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Ministry of Labor and Skills

Agricultural Machinery and Equipment Operation

Level-II

Based on March 2022, Version- II Occupational Standard

Module Title: Inspecting and Adjusting Machinery Controlling System

LG Code: AGR AMO2 M08 LO (1-3) LG (37-39)

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Table of Contents

Introduction to the Module

This unit of competency covers the knowledge, skills and attitudes required to prepare for inspection and servicing of steering, brake and clutch systems.

LG #37	LO #1- Prepare for inspection and servicing

Instruction sheet

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

- Identifying and conforming nature and scope of work requirements
- Assessing and adhering sources of workplace information and procedures
- OHS requirements and Personal Protective Equipment
- Workshop manuals, specifications and tooling procedures and information
- Selecting and preparing appropriate methods

This guide 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:

- Identify and confirm Nature and scope of work requirements.
- Workplace information sources are accessed and procedures strictly adhered.
- Identify and observe OHS requirements including regulatory requirements and Personal Protective Equipment
- Procedures and information such as workshop manuals and specifications and tooling required are sourced.
- Methods appropriate to the circumstances are select and prepared in accordance with standard operating procedures.
- Indentify and prepared Resources required for inspecting and servicing steering systems, brake and clutch system
- Observe Warnings in relation to working with wheeled and tracked vehicles

Learning Instructions:
✓ Read the specific objectives of this Learning Guide. ✓ Follow the instructions described below. ✓ Read the information written in the information Sheets ✓ Accomplish the Self-checks

Information Sheet 1

1.1 Identifying and conforming nature and scope of work requirements

While each piece of equipment has one Inspection Profile, each time that you identify a need to inspect a piece of equipment, you will need to define the Inspection Scope for that individual inspection event. Each Inspection Scope defines for an individual inspection the equipment parts that need to be inspected and the methods that should be used to inspect them.

An Inspection Scope consists of the following items:

- An Equipment record, which defines the equipment that should be inspected.
- An Inspection Task record, which provides details about the inspection event that should be performed, including information such as the desired inspection date and any minimum or maximum date ranges for the inspection event. The Inspection Task record is linked to the Equipment record
- One or more Inspection Profile records, which define the subcomponents that should be inspected.
- One or more Inspection Method records, which define the methods that should be used to inspect the individual subcomponents.

To define an Inspection Scope, you will need to create an Inspection Task record or find an existing Inspection Task record and link it to the Inspection Profile and Inspection Method records that identify the subcomponents that should be inspected and the methods that should be used. You can create an Inspection Scope from the Inspection Management Start Page or the Inspection Profile page. When you create an Inspection Scope from the Inspection Management Start Page, you will need to select the Equipment record that represents the equipment that should be inspected. When you create an Inspection Scope from the Inspection Profile page, however, the Meridium APM system assumes that you want to define the Inspection Scope for the equipment that is currently displayed on the Inspection Profile page.

1.2 Assessing and adhering sources of workplace information and procedures

Our latest Safe tip is about maintaining an inventory of internal and external sources of information on workplaces hazards

Hazards and Risks: What's the Difference?

Many people use "hazards" and "risks" interchangeably, but they're not the same thing!

A hazard is a source of potential damage, harm or adverse effect. It can affect something or someone. A hazard has the potential to cause illness or injury to people, or damage to property or equipment

A risk is the likelihood of an adverse event due to exposure to a hazard. A risk assessment determines the likelihood that an incident would take place because of the hazard, and the severity of the potential incident

List All Sources of Information

An effective workplace safety program consists of identifying and mitigating safety risks. You need to be aware of workplace hazards to properly identify safety risks. To help with hazard identification and assessment, start by creating and maintaining a list of all sources of information on workplace hazards. The sources should be consulted periodically, or whenever a new process or job task is introduced.

The following are sources of information on hazards that may already be available in your workplace and that are mentioned in OSHA's document on Recommended Practices for Safety and Health Programs:

- Equipment and machinery operating manuals.
- Safety Data Sheets (SDSs) provided by chemical manufacturers.
- Self-inspection reports and inspection reports from insurance carriers, government agencies, and consultants.
- Reports of incident investigations.
- Workers' compensation records and reports.
- Patterns of frequently occurring injuries and illnesses.
- Exposure monitoring results, industrial hygiene assessments, and medical records (appropriately redacted to ensure patient/worker privacy).

- Input from workers, including surveys or minutes from safety and health committee meetings.
- Results of job hazard analyses or job safety analyses.
- Documentation from other existing safety and health programs (lockout/tagout, confined spaces, process safety management, PPE, etc.).

1.3 Personal protective equipment and OHS hazards in the workplace

1.3.1 OHS hazards in the workplace

What Does Occupational Health and Safety (OHS) Mean?

Occupational health and safety (OHS) is a branch of public health aimed at improving workplace health and safety standards. It studies injury and illness trends in the worker population and offers suggestions for mitigating the risks and hazards they encounter on the job. The field of occupational health and safety sets standards to mandate the elimination, mitigation, or substitution of jobsite hazards. OHS programs also include processes and procedures to minimize the consequences of workplace incidents.

Some of the topics covered by OHS include the following:

Appropriate use of PPE - It is the employer's responsibility to ensure that workers have the personal protective equipment required to work safely. Depending on the job and work environment, this can include fall protection devices, hard hats, high-visibility clothing, or safety gloves.

Safe operation of the work equipment - Safety procedures ensure that employees can use heavy machinery, power tools, and other work equipment with minimal risk of injury. This includes not only the appropriate handling of the equipment, but also regular inspections and maintenance to ensure that it functions optimally.

Maintaining hydration - Since they are at work for extended periods of time, workers are at risk of dehydration if clean drinking water isn't provided for them. While this affects all workers, it is especially important for those who do intense physical labor, wear heavy PPE, or work in high-heat environments.

Good bodily movements - disorders are an extremely common type of workplace injury. To prevent them, workers need to follow ergonomic best practices. This includes safe lifting techniques, good posture, and avoiding repetitive motions while carrying out their work tasks.

1.3.2 Personal protective equipment

Keeping personal safety pertinent to accidents will contribute a lot in minimizing it.

Types of personal protective equipment

A. Eye and face
B. Head
C. Foot and leg
D. Hand and arm
E. Ears
F. Lungs

A. Eye and Face Protection

Necessary if exposed to:

- flying particles
- Liquid chemicals
- Acids or caustic liquids
- Chemical gases or vapors
- Potentially infected material
- Potentially harmful light radiation

Table 1.1: Eye protective equipment

Eye protective equipment	**Description**
Safety Eyeglasses 	Metal or plastic safety frames • Impact resistant lenses • Side shields available on some models
Goggles 	• Tight fitting • Completely covers eyes, eye sockets and surrounding face area • Provides protection from impact, dust and splashes
	• Constructed of vulcanized fiber or fiberglass • Filtered lens protects eyes from burns caused by infrared or intense radiant light • Physical barrier protects from flying sparks, metal spatter and slag chips produced during welding, brazing, soldering and cutting

B. Head Protection

Trainer must wear head protection if any of the following apply:

- Objects might fall from above and strike them on the head
- They might bump their heads against fixed objects
- There is a possibility of accidental head contact with electrical hazards

C. Foot and Leg Protection

Workers at risk of possible foot or leg injuries from falling, rolling objects, crushing or penetrating materials should wear protective footwear. Examples of situations in which the trainer should wear foot and/or leg protection include:

- When heavy objects such as barrels or tools might roll onto or fall on the employee's feet
- Working with sharp objects such as nails or spikes that could pierce the soles or uppers of ordinary shoes
- Working on or around hot, wet or slippery surfaces
- Working when electrical hazards are present

D. Hand and Arm Protection

Potential hazards include skin absorption of harmful substances

- Chemical or thermal burns
- Electrical dangers
- Cuts
- punctures
- Fractures

Protective equipment includes gloves, finger guards and arm coverings

Figure 1.1:hand protection equpment

E. Hearing Protection

Some types of hearing protection include:

- **Single-use earplugs:**

Made of waxed cotton, foam, silicone rubber or fiberglass wool, they are self-forming and, when properly inserted, they work as well as most molded earplugs.

- **Pre-formed or molded earplugs:**

Must be individually fitted by a professional and can be disposable or reusable. Reusable plugs should be cleaned after each use.

F. Respirators:

There are many hazards in farming that can cause respiratory problems. Examples of these include pesticide vapors, dusty fields, hydrogen sulfide in manure pits, and nitrogen dioxide in silos. Farmer's Lung and Organic Dust Toxicity Syndrome (ODTS) are allergic reactions to dust from moldy hay or grain which can lead to permanent lung damage or death.

- **Dusts, mists, molds, and fumes**
  - ✓ Dusts are usually the largest of the particles.
  - ✓ Mold spores released when moldy hay or grain is disturbed and some can only be seen by use of a microscope.
  - ✓ Mists are suspended liquid droplets found in areas where there is mixing, spraying or cleaning.
  - ✓ Fumes are solid particles of evaporated metals from welding.
- **Gases and Vapors**
  - ✓ Gases are chemicals that are gaseous at room temperature. Examples include hydrogen sulfide (manure pit gas), nitrogen dioxide (silo gas), and carbon monoxide.
  - ✓ Vapors evaporate from liquids like pesticides, paints.

- **Oxygen deficient atmospheres**
  - ✓ Manure storage, oxygen limited or sealed silos
  - ✓ In structures when the oxygen level is below 21 %

Figure1.2:respiratory protection

Watch https://www.youtube.com/watch?v=loQ9Dbsy2ag (03/22/2023)

1.4 Workshop manuals, specifications and tooling procedures and information

1.4.1 Workshop manuals

They are the most technical type of workshop manual and are useful for finding out the nitty gritty of maintenance details; for example, they will provide service specifications, torque values, fluid capacities, diagnostic charts, prescribed maintenance timings, detailed instructions for repair procedures

- **Types of Manuals**

One of the most widely-spread types of technical documentation is manual. Nowadays, practically everything that surrounds us has a manual.

Manuals help customers, and technical specialists use and maintain products and devices. They help managers develop their companies. But do we know all kinds of manuals that exist? Let us see!

a) **Service manual** — helps technicians and other trained people service, maintain, and repair equipment. It usually contains information on the problems and breakages that may occur and guidelines on how to fix them. Books with detailed information on how to repair a vehicle

Types of service manuals (shop) include:

- ✓ manufacturer's manuals
- ✓ specialized manuals
- ✓ general repair manuals

- **manufacturer's manuals**
    - ✓ Also called factory manuals
    - ✓ Published by a vehicle's manufacturer
    - ✓ Each manual covers a specific vehicle produced by the manufacturer during a given model year
- **specialized manuals**
    - ✓ Cover only specific repair areas
    - ✓ Produced in several volumes, each covering one section of the vehicle such as engines, body components, or electrical systems
    - ✓ Published by vehicle manufacturers or aftermarket companies
- **General Repair Manuals**
    - ✓ Published by companies other than the major vehicle makers

b) **User manual** — assists people to use a particular system or device. It provides instructions for both skilled and unskilled users for setup, operation, and maintenance of a product. It may have precautions and problem guidelines.

c) **Operation manual** — provides guidance for the staff to perform their functions correctly and efficiently. It describes what and how should be done, which is especially important for the quality of goods and services. Moreover, it contributes to the safety of products and services.

d) **Training manual** — contains instructions to improve the quality of performed tasks and processes. It is aimed at teaching and upgrading the skills of employees. It can be used as a reference document in the workplace or by a trainer to revise the material.

1.4.2 Tooling procedures and information

Hand tools are such a common part of our lives but they can also be dangerous if misused incorrectly.

Reduce the chance of an accident by following **procedures**

1. **Inspect regularly**

Regularly inspect your tools to make sure that they are in good condition.

2. **Wear gloves**

Always wear appropriate personal protective equipment.

3. **Carry with care**

Never carry tools up a ladder.

If you need to take tools up to a height use a bag or hoist them up in a bucket.

4. **Don't pocket sharp objects**

Never carry sharp or pointed tools in your pocket.

Instead, carry them in a toolbox.

5. **be aware of your surroundings**

Always be aware of the people around you when using tools.

6. Use the right tools

Always use the right tools for the job.

Never use a tool for a different purpose than it was intended.

You risk damaging the tools and injuring yourself.

7. Follow instructions

Only operate tools according to manufacturers' instructions.

8. Clean and return

After using a tool, clean it and return it to it's proper storage place.

9. Oily hands are dangerous

Don't work with greasy or oily hands.

10. Protect your eyes

Always wear eye protection.

1.4.2 Tools and equipment used for Inspect and Adjust Machinery Controlling System

- Type of tools used for routine maintenance
    a. Hand tools
    b. Power Tools

a. Hand tools

It is necessary for you to know about hand tools and shop tools. It may be possible for you to repair a component with the first available tool, but only the correctly designed and selected tool will ensure that the job is well done.

General advice and instructions for the use of hand tools

- Only use a tool for its intended purpose.
- Always use the correct size tool for the job you are doing.
- Pull a spanner or wrench rather than pushing whenever possible.
- Do not use a file, or similar, without a handle.
- Keep all tools clean and replace them in a suitable box or cabinet.

