ **Prevent from blocking up the oil circuit:**

    The leakage of front headstock cover mostly caused by over-filling the oil or a block-up of oil circuit. In this moment, remove the Headstock cover first, then blow

the air jet into two oil circuit hole, which is on upside and dome side of front Spindle bearing, in the same time to rotate the Spindle and it will work again.

- **Apron and saddle**
  - ✓ Filler hole location of Apron: On the right plat form of Saddle. The filler hole has oil plug indicates "OIL".
  - ✓ Drainer Hole location of Apron: On the bottom cover of Apron, as illustrated left, position *"A"* (also can be seen in front side of Apron downward)
  - ✓ Model No of Apron lubricant & change period Model No is way oil. ISO UG 68, suggestion changing period is every half a year

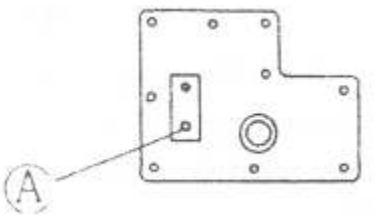


Fig 2.3 Apron and saddle

- **Gear box**

Filler hole location of Gear Box

1) Under the top cover of gearbox. Remove the top cover there is an oil plug indicates, "OIL" where filler hole is in. as per illustration "A".

2) Drainer hole location of Gear Box: On the left side of the ten-step speed change the disc downward. The drainer hole is in the screws with hexagon socket nut as illustrated "B" wheran arrow point.

3) Oil brand and oil exchange time: We suggest as show in the figure 6-4 and please change it every half-year.

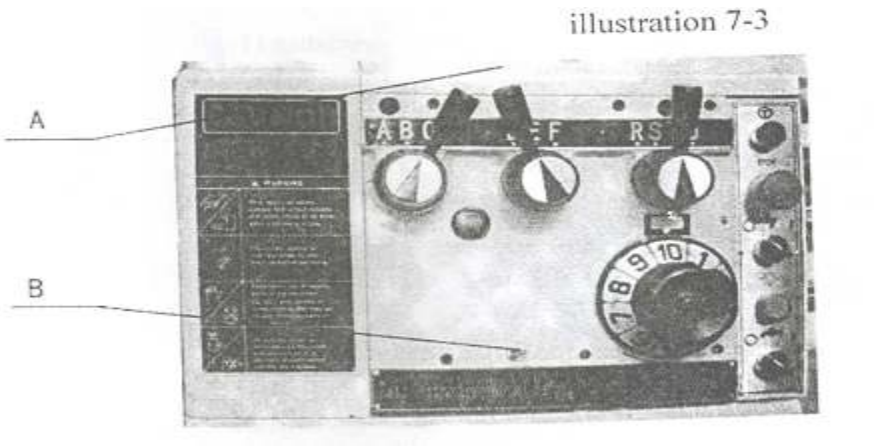


Fig 2.3 lathe Gear Box

2.2 Consumable components.

For the purpose of describing maintenance operations, it is convenient to think of equipment as a collection of interrelated parts. Maintenance operations consist largely (but not solely) in replacing parts of equipment. Maintenance strategies determine when parts or equipment need to be replaced or maintained. Throughout this subsection, we focus on the decision to maintain/replace a part, but our discussion also applies to the decision to maintain/replace equipment. Gives an overview of maintenance strategies. In this subsection in discussing different maintenance strategies.Modificative maintenance concerns interchanging a part with a technically more advanced part in order to make the equipment perform better. This form of maintenance is usually projected based and non-recurring. The maintenance strategies that occur most often are preventive and breakdown corrective maintenance. Under a breakdown corrective maintenance strategy, a part is not replaced until it has failed, while under a preventive maintenance strategy, the aim is to replace parts before failure occurs. (Off course, this aim may not always be achieved: A part can break

before its replacement occurs.)

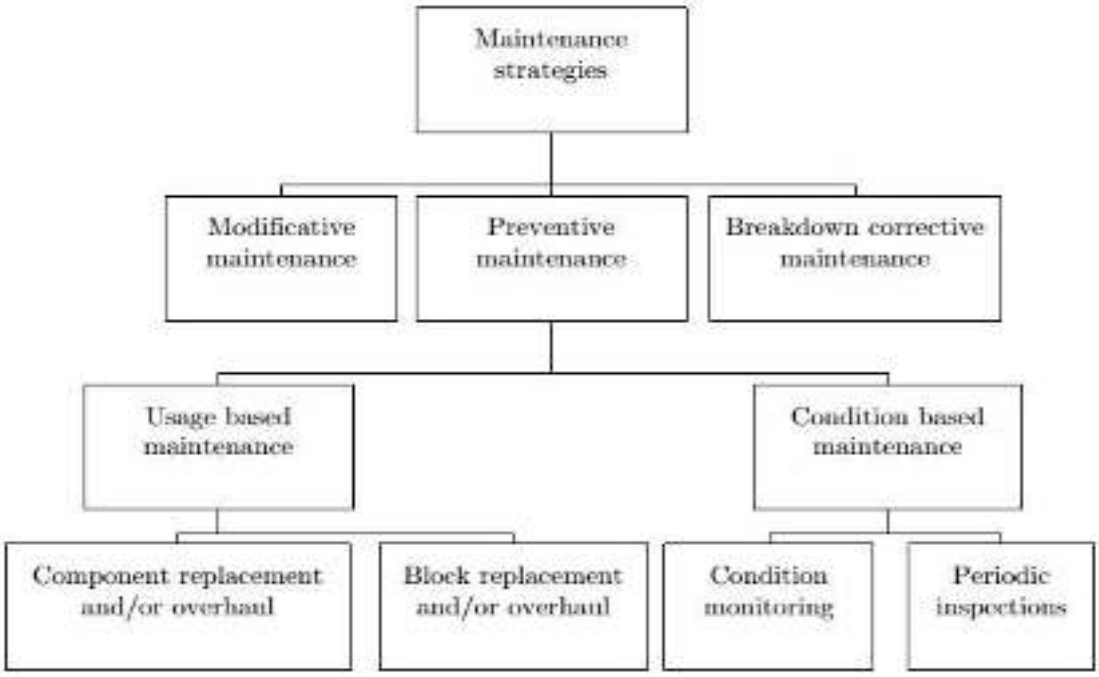


Fig 2.1maintenance stat age

Breakdown corrective maintenance is an attractive option for parts that do not wear, such as electronics. For parts that do wear, it can be beneficial to follow a preventive maintenance strategy. Preventive maintenance strategies can be further divided into usage and condition based maintenance. Under usage based maintenance, the total usage of a part is measured and maintenance is conducted when a certain threshold level has been reached. The usage of parts can be measured in many ways depending on the nature of the equipment. Time in the field is perhaps the most common mean to measure usage. For vehicles (e.g., rolling stock), mileage is a common measure of usage. The number of on-off cycles is a measure of usage for equipment that is mainly loaded at the end or beginning of on-off cycles. For example, the number of landings is a measure of usage for the landing gear of an aircraft. Since the usage of equipment is usually scheduled, the moment that maintenance is performed can also be scheduled. If there is a large set-up cost associated with maintenance, it can be beneficial to interchange several parts simultaneously (Block replacement and/or overhaul). Otherwise, maintenance can be performed

on a single component (Component replacement and/or overhaul). In condition based maintenance, the actual condition of a part is gauged and maintenance is conducted based on this. The condition of a part can be measured either periodically during inspections (Periodic inspections) or continuously through a sensor (Condition monitoring).

