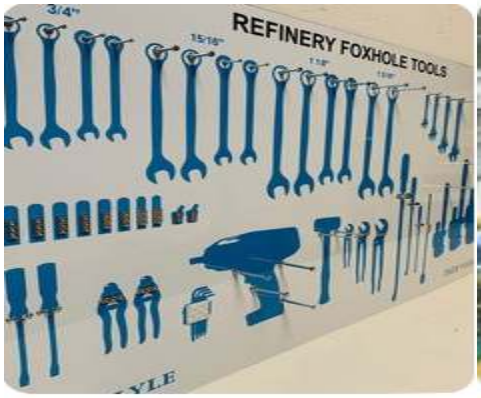
Mechanics Level – II

Based on April 2022, Curriculum Version 1



Module Title: -Performing Equipment/Machine Layout, Setting and Leveling

Module code: -IND MCS2 M09 0322

Nominal duration: - 50hours

Prepared By: Ministry of labor and skills

September, 2022

Addis Ababa, Ethiopia

Acknowledgement

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Table of Contents

Acronyms

PPE – personal protective equipment

LAP – Learning activity performance

OHS - Occupational Health and Safety

CNC – Computer numerical control

LED – Light emitting diode

WHMIS – Workplace hazardous material information system

OR – Operational requirement

FOI – First off inspection

FAI – First article inspection report

FAIR – First article inspection report

Introduction to the module

In **mechanics** filed; Equipment/Machine Layout, Setting and Leveling to prepare layout for equipment foundation, setting and undertaking leveling and alignment tasks of machines and equipment in industry application.

This module is designed to meet the industry requirement under the **mechanics** occupational standard, particularly for the unit of competency: **Perform Equipment/Machine Layout, Setting and Leveling.**

This module covers the units:-

- Plan and prepare work
- Perform layout
- Perform setting, leveling and alignment
- Assure quality and Clean up

Learning Objective of the Module

- Planning and Preparing work
- Performing layout
- Performing setting and leveling and alignments
- Assuring quality and Cleaning up

Module Instruction

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

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

Unit One: Plan and Prepare Work

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

- Work Instructions
- Occupational Health And Safety (OHS) Requirements
- Selection Of Tools And Equipment
- Calculation Of Material Quantity
- Leveling or Alignment Device Selection
- Electrical Lightings And Wirings/Gadgets For Installation
- Environmental Protection Requirements

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

- Obtain and interpret work instructions including plans, specifications, quality requirements and operational details.
- Follow Occupational Health and Safety (OHS) requirements
- Select tools and equipment to the need of a particular job.
- Calculate material quantity in accordance with plans and/or specifications
- Select and set up leveling or alignment devices to standard operating procedures
- Identify electrical lightings and wirings/gadgets for installation in accordance with standards.
- Identify and apply environmental protection requirements in accordance with environmental plans and regulatory obligations

1.1. Work Instructions

1.1.1. Definition

A Work Instruction is a document that provides specific instructions to carry out an Activity. A Work Instruction is a step by step guide to perform a single instruction. A Work Instruction contains more detail than a Procedure and is only created if detailed step-by-step instructions are needed. Procedures and Work Instructions

Work instruction describes how to perform the conversion itself. Process descriptions include details about the inputs, what conversion takes place (of inputs into outputs), the outputs, and the feedback necessary to ensure consistent results.

Work instructions should be very detailed on “how” to accomplish a specific job, task or assignment.

Individual work instructions are very specific to an industry or company. Supplemental documentation may be used including User’s Manuals, Engineering or Technical Manuals, Technical Support notes, Manufacturing Notes, etc., in order to create detailed work instructions.

1.1.2. Plans

Layout planning is planning that involves decisions about the physical arrangement of economic activity centers needed by a facility’s various processes.

Layout plans translate the broader decisions about the competitive priorities, process strategy, quality, and capacity of its processes into actual physical arrangements.

Planning to clearly communicate the central goal of an initiative, why it is important, and what to select specific and measurable objectives expected to lead to the desired result.

1.1.3. Specification

The standards against which conformity is measured can take various forms. The most common source is usually the contract technical. Other standards would often be referenced in this document, and may include any of the following:

- ✓ Contract documents/specification generally

- ✓ Contract drawings - Approved workshop drawings and/or calculations - Approved technical details/procedures
- ✓ Approved samples and/or prototypes
- ✓ Regulatory requirements
- ✓ Australian Standards
- ✓ International Standards
- ✓ Standard specifications
- ✓ Manufacturers' recommendations

1.1.4. Quality requirements

A work instruction explains how to carry out the procedure.

Consider a process as a high level, strategic method of control, in effect a summary of objectives, specifications, and broad resources needed. The procedure adds more specifics such as responsibilities, specific tools, methods, and measurement.

Use the following sequence to draft work instructions:

Step 1: Write a Clear Title

First, write the document's title. The title should refer to the task at hand. For example, "How to Disinfect Countertops" may be the title of work instructions explaining a restaurant's Opening Procedures.

Step 2: Write a Brief Introduction

Next, write a brief introduction that provides contextual background, identifies task owners, and describes the task's purpose. This step will help you develop the document with a clear goal in mind. With our previous example, the purpose of disinfecting restaurant countertops is to maintain a safe environment for patrons and follow recommended COVID-19 guidelines.

Step 3: Describe How to Do It

This step is self-explanatory: describe how workers should complete the task. Explain how to disinfect the countertops in clear, detailed language. Additionally, list all approved materials needed for the job. You may want to include relevant references—images, flow charts, and tables to enhance employee understanding.

Step 4: Format Work Instructions

Select a design format to use consistently throughout the document. Break down any necessary steps into numbered sequences, with each step representing a single action. If you're using infographics, don't just drop them onto the page. Refer to the images within the text for additional clarification.

Ideally, keep images on the left and text on the right for optimized informational processing. Also, use bold, italicized, and upper-case text to emphasize important pieces of information.

Step 5: Revise Your Document

Once you're finished writing, review your draft for opportunities to remove extraneous words, simplify complex sentences, and improve readability. Here are some quick editorial tips:

- **Abbreviate Correctly:** Spell out complex terminology on first use and enclose abbreviations in parentheses next to the initial term. Subsequently, you may use the abbreviation throughout the document. For an example, refer to the first time I wrote the term standard operating procedures (SOPs) in this article.
- **Provide a Glossary:** If you find yourself heavily referencing abbreviations, consider linking to a glossary of terminology.
- **Maintain Consistency**: For example, if you use the term "liquid detergent" in one step, continue to use that term throughout the entire document to avoid confusion.

Affordable editing software like Grammarly or Hemingway help with editing to improve both readability and remove grammatical errors.

Step 6: Provide Resources

Once your initial editing is completed, look for opportunities to provide additional resources and reading materials. You can do this either by adding footnotes or including an appendix at the end of the document.

Step 7: Test Effectiveness

Finally, test the effectiveness of your work instructions before making them available company-wide. Ask an employee or colleague to follow the directions and perform the

associated task. This exercise will reveal any instructional gaps that need clarification. Observe and take note of how your colleague performs the job so you can go back and improve the document.

Once you've confirmed the instructions are easy to understand and follow, begin including them within associated SOPs and work orders.

1.2. Occupational Health and Safety (OHS) requirements

The purpose of the Health and Safety policies and procedures is to guide and direct all employees to work safely and prevent injury, to themselves and others. All employees are encouraged to participate in developing, implementing, and Enforcing Health and Safety policies and procedures.

All employees must take all reasonable steps to prevent accidents and never sacrifice safety for expedience. Our goal is to eliminate or minimize hazards that can cause accidents.

Under the occupational Health and Safety legislation and help you to make your workplace safer and healthier.

One of your most important responsibilities is to protect your Health and Safety as well as that of your co-workers.

Your Company is committed to the goal of providing and maintaining a healthy and safe working environment, with a view to continuous improvement. This goal is only achievable by adherence to established objectives striving to exceed all obligations under applicable legislation, and by fostering an enthusiastic commitment to health, safety and the environment within Your Company personnel, contractors and visitors.