Table 1.2a: hand tool and its use

Hand tool	Example uses and/or notes	
Adjustable spanner (wrench)	An ideal standby tool and useful for holding one end of a nut and bolt	
Open-ended spanner	Use for nuts and bolts where access is limited or a ring spanner cannot be used	
Torque wrench	Essential for correct tightening of fixing. The wrench can be set in most cases to 'click' when the required torque has been reached.	
Socket wrench	Often contains a ratchet to make operation far easier	
Air wrench	Often referred to a wheel gun. Air-driven tools are great for speeding up your work but it is easy to damage components because an air wrench is very powerful. Only special, extra strong, high-quality sockets should be used	
Pliers	Used for gripping and pulling or bending	
Lever	Used to apply a very large force to a small area.	
Hammer	Anybody can hit something with a hammer,	

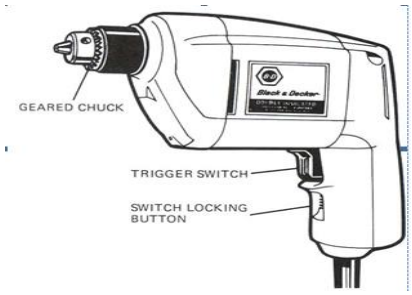
b. Power Tools

A power tool is technically a power-driven hand tool or portable power tool; these names distinguish it from the stationary power tool such as the drill press. While power tools are generally driven by electricity, the most popular power tools are:

- **Electric hand drill**
- **Electric grinders**

Electric hand drill

- ✓ It is used to drive drill bit so that holes can be drilled,
- ✓ he electric drill has an electric motor that drives the chuck



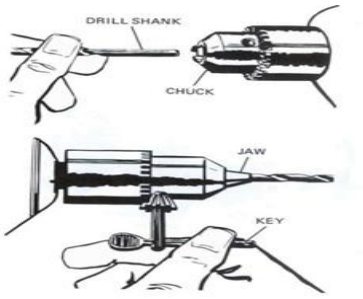


Figure 1.3a: Electric hand drill **Figure1.3b: chuck key.**

b) Electric grinders

- ✓ The grinder can be either bench – mounted or portable. It may have a grinding wheel and wire wheel. If it has two grinding wheels, then one wheel is coarse and the other fine.
- ✓ The grinding wheel is used to grind metal to the proper size and the wire wheel is used to clean parts,

Watch video **https://www.youtube.com/watch?v=LI40_Pnd9lk(05/05/2023)**

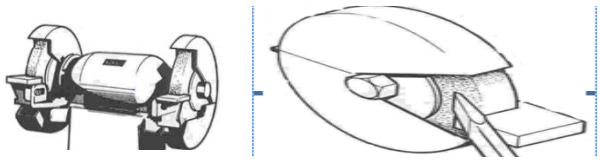


Figure 1.4: Grinding wheel

1.5 Selecting and preparing appropriate methods

Visual Inspection (VI), or visual testing (VT), is the oldest and most basic method of inspection. In its simplest form, visual inspection is the process of examining a component or piece of equipment using one's naked eye to look for flaws. Optical aids such as illuminators, mirrors, borescopes, etc. can be used to enhance one's capability of visually inspecting equipment. Cameras, computer systems, and digital image analyzers can also be used to further the capabilities and benefits of visual inspection.

Visual inspection is routinely used for internal and external surface inspection of a variety of equipment types including storage tanks, pressure vessels, piping, and other equipment.

Visual inspection is simple and less technologically advanced compared to other methods. Despite this, it still has several advantages over more high-tech methods. Compared to other methods, it is far more cost effective because there is often no equipment required; just the eyes of a knowledgeable inspector. For similar reasons, it is also one of the easiest inspection techniques to perform.

Visual inspections are generally performed as a precursor to more advanced inspection techniques that are capable of detecting flaws beyond what the human eye can see, such as subsurface cracks.

Remote Visual Inspection (RVI) is an advanced form of visual inspection that uses various types of videoprobes, video borescopes, remotely operated cameras, robotic crawlers, and other specialized tools in order to remotely examine components. In doing so, the risks associated with confined space entry are considerably reduced.

Remote Visual Inspection (RVI) is a non destrucutive testing technique dating back to the 1970s that uses various types of videoprobes, video borescopes, remotely operated cameras, robotic crawlers, drones, and other specialized tools in order to remotely examine components for corrosion and damage. There are several different methods of RVI that can be used to inspect a variety of equipment.

The three major methods of RVI are (1) **Comparison Measurement,** (2) **Stereo Measurement,** and (3) **Shadow Measurement.**

Comparison Measurement

The comparison measurement method is based on a known reference dimension in the inspection image, which is used to measure other objects in the same view and plane. The object used to provide a reference dimension can also have been set in place by the instrument manufacturer or introduced with the probe. For this method, comparison measurement accuracy depends on two factors: the distance from the distal end of the borescope to the object, and the degree to which the object plane is perpendicular to the borescope camera.

Stereo Measurement

The stereo measurement method on the other hand, which is also sometimes known as stereo probe measurement, uses a prism or dual lens to split images, allowing the camera to capture left and right views with a precise angle of separation. The position of user-placed cursors is then analyzed using a computer algorithm and triangulation geometry is applied to them to obtain accurate measurements. The accuracy of this method depends on the separation distance between the prism or dual lens and on the distance of the distal end of the borescope from the object being measured. The sharpness and contrast of the image in question are also very important for the accuracy of the measurement. Unlike other methods, the stereo method does not depend on perpendicularity between the object plane and the video borescope distal tap.

Shadow Measurement

The final method, shadow measurement, relies on a shadow triangulation of tip-to-target distance. A device known as a shadow measurement tip projects a shadow across the area being inspected. Thus, the positioning and size of the shadow in the resulting image is directly related to the distance from the tip to the object. With this information, the shadow measurement system can accurately calculate the size of any features or defects. The accuracy of this method depends on the distance from the distal end of the borescope to the object being examined. Image sharpness and contrast are less important than with the stereo method. The object plane must be perpendicular for some types of measurement and may be skewed for other types of measurements.

1.6 Operating principles of brake and clutch system

1.6.1. Brake system

- The braking system is an important system in the tractors used to slow down or stop the tractor motion.
- It is also used to prevent the tractor from moving when it is stationary.
- During field operations it helps in taking sharp turns by applying differential brakes on the two rear wheels.
- The brakes use the friction force to reduce the motion of the wheels.
- Friction is used to convert the kinetic energy into heat.
- The brake arrangement serves to intentionally offer resistance to the movement of the tractor.
- Most common are the friction brakes.
- These are essentially heat devices that change the kinetic energy of the moving vehicle into heat, by virtue of friction between a rotating component and a stationary component which are mechanically moved so that they come in contact with the rotating component.
- The stationary are lined with a hard wearing friction material.
- When this material is moved into contact with the rotating component, braking takes place.

Principle of operation brake

- Brake works on the principle of friction. When a moving element is brought into contact with a stationary element, the motion of the moving element is affected.
- This is due to frictional force, which acts in opposite direction of the motion and converts the kinetic energy into heat energy.

Classification of brake:

1. Mechanical brake and
2. Hydraulic brake.

1. Mechanical brake can be:

(a) Internal expanding shoe type

(b) External contracting shoe type and

(c) Disc type.

a. Internal expanding shoe

• Two brake shoes made of frictional material fitted on the inside of the brake drum are held away from the drum by means of springs.

• One end of each shoe is fulcrum whereas the other is free to move by the action of a cam Which in turn applies force on the shoes.

• The movement of the cam is caused by the brake pedal through the linkage.

• The drum is mounted on the rear axle whereas the shoe assembly is stationary and mounted on the back plate

b. External contracting shoe type

- This type of brake system is normally available on crawler tractors.
- The brake band directly surrounds the drum mounted on the drive axle.
- When the pedal is depressed, the band tightens the drum.

c. Disc brake:

- Two actuating discs have holes drilled in each disc in which steel balls are placed.
- When the brake pedal is depressed, the links help to move the two discs in opposite directions.
- This brings the steel balls to shallow part of the holes drilled in the disc.
- As a result, the two discs are expanded and braking discs are pressed in between the discs and the stationary housing.
- The braking discs are directly mounted on the differential shaft, which ultimately transfers the traveling effect to the differential shaft.

Braking Efficiency:

- High braking efficiency is required as on many occasions the brakes are required to stop the vehicle in emergency.
- Braking efficiencies of the order of 50-80% enable to stop within reasonable distance.
- However the stopping distance varies with the type of road conditions and condition of the tyres.

Brake actuation methods

The method of actuation decides as to how the braking effort from the point of application brake pedal, reaches tree brakes.

a. **Mechanical Actuation**- Most common in tractors.

b. **Hydraulic Actuation**- used in tractors with higher HP and motor cars.

c. **Electric Actuation**- use eddy currents for application of brakes.

d. **Vacuum Actuation-** applied in railways.

e. **Pneumatic Actuation-** applied in heavy vehicles and special purpose machines.

1.6.2 Clutch system

Clutch is a device, used to engage and disengage the tractor engine from the transmission gears and drive wheels. Clutch transmits power by means of friction between driving members and driven members. Used to connect and disconnect the engine and manual transmission or transaxle. Allows the driver to control power flow between the engine and transmission or transaxle.

Requirements of clutch:

- It should have good ability of taking load without dragging, grabbing and slipping.
- It should have higher capacity to transmit maximum power without slipping.
- It should be convenient, accessible and easy to operate, adjust and repair.
- Friction surface should be highly resistant to heat effect. The control by hand lever or pedal lever should be easy.

Types of clutch

Clutches are mainly of three types:

i. Friction clutch

ii. Dog clutch

iii. Fluid coupling

I. **Friction clutch**

A clutch in which one part turns the other by the friction between them. Friction clutch produces gripping action, by utilizing the frictional force between two surfaces. These surfaces are pressed together to transmit power

- **Advantages of Friction Clutches:**
  - ✓ Slips during engagement help the drive to pick up and accelerate the load with minimum shock.
  - ✓ They need not to be unloaded before engagement.
  - ✓ These can be used at high engagement speeds.
  - ✓ Slip under momentary shock loads, provides cushioning.

Friction clutch may be subdivided into two classes:

i. Disc/Plate clutch

a. Single plate clutch or single disc clutch

b. Multiple plate clutch or multiple disc clutch

ii. Cone clutch

a) Single plate clutch:

This may be called single disc clutch. It consists of:

- ✓ Pressure plate
- ✓ Clutch plate
- ✓ Springs
- ✓ Release fingers

The single disc clutch is a plate type of clutch in which a single thick iron plate is coated with friction material on both sides. There is only one clutch plate in this type. The clutch plate is pressed against the flywheel of the engine by the spring loaded pressure plate. The pressure produced by a number of springs, located between the pressure plate and the housing, which is

bolted to the flywheel, holds the friction surfaces firmly in contact. When the pedal of the clutch is depressed, the pressure plate is pushed back by the release fingers.

This releases the pressure from the clutch plate and disengages the clutch. Then the clutch plate stops rotating but the fly wheel continues to rotate. When the clutch pedal is released, the pressure plate forces them to turn together as one unit. Thus the power of the engine goes to the gear box for onward transmission to rear wheels. This type of tractor clutch plate is usually foot operated.

b) Multiple plate clutch

This may be called multiple disc clutch. It can be twin-disk or three-plate type of clutch . It differs from single-plate clutch in that the flywheel rims does not serve as a friction surface. It may also got a number of thin metal plates, arranged alternately to work as driving and driven members. One set is attached to the fly wheel and the other set is attached to the clutch shaft. If the plates are pressed together, the clutch is said to be engaged and the power is transmitted from the engine to the gear box for onward transmission to the rear wheels. This pressure is obtained by a set of heavy springs, fitted together in housing.

ii. Cone clutch

The principal member of the cone-clutch assembly is a metal disk with a conical peripheral surface that engages with a similarly shaped recess in the flywheel. The cone is faced with ordinary brake lining. A heavy spring placed behind the cone, exerts sufficient pressure to insure its positive engagement. A sleeve fastened to the cone extends back and is bolted to the transmission shaft. Therefore, the engagement if the clutch connects the gears with the engine. Disengagement is produced by sliding the cone and sleeve backward on the flywheel shaft extension against the spring pressure.

Advantages for cone clutch:

- Force is concentrated at a large diameter.
- Sufficient friction surface width is provided for durability.
- A full 360º of lining material is available
- It is comparatively powerful for a given outside diameter and axial energizing force

ii. Dog clutch

It is a simple clutch having square jaws, which are used to drive a shaft in either direction. It is mostly used in power tillers. A dog clutch is a type of clutch that couples two rotating shafts or other rotating components not by friction but by interference. The two parts of the clutch are designed such that one will push the other, causing both to rotate at the same speed and will never slip. Dog clutches are used where slip is undesirable and/or the clutch is not used to control torque. Without slippage, dog clutches are not affected by wear in the same way that friction clutches are. Dog clutches are used inside manual automotive transmissions to lock different gears to the rotating input and output shafts. A synchromesh arrangement ensures smooth engagement by matching the shaft speeds before the dog clutch is allowed to engage.

iii. Fluid coupling

Fluid coupling consists of a driving member and a driven member - an impeller with radical vanes, housed in a suitable casing (Fig. 10.7). A coupler is mounted on the engine crankshaft and is 3/4th filled with suitable oil. A spring loaded sealing ring is provided to make the driven shaft oil tight. At the rotation of the crankshaft, the oil is thrown out by centrifugal force from the center to the outer edge of the impeller, increasing the velocity and the energy of the oil. It then enters the runner at the outer portion and flows towards the center, causing rotation to the runner unit. As long as impeller and runner rotate at different speeds, the oil continues to circulate uniformly but when the impeller and runner start running at same speed, the circulation of oil stops. The coupling does not increase the applied torque but only transmits the torque in an uniform manner

- **Clutch Principles**
  - ✓ Vehicles with manual transmissions require a clutch
  - ✓ Power flow from one unit to another can be controlled with a drive disc and a driven disc
- **Clutch Action (Disengaged**
  - ✓ When the driver presses the clutch pedal, the clutch release mechanism pulls or pushes on the clutch fork
  - ✓ The fork moves the release bearing into the center of the pressure plate
  - ✓ The pressure plate face pulls away from the clutch disc

- ✓ The clutch disc and transmission input do not turn

- **Clutch Action (Engaged)**
  - ✓ When the driver releases the clutch pedal, the spring pressure inside the pressure plate pushes forward on the clutch disc
  - ✓ This locks the flywheel, disc, pressure plate, and transmission input together
  - ✓ The engine rotates the transmission input

1.7 Resources required for inspecting and servicing steering systems, brake and clutch controls

1.7.1 Resources required for inspecting and servicing brake systems,

The most essential tools for testing your brakes already come standard on most people: eyes, hands and feet. Before breaking out any fancier gadgets, use your peepers and mitts to verify the brake fluid level in the reservoir; inspect the condition of your brake pads; search for bubbles in the hydraulic line; check for leaks, wear and rust; ensure proper lubrication and function throughout; and see if the brake indicator light is on. Your feet and your sense of feel can diagnose several potential problems based simply on pedal and brake response, including hints of a worn-out master cylinder or vacuum booster. A soft brake pedal could signify that it's time to bleed your brakes, and slow stop times or brake lockups imply a faulty proportioning valve. We'll tell you what tools you'll need to bleed your brakes and check your brake-proportioning valve below.