2.2.1The condition of equipment can be measured:

- ✓ The condition of ball-bearings can be measured via the amplitude of vibrations around the bearing (Elwany and Gebraeel, 2008).
- ✓ The condition of a metal part can be determined by visually inspecting the number and length of cracks.
- ✓ For metal systems with moving parts, the concentration of ferrous parts in the lubrication fluid is measured as an indication of the wear and need for lubrication.
- ✓ The condition of a car engine is monitored continuously while driving by the engine-oil temperature gauge. The need for maintenance can be ascertained periodically during an inspection or at any time in case of condition monitoring. Which types of maintenance are prevalent for a given piece of equipment depend very much on the technical nature of the equipment involved? For electronics and high-tech equipment, breakdown corrective maintenance is prevalent. For aircraft, rolling stock and other heavy machinery with moving parts, the prevalent maintenance strategies are preventive (both usage and condition based).

2.2.2 Types of consumable components maintenance (Spare parts)

- **Rotable** - These are items that constitute a sufficiently large subsystem of the original equipment to warrant a separate usage based maintenance strategy. Routable are individually tracked and traced so that the correct usage can be ascribed to each routable individually. Usually, there are dedicated resources for the maintenance and overhaul of rotable. Examples include aircraft engines, rolling stock bogies (see Figure 1.2a), and elaborate weapon or radar systems
  on frigates.

(a) A bogie is an example of a rotable. (b) A compressor is an example of a repairable. (c) A gasket is an example of a consumable.

Fig 2.2 **consumable components**

- **Repairable** - These are items that are repaired after replacement after which they are *ready-for-use* (RFU) again. Contrary to rot able, repairable do not have their own usage based maintenance strategy, and are not usually individually tracked and traced.
- A repair shop handles the repair of many different types of repairable. Examples of
- Repairable include compressors (see Figure 2.2b) and pumps.

- **Consumables** - These are items that are discarded after replacement and bought new from a supplier. Generally these are relatively cheap items such as gaskets (see Figure 2.2c). These different part types generally are also connected to different maintenance strategies as shown in Table 2.2. Demand for spare parts inherits the uncertainty characteristics of the type of maintenance for which they are used; see Table 2.1. For example, there is almost no demand uncertainty for rotables, while demand uncertainty for consumables subject to breakdown corrective maintenance is high.

	Type of spare part		
Maintenance strategy	Rotable	Repairable	Consumable
Usage based	x		
Condtion based		x	x
Modificative		x	
Breakdown corrective		x	x

Table 2.1. The role of different part types in maintenance operations

2.2.3 Removing/replacing practice of different consumable components

- **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.

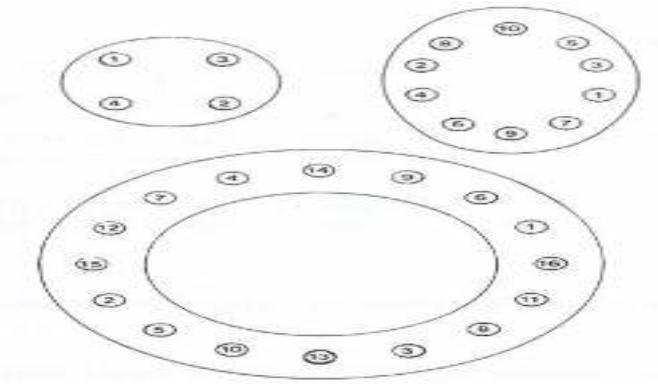


Fig.2.3 Sequence for tightening bolts.

2.2.4 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.
- **Failure patterns**

- The condition of an O-ring after disassembly may provide evidence of the cause of failure. A ring that has been extruded will show the effects of nibbling along the i.d. as shown in Fig. 2.4 **Failure patterns**

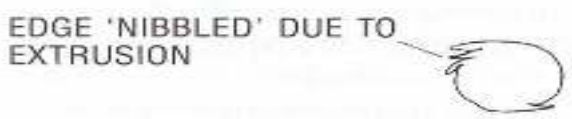


Fig. 2.4 **Failure patterns**

Damage caused to O-rings during assembly will usually be evident as nicks or cuts or possibly as twisting.

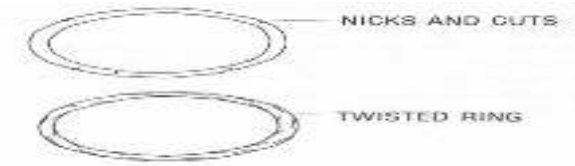


Fig2.2. evidence of damage during assembly.

2.2.5 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.

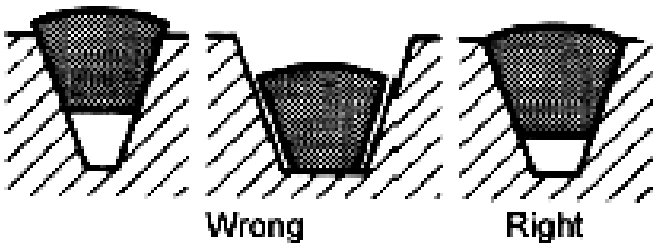


Fig. 2.4 Check if the V-belt will fit to the pulley

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.

2.3fluids and lubricants

2.3.1. Introduction

Fluids are used in metal machining for a variety of reasons such as improving tool life, reducing work piece thermal deformation, improving surface finish and flushing away chips from the cutting zone. Different applications and/or materials require slightly different cutting fluids. These fluids are designed to provide the correct amount of lubrication, cooling, better surface finish, increased tool life and more. All cutting fluids (especially WS11) should be thoroughly cleaned / removed from the machine when finished! The machine should be dry and a light "misting" of WD40 applied to the entire vice, tables and machine ways to prevent corrosion.

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

Cooling vs. Lubrication

every operation has its own specific requirements for cooling versus lubrication. By varying the mixing ratio or concentration of a water extendible coolant, you can alter the balance of cooling and lubrication. In general, the more water (leaner mix), the better the cooling; the more concentrate (richer mix), the better the lubrication provided. When machining, the requirements for lubrication are generally greater than for cooling; hence a richer concentration is used. When grinding, the requirements for cooling are greater, hence a more lean concentration is used (but not so lean as to cause rust). There are exceptions to every rule and this one is no different. Some high-speed machining can be performed well with rather lean mixes, and some grinding applications such as form or creep-feed grinding require a rich mixture for high lubricate. Each operation should be evaluated on its own to determine proper concentration.

2.3.2Classifications of Metalworking Lubricants

- **Neat or Straight Oils**
  - ✓ Neat oils are made up primarily of naphthenic or paraffinic base oils with extreme pressure additives such as chlorine, sulfur and fats. Neat oils will not emulsify with water nor do they contain any water.
- **Soluble Oils**
  - ✓ Greater than 30% mineral oil and no water in concentrate. Dilution appears milky and not translucent.
- **Semi-Synthetics**
  - ✓ Less than 30% mineral oil content in concentrate and the concentrate contains water. Dilution appears translucent.
- **Synthetics**
  - ✓ Zero mineral oil content. Dilution looks transparent and is a true solution with no droplet formation like semi-synthetics and soluble oils.