1.2.1. Workplace safety

A dirt or concrete floor is recommended, however, a wood floor covered with sand or wet down is permissible.Protect any nearby combustibles (walls, floors, etc.) from slag and flying hot metal with approved fireboard such as 518" gypsum. Work in a well-ventilated area. DO NOT ventilate with oxygen from tanks.

Fireproof any surface used as a worktable. Fire brick is recommended because it is inexpensive, easy to find, and long-lasting.

1.2.2. Personal Protection Equipment

Personal Protective Equipment (PPE) is essentially a range items you can wear that will protect you against various hazardous conditions. PPE is important because it prepares you for health and safety risks and gives you extra protection in the event of an accident or against the elements. When used properly, PPE acts as a barrier between infectious materials such as viral and bacterial contaminants and your skin, mouth, nose, or eyes (mucous membranes).

PPE includes gloves, gowns, laboratory coats, face shields or masks, eye protection, resuscitation masks, and other protective gear such as hats and booties.

- ✓ Clothing shall be appropriate to the duties being performed. Long pants, a clean neat shirt and steel toed shoes are the minimum requirements.
- ✓ Horseplay, fighting or tomfoolery is strictly prohibited
- ✓ Do not attempt to use unless all guards and safety devices are in place and securely attached.
- ✓ Stop machine before making measurements or work adjustment.
- ✓ All spills will be immediately cleaned up and reported
- ✓ Remove your watch, rings etc. before using machine.
- ✓ Aisles are to be kept clear at all times

Figure 1.1. PPE

1.2.3.Machine safety

Hand tools are to be used for their intended purpose only Machinery and tools must be cleaned up before the end of your workday.

Only licensed personnel may operate machine or other warehouse. Equipment and must wear a seatbelt while doing so. Riding on equipment is prohibited except where designated for operator. Do not unload a truck alone under any circumstances, if someone cannot help you then wait or call someone else for help.

When identifying the hazards related with machines, we shall consider

- ✓ type of machines
- ✓ layout of machines
- ✓ Driven method, e.g. electricity, air, etc.
- ✓ Operating parameters, e.g. speed, pressure, temperature, size of cut, mobility, etc.
- ✓ materials to be processed or handled and method of feed
- ✓ operator position and controls
- ✓ access for setting adjustments and maintenance
- ✓ Environmental factors, e.g. dust, fumes, noise, temperature, humidity etc.
- ✓ operating requirements including what the operator needs to do

Typical hazards related with operation of machines include:

- ✓ mechanical:e.g. crushing, shearing, cutting or severing, stabbing or puncture
- ✓ high pressure fluid ejection
- ✓ electrical shock noise and vibration
- ✓ contact with extremes of temperature
- ✓ ergonomics
- ✓ loose clothing

Figure 1.2. Showing machine accident

1.2.4. Standard electrical safety

Electrical safety is a system of organizational measures and technical means to prevent harmful and dangerous effects on workers from electric current, arcing, electromagnetic fields and static electricity.

- **Lightning and earthling protection**

Lightning and Earthling protection systems are essential for the protection of humans, structures, protecting buildings from mechanical destruction caused by lightning effects and the associated risk of fire, Transmission lines, and electrical equipment from electric shock and Overcurrent.[5]

A. Earthling protection systems

- ✓ TT earthling system
- ✓ TT system
- ✓ TN system
- ✓ IT system

B. Lightning protection systems

- ✓ lightning rod (simple rod or with triggering system)
- ✓ Lightning rod with taut wires.
- ✓ lightning conductor with meshed cage (Faraday cage)

1.3. Selection of tools and equipment

Each tool is precisely designed for a specific purpose, so choosing the correct tool will also decrease the amount of effort required to get a job done right without causing damage to either the equipment or the surface being worked on. Many construction accidents can be prevented by taking the time to plan ahead.

With the right tools, you can work more efficiently and get the job done right. It is important to select the right tools for the job when working with tools. The wrong tools can not only make the job more difficult but can also pose a safety hazard. Using the proper tools can help you avoid injuries while working.

1.4. Calculation of material quantity

To calculate the quantities of materials, you need to multiply the total Centre line length with breadth and depth of the construction.

To calculate the raw materials inventory, add the cost of the direct materials in production with the manufacturing overhead.

A data sheet is a template that defines the specifications of an asset for the calibration process. A data sheet defines the asset function specifications and the calibration point of an

asset. The data sheet also defines the functional checks and dynamics checks of an asset, if required.

Data sheets provide technicians with the information that they need to perform a calibration. A data sheet is a template that defines the specifications of an asset for the calibration process.

A data sheet defines the asset function specifications and the calibration point of an asset. The data sheet also defines the functional checks and dynamics checks of an asset, if required.

Data sheets are associated with assets and are copied to calibration work orders for the asset. On the work order data sheet, the technician enters calibration As Found and As Left data. This data is used to analyze asset performance and calibration frequency.

The data sheet also records uncertainty measurement data for instruments and measuring and test equipment (M&TE). This uncertainty data is calculated and imported from an external source into the Data Sheet Template application and the Work Order Tracking application.

From the practical point of view, the following requirements should be fulfilled.

- ✓ The groundwater table should be as low as possible and groundwater level deeper by at least one-fourth of the width of foundation below the base plane. This limits the vibration propagation, groundwater being a good conductor of vibration waves.
- ✓ Machine foundations should be separated from adjacent building components by means of expansion joints.
- ✓ Any steam or hot air pipes, embedded in the foundation must be properly isolated.
- ✓ The foundation must be protected from machine oil by means of acid-resisting coating or suitable chemical treatment.
- ✓ Machine foundations should be taken to a level lower than the level of the foundations of adjoining buildings.

Table 1.1.Quintity calculation

Definition	Machine relate to the foundation	Where
Lf (length of the foundation)	Lb + 2C, where c= 10% of Lb	Lb = length of the base plate C = clearance Wb = width of the Base plate. Wm =weight of the machine Kg d= density of the concrete Kg/m3 Sb=Soil bearing Capacity in kg/m^2 N = Factor of Safety
a (upper width of the foundation)	Wb + 2C, where c= 10% of wb	
Wf (weight of the foundation)	3-5 (Wm)	
Vf (volume of the foundation)	Wf/d	
b (Lower width of the foundation)	N(Wf +Wm)/Sb.Lf	
h (depth of the machine foundation)	2Vf/(a+b)Lf	

Weight of Steel bar Reinforcements (W_{SB}) ,W_{SB} = 0.5 % to 1% x W_f

Anchor Bolts Recommendation :The anchor Bolts should be imbedded in the Concrete at least 30 times the bolt diameter.

Notes :The vertical distance from the floor or soil level to the top edge of the Foundation must be around 6 inches (120 mm) as a minimum distance.

1.5. Leveling or alignment device selection

The term level is defined as "being perpendicular to a vertical line.” If an object is parallel to the horizon, it also said to be "level".

A machine leveling procedure is a process that helps ensure your machines are optimized for production. Without this procedure in place, you risk damaging your machine assets. From lathes to CNC machines, a machine leveling procedure is crucial. It improves efficiency, reduces downtime, and prevents costly errors.

A. Leveling devices

1. **Surveyor's leveling instrument**: Tilting level, dumpy level or automatic level are terms used to refer to types of leveling instruments as used in surveying to measure height differences over larger distances.

Figure 1.2. Surveyor's leveling instrument

2. **Carpenter's level: A** traditional carpenter's **spirit level** looks like a short plank of wood and often has a wide body to ensure stability and that the surface is being measured correctly. In the middle of the spirit level is a small window where the bubble and the tube is mounted. Two notches (or rings) designate where the bubble should be if the surface is level. Often an indicator for a 45 degree inclination is included.

Figure 1.3.Carpenter's level

3. **Line level**: A line level is a level designed to hang on a builder's string line. The body of the level incorporates small hooks to allow it to attach and hang from the string line.