First, however, let's look at how to test your brake fluid. Remember, unless it contains rust or appears muddy brown, you cannot visually detect when brake fluid needs replacing, so use one of these instead:

a. **Optical refractometer:** Measures the refraction of light through a fluid sample to determine moisture content and boiling point
b. **Chemical test-strips:** Change color to indicate copper buildup, a signal that the fluid's anticorrosion additives are nearly kaput
c. **Electronic testers**: Estimate brake fluid's boiling point, either by measuring its conductivity or, ideally, by boiling a sample

When it comes to bleeding brake fluid, pumps and vacuums are your best friends, and are quicker and easier than gravity or brake pumping. Hook a pressure tank to the master cylinder reservoir to push the old fluid out, or attach a vacuum bleeding tool to the bleeder screws to pull it out.

Gauges are invaluable for checking your braking system's hydraulic and pressure conditions. To test a suspect proportioning valve, simply install a hydraulic gauge on either side of it. You can verify engine vacuum (used by the power brake booster) by connecting a vacuum gauge to the supply hose running from the intake manifold.

As for the brakes themselves, you'll need a micrometer or vernier calipers to measure brake pad and rotor thicknesses, as well as the rotor runout (wobble), flatness and parallelism.

Understanding problems with electrical mechanisms or switches, such as components of the Antilock Braking System (ABS), will require a computerized scan tool or diagnostics tool and the applicable shop manual [source: Senter].

Now it's time to bring this to a slow, smooth stop. Good luck, and remember: Take care of your brakes and they'll take care of you.

1.7.2 Resources required for inspecting and servicing clutch systems

- The most essential tools for testing clutch are;
  - ✓ Clutch Cylinder Pliers.
  - ✓ Clutch Aligning Shafts.
  - ✓ Clutch Spring Compressors.
  - ✓ Spicer Clutch Adjustable Wrenches.
  - ✓ Clutch Adjusting Tools.
  - ✓ Clutch Wear Installers.

1.7. Resources required for inspecting and servicing steering systems

- The most essential tools for testing clutch are:
  - ✓ Steering Wheel Puller
  - ✓ Steering wheel Lock Plate Tool ·
  - ✓ Steering Pump Puller Kit
  - ✓ Inner Tie Rod End Tool
  - ✓ Front End Service Kit.

1.8 Observing warnings of wheeling and tracking vehicles

Lifting plant and equipment can cause accidents if they are used unsafely or poorly maintained. Vehicles falling/rolling off incorrectly positioned jacks or stands, particularly where they are not chocked, are one of the main causes of fatal accidents in MVR. Working beneath a vehicle is often required to check for faults, servicing and repairs etc but because these tasks are so common people get used to working under potentially lethal weights. Unfortunately, serious and fatal accidents happen every year even though the dangers and precautions are well known. You must always use the right equipment for the job. Don't be tempted to take short cuts or use inappropriate equipment to lift heavy items**.**

Use equipment correctly

- Make sure there are safe working procedures in place when moving heavy loads, particularly when they are raised
- Use the correct pins for axle stands - screwdrivers, nails and bolts are not acceptable
- Use stands on a hard, level surface eg concrete and avoid lifting on sloping ground

Securely chock wheels remaining on the ground

- Make sure that all lifting points for jacks and stands are correct for that vehicle - consult the vehicle manufacturer's handbook for guidance
- Do not exceed the rated capacity (safe working load) of any lifting equipment
- Ensure that vehicles are always properly supported - do not rely on jacks alone

Make sure lifting equipment is correctly installed

- Make sure the floor and fixings meet the lift manufacturer's specification

- Once installed, the lift must be tested before it is used by a competent person, who will issue a certificate
- Regularly check the fixing bolts with a torque wrench to ensure they remain tight

Make sure the ground if firm and level before raising a vehicle

If the area is unsuitable then move the vehicle to a safer place before any attempt is made to lift it to undertake any repairs

Self-check 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Choose the best answer

1. Which of the following is true about Operating **principles of brake system?**

A. prevent the tractor from moving when it is stationary

B. The brakes use the friction force to reduce the motion of the wheels.

C. The stationary are lined with a hard wearing friction material

D. all of the above

2. Which of the following statements about safety glasses is true?

A. They should offer side protection.

B. The lenses should be made of a shatterproof material.

C. Some service operations require that additional eye protection be worn with safety glasses.

D. All of the above statements are true.

3. Which of the following is true about **Advantages of Friction Clutches:**

A. They need not to be unloaded before engagement.

B. These can be used at high engagement speeds.

C. Slip under momentary shock loads, provides cushioning.

D. ALL

4. Heavy protective gloves should be worn when.

A. welding B. grinding metal

C. working with caustic cleaning solutions D. all of the above

5.Which of the following is/are important when working in an automotive shop?

A. using the proper tool for the job

B. avoiding loose-fitting clothes

C. wearing steel-toed shoes

D. all of the above

Test II: Short Answer Questions

1. What is a current hazard on your farm that is controlled with a type of PPE?

2. Could this hazard be controlled administratively?

3. Could this hazard be controlled by using an engineering control?

4. Name a place/task on your farm where each of the following types of PPE should be implemented.

A. Eye/Face Protection----------

B. Head Protection:----------

C. Foot/Leg Protection:----------

D. Hand/Arm Protection:----------

E. Hearing Protection:----------

F. Lung Protection:----------

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5. What are the main tasks of a Clutch?

LG #38 LO #2- Inspect control systems

Instruction sheet

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

- Inspection of suspension and steering system components
- steering system inspection method
- Inspection of clutch and brake controls
- Using mathematical ideas and techniques to calculate time, tolerances, and apply accurate measurements
- Making adjustments of wheel bearing and brake/clutch pedal travel
- Comparing results
- Documenting and recommending results
- Forwarding report

This guide 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:

- Conduct and implement Inspection of suspension and ***steering system components*** by applying manufacturer recommended ***steering system inspection method.***
- Conduct Inspection of clutch and brake controls in accordance with operational manual
  - Adjustments including wheel bearing adjustments and brake/clutch pedal travel
  - Results are compared with manufacturer/component supplier specifications to indicate compliance or non-compliance.
  - Results are documented with evidence and supporting information and recommendation(s) made.
  - Report is forwarded to persons for action in accordance with workplace procedures.

Learning Instructions:

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

Information Sheet 2

2.1 Inspection of suspension and steering system components

2.1.1 Steering system

The steering system converts the rotation of the steering wheel into a swivelling movement of the road wheels in such a way that the steering-wheel rim turns a long way to move the road wheels a short way. The system allows a driver to use only light forces to steer a heavy car.

Functions of a Steering System

- Provide precise control of the wheel direction
- Maintain correct steering effort
- Transmit road feel to the driver's hands
- Absorb most of the road shock going to the steering wheel
- Allow for suspension action

There are three basic types of power steering systems found in vehicles

a. hydraulic power steering (HPS)
b. electric power hydraulic steering (EPHS)
c. Fully electric power steering (EPS). .

a. hydraulic power steering (HPS)

Hydraulic power steering (HPS) uses hydraulic pressure supplied by an engine-driven pump, known as the power steering pump, to assist the motion of turning the steering wheel. The power steering pump is turned by the accessory drive or serpentine belt and provides pressurized power steering fluid to the high side power steering hose which delivers it to the input side of the power steering control valve at the steering gear. Power steering fluid is drawn from the power steering fluid reservoir which is maintained at the appropriate level by a low side power steering hose that returns the fluid from the gear at a much lower pressure.

HPS provides many disadvantages. Since the power-steering pump equipped on most vehicles runs constantly and pumps fluid all the time, it wastes horsepower. This wasted power translates into wasted fuel and higher emissions. In addition, this system is susceptible to leaks and noises, and commonly results in failure due to a broken belt

b. electric power hydraulic steering (EPHS)

Electric power hydraulic steering (EPHS) is a hybrid of hydraulic and electric. In this system, a hydraulic pump gets its energy from an electric motor instead of a belt driven by the engine. In EPHS the customary drive belts and pulleys that drive a power steering pump are replaced by a brushless motor. The power steering is driven by this electric motor, which reduces the amount of power that needs to be taken from the engine. In the electric power steering (EPS) system, an electric motor replaces the hydraulic pump and a fully electric power steering system is established. The electric motor is either attached to the steering rack or to the steering column. The electronic control unit controls the steering dynamics. EPS is often a preferred system since it results in better fuel economy and lower emissions.

EPS provides many additional advantages. The amount of assistance provided by EPS is easily tunable to the vehicle type, road speed, and even driver preference. Another benefit is the elimination of environmental hazards posed by leakage and disposal of hydraulic power steering fluid. In addition, electrical assistance is not lost when the engine fails or stalls, whereas hydraulic assistance stops working if the engine stops.

Components of steering system and their function

The following are the main components of steering system.

1. Steering wheel
2. Steering column or shaft.
3. Steering gear
4. Drop arm or pitman arm
5. Ball joints
6. Drag link
7. Steering arm

8. Stub axle
9. Left spindle and kingpin
10. Left tie rod arm
11. Track rod or tie-rod
12. Right tie rod arm, spindle and kingpin
13. Steering stops.

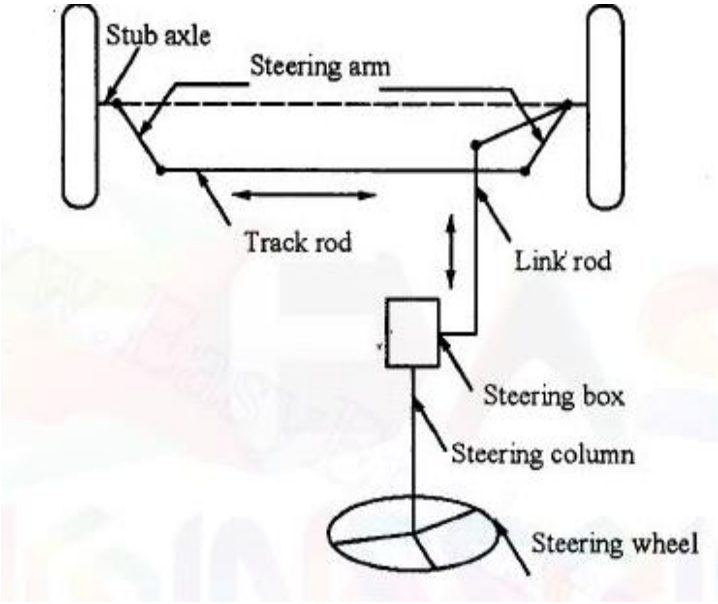


Figure2.1: part of steering system

1. **Steering wheel**

It is the control wheel to steer a vehicle by the driver. It contains traffic indicator switch, light switch, wiper switch etc.

2. **Steering linkage.**

The steering wheels are turned by the steering linkage. The steering linkage consists of pitman arm, ball joints, drag link, steering arm, spindle, tie rod and kingpin assembly

a. Pitman arm

It is also called drop arm which converts the output torque from the steering gear into force to the drag link. It is connected to the sector shaft of the steering gear by a split joint. Either full serrations or partial splines are used for transmitting the torque from the sector shaft to the pitman arm. The split arm is tightened around the sector shaft by a clamping bolt It is done for

differentiating the male and female serrations or splines. The end of the pitman arm connected with the drag link has a tapered hole. The ball stud on the drag link is fixed into this hole.

b. Ball joints

These joints are connected at both ends of the drag link and tie rod. It performs the angular displacement, rotational movement of the drag link and the tie rod produced by the front wheel rotation and suspension articulation.

c. Drag link:

It is connected between pitman arm and steering arm. It is a single prece forged component having a ball joint socket formed at the end in some other cases.

d. Steering arm:

It is also a forged component which is connected to the steering knuckle. During turning, the drag link force is converted into a turning moment about the left kingpin. The steering arm is connected to the spindle through a keyway, locking taper and nut. The arm is extended either to the front or rear spindles according to package constraints. The end of the steering arm connects with the drag link and a tapered hole receives the ball stud.

e. Left spindle and kingpin

The torque obtained by the steering arm rotates the left spindle, wheel and tyre about the kingpin.

f. Left tie rod arm:

The left tie rod arm is connected with the spindle in the same way as the steering arm. It converts the available torque to turn the right wheel into force in the tie rod. The tie rod has a tapered hole to receive the tie rod ball stud.

g. **Tie rod**:

The tie rod is a tubular member. Both the left and right tie rod arms are connected by this tie rod. The force is transmitted between these two components. The tie rod ends have female threads. But the ball joint shafts have mating male threads. The threaded connections are held together firmly by locking clamps after setting the correct length. The length of the tie rod is an adjustable one to the specified amount.