2.3.3. 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 work piece is not visible through fluid.
  - ✓ Less cooling in high-speed applications vs. synthetics or semi synthetics.
  - ✓ May tend to pick up tramp oils due to partial mechanical emulsification from circulation through the coolant pump.

- **Semi-Synthetic Advantages**
  - ✓ Leaves oily film on machine and parts for protection.
  - ✓ Tend to reject tramp oils.
  - ✓ Very stable emulsion, long lasting.
  - ✓ Better cooling allows higher cutting speeds.
  - ✓ Semi-synthetics offer the best of both technologies; soluble oils and synthetics.

- ✓ Semi-synthetics emulsions offer micro size oil droplets that have advantages in single point turning applications where optimal cooling and less lubrication is required.
- ✓ Our semi-synthetics are ideal for powdered metals, cast iron and metals that when cut don't create chips but rather sand-like swarf that can clog filters and form sump clinkers. Monroe's semi-synthetics are great for cast iron machining and grinding applications.
- ✓ Semi-synthetic coolants are great for cleanliness and work piece visibility.

- **Semi-Synthetic Disadvantages**
  - ✓ Low oil content reduces the physical corrosion film that is needed in some applications.
  - ✓ Mists, smoke or disposal may be a problem due to oil.
  - ✓ Semi-synthetics are not very forgiving when it comes to concentration control and rust and corrosion could be the results of poor fluid management.

- **Synthetics Advantages**
  - ✓ Rapid heat dissipation.
  - ✓ Excellent work piece visibility.
  - ✓ Total rejection of tramp oils possible.
  - ✓ Usually easy to measure and control concentration.
  - ✓ Bacterial attack may be easier to control.
  - ✓ Usually stable and potentially long-lasting.
  - ✓ No oil mist problem; no oil disposal concerns.
  - ✓ Easily filtered.
  - ✓ Recycling or reclaiming is usually highly effective.

- ✓ Low consumption due to the fact that synthetics are true solutions with no droplet formation adding to carry off issues.

- **Synthetics Disadvantages**
  - ✓ High performance products can be expensive.
  - ✓ Residual films may be tacky or sticky, which may cause gumming in the moving parts of the machine.
  - ✓ Compared to oils, they have significantly reduced corrosion protection.
  - ✓ Less forgiving in poor fluid management scenarios and require tighter control of concentration ratios to protect against rust and corrosion.

2.3.4. Coolant maintenance

- Good coolant maintenance programs will include regular laboratory tests of the coolant, either in-house or by the coolant manufacturer. This section contains suggestions for proper maintenance and control of coolant that the customer can perform. Implementing these suggestions is not as straightforward as it seems. Particularly in small systems or individual sumps, control and maintenance of coolant can be challenging.
- Frequent testing and adjustment of coolant is feasible on large central systems where the cost of these procedures is easily justified in the control of 10,000 gallons of coolant. It is not as easy to justify detailed analysis of a 100 gallon sump. Unfortunately small systems are subject to much more rapid changes and greater fluctuations and therefore actually should be checked *more* frequently than large tanks to maintain good control. These factors make the choice of coolant particularly critical for small sumps.
- Small coolant systems normally use less effective equipment for filtration and oil separation than those found on central systems. This requires that the coolant in small systems be more tolerant of contamination from metal fines, tramp oils and other materials or contaminants.

2.3.5. Coolant life

- Many factors are involved in the success or failure of a metalworking coolant. This brochure will attempt to address the most frequently encountered factors, and also offer tips and techniques for maximizing the performance of your fluid.

<u>These guidelines should be strictly adhered to for optimal results</u>:

- **Preparing the machine**
  - ✓ The most important step in maximizing coolant life is to start with a clean sump.
  - ✓ Any bacteria, fungus, dirt and/or sludge left from the previous coolant can decrease the life of the new fluid.
  - ✓ Thoroughly cleaning with a good machine cleaner is recommended before the introduction of any new coolant.
- **Astor-clean a** is a low-foam alkaline cleaner designed to remove process oils, gummy deposits of oil, grease, swarf and normal shop soils from machine tools, floors, and other hard surfaces. Astro-Clean A combines organic and mineral alkalinity builders, detergents, water conditioners and deodorizer for optimum sanitizing performance.
- Astor-Clean A also contains special additives designed to penetrate deep into compacted chips and swarf, and render the machine neutral of bacteria and fungus. Astro-Clean A is mild enough on the operator's skin that there is no concern for operator discomfort during the 24 hour cleaning cycle.

2.3.6 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.

2.3.7 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 refract meter and make necessary corrections before machining.

Note: Due to the detergency of fresh emulsions they will continue to clean a sump and system after the initial charge. This may result in:

- A temporary flush of odors from loosened deposits
- A temporary spike in bacteria levels Don't be alarmed if the appearance of floating masses of sludge which have been dislodged from the inaccessible areas of the sump and or system. These are considered normal and will usually occur within the first two weeks of use of a fresh charge. Once removed these floating masses should not reappear.

2.3.8. Concentration control

Once a new coolant is in, concentration control is the most important parameter for a Coolant user to monitor. It is imperative for long coolant and tool life.

As a rule of thumb:

- Concentration consistency can be achieved by never adding straight water or adding straight concentrate to the machine sump; always add a weak dilution half of the goal concentration. If the goal concentration is 7% always add 3.5% concentration. The reason for this is that the water evaporation rate versus additive and component depletions corresponds to this formula.
- **Low concentration** is the most common cause of coolant problems that customers experience. Our coolants have been designed to operate at a minimum concentration of 4% (25:1). A lower concentration than this, even for a short period, could lead to problems such as machine and work piece corrosion, poor tool life and rancidity of the in-service coolant

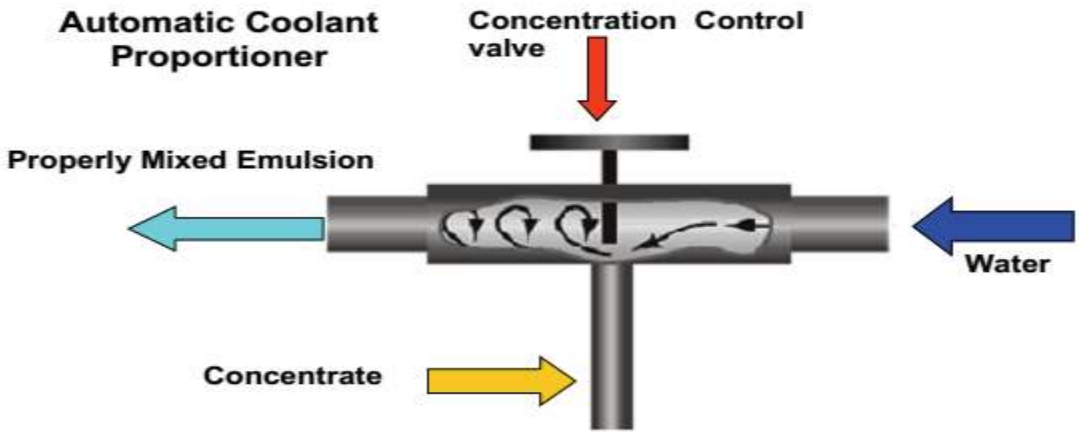


Fig 2.5 automatic proportional

- **Refract meters:** designed for measuring the concentration of an aqueous solution, can be used for checking cutting and grinding fluid concentrations. Hand refract meters are useful for day-to-day control of concentration and are much faster than the laboratory procedure. To use a refract meter, you simply place one or two drops of the coolant solution onto the prism surface, close the cover plate, look through the eyepiece (facing the light) and read the scale. Compare this reading with
  the Bricks chart for your coolant to get actual concentration. It is important to ensure that your refract meter reads zero on water alone. This is accomplished by placing a drop of water on the prism and reading the results normally. If the reading is not zero, an adjustment screw must be turned to calibrate the unit.