Figure 1.4.Line level

4. **Engineer's precision levels:** An engineer's precision level permits leveling items to greater accuracy than a plain spirit level. They are used to level the foundations, or beds ofmachines.

Figure 1.5.Engineer's precision levels

5. **Theodolite**: is a precision instrument for measuring angles in the horizontal and vertical planes. Theodolites are used mainly for surveying applications, and have been adapted for specialized purposes in fields like meteorology and rocket launch technology.

Figure 1.6.Theodolite

6. **Digital levels: -** are increasingly common in replacing conventional spirit levels particularly in civil engineering applications, such as building construction and steel structure erection, for on-site angle alignment and leveling tasks. The industry practitioners often refer those leveling tool as: “construction level”, “heavy duty level”, "inclinometer" or “protractor”.

Figure 1.7.Digital level

B. Alignment devices

The real definition of an alignment method is a method or way to align a moving object and an object that is moved. Even though it is said to be parallel, in fact in this method there is also a known tolerance, which is up to 0.05 mm. This is because getting a straight line is not always 100% possible.

Doing the alignment method can use several tools. There are four types of equipment that are often used, namely a ruler, dial indicator, level precision, and laser. The explanation of each tool will be explained in the points below.

1. Ruler

The alignment method using a ruler is the most traditional. This method relies on the accuracy of the user's eye in seeing the presence or absence of deviations. Apart from metal rulers, other commonly used tools are the taper gage and the feeler gauge (inside micrometer).

For small machines, alignment with a ruler is still possible. However, it should not be applied to machines with large capacity or high rotation. Why? This method has a very low level of precision. The results given are often inaccurate, which can lead to asymmetry of machine components.

Figure 1.8.Magnetic beam height ruler

2. Dial Indicator

The alignment method with the dial indicator can be done in two ways, namely reverse and rim and face. The reverse method is commonly used when one of the engine shafts is difficult to move (there is no room for the dial). The reverse is quite efficient because only by turning one axle, the engine pair are symmetrical. Suitable for engines without thrust bearings.

Meanwhile, the rim and face are alignments by rotating two axles at the same time. This method is quite accurate and can be used on shafts with small or large diameters. In addition, rim and face also simplify calculations, thereby shortening work time.

Figure 1.9. Dial indicator

3. Level of Precision

The real function of level precision is to adjust the level of the machine. Usually used on machines that cannot be measured with a dial indicator, for example, alignment for APH bearing support, APH post rotor, to impeller force draft fan. The way it works is similar to a water pass device. Even so, the level of precision has higher accuracy.

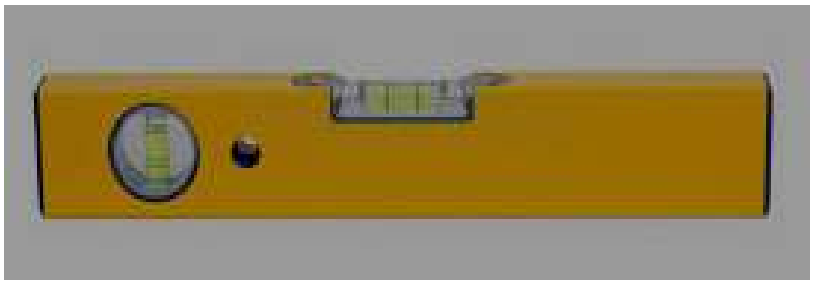


Figure 1.10. Level of Precision

4. Laser

The alignment method can be done using a laser. As the name suggests, this method makes use of a laser beam emanating from an infrared sensor to align the shaft. The symmetry of the shaft is measured by a laser beam that is fired by an infrared sensor. This method is

considered efficient because it provides fast and accurate results. The entire calculation process is carried out automatically.

Figure 1.11. Showing Laser alignment

1.5.1. Major Benefits of Alignment

You have much to gain in both time and money through having your machines aligned to the correct tolerances. An investment in a laser based alignment system such as Easy-Laser® rapidly pays for itself through lower costs for replacement parts, less downtime and smaller electricity bills. Correctly aligned machines reduce the risk of expensive breakdowns and downtime. The benefits of alignment are many:

- ✓ Increased availability and productivity of the machine = assured production
- ✓ Increased life of bearings and seals = less use of replacement parts
- ✓ Complete seals = less leakage and better working environment
- ✓ Optimally utilized lubricant = less risk of overheating and secondary damage
- ✓ Less lubricant leakage = less lubricant consumption
- ✓ Reduced friction = lower energy consumption
- ✓ Less vibration = reduced noise level
- ✓ Less risk of serious breakdowns = safer working environment

1.6. Electrical lightings and wirings/gadgets for installation

A. Electrical Lighting

An electric light, lamp, or colloquially called light bulb is an electrical device that produces light. It is the most common form of artificial lighting. Lamps usually have a base made of ceramic, metal, glass, or plastic, which secures the lamp in the socket of a light fixture. The electrical connection to the socket may be made with a screw-thread base, two metal pins, two metal caps or a bayonet cap.

The three main categories of electric lights are incandescent lamps, which produce light by a filament heated white-hot by electric current, gas-discharge lamps, which produce light by means of an electric arc through a gas, such as fluorescent lamps, and LED lamps, which produce light by a flow of electrons across a band gap in a semiconductor.

Lighting installation means a fixed electrical lighting system in the building 'luminaire' means a lighting device, which distributes light from a single lamp or a group of lamps; a luminaire should include control gears if applicable, and all necessary components for fixing and mechanical protection of lamps.

Figure 1.12. Electrical Lighting

B. Electrical wiring

Electrical wiring is an electrical installation of cabling and associated devices such as switches, distribution boards, sockets, and light fittings in a structure.

Wiring is subject to safety standards for design and installation. Allowable wire and cable types and sizes are specified according to the circuit operating voltage and electric current capability, with further restrictions on the environmental conditions, such as ambient temperature range, moisture levels, and exposure to sunlight and chemicals.

- **Wiring accessory**

- ✓ Switches & Sockets
- ✓ Outdoor Switches & Sockets
- ✓ Back Boxes
- ✓ Junction Boxes
- ✓ Metal Clad Switches & Sockets
- ✓ Grid & Modular Wiring
- ✓ lugs & Fuses
- ✓ Timers & Controllers

Figure 1.13.Wiring Accessories

1.7. Environmental protection requirements

The Environmental Protection Agency (EPA) is a federal government agency, created by the Nixon Administration, to protect human health and the environment. The EPA creates and enforces environmental laws, inspects the environment, and provides technical support to minimize threats and support recovery planning.

Your working institution must committed to the protection of the environment for present and future generations. All employees are responsible for incorporating into their planning and work the actions necessary to fulfill this commitment.

Your company will meet these responsibilities by endeavoring to provide the resources for continuing to:

- Design and manage our operations to meet or surpass applicable environmental laws.
- Work in partnership with customers, suppliers, trade associations and government agencies to promote the environmentally safe handling and disposition of materials and products.
- Acquire knowledge and technologies to improve the environmentally save efficient use of our processes and products. Formulate and implement effective environmental emergency response systems.

Ten simple choices for a healthier planet:-

- ✓ Reduce, reuse, and recycle - Cut down on what you throw away
- ✓ Volunteer - Volunteer for cleanups in your community
- ✓ Educate
- ✓ Conserve water
- ✓ Choose sustainable
- ✓ Shop wisely
- ✓ Use long-lasting light bulbs
- ✓ Plant a tree

Self-Check-1

Directions: Answer all the questions listed below.

Part I: <u>say true or false</u>

1. Work Instruction is a document that provides specific instructions to carry out an Activity.
2. The Environmental Protection Agency (EPA) is a federal government agency, created to protect human health and the environment.
3. Working institution must committed to the protection of the environment for present and future generations.
4. Wiring is subject to safety standards for design and installation.
5. Theodoliteis a precision instrument for measuring angles in the horizontal and vertical planes.