In the direct cross type steering linkage. the pitman arm is directly connected to one tie rod which in turn is connected to another tie rod. The other end of the tie rod is connected to steering arms.

h. **Right tie rod arm, spindle and kingpin**:

It converts the force from tie rod into a moment to turn through the knuckle arm, the right spindle wheel and the tyre about the kingpin. The right spindle and the kingpin assembly are merely similar assembly on the left side. But it has no steering arm connected to it.

i. Steering stops:

Stops are used to limit the angular deflections of front wheels. It also avoids the rubbing of tyres against the frame produced by wear and tear of tyres. These steering stops are used at two different places. First, they are fixed' in the path of motion of the steering arm or drop arm. Then, they are fixed in the path of motion of the steering knuckle. https://learnmech.com/components-of-steering-system-and-their-function/(1/05/2023)

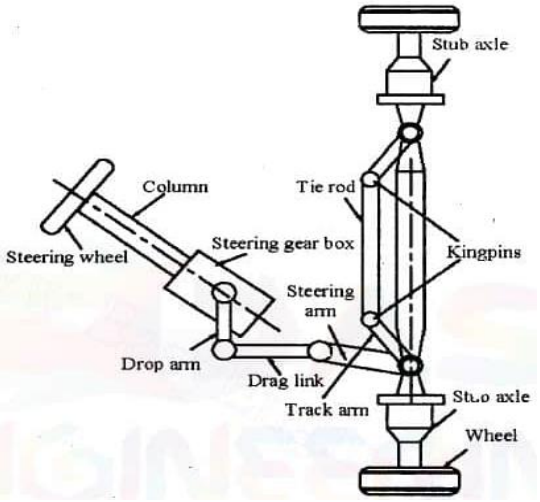


Figure 2.2: Arrangement of steering system component

3. **Steering shaft**

The steering shaft is fitted inside the hollow steering column. When the steering wheel is turned, the steering shaft will also be rotated. Due to this, the motion is transmitted to the steering box

4. **Steering gear:**

The pitman arm is splined to the steering gear box rocker arm at one end and the other end is connected to the drag link by a ball joint**.**

Inspection of steering system components

Steering System Problem

Inspect and test the steering system to find the source of the trouble. Symptoms of steering problems include play in the steering wheel, hard steering, and abnormal noises when turning

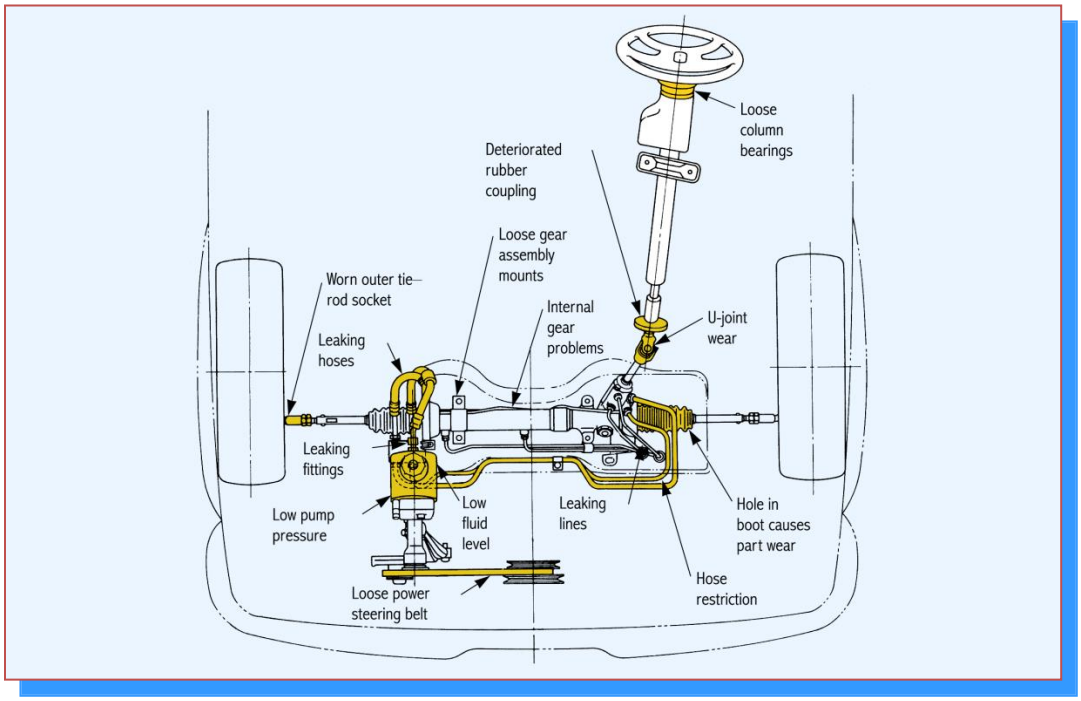


Figure2.3: Steering System Problems

Steering Wheel Play

- Amount that you can turn the steering wheel without front wheel movement
- Caused by worn ball sockets, a worn idler arm, or too much clearance in the steering gearbox
- Compare the play to service manual specifications

Dry Park Test

With the vehicle on the ground, rotate the steering wheel back and forth while someone watches for part wear

Hard Steering

- Caused by problems with the steering gear, power steering components, ball sockets, or the suspension system
- Check the condition and tension of the power steering pump belt
- If the belt is slipping, hard steering could result
- Check for cracks and glazing and compare the tension to specs

Steering System Noise

- Noise can be a sign of worn parts, dry bearings or ball sockets, loose parts, slipping belts, or a low power steering fluid level
- Belt squeal and power steering pump noise both occur when the steering wheel is turned
- Pump noise can result from a low fluid level or aerated fluid

Steering Component Inspection

Flexible steering joint

Rag joint

Check the flexible coupling connecting the steering shaft to the steering gear. Replace if damaged or deteriorated.

Flexible joint

Inspect and replace if the joint binds, is excessively loose or show signs of rust.

Idler arm

- Check for damaged attachment points, bends and twists.
- Check for ball joint and bushing wear.

Outer tie rods

- Steer the wheels back and forth checking for looseness of the ball joint stud.
- Depress the tie rod ball joint and check for excessive up and down play. Replace the tie rod if any movement is detected.
- Twist the tie rod by hand. The tie rod should rotate through its entire operating range without binding. Replace the tie rod if it will not rotate freely.
- Inspect protective rubber boot for damage. Torn or damaged boots will allow dirt to enter the socket area and destroy the socket.
- Inspect the adjustment sleeve. Replace the sleeve if bent or damaged.

Pitman arm

- Check for tight fit to steering gear or sector shaft.
- Check for bends or twists and ball joint wear.

Power steering systems

- Check the pump, belt and hoses for leaks, damage or signs of wear or deterioration.

Rack and pinion style inner tie rods

- Rock the steering wheel side to side. A worn inner socket will allow the tie rod to move in and out independent of the rack gear.
- Replace bellows boots that are torn, cracked or softened from steering fluid.
- Check for bent rods, and damaged or worn ball joints.

Spindle

- Inspect ABS plug for damage. ABS wire must remain secured to spindle. Inspect for scored bearing race areas.
- Do not use spindles that have corrosion on areas where seals or bearings contact. Inspect for obvious distortion.

Steering arm

- Measure the distance from the brake rotor to the ball joint. Compare this measurement from one side of the vehicle to the other. The measurements should be equal. Unequal measurements indicate a bent steering arm.
- In addition, the steering arm should be measured to a symmetrical location on the upper or lower control arm. This measurement checks for vertical movement in the steering arm.

Steering column

- Check mounting points for damage.
- Rock the steering wheel from side to side and up and down to check for any wobble or abnormal steering effort or noise. If there is excessive movement or an audible clunking or grinding sound, replace the steering column.
- Inspect for obvious compression of the column jacket.

Steering center link

- Have an assistant steer the front wheels back and forth and observe the center link joints. Any looseness is not acceptable.
- Check for signs of impact or bends.

Steering gear box

Rack and pinion

- Check the rack for looseness by trying to move it up and down and side to side. Inspect the insulator bushings and replace them if cracked or damaged.
- Inspect the rack for housing cracks and cracked or broken mounting ears.
- Check the bellows boot by squeezing it. Power steering fluid leaking from the gearbox into the bellows boots will make the boot feel soft.
- Unclamp the bellows boot from the inner tie road and push the boot inward to expose the tie rod. Signs of fluid indicate damaged or worn rack housing seals.
- Inspect threaded tie rod ends for damage.
- Check for pinion shaft end-play and excessive steering wheel free play.
- Inspect housing for corrosion or leaks.

Steering knuckle

- Place a straight edge vertically on the brake rotor. Measure from the straight edge to several points on the steering knuckle. Compare these measurements from one side of the vehicle to the other. The measurements should be equal. Unequal measurements indicate a bent steering knuckle.
- Check for signs of flaking coatings or corrosion on the knuckle. When a cast part is bent it may disturb and loosen any coatings or corrosion that has built up on the part if the degree of bend is severe enough.
- Discard any knuckle that shows signs of previous repair by heating, welding or straightening.
- Check knuckle for cracks, twisted ears and damaged attachment points such as elongated holes.

Steering linkage

- Vehicle on ground Have an assistant rock the steering wheel while checking the steering linkage for any side-to-side (lateral) looseness.
- Vehicle weight off front tires
    - ✓ Steer each front wheel by hand to identify components with excessive lateral movement.
    - ✓ Rotate steering linkage components by hand to check for binding of ball joints and excessive up and down (vertical

Steering wheel

- Check for a cracked or bent wheel and damage resulting from air bag deployment https://www.tech-cor.com/auto-information-library/resources/industry-information/steering-suspension-component-visual-inspection-guidelines/ (05/5/2023)

2.1.2 Inspection of suspension system

The suspension system supports the vehicle, allowing the wheels to move up and down over irregularities in the road. It cushions the ride for the frame, engine, transmission, and passengers, while keeping the tires in firm contact with the road under all conditions. Suspension system parts include springs, dampening devices (shocks), ball joints, steering knuckles, and spindles or axles. Two types of front suspension systems are widely used in today's vehicles:

Objective of Suspension System:

Ride comfort is considered as the first objective of the suspension systems of vehicles including tractors. Ride comfort is an important characteristic of vehicles that indicates how much riding is comfortable for passengers. Ride comfort is very important for agricultural tractors also, because the acceleration transmitting to the driver compared with other vehicles is very high due to more undulations in the agricultural fields as compared to the smooth road. In addition, the operators of agricultural tractors spend many hours in the field during peak working seasons. These conditions can affect the comfort, efficiency, alertness, and health of the operators.

Handling is a characteristic of a vehicle that provides stable and safe driving that can be created via a steady contact between the tires and surface. Handling is also called road holding, ride stability, and driving safety, implying the same meaning. The handling capability of a vehicle is

important during maneuvers such as at turning, braking, or accelerating. In these extreme situations, weak handling reduces the control ability of the vehicle and can affect the safety of the passengers/drivers. Due to this fact, handling is considered as an important capability for vehicles, and beside the ride comfort, it is considered as the main target of using the suspensions in vehicles.

The early agricultural tractors had no suspension systems, and different types of suspension systems were employed in them gradually with time. The primary systems were seat suspensions, which were used with the aim of improving ride comfort of tractor drivers. Along with the development in tractors technology, chassis suspensions were also used for these vehicles. These systems were able to improve the handling of tractors besides the ride comfort of them. This provided more safety and stability for tractors, and their travel speed was increased This begins with characteristics of tires, and suspensions of seat and cabin. Then, the chassis suspension systems of tractors including front axle and full suspension were introduced in the tractors.

Suspension Characteristics of Tires

When pneumatic tires were used first time for agricultural tractors, ride comfort and handling were improved, and the travel speed of tractors was increased upto 20 km/h. Tires are the first elastic elements between a vehicle and the ground surface. For that reason, the suspension properties of the tires have an important role in the dynamic behavior of tractors, particularly for tractors having no other suspension systems.

The suspension characteristic of a tire can be demonstrated by a simple model, which is constructed of a spring and a damper in parallel. Based on this model, the measured stiffness and damping characteristics of a typical tire for agricultural tractors are presented. The stiffness and damping coefficients of the tire are correspondingly too high and too low than typical suspension characteristic needed for a tractor. Therefore, tires are not able to work lonely as a proper suspension system, because high stiffness of tires is equal to a very hard suspension that is unable to provide good ride comfort. On the other hand, with very low damping capacity of tires, they are not able to provide effective control on vibrations. In addition to the improper value of

stiffness and damping coefficient of tires, these characteristic are not constant and depend on the inflation pressure and speed of tires. All these factors cause a poor dynamic behavior for the conventional tractors that have no primary suspension,

Types of suspension system

a. Seat Suspension:

The first system used for the tractor was suspension for the seat of the operator. This system is placed directly between the driver seat and tractor body, and it affects directly driver comfort and reduces the vibration experienced by him. Seat suspensions are not so complicated, inexpensive and have a robust construction. For these reasons, they are used on all modern agricultural tractors . A suspension seat is made of typically a foam cushion suspended on a parallel spring and damper set. Type of suspension systems may be mechanical, pneumatic, hydraulic, hydro-pneumatic, or a combination of these systems.