Hand Refractometer

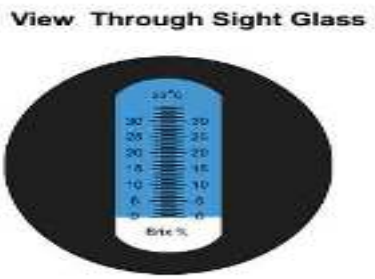


Fig 2.**5 refract meters**

2.3.9. Contamination

- **Tramp oils**
  - ✓ An important factor in coolant life is control of tramp oils. This term refers to any oils which are not part of the original coolant formulation, including way lubes, hydraulic oil, tapping fluids, gear lubes, etc. which find their way into the coolant.
  - ✓ These tramp oils carry their own contaminants, such as sulfur, phosphorous or solvents, which can be detrimental to the coolant, either by destabilizing the emulsion or by providing food for bacteria. If tramp oil is allowed to cover and "seal off" the surface of the sump, bacteria will grow and multiply rapidly, producing the "rotten egg" odor familiar to many machinists. Keeping the level of floating oils to a minimum will prevent this.
  - ✓ Another problem with tramp oils is the potential for dermatitis caused by skin contact with these oils, which may contain irritating components. Monroe's metalworking fluids are designed to reject rather than emulsify these oils, causing them to float to the surface, making removal a simple job. They can be skimmed from the surface of the sump by any
    of a variety of methods, such as oil wheels, rope-type skimmers, absorbent pads or even shop vacuums.

- **Solids contamination**
  - ✓ An area for concern that is so often overlooked is the level of chips, fines or swarf in the sump. Quantities of these small particles can provide an enormous surface area for bacteria to attach themselves to while at the same time creating "dead areas" where coolant cannot circulate. There are many methods available for removal of these particulates such as magnetic wheels, conveyors or index able filters. In general, the less solid material in the sump or system, the better.

- ✓ Due to the nature of manufacturing facilities today, it is rare that only one type of material would be machined. Because of the numerous types of metal chips that conglomerate at the bottom of the sump, there is a potential to create galvanic reactions, which could harm the coolant emulsion and result in shortening the coolant life span. Corrosion is also possible.

- Fig 2.**6 Solids contamination**

2.3.10. Daily coolant upkeep

- **Daily In-service Coolant Management**
  - ✓ Run oil skimmers to remove excess tramp oil from coolant. These are generally more efficient if run during down time, when the coolant is still and the oils can float to the surface. A wet/dry vacuum can also be used to remove floating oils. Dispose of as waste oil.
  - ✓ Circulate coolant and check concentration with a refractometer. Maintain fluid level. Add rich or lean pre-mixture of coolant and water where needed.
  - ✓ Check pH. (If pH starts to fall, add coolant to bring up concentration. If pH does not stabilize, it is time to replace coolant. If coolant needs to be replaced, dump old coolant, clean machine and charge with fresh coolant.)

- ✓ Record data on a machine check sheet (See example). This can be used to follow trends of a particular machine.
- ✓ Check all filters, chip strainers and canister filters.Provide aeration of coolant during extended periods of idle time. An air lance with 5 psi pressure allowed to bubble *gently* in an idle sump is often sufficient to prevent excessive anaerobic bacteria formation.

2.4. Minor machine repairs

2.4.1. Introduction

Repair means responding to the breakdown of equipment and undertaking work to correct the problem in order to return the equipment to a working condition. Before equipment can be repaired, you need to be aware that there is a problem! Therefore, there should be a clearly understood **system for reporting faults and breakdowns** and equipment users should be encouraged to report faults and breakdowns as soon as possible. If there is no back-up equipment, a breakdown will mean that the service the equipment was providing will come to a halt.

- ✓ **Simple repairs** can be done by the in-house or external **maintenance and repair team**. If the equipment is repaired where it is used, it is important that the team is trained to work safely and that they don't create hazards for patients or staff.
- ✓ **More complex repairs** will be carried out by **specialized maintenance personnel**; they might come to the eye care unit or you may have to send the equipment to them for repairs.

In all these situations, it is important to keep equipment users informed of how long their equipment will be unavailable. Some items of equipment will be found to be damaged beyond repair. For others, spare parts may no longer be available as the equipment has become outdated. These will have reached the end of their lives and must be taken out of service (decommissioned or retired) and be replaced if the service they provide is to continue. Equipment that is being

decommissioned should be disposed of safely and according to proper disposal procedures. Remember to update your records accordingly. **'Plan for maintenance when you purchase the equipment'**

2.4.2 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. 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

What should be recorded	This provides information about…
The details of repair work done on	• The history of each machine

What should be recorded	This provides information about…
each machine (including cause/suspected cause, and who carried out the repair)	• Common problems
The spare parts and materials used	• The parts most frequently used • What needs to be re-ordered
The date equipment has broken down, and the date it is repaired.	• What still needs to be repaired (which allows you to prioritise the next week's tasks) • The duration equipment is not in use (down-time)
The causes of any delays	• What the most common causes of delays are (skill, labour, spare parts, transport, bureaucratic delays, money) and what additional resources may be needed to complete work on time

- ✓ Repair record, and what useful information this can provide.
- ✓ To check foundation condition to repair it, if required

2.5 Adjustment on Spindle Bearing:

The front and the intermediate section 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 heated or damage the rolling surface of bearing and lessen its dynamics. Make sure to fix the setscrew completely after adjustment ad illustrated.

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.

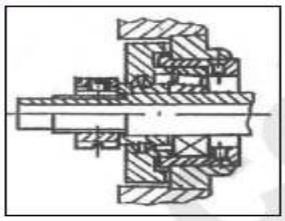


Fig2.7Adjustment on Spindle Alignment

- **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-clockwise 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-off when load is over 12 Kg.