Part II: <u>Choose</u>

1. Electrical installation of cabling and associated devices such as switches, distribution boards, sockets, and light fittings in a structure is
   A. Electrical wiring C. OHS
   B. PPE D. Laser
2. Of the following which one is wiring accessory?
   A. Back Boxes C. lugs & Fuses
   B. Junction Boxes D. all
3. Which choice is important for environmental protection?
   A. Conserve water C.Shop wisely E. all
   B. Use long-lasting light bulbs D. Plant a tree
4. Which one is NOT among the benefits of alignment?
   A. less lubricant consumption
   B. Reduced friction
   C. Less vibration
   D. Less risk of serious breakdowns E. none
5. Which one equipment/tool is used to do alignment?

A. ruler C. level precision E. all
B. dial indicator D. laser

6. Among the following which one is not a leveling device?
   A. Line level C. engineering precession level E. none
   B. Digital level D. All
7. When identifying the hazards related with machines, we shall consider
   A. Type of machines C. Driven method E. All
   B. Operating parameter D. layout of machines

Part III: Short answer

1. Define work instruction.
2. What is electrical wiring?
3. List at least 3 alignment devices.
4. List 4 leveling devices.
5. What are the typical hazards related with operation of machines?
6. List at list 4 benefits of alignment.
7. What is the purpose of OHS?

Operation sheet

Operation Title: Drafting work instruction.

Instruction: Draft work instruction according to the procedure.

Purpose: To draft work instruction.

Required tools and equipment: pencil/pen, paper, ruler, eraser.

Procedures:

Step 1. Write a clear title

Step 2. Write a brief introduction

Step 3. Describe how to do it

Step 4. Format work instruction

Step 5. Revise your document

Step 6. Provide resource

Step 7. Test effectiveness

Quality criteria: The drafted work instruction must done with standard procedure.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction: Draft work instruction in **5** hours.

Unit Two: Perform Layout

This unit to provide you the necessary information regarding the following content coverage and topics:

- Shop area inspection
- Layout of equipment in workshop
- Locationmarking
- Work area preparation

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 shop area for proper placement of equipment / machine
- Take in consideration for the flow of equipment, material or personnel.
- Do layout of equipment in workshop.
- Mark locations for form works, anchor bolts.
- Clear and prepare work area for safe erection of formwork.

2.1. Shop Area Inspection

Regular workplace inspections are essential in preventing all sorts of incidents, injuries, illnesses, property damages, or loss of revenue. There are some companies out there that for mainly financial reasons skip these inspections in the hopes of cutting on expenses.

Inspections help to management make key decisions, control costs, and protect the company. Inspections help prevent accidents and provide evidence of due diligence for liability protection.

Workplace inspections help to 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.

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, office storage areas and locker rooms.

2.1.1. Workplace Elements

Workplace elements are – the people, the environment, the equipment and the process. The environment includes such hazards as noise, vibration, lighting, temperature, and ventilation. Equipment includes materials, tools and apparatus for producing a product or a service. The process involves how the worker interacts with the other elements in a series of tasks or operations.

2.1.2. Types of workplace hazards

Hazards in the workplace occur when the working environment can cause injury, illness or death. The hazards can result from many of the different aspects of the working world, including equipment, dangerous materials, unsafe working practices and the behavior of people.

Workplace hazards fall into six core types – safety, biological, physical, ergonomic, chemical and workload.

1. **Safety hazards** such as those caused by inadequate machine guards, unsafe workplace conditions, unsafe work practices.
2. **Biological hazards** caused by organisms such as viruses, bacteria, fungi and parasites.
3. **Chemical hazards** caused by a solid, liquid, vapor, gas, dust, fume or mist.
4. **Ergonomic hazards** caused by physiological and psychological demands on the worker, such as repetitive and forceful movements, awkward postures arising from improper work methods, and improperly designed workstations, tools, and equipment.

5. **Physical hazards** caused by noise, vibration, energy, weather, heat, cold, electricity, radiation and pressure.
6. **Psychosocial hazards** that can affect mental health or well-being such as overwork, stress, bullying, or violence.

2.1.3.Importance of work place inspection

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 steps taken to eliminate hazards or control the risk (e.g., engineering controls, administrative controls, policies, procedures, personal protective equipment)

2.1.4. Shop area Inspection report

An inspection report is a record produced by either insurance or safety inspection companies who look for potential risks at a property or in the functioning of machines. The risks could be related to physical, environmental, or financial considerations.

A. Diagram of Area

Use drawings of the plant layout or floor plans to help you draw a diagram. Divide the workplace into areas based on the process. Visualize the activities in the workplace and identify the location of machinery, equipment and materials. Show the movement of material and workers, and the location of air ducts, aisles, stairways, alarms and fire exits. Appendix A shows a sample diagram. Use several simple diagrams if the area is large. Ask workers and supervisors for their comments on the information - they know the area better than anyone else.

B. Equipment Inventory

Know what type of machinery or equipment is present. Review technical data sheets, or manufacturers' safety manuals. Read work area records to become familiar with the hazards of the equipment.

C. Hazardous Product or Chemical Inventory

Determine which products are used in the workplace and whether safety data sheets are available. Find out if all sources of exposure are properly controlled. Make sure that all workers have received education and training in how to safely use, handle and store the products they work with. Check that all hazardous products are labelled appropriately according to Workplace Hazardous Materials Information System (WHMIS) requirements.

D. Checklists

A checklist helps to clarify inspection responsibilities, controls inspection activities and provides a report of inspection activities. Checklists help with on-the-spot recording of findings and comments but be careful. Do not allow the inspection team to become so intent on noting the details listed in the checklist that it misses other hazardous conditions. Use checklists only as a basic tool. Refer to the related documents for sample checklists that you can use as a guide to develop a checklist that is customized for your workplace.

2.2. Layout of equipment in workshop

In general, a most economical plant layout is that in which spacing of the main equipment items is such that it minimizes the interconnecting pipe work and structural steel work. As a general rule, layout should be as compact as possible with all equipment at ground level and it should conform to access and safety requirements.

Equipment should be laid to give maximum economy of pipe work and supporting steel. Normally, they should be laid out in a sequence to suit the process flow, but exceptions to this arise from the desirability to group certain items such as tanks or pumps or perhaps to isolate hazardous operations.

In general, high elevation should only be considered when ground space is limited or where gravity flow of materials is desired.

Equipment items which are considered to be a source of hazard should be grouped together and wherever possible should be located separately from other areas of the plant.

Provide sufficient clear space between critical and mechanically dangerous or high temperature equipment to allow safety of operating or maintenance personnel.

The equipment needing frequent internal cleaning or replacement of internal parts should be laid out for ease of maintenance.

The workshop layout is the art of planning and positioning the machine tools, equipment, allied equipment, employee amenities, and other required utilities/spaces to achieve maximum utilization of labor, machinery, and space and increase the overall efficiency.

An effective layout not only looks attractive, but also helps the viewer understand the message the design is conveying. In other words, understanding layout is key when it comes to creating user-friendly, engaging designs, particularly in the realms of web design and advertising.

2.2.1. Types of layout

There are four basic layout types: process, product, hybrid, and fixed position.

A. Process layouts (Job shop)

In process layout, the work stations and machinery are not arranged according to a particular production sequence. Instead, there is an assembly of similar operations or similar machinery in each department (for example, a drill department, a paint department, etc.)

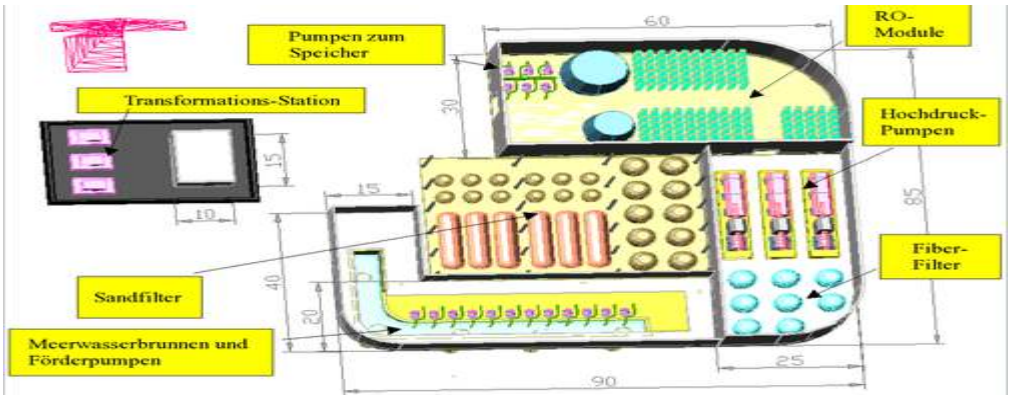


Figure 2.1. Process layouts (Job shop)

Designing steps

Step 1. Gather information: - space needed, space available, identify closeness measure.