Figure2.4: Modern seat using "active seat" technology

b. Cabin Suspension

In modern agricultural tractors, a cabin is used in order to isolate the driver from the outside, and it protects the driver from the annoying environmental conditions, dust, and noise. Using a suspension system for the cabin, driver place could be isolated from the tractor vibrations as well. A cabin suspension can offer more benefits than a seat suspension and provide better ride comfort for the driver. Cabin suspension decreases the structurally transmitted noise to the drivers. Since the mass of a cabin is greater than a seat, the natural frequency of cabins is lower

than the one of seat suspensions. The manufactured cabin suspensions of the agricultural tractors can be categorized in two groups of semi suspended and fully suspended. In the first group, the rear side of the cabin is connected to the chassis by means of two suspension units in its corners. In spite of this, the front side is connected to the tractor chassis without suspension and only via a joint-type link. This type is often used for the tractors with front axle suspension. In this system, body vibrations appear on the cabin as pitch rotational movement, and response of this system to the roll movement of the tractor body is very limited.

c. Hitch Suspension

During transportation, tractors mounted with implements, change largely the mass characteristics of the tractors, and influence mainly the dynamic behavior of the tractors. Without the primary suspension, the tires are the only elastic elements that affect the handling of the tractors, whereas the tires have no required suspension properties. Under these conditions, the dynamic behavior of the tractor becomes worse under the influence of the attached implements, particularly the bounce and pitch movement of the tractor are increased. This situation causes a reduction in the control ability of the tractor, especially during high-speed transports which leads to unsafe modes.

In order to reduce the effect of the mounted implements on the tractors and in order to control their vibration, a suspension system can be used in the connection between them and the tractors. Since the implements are normally mounted on a tractor via the three-point hitch, this suspension is applied to this mechanism and called “hitch suspension”. Such a system that employs a hydro-pneumatic suspension in damping the pitch vibrations of the implement. A hydraulic actuator is used instead of the upper link in this system . This actuator is connected to a hydraulic accumulator through a throttle valve and works as a hydro-pneumatic suspension

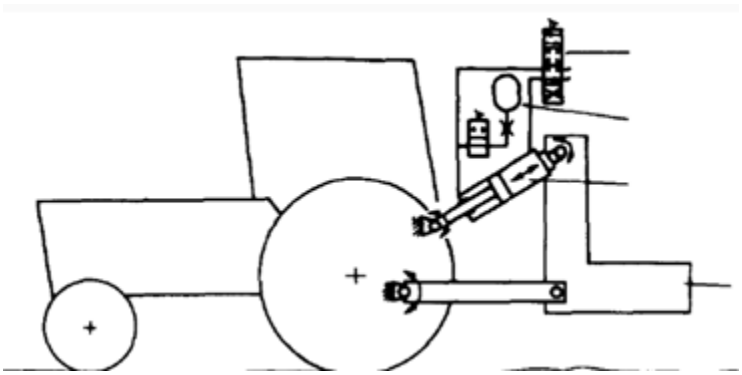


Figure2.5: A hydro-pneumatic shock absorber system applied to the tractor three-point hitch

d. Front Axle Suspension

When, four Wheel Drive (4WD) tractors became popular due to the better traction performance. The front wheels acquired a new role in the traction capability of the tractors and also in the steering ability of them. In this condition, there is a typical problem of the pitch movement of the tractors, because it creates load variation on the front tires and cause the problem of bouncing, particularly during of the pulling heavy loads by tractors. This produces a traction variation effect, called “power hop,” that is not only uncomfortable for the operator, but also causes a major loss in the traction efficiency of the tractors. In order to overcome this problem, the front axle suspension was used for tractors. This suspension provides a stable contact between the front tires and ground that leads to a significant improvement in the traction and steering capability of tractors. Because of this advantage, front axle suspension has become a common option in 4WD tractors now. In addition, the front wheels are the navigating wheels. They take the major steering and brake loads of a tractor. Front suspension by keeping front tires in firm contact with the ground, allows better steering control and brake efficiency. This promotes the handling capability and increases consequently the travel speed of a tractor.

However, influence of the front suspension on ride comfort of tractors is not notable as much as the influence of this system on the handling of tractors**.**

e. Full Suspension

Higher travel speed is taken into consideration for the modern tractor design. This led to try for development of high tractor speeds, which are able to cover the transportation needs of agricultural applications. As mentioned above introduction of the front suspensions in tractors provided a major benefit regarding the high travel speed. However, front axle suspensions can be sufficient just to reach to a limited maximum speed. In order to achieve a higher speed, the full suspension is needed for tractors. A full suspension tractor is a tractor equipped with both rear and front axle suspensions. These tractors can provide improvement on both driving behaviour and ride comfort, promising the possibility for the rise in the driving speed. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=2288 (01/05/2023)

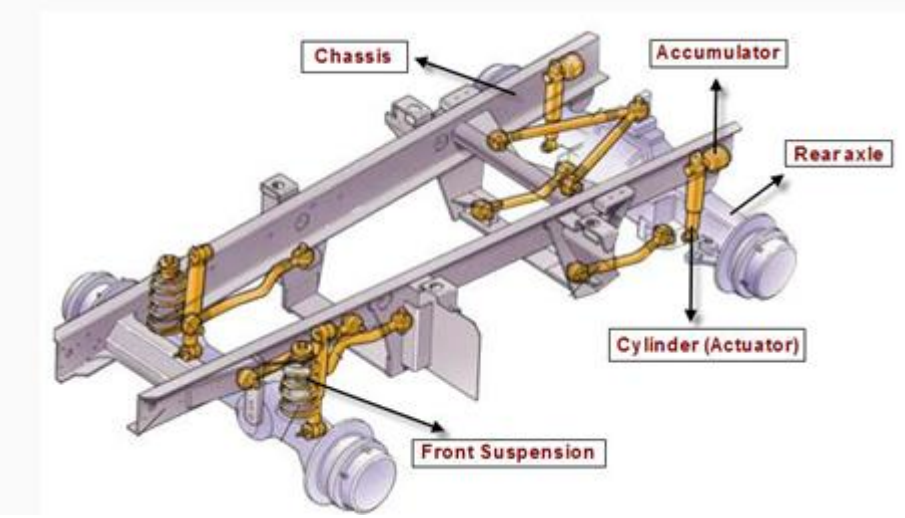


Figure2.6: Full frame construction of fully suspension

How to inspect your suspension system?

1. **Pay attention if your ride begins to feel rougher**.

Over time, components of your suspension can wear out. While visually inspecting components can often let you know if they've become compromised, the easiest way to determine if you are having a suspension issue is by paying attention to how the ride in your vehicle feels. If it has become progressively rougher, it is likely because the suspension is no longer absorbing the bumps the way it is supposed to.

- If you begin to feel more bumps and shakes as you drive, there may be an issue with your suspension.
- Sometimes a rougher ride will come coupled with audible squeaks as the suspension struggles to manage bumps in the road.

2. **Take note if your vehicle pulls or squeaks during turns**.

If you begin to feel as though the vehicle is working against you as you turn, it is likely the result of a failing suspension component. Different parts of your suspension can affect the steering response, angle of the tires, and the center of balance of the vehicle. Each of these elements can make your vehicle cumbersome or difficult to turn. A bad tie rod end will make steering response sluggish. If you hear an audible creek while turning the wheel, it may be the result of a bad lower ball joint. Conversely, if you hear knocking as the weight transfers in the vehicle during a turn, it may be caused by a bad sway bar end link.

- Pay attention to how the vehicle reacts as you turn and compare it to your previous experiences in the vehicle to assess if there is an issue.
- Listen carefully to see if components of your suspension are squeaking under pressure.
- Every vehicle behaves a little differently while turning, so previous experiences with the vehicle can make assessing issues much easier.

3. **Inspect the tread wear on your tires.**

Your tires should wear fairly evenly across the Width of the tread. If you rotate your tires regularly, they should be worn close to evenly throughout. If you happen to notice the inside or outside of the tire is wearing at a faster rate than the rest, it could be an issue with the camber of your wheels and tires. Camber is the term used to describe the angle the wheel sits in relation to the vehicle and road.

- A vehicle with negative camber will wear the inside of the tires more quickly.
- A vehicle with positive camber will wear the outsides of the tires more quickly.
- Camber is determined by your suspension components and wheel alignment.

4. **Try braking abruptly to see if the nose dives as you stop**

If you are having issues with your front struts or shocks, your suspension may struggle to keep the vehicle level under hard braking. Stop quickly in a safe area and pay attention to the front of your car. If the nose of the vehicle dives or drops as you slow down, it may be as result of bad

shocks or struts. If you can hear an audible clunk from the front of the vehicle as you brake, there is either an issue with your control arm or sub frame bushing.

- Your suspension should be able to support the weight of your vehicle and keep it fairly level during most situations.
- The front corner of your vehicle may also drop as you turn in the same direction. This is caused by the same failure.

5. **Look to see if the vehicle sits level**

With the vehicle parked, walk around it and visually assess how level it seems to be sitting. If one side of the car rests higher than the other, there are likely worn out or broken suspension components to blame.

- It is not uncommon for the front of the vehicle to ride slightly lower than the rear in many vehicles such as pickup trucks, but the vehicle should otherwise be level.

6. **Pay attention to swaying and bouncing at low speeds.**

Your vehicle should have no difficulty withstanding bumps in the road at low speeds. If you go over a bump and feel your vehicle sway back and forth or bounce after passing the bump, your suspension is struggling to support the weight of the vehicle.

- Your vehicle should be able to go over a bump and quickly regain composure at low speeds.
- If your vehicle sways back and forth after going over a bump, there is likely an issue with your suspension**.**

2.2 steering system inspection method

1. Current Procedures for Steering System Inspection

There are several systems that allow a more or less direct measurement of the steering angles like the one depicted in Figure below. These devices are used only in exceptional cases such as the vehicle accidents that may have caused structural damage. In terms of vehicle inspection, a widespread usage of these devices is infeasible due to their high cost and for being very time consuming. These kinds of systems are usually available in manufacturer vehicle dealers and vehicle repair

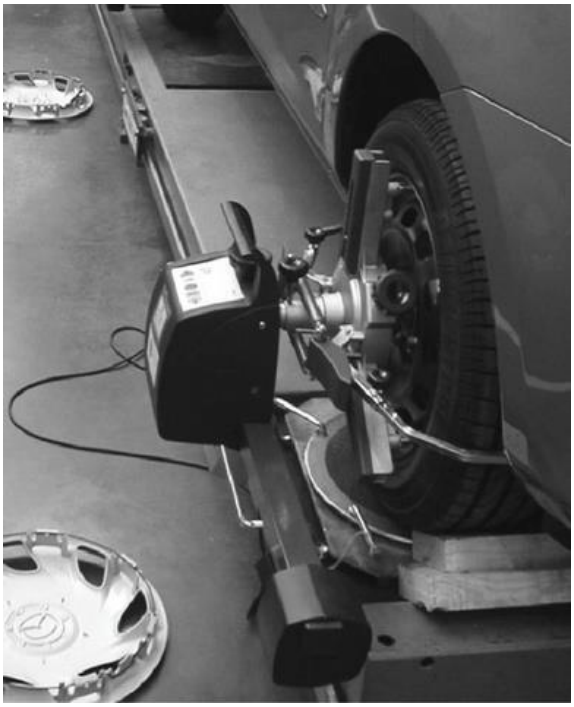


Figure: Wheel steering sensor of the steering angle meter system

2. Test Methodology

The main tool used in the development of the experimental study is the dynamometer plate. This device allows characterizing the forces in the tyre-road interface. A dynamometer plate consists of a metallic plate supported by eight load cells which measure the forces in the vertical direction and in the contact patch (longitudinal and lateral forces). The dynamometer plate allows a complete force and momentum measurement on a three-dimensional reference system at several conditions: different speeds (it has been checked that force measurements are independent from

the speed in the range 0–40 km/h), loads, and geometrical positions. It is important to emphasize that, in this measurement process, data are carried out through the forces transmitted by friction. The plate is linked to the frame by load cells which record the forces generated in the contact patch and those forces are transmitted by friction to the dynamometer plate. The plate has high stiffness, which ensures a direct measurement of the forces generated in the contact patch, allowing testing the tyre in real operating conditions mounted in any vehicle . On the other hand, considering the possible implementation of this device as part of the real inspection system

The test methodology employed consists of three stages:

1. setting the test conditions: steering angles, pressure, and vertical force;
2. dynamometer plate measurement: with the conditions set on the previous stage, the measurement has been repeated 10 times in order to minimize errors;
3. Data analysis: finally, the data is analyzed checking if the 10 measurements have been correctly done; a statistical analysis is also performed**.**

2.3 Inspection of clutch and brake controls

Inspection of clutch

During a clutch check and adjustment service, your clutch will be examined for signs of excessive wear and will be adjusted so it can release properly. If you have a hydraulic clutch, it will be inspected for leaks and adjusted if necessary.