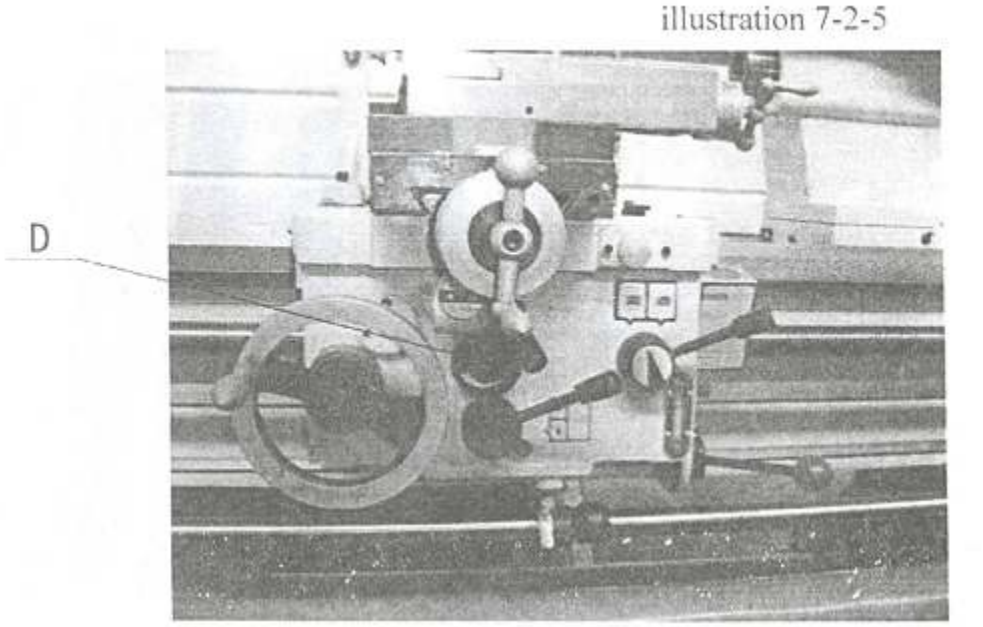
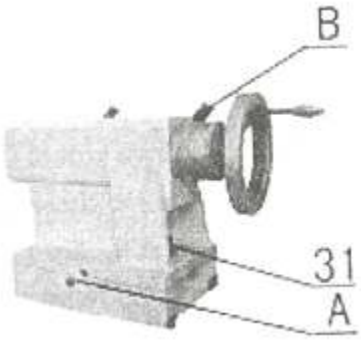


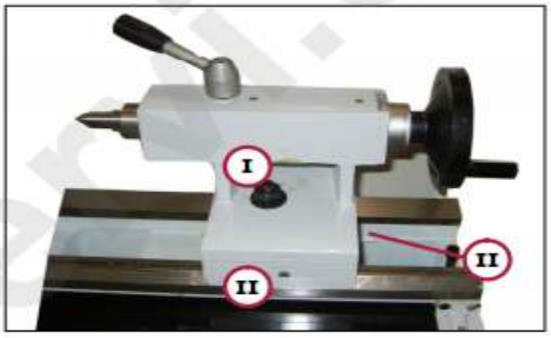
Fig 2.8 Feed load adjustment

- **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 the clamping lever a bit and it recover in good order again.



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.



- **Fig2.9 Adjustment of tailstock cantering**

- **Belt tension adjustment**

  After long period of working belts will get slacked. So you need to adjust it for some times.

  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 cause 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.

illustration 7-6

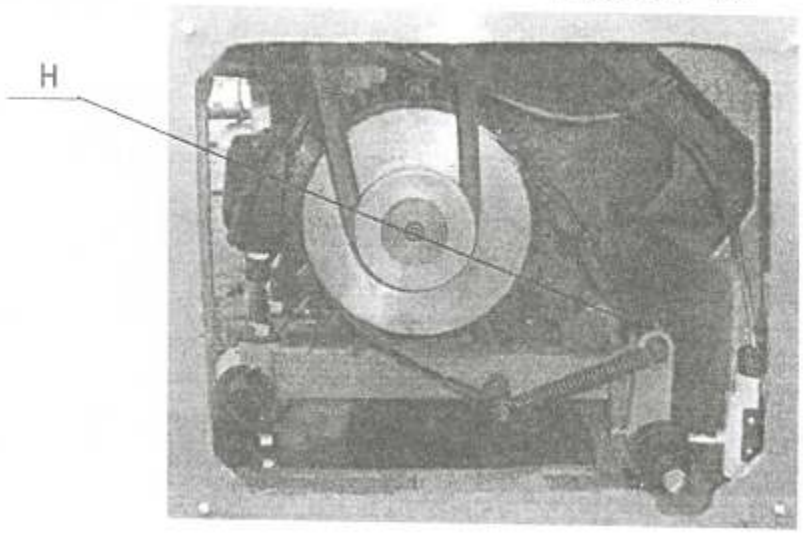


Fig 2.10 adjustment v-belt

- **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

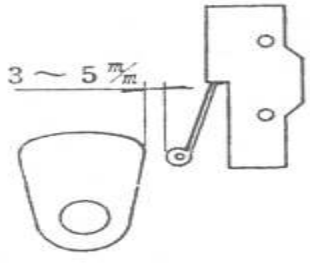


Fig 1.11adjustment Brake and micro switch

- **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.

2.5.2 Trouble shooting portion of machine

Table 2.3Trouble shooting portion of machine

TROUBLE	PROBABLE CAUSES	REMEDY
Overheat of headstock bearing	1. Oil level in headstock is too low or too high.	Check the oil level and replenish or discharge the oil to the proper level.
	2. Quality and viscosity of oil is wrong	Replace the oil with recommended one.
	3. Oil is too dirty.	Replace oil.
	4.Oil hole in bearing obstructed by dirt.	Remove the dirt from the oil hole.
	5. Bearing obstructed by dirt.	Clean the bearing and renew oil.
	6. Badly worn bearing.	Replace bearing.
	7.bearing in its case is not improper position.	Dismantle and reassemble it.
	8. Bent or sprung main spindle.	Replace main spindle.
	9. Too much end thrust.	Adjust thrust nut.
Oil leakage from gearbox.	10.Plug of drain not tightly.	Remove recement threat: replace and tighten.
	11.Headstock cracking.	Repaired by special welding.
	12.Leakage from overflow headstock cover.	Tighten cover screw or replace gasket.
	13.Leakage from overflow spindle bearing house.	Replace oil ring.
Excess noise of vibration of machine	14.Badly worn bearing.	Replace bearing.
	15.Badly worn gear.	Replace gear.
	16.Bent or sprung shaft.	Replace shaft.
	17.lose of foundation bolts.	Tight foundation bolts.

TROUBLE	PROBABLE CAUSES	REMEDY
Chatter	18.Clamp of work piece in from loose status.	Tighten clamp.
	19.Spindle bearing thrust too loose.	Adjust bearing thrust.
	20.Headstock is not tight with bedway.	Tighten headstock screw.
	21.Excess clearance between carriage and bedway.	Adjust carriage back clamp.
	22. Excess clearance in cross or compound slide.	Adjust taper gib.
	23.Cutting angle of cutting tool is not correct.	Regrind tools to correct cutting angles.
	24.Edge of cutting tool has been worn-out.	Regrind cutting tool.
	25.Weak of tool shank and too long for extension.	Replace with rigid tools or reset the tools.
	26.Tool fixed to holder not tight enough.	Tighten tool again.
	27. Unbalances of workpiece or chuck when high speed revolution.	Balance or reduce spindle speed revolution.
	28.Front point of cutting tool not in correct position.	Reset cutting tool.
Bending, when long workpiece cutting	29.Feed valve too large.	Reduce feed valve size.
	30.Workpiece too thin or tool long.	Use following rest and adjust position of tool.
Accuracy of product fails	31.Accuracy fails in machining.	Check the accuracy of correlation between products and machine (ref. Accuracy chart.)
Uneasy to hold gear change lever.	32.Set spring broken or too weak.	Adjust adjusting screw or replace the spring.