Step 2. Develop alternative block plans: - using trial and error method or decision support tools

Step 3. Develop a detail layout: - consider exact size/shape of department and work center including aisle and straightway.

B. Product layouts (Flow shop)

Flow Shop is a form of facility setup, and is also called Line Layout. This refers to the process or shop which, when all works (jobs) have the same processing route, is set up based on the flow.

Figure 2.2. Product layouts (Flow shop)

C. Hybrid layouts (Cellular)

Hybrid layout refers to a layout with both dedicated and shared machine cells. In cellular manufacturing, parts and machines are formed into clusters. Parts in the same cluster constitute a family. The machines in a cluster are formed into a machine cell.

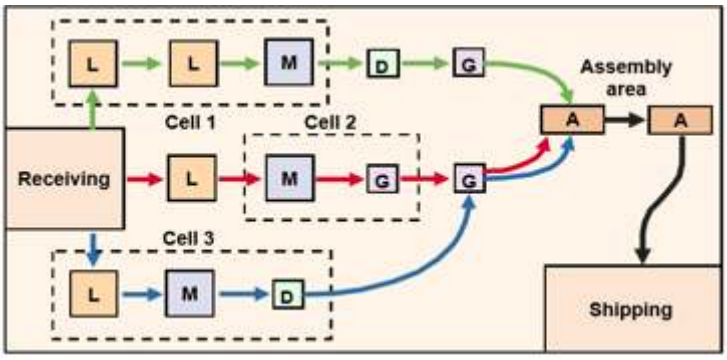


Figure 2.3.Hybrid layouts (Cellular)

D. Fixed-Position layouts

In a fixed-position layout, the product (by virtue of its bulk or weight) remains at one location. Manufacturing equipment is moved to the product rather than vice versa.

A fixed-position layout lets the product stay in one place while workers and machinery move to it as needed. Products that are impossible to move ships, airplanes, and construction projects are typically produced using a fixed-position layout.

Examples of this type of project are a ship, a highway, a bridge, a house, and an operating table in a hospital operating room.

Figure 2.4. Fixed-Position layouts

2.2.2. Workshop Layout Techniques

In designing or improving the plan of plant layout, certain techniques or tools are developed and are in common use today. The techniques or tools are as follows:

1. Charts and Diagrams:

In order to achieve work simplification, production engineers make use of several charts and diagrams for summarizing and analyzing production process and procedure. These include

- **Operation process chart:** It subdivides the process into separate operations and inspection. When a variety of parts and products are manufactured which follow a different path across several floor areas, an operation process chart may be necessary for the important material items or products. The flow lines of the charts indicate the sequence of all operation in the manufacturing cycle.
- **Flow process chart:** This chart is the graphic summary of all the activities taking place on the production floor of an existing plant. By preparing this type of chart, it

can be found out as to where operations can be eliminated, rearranged, combined, simplified or subdivided for greater economy.

- **Process flow diagram:** The diagram is both supplement and substitute of process flow chart. It helps in tracing the movement of material on a floor plan or layout drawing. A diagram may be drawn to scale on the original floor plan to show the movement of work. It is a good technique to show long materials hauls and backtracking of present layouts,thereby indicating how the present layout may be improved. Colored lines can show the flow of several standards products.

Layouts, thereby indicating how the present layout may be improved. Colored lines can show the flow of several standard products. This diagram can be used to analyze the effectiveness of the arrangement of the plant activities, the location of specific machines, and the allocation of space. It shows how a more logical arrangement and economical flow of work can be devised.

2. Machines Data Card:

This card provides full information necessary for the placement and layout of equipment. The cards are prepared separately for each machine. The information generally given on these cards include facts about the machine such as capacity of the machines, space occupied, power requirements, handling devices required and dimensions.

3. Templates:

Template is the drawing of a machine or tool cut out from the sheet of paper. Cutting to scale shows the area occupied by a machine. The plant layout engineer prepares a floor plan on the basis of reel vent information made available to him. The template technique is an important technique because (i) it eliminates unnecessary handlings, (ii) minimize backtracking of materials, (iii) it makes the mechanical handling possible, (iv) it provides a visual picture of proposed or existing plan of layout at one place, (v) it offers flexibility to meet future changes in the production requirements.

4. Scale Models:

Though the two-dimensional templates are now in extensive use in the fields of layout engineering but it is not much use to executives who cannot understand and manipulate them. One important drawback of template technique is that it leaves the volume, depth, height and clearance of the machines to the imaginations of the reader of the drawing. These drawbacks

of the template technique have been removed through the development of miniature scale models of machinery and equipment cast in metal. With scale models, it has now become possible to move tiny figures of men and machines around in miniature factory .The miniature machines and models of material handling equipment are placed in a miniature plant and moved around in pawn on a chessboard.

5. Layout Drawings:

Completed layouts are generally represented by drawings of the plant showing wall, columns, stairways, machines and other equipment's, storage areas and office areas.

2.3. Location marking

Marking media is especially used for marking or layout of guidelines before machining or cutting by hand tools in a machine part and also in fitting operations. Machining operation is mostly done by lathe machine, shaper machine, milling machine, planer machine, etc.

The following principles should be followed while locating surfaces.

1.At least one datum or reference surface should be established at the first opportunity.

2. For ease of cleaning, locating surfaces should be as small as possible.

3. The locating surfaces should not hold sward and thereby misalign the workpiece
4. Sharp corners in the locating surfaces must be avoided
5. Adjustable type of locaters should be used for the location on rough surfaces

2.3.1. Types of Marking Media

Marking media can be divided into four categories.

1. White Wash
2. Prussian Blue
3. Copper Sulphate
4. Cellulose Lacquer

Figure 2.5. Location markers

2.3.1.Methods of Marking

The following methods are often used for marking.

- ✓ Datum Line Method
- ✓ Center Line Method
- ✓ Marking by Template
- ✓ Marking of Center on Round Rod End

1. Datum Line Method

In this method, first, a baseline is applied which is called a datum line and all further lines are preceded by the preceding line. This method is used where the attached arms of the job are finished at right angles.

2. Center Line Method

This method of marking is used on odd-shaped jobs. Firstly, a center line is drawn and other joint lines of marking are attached with reference to this center line.

3. Marking by Template

In this method, a template is used for marking which is made of a thin metal sheet in proportion to the size. Identically sized jobs are done by this method of marking.

4. Marking of Center on Round Rod End

There are following methods are used during the marking of the center on the round rod end:

A. By jenny caliper
B. By surface gauge or Vernier height gauge
C. By center head of the combination set

A. By Jenny Caliper

Open a little more or less than the radius of a round job and rotate from different four places and then center find out.

B. By Surface Gauge or Vernier Height Gauge

Place the job on the V-block and Square the surface gauge or Vernier height gauge by drawing lines from the four different positions of the job. Put the hypotenuse lines, which means joining opposite corners of the square. Set the cutting location of these lines, slightly more or less than the center. The intersection of these lines is the center of the end of the round rod.

C. By Center Head of the Combination Set

Put the center head on the job and draw a line. Rotate the center head and put the second line at the right angle of the first line. The intersection of these two lines is the center of the end of the round rod.

Hints to be noted while marking

- ✓ Carefully study the drawing of the workpiece.
- ✓ Determine the datum surfaces from which all marks are to be marked
- ✓ Calculate all the dimensions and allowances of the workpiece
- ✓ Check the correct use of marking media on the surface of the workpiece
- ✓ First put straight horizontal, vertical, and slant lines and then apply lines of circles, arcs, rounding, etc.
- ✓ After the marking is complete, clean the job and the tools used.