Causes of Clutch Failure

a. Clutch Master/Slave Cylinder

A clutch master cylinder has a reservoir that holds brake fluid. The master cylinder is connected to the slave cylinder via hoses. As the clutch pedal is depressed, brake fluid moves from the master cylinder to the slave, which applies pressure to engage the clutch. Both the master and slave cylinders have seals that can wear out which will cause a leak. A leak will eventually lead to a clutch malfunction. Common symptoms of a failing master or slave clutch cylinder include the clutch going all the way to the floor, not being able to shift gears and a brake fluid leak.

b. Clutch Fluid Leak:

Clutch fluid is actually just brake fluid. A leak in the system will make it hard to change gears and the clutch pedal may go all the way to the floor. The may also be a puddle of brake floor on the garage floor. A fluid leak is often a symptom of a more serious problem.

c. Slipping Clutch:

Clutches are designed to slip a bit when the clutch is first engaged or during gear change to provide a smooth ride but once the clutch is fully engaged there shouldn't be any slippage. In most cases, slipping will happen while the vehicle is hauling a load or when going up a hill. Slipping can cause the clutch to get hot, which can result in burned clutch facings, which can damage the flywheel and pressure plate. Normal wear and tear is usually the cause of a slipping clutch. The problem should be addressed as soon as the first symptoms appear to avoid additional damage.

d. Chattering or Jerky Clutch:

A grabby or jerky clutch is often caused by oil or grease that has gotten on the clutch linings. A warped flywheel or a loose clutch cover can also cause this problem.

e. Air in Hydraulic Line:

If there is air in the hydraulic line it will take up space that the fluid needs to build the proper pressure. This can result in a sticking clutch**.**

f. Misadjusted linkage:

The linkage that connects the pedal to the clutch system can become misadjusted. A sticking clutch is often a sign of this problem. The linkage will need to be adjusted to correct this problem.

g. Broken Clutch Cable:

The clutch cable can end up stretched or broken. If this is the case the clutch will often stick. The cable will need to be replaced.

h. Clutch Will Not Release:

There are many things that can cause a clutch to not release. Everything from the damaged input shaft splines to a worn bearing retainer to a bent clutch disk. A vehicle that has a clutch that will not release should be inspected as soon as possible as not repairing it will lead to further damage**.**

i. Hard Clutch:

If the clutch feels hard or stiff there is a good chance there is a problem with the pedal linkage or the clutch cable.

Common Symptoms Damaged or worn clutch parts

- Damaged or worn clutch parts can cause a variety of symptoms:
  - slipping
  - grabbing
  - dragging
  - abnormal noises
  - vibration

Worn Clutch Disc: Causes clutch slippage and may damage flywheel and pressure plateThe clutch disc is a friction plate that allows the transmission to work with the engine, so you can shift gears. Through wear and tear, the friction coating of the clutch disc wears off and once bare, it is metal against metal as you shift gears. This produces not only damage but also a burning smell.

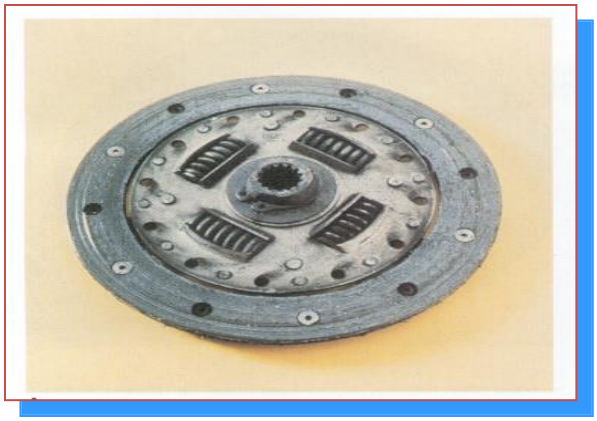


Figure 2.3(a): Worn Clutch Disc

Separated Lining: This can be caused by a variety of factors such as a damaged pressure plate, worn, binding or misadjusted linkage, incorrect clutch components, and even normal wear.
this clutch disc exploded from high speed shift.

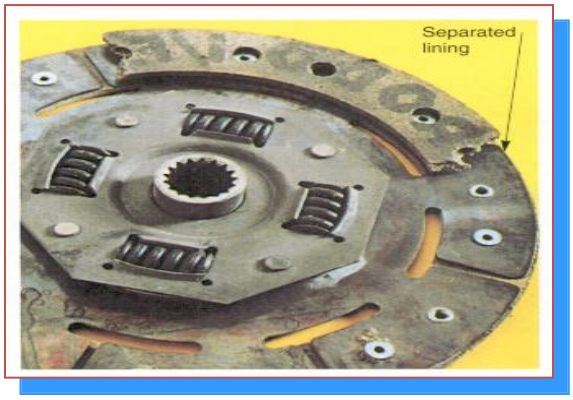


Figure 2.3(b): Separated Lining

Burned Clutch Disc: The most telling sign of a burnt clutch is the smell it gives off. If the clutch facings start to burn, the smell will resemble that of burnt toast. This could cause the whole clutch to fail, at which point your car would stop being able to accelerate or shift gears.Caused by oil contamination, not enough clearance, or the driver riding the clutch

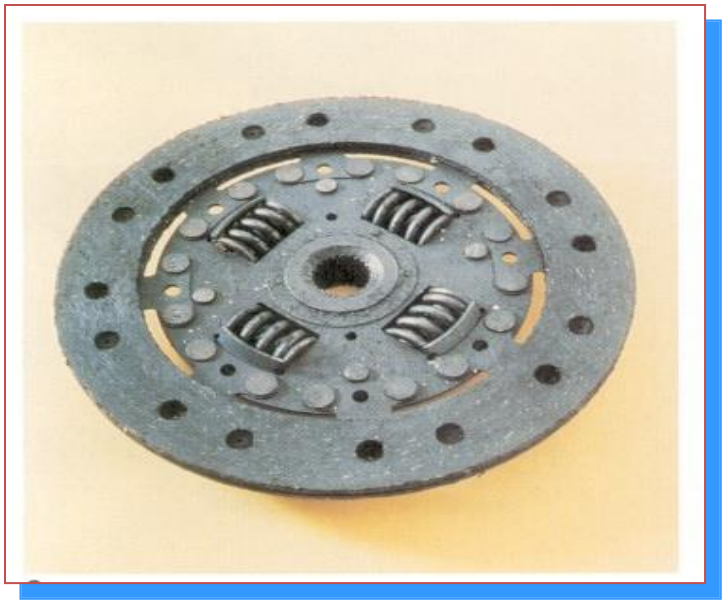


Figure 2.3(c): Burned Clutch Disc

Scored Lining: This can be caused by a variety of factors such as a damaged pressure plate, worn, binding or misadjusted linkage, incorrect clutch components, and even normal wear.Caused by the use of an unmachined flywheel or badly scored pressure plate

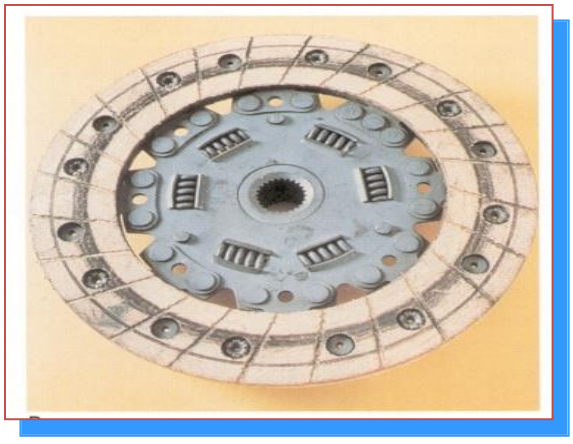


Figure 2.3(d): Scored Lining

Damaged Hub Spines: Damaged when the transmission was drawn into place with bolts.

Figure 2.3(e): Damaged Hub Spines

Dry Release Bearing: Produced a loud grinding noise anytime the clutch pedal was pressed Although release bearing is characterized by high strength, its main cause is the human factor - many drivers keep their foot on the clutch when the transmission is off. For this reason, most of the release bearings wear out.

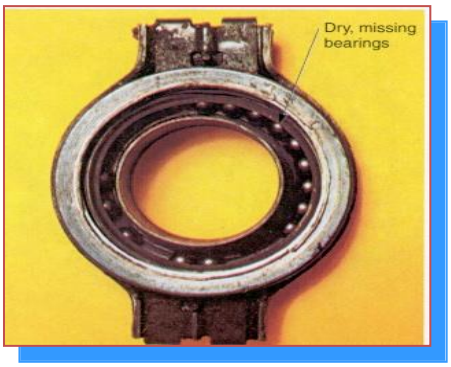


Figure 2.3(f): Dry Release Bearing

Scored Pressure Plate: Caused by a worn clutch disc, the driver slipping the the clutch, or binding linkage

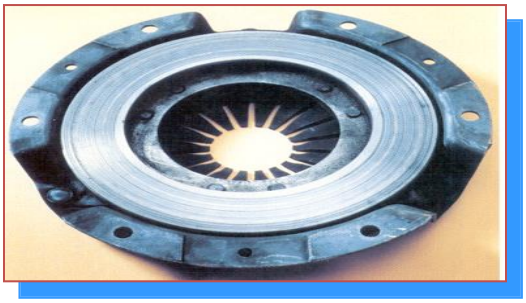


Figure 2.3(g): Scored Pressure Plate

Broken Diaphragm Springs: If you mean the spring in the driven plate, they can break up for various reasons. They can catch on flywheel bolts when the plate is very worn and they can go due to abuse. Sometimes they get a bit weak and move about slightly in their slots and wear thin and break. Caused by installation error, or adjustment too tight

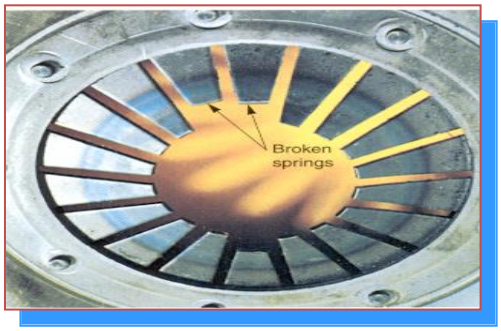


Figure 2.3(h): Broken Diaphragm Springs

Broken Release Levers: Caused by no free play, a bad release bearing, or improper part alignment

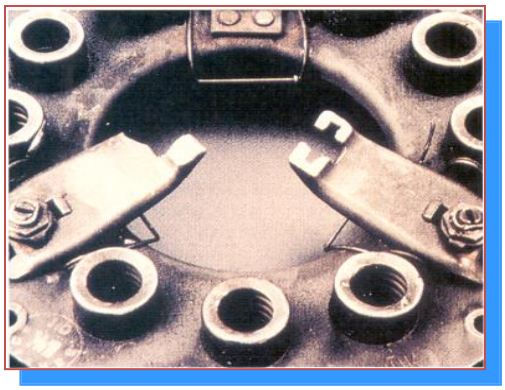


Figure 2.3(i): Broken Release Levers

Free Travel (Free Play):

- Distance the clutch pedal or fork moves before the release bearing acts on the pressure plate
- Some free travel is needed to ensure complete clutch engagement
- **Excess free travel**
  - ✓ due to part wear that reduces clutch release action
  - ✓ can cause clutch drag even with the pedal fully depressed
- **Insufficient free travel**
  - ✓ due to bent parts or similar problems
  - ✓ can cause clutch slippage

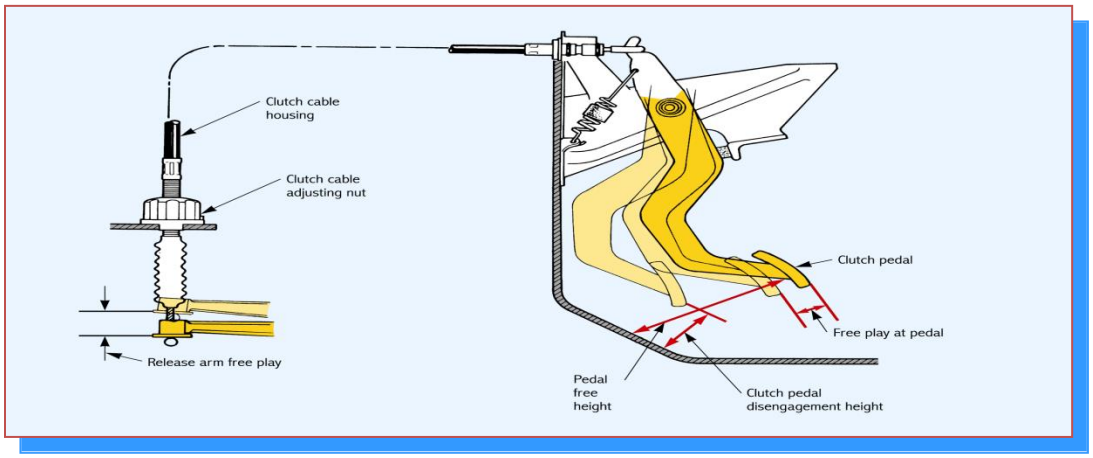


Figure 2.3(j): Free Travel (Free Play):

Clutch Slippage

- Indicated when the engine races without a corresponding increase in road speed
- Caused by the clutch disc sliding between the flywheel and the pressure plate
- Occurs when accelerating, shifting, or climbing a hill

Grabbing Clutch

- Produces a very severe vibration or jerking motion when the vehicle is accelerated from a standstill

- Common causes:
  - ✓ problems with the clutch disc
  - ✓ problems with the flywheel
  - ✓ problems with the pressure plate
  - ✓ broken engine mounts

Dragging Clutch

- Makes the transmission grind when trying to engage and shift gears
- The clutch disc is staying engaged to the flywheel, turning the transmission
- Common causes:
  - ✓ too much free play
  - ✓ warped or bent clutch disc
  - ✓ oil, grease, or corrosion on the friction surfaces
  - ✓ rusted or damaged input shaft splines

Abnormal Clutch Noises

- Noises when the clutch is disengaged
  - ❍ dry or worn release bearing
  - ❍ worn pilot bearing
- Noises when in neutral, disappearing when the clutch pedal is depressed
  - ❍ problems inside the transmission

Inspection brake system

During a brake inspection the entire brake system is checked; this includes the following:

- Brake pedal,
- Brake fluid,
- Brake lines and hoses,
- Brake assemblies (whether they are disc brakes or drum brakes).
- Parking brakes should also be checked at this time.
  - ✓ Most manufacturers recommend a periodic inspection of the brake system

- ✓ When inspecting the brake system, check the brake pedal action, fluid level, and the condition of the brake lines, hoses, and wheel brake assemblies