TROUBLE	PROBABLE CAUSES	REMEDY
Misalignment of chuck with main spindle	33.Incorrect position of cam.	Adjust cam and lock in proper position.
Uneasy to cut thread	34.Excessive clearance of lead screw in axial direction.	Adjust the thrust nut of the leadscrew holder.
	35. Excessive clearance between saddle and cross slide or cross slide and tool post slide.	Adjust slide gib to proper position.
	36.Worm thread or nut in cross slide or tool post slide.	Adjust or replace it.
	37.Excessive clearance of handwheel.	Adjust the set bushing of handwheel.
Tailstock is uneasy to clamp with bed stably	38.Clamp handle lever too long or too short.	Adjust the adjusting nut of clamp block.

Self check-2

Part -I choice

Directions: select the correct answer for the give choice

1. 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
2. Which one of the following is Properties of a good viscosity?
    A. A low viscosity oil is thin and flows easily
    B. High viscosity oil is thick and flows slowly.
    C. As oil heats up it becomes more viscous (Becomes thin) If the oil is too thin(has very low viscosity)
    D. All
3. One of the following is a category of wear.
    A. Adhesive
    B. Abrasive
    C. Corrosive
    D. All
4. One of the following is not the methods for lubricating tools/machine
    A. Manual Devices
    B. Drop-feed Devices
    C. Splash or Bath Lubrication
    D. Ring, Chain, Oilers
    E. None

Part II: True or False

Directions: Say True or False

1. More complex repairs is not need specialized maintenance personnel.
2. In medium repair disassemble more unit of machine will be done
3. Donkey's job" and is left to some unskilled worker to decide and do. Cleaning is often considered
4. Lubrication can be considered as vital part of a machine as any of the working parts.

Part III: Short answer writing

Direction: Give short answer to the following questions.

1. Write the Classification of lubricants?
2. Write the Functions of metalworking fluids?
3. What is the difference between cleaning and lubrication?

Operation sheet-1

- **Operation: Title:** Clean machines/equipment
- **Purpose: to perform** Clean machines/equipment
- **Instruction:** Cleaning the Machine according to proper procedures

Required tools and equipment

- Personal protective equipment (PPE)
- Scrap brush
- Broom dustpan
- Spray bottle
- Rag

Precautions: Maintenance Hazards

- **Procedures in doing the task**

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

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

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

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

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

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

Step 7-Gently mist the slides, ways, chuck(s) with WD40. Move the carriage and slides to mist all surfaces.

Step 8-Sweep the floor and surrounding areas. Chips are to be placed in chip buckets, not regular trash cans.

Step 9 -There should be NO visible chips of any size on the machine. Leave it cleaner than when you found it.

- **Quality Criteria:** according manufacture manual standard

Operation sheet-2

- **Operation: Title:** Lubricating a bearing
- **Purpose:** to perform Lubricating a bearing
- **Instruction:** according to maintenance procedures Lubricating the bearing

Required tools and equipment

- Personal protective equipment (PPE)
- Scrap brush
- Broom dustpan
- Spray bottle
- Rag

Precautions: Maintenance Hazards

Procedures in doing the task

- STEP 1. Prepare all tools, materials and equipment's needed
- STEP 2. Check if there is a grease nipple on both side end of the motor..
- STEP 3. If there is grease nipple, insert the grease gun and pump grease inside the motor bearing
- STEP 4. If there is no grease nipple, open the motor at both end by a screw driver and spanner.
- STEP 5. Remove the bearing [use the gear puller if needed]
- STEP 6. Open the side cover of the bearing, check if presence of foreign objects are seen, and clean the bearing with kerosene or the like if needed.

- STEP 7. Repack the bearing with grease then close the cover.
- STEP 8. Return the bearing and close the motor.
- STEP 9. Commission the motor

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 3 hours.

Task 1: Clean machines/equipment

Task 2: Lubricating a bearing

Unit Three: Preventive Maintenance

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

- tools defects
- hand tools defective
- clean material
- Lubricate and store tools.
- 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 defects
- Identify hand tools defective
- Use clean materials
- Apply Lubricate and store tools
- Accomplish reports

3.1 Tools defects

3.1.1INTRODUCTION

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.

3.1.2. Practices to identify defective and non-defective hand tools

1. **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.
2. **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.
3. **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.
4. **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 ט
- Ensure defective tools are repaired ט
- 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 sa

3.2hand tools defective

Reports

Keeping inspection records is important. Past inspection records show what has been previously identified. They also show what an earlier inspection team concentrated on and what areas it did not inspect. Do not simply repeat or copy previous inspection results. Use the older inspection reports to help look for issues, and then determine whether recommendations were implemented. Note if the changes have been effective.

3.2.1Types of inspection reports

The following describes three other types of inspection reports:

- Ongoing
- Pre-operation
- Periodic

Ongoing inspections. 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.

Example of Workplace Inspection Report

Table 3.1 Workplace Inspection Report

Inspection Location: _____ Date of Inspection: _____

Department/Areas Covered: _____ Time of Inspection: _____

Observations							
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: _____

3.2.2Final 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:

A = Major - requires immediate action

B = Serious - requires short-term action

C = Minor - requires 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

3.3 3clean material

Types and Kinds of 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 non polar. Polar solvents are solvents which dissolve/are soluble in water; while non polar 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.

Kinds of cleaning solvent based on their solubility in water:

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	

. 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

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 by pouring some on a soft rag and wiping 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, Lest oil, 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 T 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.

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.

3.4. Lubricate and store tools

3.4.1 INTRODUCTIN

Lubricant is a substance that reduces friction, heat, and wears 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.

- **Performance Standards**

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.