2.3.1. Procedures of location marking

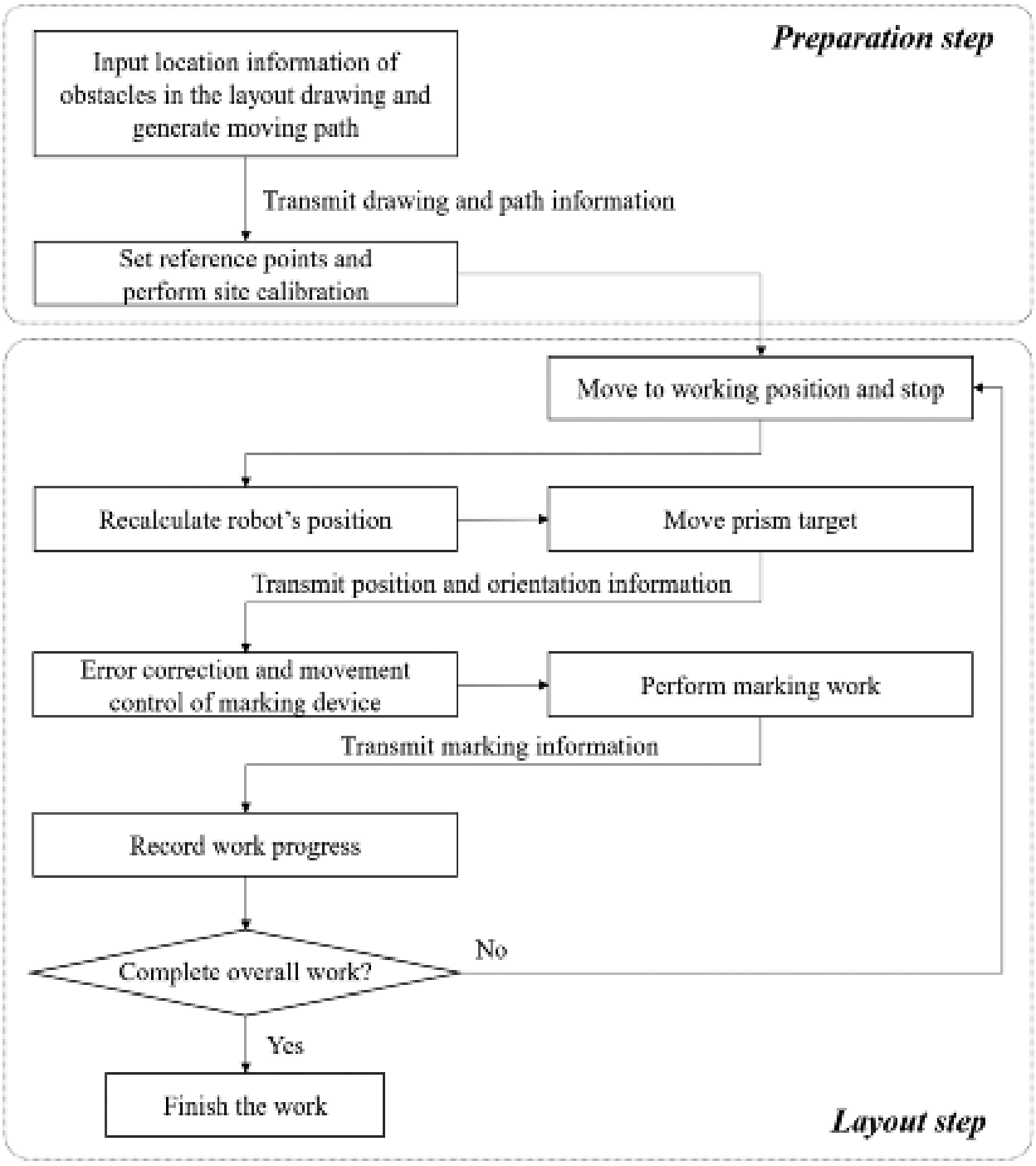


Figure 2.5. Procedure for location marking

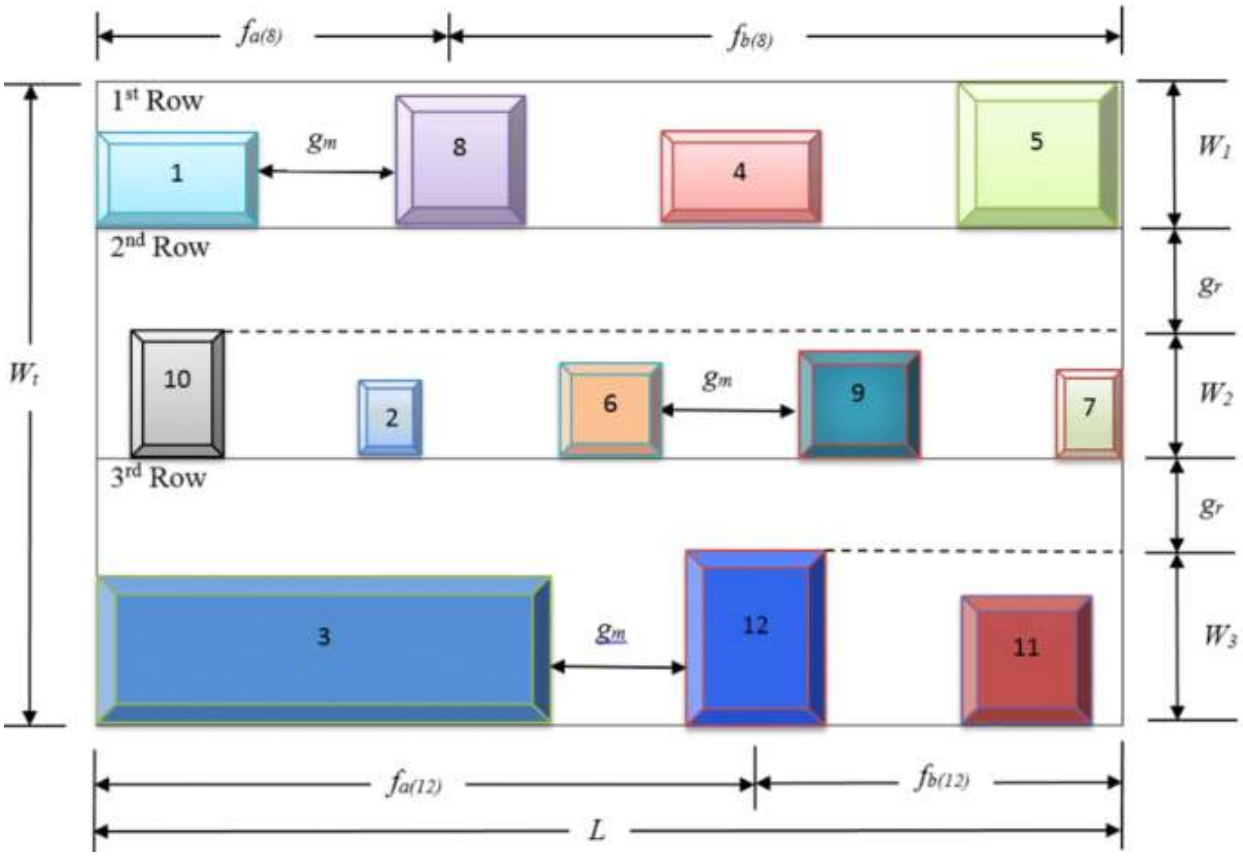


Figure 2.6.Machine layout Location marking

2.4.Work area preparation and erection formwork

Cleaning even if things are not dirty. A regular cleaning schedule prevents things from having the chance to get dirty. Maintaining the workplace in high standard of housekeeping. Surface preparation can take the form of chemical or mechanical methods, including the use of solvents, abrasive blasting materials, heat, acids and jets of water. There are also more traditional techniques using hand or power tools.