Checking Brake Pedal Action

- Apply the brake pedal and compare the movement to specifications
- Brake pedal application specs:
  - ❍ pedal height
  - ❍ pedal free play
  - ❍ pedal reserve distance

Checking Brake Fluid

- Remove the master cylinder cover or view the level through the side of the plastic reservoir on some models
- Typically, the brake fluid level should be 1/4" (6 mm) from the top of the reservoir

Checking for Leaks

- Inspect for leaks whenever the fluid level in the master cylinder is low
- Check brake lines, hoses, calipers, and wheel cylinders
- Check below the master cylinder mounting point at the cowl or booster
- Leaks show up as darkened, damp areas

Checking the Parking Brake

- Apply the parking brake
- The pedal or lever should not move more than 2/3 of full travel
- The parking brake should keep the vehicle from moving with the engine idling and the transmission in drive
- Inspect the cables for fraying and high friction

Vacuum Booster Service

- Inspect the brake booster and the vacuum hose
  - ✓ hoses may collapse or harden

- To test the booster, pump the brake pedal to remove any vacuum
- Apply the brake and start the engine
    - ✓ The pedal should drop slightly as engine manifold vacuum develops

Hydraulic Booster Service

- Check all the hydraulic lines for signs of leakage
- If the booster is inoperative, check the power steering fluid level
- Most boosters are not serviceable without special equipment and procedures

Master Cylinder Service

- A faulty master cylinder may leak fluid past the rear piston or leak internally
- Inspect for external leakage where the master cylinder mounts to the booster or cowl
- Internal leakage will cause the pedal to slowly sink to the floor when applied

Master Cylinder Removal

- Disconnect the brake lines using a line wrench
- Unbolt the master cylinder from the booster or cowl
- On a vehicle without a power-assist booster, disconnect the push rod from the brake pedal assembly

Master Cylinder Rebuild

- Following the service manual procedures, drain the fluid and disassemble the unit
- Honing may be used to remove minor corrosion or pits from the cylinder
- Measure piston-to-cylinder clearance
- Inspect each component and replace all cups and seals

- Clean and lubricate the components with brake fluid and reassemble the unit

Installing a Master Cylinder

- Bolt the master cylinder to the cowl or booster
- Check the adjustment of the push rod if specified
- Install Bleed the air from the fittings
- Tighten the fittings
- Fill the reservoir with fluid
- Check brake pedal feel and road test the vehicle
- all the brake lines with the fittings lightly tightened

Brake Line and Hose Service

- Lines are subject to corrosion or damage
- Hoses may deteriorate over time
- When replacing brake lines, use approved double-wall steel tubing

2.4 Using mathematical ideas and techniques to calculate time, tolerances, and apply accurate measurement

2.4.1Time Formula

The formula of time helps in calculating the time taken by an object to travel a certain distance at a given speed. The SI unit of time is s. Let us study the formula of time using some solved examples**.**

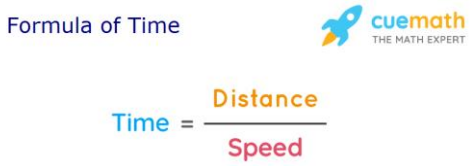
What Is the Time Formula?

Time formula can be defined as the ratio of distance covered by an object to a unit speed. Time refers to the progression of events. This progression is in such a manner that it goes from the past to the present and finally into the future.

Formula for Time

The Formula of Time of a given body can be expressed as,

Time = Distance÷Speed



How To Use Time Formula?

Time formula can be used to find the time taken by an object, given the distance and unit speed. Let's take a quick look at an example showing how to use the formula for time.

How To Calculate Distance Using Time Formula?

The formula for time is given as [Time = Distance ÷ Speed]. To calculate the distance, the time formula can be molded as [Distance = Speed × Time].

How To Calculate Speed Using Time Formula?

The formula for time is given as [Time = Distance ÷ Speed]. To calculate the speed, the time formula will be molded as [Speed = Distance Travelled ÷ Time].

How To Use the Formula for Time?

Time formula can be used in our day-to-day lives to find how much time is required in any task**.**

2.4.2 What are Machining Tolerances?

Machining tolerance, also known as dimensional accuracy, is the amount of acceptable variance in the dimension of a part. This is expressed as a maximum and minimum dimensional limit for the part. Parts are considered to be within the tolerance if their dimensions fall between these limits. If the part’s dimensions fall outside of these limits, however, these parts are outside the acceptable tolerance and considered unusable.

For designers, determining the appropriate tolerances for a part is an essential task in preparing a design for an order. However, it can be difficult to determine appropriate tolerances for a part, especially parts that are made of non-metallic substances. To develop appropriate machining tolerances for your designs, understanding standard manufacturing tolerances and the tolerances that certain materials and machining processes are capable of will be essential. For this reason, we've created some machining tolerance guidelines to help you determine machining tolerances for your nonmetallic parts

Overview of Machining Tolerances

Machining tolerance is defined as the total amount a specific dimension is permitted to vary from the given value. This can be expressed in a few different ways:

- The upper and lower limits (e.g. 0.2500, 0.2498)
- The allowable amount above and below a defined dimension (e.g. 0.2499 ±0.0001)
- The allowable variance by itself (e.g. ±0.0001)

The range of allowable dimensions within this defined area is known as the tolerance band. The larger the difference between the upper and lower limits, the larger or "looser" the tolerance band. The smaller the difference between the upper and lower limits, the smaller or "tighter" the tolerance band. Tolerances may also be expressed with any number of decimal places. The more decimal places are included, the stricter the tolerance is.

2.5 Making adjustments of wheel bearing and brake/clutch pedal travel

Making adjustments of wheel bearing

With use (particularly with loader tractors where there is extra weight) tractor front wheel bearings do wear. Regular greasing reduces this, but eventually adjustment or replacement of the bearing is required. One method to check bearing condition is to jack up the front of the tractor and spin the front wheels. Any rumbling noises indicate damaged or worn bearings.

To replace/adjust the bearings use the instructions below.

1. Jack the tractor up and place on axle stands after slackening the hub cap.
2. Remove hub cap, followed by split pin through the castellated nut.
3. If renewing bearings remove nut, remove hub from axle and exchange the bearings and seal, repacking with grease during assembly. Then remount the hub to the axle.
4. As the castellated nut is re-tightened, rotate the hub until it starts to become slightly stiff to turn. Now slacken the nut two flats, checking that the hub rotation eases.
5. Always use a new split pin to secure the castellated nut once the adjustment is set. Be aware that there may be more than one split pin hole available to use.
6. 3/4 fill the hub cap with grease and refit.

Making adjustments of brake pedal:

To adjust your tractor's brake pedal follow the follow following steps

- Park the tractor safely and securely.
- Shut off the engine.
- Check all the tires safely and securely.
- Engage the parking brake.
- Confirm that the parking brake lock holder is surely applied and that the parking brake lock lever is locked securely.
- Periodically clean and apply oil to prevent dust or rust that could interfere with its proper operation.
- Remove the rear right wheel.
- Disengage the parking brake.
- Adjust the brake pedal's free play.

- ✓ Loosen the lock nut
- ✓ Rotate the brake rod
- ✓ Tighten the lock nut.

Making adjustments of clutch pedal

The clutch is an indispensable important component on the tractor. It is used to transmit and cut off the power transmitted by the tractor engine to the gearbox and power output device, and to prevent damage to the parts when the drive train and power output device are overloaded

The clutch transmits torque by the friction force generated by the active friction plate and the driven friction plate. The magnitude of the friction force depends on the value of the friction plate pressing force and the nature of the surface material of the friction plate.

However, with the increase in the number of uses or improper use, the clutch transmission mechanism will wear out, and the clutch friction plate will also become thinner due to wear, so that the friction force of the main and driven parts of the clutch will be weakened, and the clutch will fail in the process of transmitting torque .

Therefore, after the clutch is used for a period of time, it should be adjusted according to the needs, which can effectively reduce the damage of the clutch, increase the use efficiency, extend the use period, and obtain better economic benefits.

1. **Height adjustment of clutch release lever**

The inner end of each clutch release lever must be in contact with the release bearing at the same time. If the inner end of the release lever varies, the clutch will shake when it is engaged.

Therefore, during tractor assembly and maintenance, it is necessary to check the contact between the inner end of each separating lever and the separating bearing. The inner end of each separating lever is required to be in the same plane, and the error should conform to the original factory regulations, generally not more than 0.25 mm.

If it does not meet the requirements, it should be adjusted. The method is to adjust the position of the adjusting screw on the inner or outer end of the separation lever.

2. Adjustment of clutch pedal free stroke

Because the clutch is frequently used, the clutch operating mechanism requires light handling to reduce the driver's labor intensity.

The ease of operation includes two aspects. First, the force applied to the tractor clutch pedal should not be too large; generally it is from 196 to 245 N. Second, the total stroke of the pedal should be within a suitable range. If it does not meet the requirements, it should be adjusted.

The clutch pedal height can be measured with a ruler. Use a steel ruler against the cab floor to measure the height when the pedal is fully relaxed. Then press the pedal lightly with your hand. When the tractor pressure increases, it means that the end face of the separation bearing has disconnected the inner end of the lever to stop pushing the pedal. Then measure the height of the pedal.

The difference of the two height measured is the free travel of the pedal. After measuring the free travel of the pedal, it should be compared with the technical standards of the model. If it does not meet the requirements, it should be adjusted.

3. Discharge of air in clutch hydraulic system

After the tractor clutch hydraulic control system is overhauled, air may enter the pipeline and the hydraulic system when brake fluid is added. After the air enters, due to shortening the stroke of the master tractor cylinder push rod. The clutch is not completely disengaged.

Therefore, after the hydraulic system is overhauled or when the hydraulic system is suspected of entering the air, the air in the hydraulic system should be eliminated. T**he elimination method is as follows**.

- Use a jack to lift the vehicle, and then use the bracket to support the vehicle. Increase the brake fluid in the tractor master cylinder reservoir to the specified height.

- Install a hose on the tractor air release valve of the working cylinder and connect it to a reservoir cup containing brake fluid.
- Two people are required to work together to exhaust air. One person depresses the clutch pedal in the cab, and the other person exhausts air at the cylinder of the tractor.

- While pressing the pedal to maintain pressure, loosen the vent screw. Tighten the vent screw and release the clutch pedal. Repeat several times until there is no air bubble in the brake fluid flowing out of the oil drain pipe.
- During the venting process, the reservoir cup cannot bottom out and brake fluid must be added continuously. After exhausting, tighten the bleed screw.
- After the air is removed, the free stroke of the pedal needs to be checked and adjusted again

2.6 Comparing results

Control system **inspection** must be completed without causing damage to any component or system. Inspection results are compared with manufacturer specifications and standards.
Inspection findings are reported according to workplace procedures, legislation, policies including recommendations for necessary repairs or adjustments

When creating an inspection report, organization and structure are key. Create a checklist of all tasks you need to tick off prior to and during the inspection to have a clear view of what still needs to get done. Break the report into sections (introduction, findings, and analysis). During the inspection, fill in your previously set sections clearly and concisely with information from the inspector.

Tips when comparing documenting an inspection report:

- Determine the intent of the inspection
- Know who will be reading the inspection report
- Check what needs to be on the report
- Utilize tools that can help create inspection reports
- Document the results of inspection
- Recommendations are considered
- Know the standards/specifications of inspection
- Mind the legislation and policy of workplace and governments
- Don't rush it
- Know your report writing template

- Cater each report to the property
- Stick to the facts
- Be concise and understandable
- Take LOTS of photos
- Manage your risk

Table 2.5 control system inspection check list

Date of inspection	Control system inspected	Tools or Materials used	Reason for inspection	workplace	Performed by	Checked by	Results	Standards/ specification	Remark

2.7 Documenting and recommending results

Inspection in instrumentation is a vital skill for ensuring the accuracy, reliability, and safety of measurement and control systems. But how do you communicate your findings and suggestions to your clients, managers, or colleagues? In this article, we will discuss some best practices for documenting and reporting the results and recommendations of inspection in instrumentation.

Identify the problem

Identify the problem clearly and precisely. This means defining the symptoms, the expected performance, the scope, and the urgency of the issue. You should also gather relevant information, such as the system specifications, the operating conditions, the maintenance history, and the user feedback. This will help you to narrow down the possible causes and solutions.

Perform the inspection

The next step is to perform the inspection using appropriate methods and tools. Depending on the type and complexity of the problem, you may use visual inspection, testing, measurement, simulation, or troubleshooting techniques. You should follow a logical and systematic approach, such as the divide-and-conquer, top-down, or bottom-up methods, to isolate and verify the fault. You should also document your steps, results, and observations carefully and accurately.

Evaluate the options

Once you have identified the fault, you should evaluate the possible options for resolving it. This may involve comparing the costs, benefits, risks, and feasibility of different actions, such as repairing, replacing, calibrating, or upgrading the faulty component or system. You should also consider the impact of your decision on the overall performance, reliability, and safety of the instrumentation system.

Make the recommendations

Based on your evaluation, you should make the recommendations that best suit the needs and expectations of your client, manager, or colleague. You should explain your rationale, evidence, and assumptions clearly and convincingly. You should also provide alternative or contingency plans in case of unforeseen circumstances or changes in requirements. You should also specify the expected outcomes, time frames, and resources needed for implementing your recommendations.

2.8 Forwarding report

Prepare the report

The final step is to prepare a comprehensive and professional report that summarizes your fault diagnosis process and recommendations. You should follow the format, style, and guidelines of your organization or industry. You should also use clear and concise language, diagrams, tables, charts, and references to support your claims and arguments. You should also proofread and edit your report for accuracy, clarity, and readability.