3.4.2Lubricating and storing tools

1. **Lubricating and storing vice**

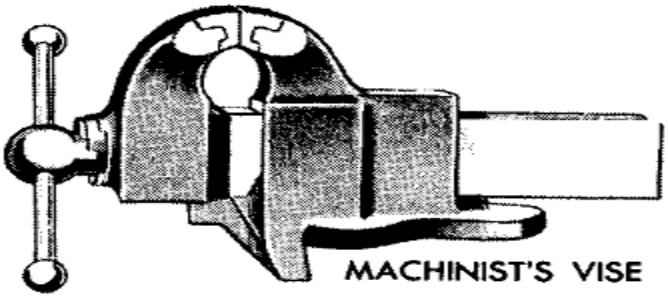


Fig 3.1 Lubricating and storing vice

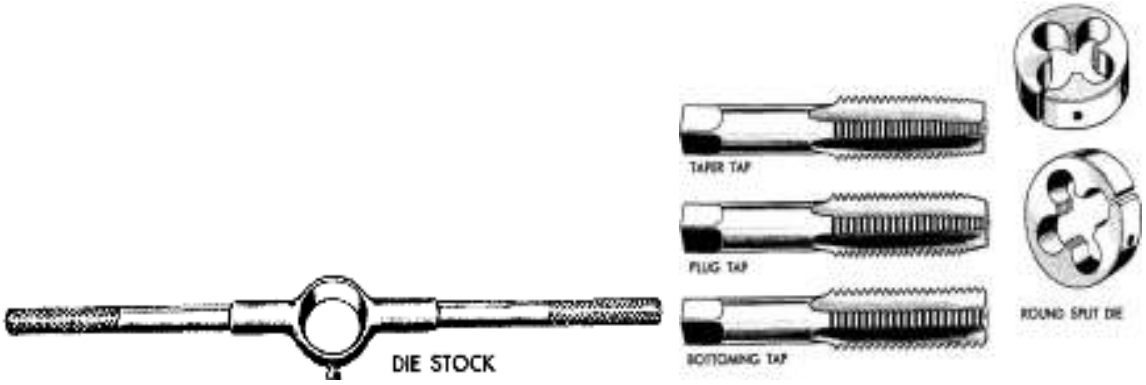
3.4.3Lubrication

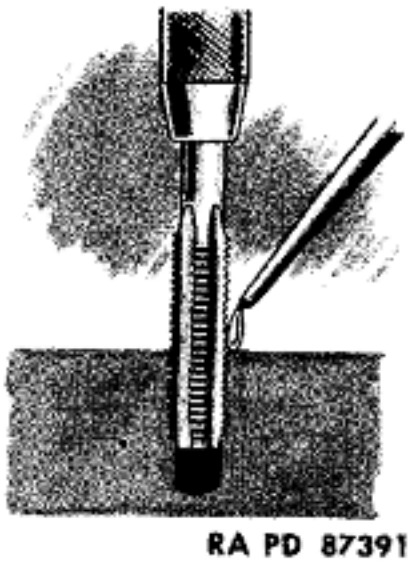
Lubricate slide and worm lightly with preservative lubricating oil (special) or engine oil (SAE 10). Lubricate sparingly; excessive amounts help cause a messy shop.

Storage

Wash lubricants from vise with dry cleaning solvent. Dry vies 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.

2. **Lubricating and storing taps and dies**





Lubricants for Hand Tapping and Die-cutting Threads

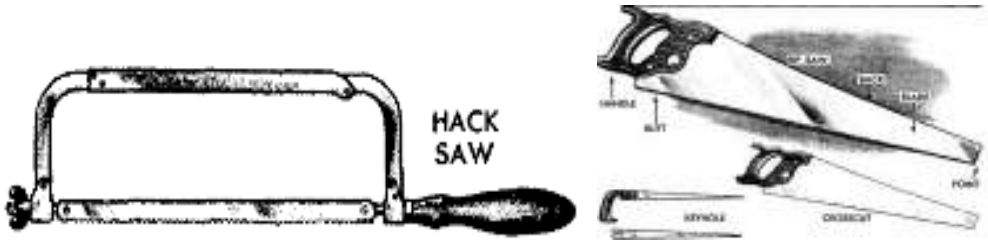
Mild steel—Mixture of 75% engine oil (SAE 10) and 25% white lead.
High carbon and alloy steel—Lard oil.
Hard steel—Turpentine.
Brass—Lard oil.
Copper—Lard oil.
Aluminum—Dry cleaning solvent.
Monel metal—Lard oil and white lead.
Cast iron—Dry.

Fig 3.2 Lubricating and storing taps and dies

3.4.5 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

1. **Lubricating and storing saws**



1. **Fig 3.2 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.

2. **Lubricating and storing clamp**

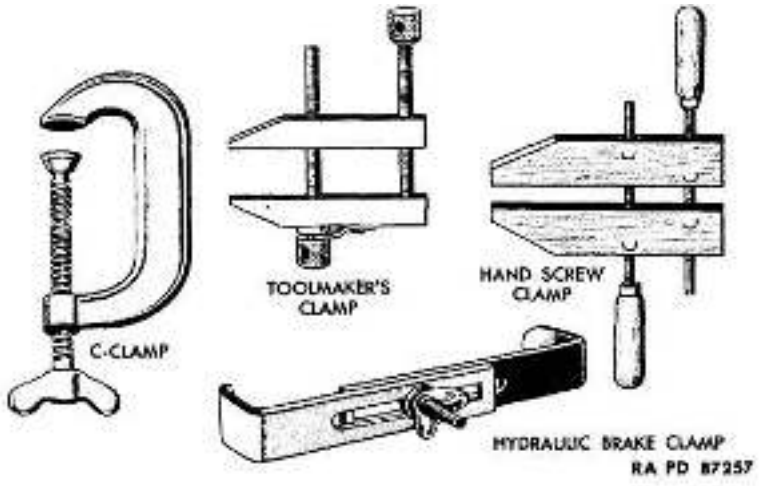


Fig 3.3 Lubricating and storing clamp

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 aluminium 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 callipers

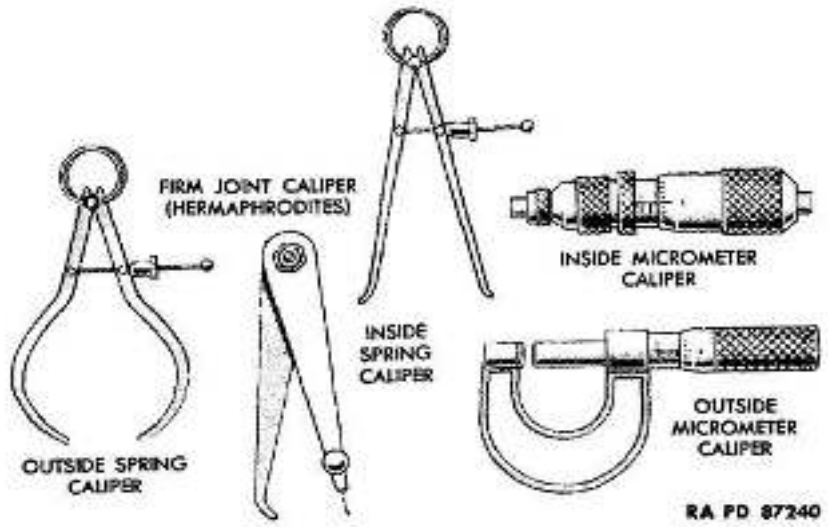


Fig3.4 **Lubricating and storing callipers**

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

Part I: True or False

Directions: Say True or False

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.
4. Store taps and dies in racks or divided boxes to protect cutting edges from contact with metal.
5. Engine oil (SAE 10) is not good for lubricating

Part- I I choice

Direction: Give short answer to the following questions

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_____.
   I. length of service
   II. Trade mark of the manufacturer
   III. Physical appearance

A. I only C. II only

B. III only D. I, II, and III

3. Which is determined after the operation of a hand tool is tested?
   A. Service span
   B. Performance
   C. Physical appearance
   D. Repair Maintenance
4. All defective hand tools with major defects are subject to _____.
   I. Repair
   II. Condemnation
   III. Display/sample

   A. I only C. II only

   B. III only D. I, II, and III
5. Service span of a tool pertains to _____.
   A. Maintenance schedule C. Determining when the tool is acquired
   B. Functionality of a tool D. Defectiveness of a tool

Part III: Short answer writing

Direction: Give short answer to the following questions

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

Operation sheet-3

- **Operation: Title:** clean material
- **Purpose: to perform Clean hand-held workshop tools**
- **Instruction:** Use Clean Material Cleaning hand-held workshop tools according to proper procedures

Required tools and equipment

- Personal protective equipment (PPE)
- Scrap brush
- Broom dustpan
- Spray bottle
- Rag
- Vacuum cleaner

Precautions: Maintenance Hazards

- **Procedures 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

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 3 hours.