Surface preparation is the most critical aspect of a coating system's performance, in which coating performance is determined by the coating's ability to adhere to the substrate material. Surface preparation removes uncontrolled impurities like mill scale and grease to create an appropriate coating profile.

Materials used for the construction of concrete formwork range from traditional materials such as Timber, steel, aluminum, and plywood to nontraditional materials such as fiberglass. The systems used can be a combination of two materials. Wood products are the most widely used material for formwork.

Check Plant, tools and equipment

Prepare a standard checklist: - Checklist should be very detailed and stringent based on the set of standard values for inspection implement a periodic clean-up schedule; and an award and sanction scheme.

Evaluate workstations according to the standard checklist.

Example

- ✓ Is flooring clear of obstacles and spilled substances
- ✓ Are aisles, exits and traffic areas clear?
- ✓ Are walls clear and clean?
- ✓ Are tools stored in proper storage areas when not in use?
- ✓ Are defective hand and power tools/attachments removed from storage area for repair?

2.4.1. Erection of formwork frames

Formwork frames should be erected progressively to ensure the installers' safety and the stability

of the overall structure.

Braces should be attached to the frames as soon as practicable and designated access ways should

be indicated by using bunting or by other means.

If side bracing or other edge protection is installed progressively on formwork frames other control measures to prevent a fall occurring may not be required.

Many conventional formwork frames consist of diagonal braces that cross in the middle. While these braces are not considered to be suitable edge protection for a completed formwork deck, they may provide reasonable fall protection during frame erection. This is

only the case where braces are installed in a progressive manner as soon as the frames are installed.

As the height of formwork frames increase there is a greater need to provide lateral stability to the frames. Ensure framing, including bracing, is carried out in accordance with on-site design documentation and manufacturers' instructions. People erecting formwork must be trained to erect formwork using safe methods.

The risk of internal falls while erecting frames can be controlled by fully decking each lift of the formwork decks and false decks. This involves:

- ✓ positioning a full deck of scaffolding planks or other suitable decking at each lift
- ✓ positioning decking on the next lift while standing on a fully decked platform, and
- ✓ Leaving each lift fully decked in place until it is dismantled.

Self-check-2

Directions: Answer all the questions listed below.

Part I: <u>say true or false</u>

1. Inspections help to management key decisions, control costs, and protect the company.
2. A regular cleaning schedule prevents things from having the chance to get dirty.
3. Ergonomic hazards caused by physiological and psychological demands on the worker.
4. In process layout, the work stations and machinery are not arranged according to a particular production sequence.
5. Prussian blue is one the methods of marking.
6. Two plants having similar operation may not have identical layout.

Part II: <u>Matching</u>

<u>AB</u>

1. Products stay in one place while worker and machinery move	A. Process layout
2. Assembly of similar operation or similar machinery	B. product layout
3. Flow shop or line layout	C. Hybrid layout
4. Machines are formed into cluster	D.Fixed-position layout
5. Marking method	E. Datum line

Part III: Short answer

1. What are the 4 marking methods?
2. List marking Medias.
3. How do you inspect shop area?
4. List types of workplace hazards.
5. What is the importance of inspecting workplace?
6. How do you report the inspected area of workplace?

Operation sheet-1

Operation Title: Developing process layout.

Instruction: Draw your workshop process layout.

Purpose: To arrange the workshop according to the standard.

Required tools and equipment:

1.Mechanical pencils

2. Clutch pencils

3. Technical pens

4. Rulers

5. Compass

6. Drawing boards

7. Erasers

8. Sharpeners

Precautions: Drawing materials should be fulfilled!

Procedures:

Step 1. Gather information

Step 2. Develop alternative block plans

Step 3. Develop a detail layout

Quality criteria: Draw the exact process layout of the workshop neatly.

LAP Test -1	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Draw the process layout of your workshop within 3 hours.

Operation sheet-2

Operation Title: Developing process layout.

Instruction: Prepare your workshop process layout.

Purpose: To arrange the workshop according to the standard.

Required tools and equipment:

1. Tape measure
2. Bevel gauge
3. Combination square
4. Rulers
5. Compass
6. Straight edge
7. Marking media

Precautions: All safety standards must be kept!

Procedures:

Step 1. Gather information

Step 2. Develop alternative block plans

Step 3. Develop a detail layout

Quality criteria: Draw the exact process layout of the workshop neatly.

LAP Test- 2	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction : Implement your process layout drawing you did on LAP test 1 within 8hours.

Task 1. Measure and mark the location as your drawing.

Task 2. Put machines/ equipment on the marked area.

Unit Three: Perform Setting and Leveling and Alignment

This unit to provide you the necessary information regarding the following content coverage and topics:

- Machinesetting
- Machine adjustment
- Equipment leveling
- Leveling and alignment task completion

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:

- Set machine
- Adjustment machine
- Level equipment
- Complete leveling and alignment tasks

3.1.Machine setting

Machine setup time refers to the period of time that is required to prepare a machine for its next run after it has completed producing the last part of the previous run. To set up workshop machine the following things should be considered.

1. **Consider Your Workflow**

First of all one has to think about the workflow. Consider the path a piece of timber takes from the moment it enters your workshop. This will help guide you through nearly all of your shop layout decisions in the future. Grouping of tools near to where it is going to be used most of the time in important, otherwise it will always be running around looking for stuff.

2. **Grouping Your Tools**

Tools that perform similar functions or are usually used in succession should be located together. One of the most important groupings is the jointer/planer/table saw trio. During the machining process, these three machines will be used repeatedly so it's a good idea to shorten the distance between them.

3. **Workbenches must be well lit**

Natural light makes it easy to see what you're working on and it's free, it makes it a more pleasant working environment as well. Your workbench is where you will likely spend most of your time so why not have it located in a comfortable spot that gives you a nice view out the window. Remember no loose and tangled power cords on the floor!!!

4. **Timber Storage**

Store your timber near to the entrance of your workshop if you do not have a separate storage facility for your wood. This way when you come back from the timber dealer, you can back up your vehicle and quickly offload the stock into the workshop. Make sure that your timber stock is not near damp areas or open flames. Sort timber types together otherwise it will be a nightmare finding the correct piece of timber for different projects. Also separate timber according to size.

5. **Assembly Area**

During nearly all stages of a project, the assembly area is the focus point. It makes sense then to have the assembly space located somewhere near the center of the workshop. This way, your project parts are never more than a few steps away and easily brought together. Doing this at a later stage is going to be a difficult exercise. Make sure that your assembly area is always kept clean and free of extension power cords, if you need extra electricity cable points let it come down from the ceiling on square tubing. Never start putting anything other than assembly parts or projects in the assembly area otherwise this is going to become a habit hard to be broken.

6. **Finishing Area**

If you do not have a dedicated spray booth for preparing, mixing, and applying finishes, try to locate it near a window. Often times we're dealing with toxic chemicals and it's nice to have one or two open windows nearby for ventilation. You'll have the additional bonus of natural light to help with color matching and better inspection of your work. Keep the workshop well ventilated at all times and don't skimp on paying a few extra bucks for good lighting.

7. Put machines in the right place

Certain machines work better against the wall than others. Band saws, router tables, drill presses, mortises, and stationary sanders are all good candidates for placing against the wall. If you keep these tools next to each other you need to leave enough space in between them to operate correctly, however you may need to occasionally pull them away from the wall for full access if you do not have enough space in you workshop.

Figure 3.1. Showing machine set ups

3.2. Machine adjustment

We offer precision adjustment of new or older machines upon request. The machine is disassembled to functional units or pieces, checked, modified and/or re-grinded or scraped if need be to the best possible precision.

The Adjuster changes parts and makes the adjustments needed to change the machine from one size or style of envelope to another. Fine Adjustments. The adjuster must make small changes in the machine settings to correct irregularities that may detract from the envelope's quality.

Machine Adjusters are responsible for setting up, adjusting, troubleshooting and operating folding machines.

- **Rubber Inserts**

The Rubber Inserts are suitable for use as non-slip devices and floor protectors. They can be retrofitted to Knuckle Feet D40 and D80.