Share the feedback

The last but not least step is to share your feedback with your client, manager, or colleague. You should present your report in a timely and respectful manner, and be prepared to answer any questions or concerns they may have. You should also solicit their feedback on your work and performance, and use it to improve your skills and knowledge. You should also follow up on the implementation and outcomes of your recommendations, and document any lessons learned or best practices for future reference.

Self-check 2	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Why you should inspect brake system?
2. Why you should inspect steering system?
3. List steps to adjust brake pedal?
4. Why you should inspect suspension system?
5. Discus how to service Brake Line and Hose?
6. Discuss how to Installing Master Cylinder?
7. List Causes of Clutch Failure?
8. List objective of suspension system?

Test II: Choose the best answer

1. **Which of the following are causes of Dragging Clutch?**
   - **a.** too much free play
   - **b.** warped or bent clutch disc
   - **c.** oil, grease, or corrosion on the friction surfaces
   - **d.** rusted or damaged input shaft splines
   - **e.** all the above
2. **Which of the following are causes of grabbing Clutch?**
   - **a.** problems with the clutch disc b. problems with the flywheel
   - **c**. problems with the pressure plate d. broken engine mounts
   - **b.** all the above
3. **which of the following are Common Symptoms Damaged or worn clutch parts?**
   - **a.** Slipping b. grabbing c. dragging d. abnormal noises e. all of the above

Note: Satisfactory rating - 8 points Unsatisfactory - below 6 points

You can ask your teacher for the copy of the correct answers.

Operation Sheet -2

2.1 perform inspection of steering system.

a. Tools and Equipment(PPE)

- Head Protection
- Hand and arm Protection
- Foot and Leg Protection
- Eye and Face Protection
- Steering Wheel Puller
- Steering wheel Lock Plate Tool
- Steering Pump Puller Kit
- Inner Tie Rod End Tool

b. Procedures/Steps/Techniques to perform inspection of steering system.

- Push and pull the steering wheel in line with column.
- Push steering wheel or handlebar in various directions at right angles to the column or forks.
- Check visually for play.
- Check the condition of flexible couplings or universal joints.

2.2 perform inspection of brake system.

a. Tools and equipments

- micrometer or vernier calipers
- Safety Glasses
- Dust Mask
- Wrenches ·
- Allen Wrenches,
- Hex Keys,
- Torx and Allen Sockets
- Ratchet and Socket Set.

b. **Procedures/Steps/Techniques to inspection of brake system.**

- Test drive the car
- Inspect the tires
- Check the vehicle's suspension system.
- Look for leaking, cracked or damaged hoses.
- If needed, replace any leaking or damaged steel lines.
- Replace any leaking or damaged calipers.
- Check brake master cylinder for leaks. ...
- Test the brake pedal

2.3 perform inspection of Suspension system.

a. Tools and Equipment(PPE)

- Head Protection
- Hand and arm Protection
- Foot and Leg Protection
- Eye and Face Protection
- Coil Spring Compressor
- . Ball Joint Tool
- Suspension Bush Tool
- Shock Absorber Removal Tool
- Hydraulic Shop Press.

b. **Procedures/Steps/Techniques to inspection of Suspension system..**

- Pay attention if your ride begins to feel rougher
- Take note if your vehicle pulls or squeaks during turns.
- Inspect the tread wear on your tires.
- Try braking abruptly to see if the nose dives as you stop
- Look to see if the vehicle sits level
- Pay attention to swaying and bouncing at low speeds**.**

LAP TEST-2	**Performance Test**

Name……. ID……... Date…….

Time started: _____ Time finished: _____

1.1 Instructions: To perform wearing PPE, to perform **inspection of steering system.**, to perform **inspection of brake system , to perform inspection of Suspension system** check the presence of all required facility which is listed in information sheet and operation sheet carefully.

Task-1 performs how to wear and remove or take off PPE.

Task-2 Handle and operate hand and power tool.

Task-3 performs inspection of steering system.

Task-4 perform inspection of brake system

Task-5 perform inspection of Suspension system

LG #39	LO #3- Complete inspection and adjustment work

Instruction sheet

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

- Making final inspection of protective guards, safety features and cowlings
- Cleaning and storing machine/equipment
- Processing job card

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

- Inspect to ensure protective guards, safety features and cowlings are in place.
- Clean Machine/equipment is cleaned for use or storage to workplace expectations.
- Job card is processed in accordance with workplace procedures.

Learning Instructions:

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

Information Sheet 3

3.1 Making final inspection of protective guards, safety features and cowlings

Inspections help prevent incidents, injuries and illnesses. Through a critical examination of the workplace, inspections help to identify and record hazards for corrective action. Health and safety committees can help plan, conduct, report and monitor inspections. Regular workplace inspections are an important part of the overall occupational health and safety program and management system, if present.

What is the purpose of inspections?

Inspections are important as they allow you to:

- listen to the concerns of workers and supervisors
- gain further understanding of jobs and tasks
- identify existing and potential hazards
- determine underlying causes of hazards
- recommend corrective action
- monitor the steps taken to eliminate hazards or control the risk (e.g., engineering controls, administrative controls, policies, procedures, personal protective equipment)
- meet regulatory and management system requirements

How do you plan for inspections?

Planning is essential for an effective inspection. Every inspection must examine who, what, where, when and how. Pay particular attention to items that are or are most likely to develop into unsafe or unhealthy conditions because of stress, wear, impact, vibration, heat, corrosion, chemical reaction or misuse. Include areas where no work is done regularly, such as parking lots, rest areas, storage areas and locker rooms.

3.2 Cleaning and storing machine/equipment

3.1.1 Introduction:

Tools and equipment are cleaned, secured and stored to manufacturer' specifications and supervisors' instructions. To perform routine maintenance it's important to store those items properly to insure that they will be in proper working condition for the next time that the owner wants to use them.

- Choose a moisture free environment:
- Clean the equipment after every use
- Keep from children's reach
- Cover if necessary
- Keep your equipment within reach:
- Take extra security measures if necessary
- Make sure gas tanks are secure

3.1.2 Cleaning tools

To ensure tools have a longer utility and lifespan, they must be properly cared for cleaning your tools should be approached in the same manner that you clean any other equipment or surface in your facility.

- The cleaning principles are:
  - ✓ **Dry clean**. Remove visible and gross soils and debris.
  - ✓ **Pre-rinse**. Rinse all areas and surfaces until they are visibly free of soil.
  - ✓ **Wash (soap and scrub).** Use the right detergent in the right concentration with the right level of mechanical action in the right water temperature for the right contact time
  - ✓ **Inspect.** . Look again at crevices and other contamination traps to ensure they're free of soils and detergents
  - ✓ **Dry.** Ensure adequate time is allotted for equipment to thoroughly dry.

3.1.3 Securing tools

Safeguards are essential to protect workers from injury. Any machine part, function, or process that might cause injury should be secured. When the operation of a machine may result in a contact injury to the operator or others in the area, the hazard should be removed or controlled

3.1.4 storing, tools

Storing your tools prevents them from collecting dust, grease, and rust. If you take care of your tools, they'll last longer and perform better for a more extended time. Taking care of your tools also allows you to save money, as you'll avoid having to replace damaged ones

3.3 Processing job card

A job card is a detailed description of work that is performed for a work order. These specify planning and scheduling information that can be used by your production facility's digital machines. They can have a number of specifications such as capability, class, and category.There are a variety of job cards, the functions of which sometimes overlap depending upon the production and the preferences of the company producing it and they don't necessarily have to be physical cards. The basic idea is that job cards are a timing method in monitoring a job to be done within a specified time frame.

Job cards have found popularity in businesses dealing with production and also other industries such as electrical contracting, plumbing, and facilities management. They are used to send the details of jobs to workers out in the field and to receive the information back about the work done each job. It is a good way to save time for the administration department as the details are just printed out and handed to an engineer for him or her to fill out the job card by hand once all the related work is done.

Job cards can easily transfer written info by your production employees into the system and allow it to be used by other production modules without having to copy and paste the details anew. They are also free of the issues associated with manually reading off data from the engineers and workers on the ground provided that you have set up a suitable schedule for it; indecipherable handwriting,

which is an issue compounded with your workers having to deal with being busy or work in a difficult location.

A job card is thus all about timing. There are many details involved such as the materials used, time allowed to prevent production from being run over, current reports, units produced, units left to produce, materials accumulated to be used, and so on. These are all things that may be found on a job card. A business will have a number of job cards that equal exactly the number of operations that are done in that business.

A marked improvement in matching your invoices can be seen. Automation in this regard can help you raise your invoices as soon as the jobs are complete and automatically include the information that the customer requires

Job cards can come in crucially important if you want to set up a master production schedule (MPS) it is a plan for products to be produced in each time period such as production, staffing, inventory, and so on.

An MPS will come to drive much factory activity so a well-set up MPS will definitely influence profitability in a positive manner. An MPS can identify problems in significant processes and resources in order to help you in optimizing production.

Typical master production scheduling software is held down by software limitations that disallow them from including every aspect of production, just key elements,

MRP can facilitate integration between your job cards and a master production schedule to cover for the latter’s shortcomings.

Not only do you avoid shortages, costly expediting, last-minute scheduling, you also improve efficiency among employees at the base level and prevent inefficient allocation and use of resources.

Working with an MPS allows an organization to consolidate planned parts, and produce strongly beneficial schedules.

By using many variables as inputs, an MPS system will generate a set of outputs used for decision making.

You may input data such as demand forecast, production costs, inventory money, customer needs and demands, supply, material inventory size, production lead time, and capacity.

It is also possible to generate input automatically by an ERP/MRP system that links a sales department with the production department.

Sales and logistics department data being input can automatically alter demand forecast data and the inventory size data contained within the MOS. Outputs may include data such as amounts to produce, quantity available, etc.

An effective MPS combined with job cards will ultimately give your production, planning, sales, and management departments the necessary information quickly and reliably to plan and control manufacturing.

It can also enable your marketing department the confidence to make legitimate and accurate delivery commitments to partnered warehouses and customers. You also end up increasing the efficiency and accuracy of a company's manufacturing.

ADVANTAGES OF A JOB CARD

1. Provides first hand job related information such as materials required and skill set applicable to complete the job.
2. Helps you to find the right type of employee suitable enough to deliver a specific job successfully.
3. Helps you to establish effective hiring practices. Questions such as who is to be filled where, when, and how, who is to be relocated and why; these can all be answered by using job cards and you and your managers the guidance to establishing and maintaining effective hiring practices.
4. Guides you through performance evaluation processes as they help your managers and you evaluate the performance of each employee by comparing it with the desired output. As a result, you also get a nuanced and informed idea of who you should promote and when. Skill gaps and mistakes can be identified easily and worked upon.
5. Helps you analyze training and development needs in accordance with type of training and content of training.

Self-Check – 3	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Discuss how to Recording and reporting Machinery and Equipment during servicing activities?(2pt)
2. List the Advantages of keeping an equipment maintenance record?(2pt)
3. Discuss how to Cleaning, securing and storing tools which used for Inspect and Adjust Machinery Controlling System
4. Discuss waste management strategies which reduce the volumes of waste going to Land fill from workshop operations.(2pt)
5. Discuss job card processing (2pt)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers .

Operational sheet 3

3.1 Procedures of cleaning and storing, of tools and equipment.

a. Tools use for Inspect and Adjust Machinery Controlling System

- ✓ Steering Wheel Puller
- ✓ Steering wheel Lock Plate Tool
- ✓ Steering Pump Puller Kit
- ✓ Inner Tie Rod End Tool
- ✓ micrometer or vernier calipers
- ✓ Safety Glasses
- ✓ Dust Mask
- ✓ Wrenches ·
- ✓ Allen Wrenches,
- ✓ Hex Keys,
- ✓ Torx and Allen Sockets
- ✓ Ratchet and Socket Set.

b. **Tools use for cleaning**

- ✓ Brush.
- ✓ Multi-purpose duster.
- ✓ Sponges.
- ✓ Vacuum pump.
- ✓ Microfiber cleaning cloths.
- ✓ Broom and dustpan.

c. Procedure

a. Use personal equipment
b. Read and follow manual
c. Select storage shed to protect
d. Inspect tools regularly
e. clean and dry
f. Store in storing house

LAP TEST-3

Name ……ID…….Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2**hour. The project is expected from each student to do it.

Task 3.1 Clean, and store all tools use for routine Inspect and Adjust Machinery Controlling System

REFERENCE

Books:

- ERIC O.(2012).Machinery hand book 29th edition
- Eric O.(2022).Machinery hand tool box Thirty first Edition.
- Heriss person smith.(2011).farm machinery and equipment .
- Jagvir D.(2018).farm machinery and equipment –I(practical manual).

Website

https://www.wolterskluwer.com/en/expert-insights/identify-sources-of-information-on-workplace-hazards-safetip-188

https://courseware.cutm.ac.in/wp-content/uploads/2020/12/Brake-system.pdf

https://www.bluestar.com/get_informed/article/the-power-steering-system-steering-gear

https://learnmech.com/components-of-steering-system-and-their-function/ streering system

http://ecoursesonline.iasri.res.in/mod/page/view.php?id=2288 (01/05/2023)

https://www.wikihow.com/Inspect-Your-Suspension-System (inspect susption (02/05/2023)

https://www.syncoria.com/blog/how-to-use-job-card (02/05/2023) job card

https://www.ccohs.ca/oshanswers/prevention/effectiv.html (05/05/2023)

https://www.lee.k12.al.us/site/handlers/filedownload.ashx?moduleinstanceid=9133&dataid=4086&FileName=Standard%205%20Steering%20and%20Suspension%20eBook.pdf (suspation and steering ebook(03/05/2023

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