Task 1: clean material

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:

- tools, instruments and equipment inventory
- inventory results
- Store 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 tools, instruments and equipment inventory
- determine inventory results
- apply Store tools and equipment

4.1tools, instruments and equipment inventory

4.1.1Introduction 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 there 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.

4.1.2Classification 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 years to 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 as 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.

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.

4.1.3 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.

4.1.4 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.

4.1.5 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 ensures 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.

4.1.6 Benefits of inventory control

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

1. Improvement in customer's relationship because of the timely delivery of goods and service.
2. Smooth and uninterrupted production and, hence, no stock out.
3. Efficient utilisation of working capital. Helps in minimising loss due to deterioration, obsolescence damage and pilferage.
4. Economy in purchasing.
5. Eliminates the possibility of duplicate ordering.

4.2inventory results

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.

4.2.1 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 collect 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.

4.2.4 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.

Table 4.1 **Sample of project report**

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, and 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:-

I. 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.

1.5 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:

- name
- number
- size

In addition the stock record would include:

- amount on hand
- minimum stock level
- amount on order
- retail price
- 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

Table4.2. 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

4.3Store tools and equipment

4.3.1How 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.

4.3.2How 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

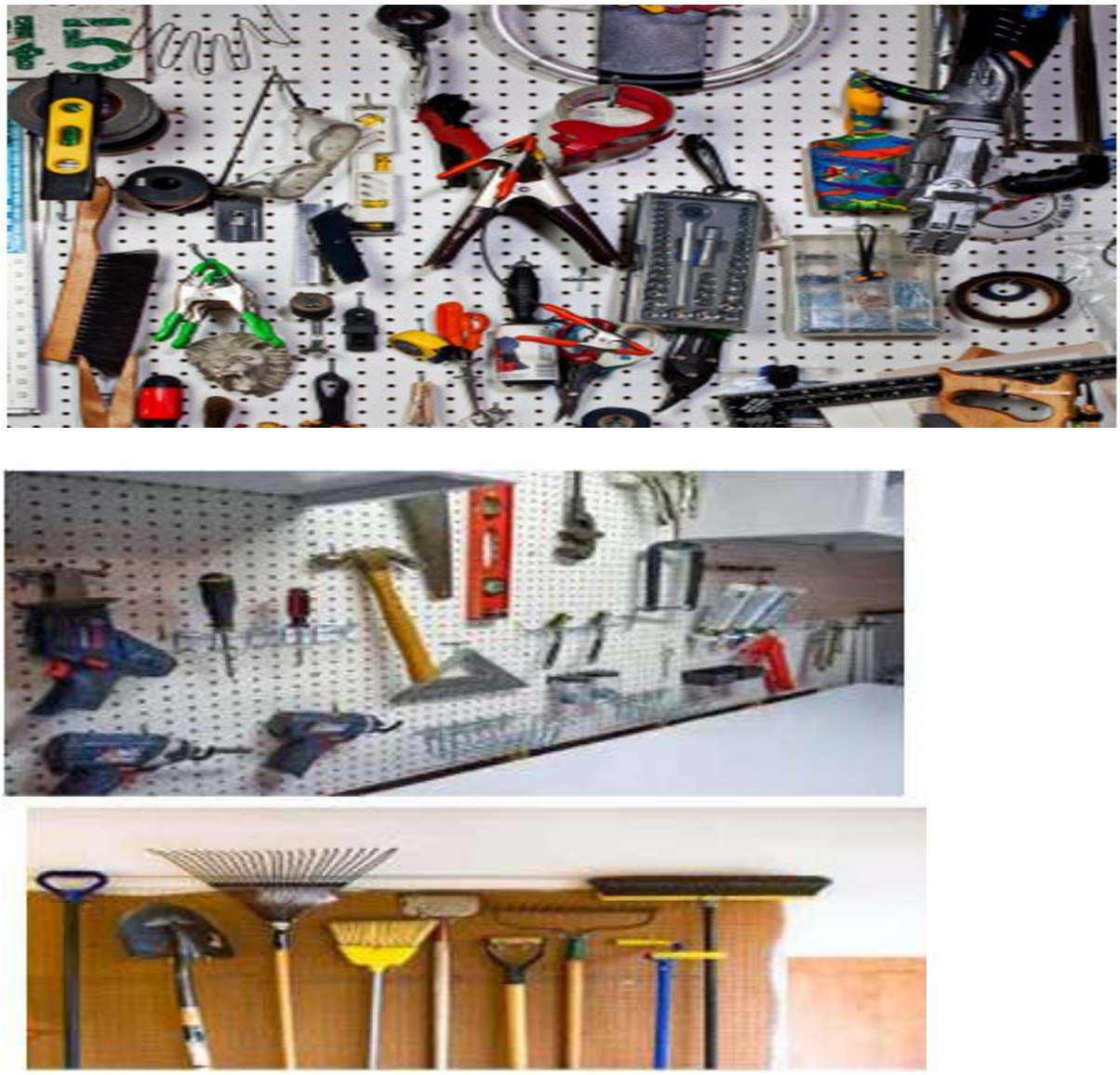


Fig 4.1 Store Tools

4.3.3Functions 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

Part -I choice

Directions: select the correct answer for the give choice

1. An inventory that can be economically restored to a serviceable condition is ----------
   A. Repairable Inventory
   B. Rotable Inventory
   C. Expendable Inventory
   D. None
2. Which type of inventory is more expensive
   A. Repairable Inventory
   B. Rotable Inventory
   C. Expendable Inventory
   D. All
3. ---------- inventory has a higher scrap rate than Rotable inventory
   A. Repairable
   B. Expendable
   C. Recoverable
   D. none
4. Which one is fixed asset
   A. Building
   B. Road
   C. Levees
   D. all
5. Which of the following is benefits of inventory control
   a. Economy in purchasing.
   b. Eliminates the possibility of duplicate ordering
   c. Improvement in customer's relationship
   d. all

Part I I: True or False

Directions: Say True or False

1. Maintenance documentation builds on the operator report.
2. A maintenance technician needs to know how to effectively troubleshoot the process.
3. Accurate safety information - should provide a list of all the hazards associated with the process
4. Record and collect information ensuring appropriate information
5. stock record system not includes name of item

Part III: Short answer writing

Direction: Give short answer to the following questions

1. Write classification of inventory?
2. Write purpose of inventory?

Operation sheet-4

- **Operation: Title:** tools, instruments and equipment inventory
- **Purpose:** to perform tools, instruments and equipment inventory
- **Instruction:** use appropriate inventory documents to apply tools, instruments and equipment inventory

Required tools and equipment

- Personal protective equipment (PPE)
- Scrap brush
- Broom dustpan
- Spray bottle
- Rag

Precautions:

- **Procedures in doing the task**
  - Step1. Safety (clean work area &wear PPE)
  - Step2. Select inventory work shop
  - Step3.idrntefy tools, instruments and equipment inventory
  - Step4. record tools, instruments and equipment inventory
  - Step5.report tools, instruments and equipment inventory
  - Step6.sotre to file cabinet