Figure 3.2.Rubber

- **Base Plate/Transport Plate**

Base Plate/Transport Plates are stable fastening plates for adjustable feet, castors, ring bolts and other elements. They can be screwed into the core bores in the profile end faces or onto the sides of the profiles.

Figure 3.3. Base Plate/Transport Plate

- **Foot Clamps**

Foot Clamps are used for floor or wall mounting of Knuckle Feet D60 and D80. The fastening set can be used to mount a machine to concrete.

Figure 3.4. Foot Clamps

Adjusting the machine is most beneficial when done in tandem with the correct threading techniques, thread and needle selection for the fabric, and sewing technique being performed. Machine settings alone won't create the perfect project, but they will greatly increase the likelihood that the garment is successful.

Adjustments are an ordinary part of daily work routines and if they are handled properly, can result in higher rates of productivity and efficiency.

The problem is that many equipment adjustments happen at inappropriate times or without the consent of management. Shift changes and other workplace events inevitably lead to adjustments by individual operators and can lead to a disruption of production standards.
It helps to create a system that minimizes unnecessary adjustments and facilitates adjustments that can be quickly repeated time after time. In additional to regular inspections, owners and managers should identify standards for adjustments that occur at specific points in the manufacturing process, including the following equipment adjustment events.

- **Reconfiguration.** It's common for manufacturing equipment to be resized and reconfigured to accommodate changes in the manufacturing process. However, it's

important to make sure that reconfigurations are done to accommodate system wide process modifications rather than personal operator preferences.

- **Machine wear.** Time takes its toll on manufacturing equipment. With each passing day, the equipment you rely on for production is getting a little bit older - and a little less capable of meeting your production standards. Equipment adjustments can compensate for age, as long as they are performed in accordance with the manufacturer's guidelines.
- **Installation.** For most pieces of manufacturing equipment, the installation process consists of a series of adjustments that are necessary to bring the machine into peak working order. These adjustments are often highly technical and done with the assistance of the machine's manufacturer reps - not necessarily by the person who will ultimately be responsible for operating the equipment.
- **Customer specifications.** Some companies routinely adjust their machines to accommodate specific client requests. That shouldn't be a problem unless you fail to accurately document the equipment's standard setting or customer specs for future orders.
- **Change in use.** Another common practice is for manufacturers to use the same piece of equipment to produce multiple products. When the product changes, the equipment needs to be adjusted according to pre-determined standard settings that have been carefully documented by managers and operators.

Operational requirements best practices:-

1. Early involvement by all stakeholders in the process
2. Be clear and precise
3. The simpler the better
4. Make sure the user understands them
5. Avoid unreasonable expectations
6. Every requirement must have a purpose
7. Make sure they are achievable

3.3. Equipment leveling

Keeping everything level is crucial when you are working on machines. In particular, leveling is used on machine tables, rails, and bases.

Accuracy is everything if you are designing products that follow a specific profile. For example, with a machine leveling process, you make sure that all components are precisely aligned and straightened out.

This process occurs during the installation or adjustment of a machine. To achieve optimal geometric relationships, machine tooling operators have standards to follow. To do this, they check alignments using three axes: x-axis, y-axis, and z-axis.

Moreover, operators use a number of tools and approaches to check for alignments and correct errors. This will involve aligning work surfaces with spindles and axes. Through proper alignment, there is little or no room for error in the production of machine parts.

3.3.1. Importance of leveling

Construction and land development make use of leveling. Developers will need to locate elevations so they can level them out before construction.

Leveling is also crucial to check if floors, ceilings, and other surfaces are perfectly horizontal. Skipping the leveling procedure results in poor-quality work, leading to crooked surfaces that are highly vulnerable to earthquake damage.

Machine leveling also uses the same principle. If you are in the business of metalworking, machining, or tooling, precision has an important role to play.

At a machining center, a workpiece needs to be shaped, milled, or ground to fit the application it is used for. For this, every component needs to be in spec so they can perform as intended. When it comes to leveling workpieces, work holding tools are often used.

Machine leveling is also important for preventing damage during an application. An end mill, for instance, will need to be properly perpendicular to the work surface. Otherwise, the work may not turn out accurately, and the machine may get damaged.

Leveling is crucial to manufacturing high-quality machine parts. It is used on automation systems and additive manufacturing facilities. It optimizes CNC machining tools and tooling equipment. All in all, machine leveling involves compliance with quality standards.

3.3.2. Leveling Procedure

You know the basics of machine leveling, it's time we look at the specific steps to take in the process. Here is an overview of how machining tools are leveled for optimal performance and quality:

1. Check the precision level for accuracy before leveling the machine

Prior to leveling a machine, you need to calibrate the precision level (or machinist level) first. To do this, place the level on a different machine.

Let it stay there for about five minutes before checking if the bubble is aligned with the center. Flip it over 180 degrees and check again. If the bubble is off-centered, repeat the process.

After that, check the machine if it is at a height above the coolant pans and conveyors. Don't sit the machine too far above the pains. To ensure stability and prevent excessive coolant splashing, sit the machine low using leveling screws.

2. Move the machine so that all axes are at the center of their stroke

You need to make sure the machine is perfectly balanced. Move it and position the axes at the center of their stroke. This allows for optimal weight distribution and flatness while leveling.

3. Place at least two levels on the machine if possible

Next, you will need to place levels on the ways or linear guides. If possible, use two levels. Place one parallel to the ways and another perpendicular to them.

At this point, you may need to adjust the jackscrews to bring out the levels. Different manufacturers provide different instructions for adjusting, so take time to learn the leveling tools you are using.

4. Move the axes to the positive stroke and then to the minus end stroke

During leveling, move the axes to the positive stroke. After that, move the jack bolts and make sure they are the same as the levels were at the center.

From there, bring the axis back to the minus end stroke and adjust accordingly. As you do so, the levels should go back to the starting point.

5. Check levels of the table and ensure accuracy

Once you are done leveling, check for accuracy using a square. If you are satisfied with the result, touch down all the supports below the magazine, electrical cabinets, and pallet changer.

6. Final Tips for Leveling a Machine

If you look at it closely, the machine leveling procedure is a straightforward process. It only requires experience and the proper tools to get the job done.

To ensure optimal leveling, calibration using a precision level is crucial. This is to ensure that the level is accurate and prevent unwanted errors during the machining process.

In addition, it's important to place the machine at a short distance from the ground. It may not be stable when it's positioned high up. At an elevation, the coolant creates spills as it drops to the pans. To be safe, keep the machine as low as possible. This will also make it easier to manipulate the machine.

It is often best to use two machinist levels instead of one. Place one parallel to the guides and another perpendicular to the guides. Don't forget to adjust the jack screws if you think the machine needs additional leveling.

To make the job easier for you, you can use **leveling feet** to stabilize the machine. This is ideal if you are installing the machine on uneven ground. For applications involving shaft alignment, you may need a quality slotted leveling shim.

Example: - Horizontal CNC machine Leveling Procedure:

1. Calibrate and check the precision level for accuracy before leveling the machine.

NB: Place the level on a somewhat known level surface maybe on another machine. After placing the level and letting the level sit for 5 minutes to get to room and pallet temperature. Then note the position of the bubble, and then rotate the level 180 degrees and make sure the level repeats. If it does not calibrate the level.

2. Next check that the machine is at a height where the coolant pans and conveyors fit under the machine. When leveling a machine lower is always better for a couple reasons. When the machines are sitting on leveling screws the higher up the less stable. Also keeping the machine tool lower prevents excessive splashing of coolant on to the floor through areas between coolant tanks and conveyors.

3. Next move the machine so that all axes are at the center of their stroke. This will balance the weight among all the jack screws for better feel and even weight distribution when leveling.

4. Place two levels if possible on the machine. One parallel with the ways or with the linear guides and one perpendicular with the ways.

Adjust the jack bolts on the machine so that it is level using 3 screws on each side of the machine. Every machine has its tricks to use certain screws to make things easier so this is a general rule of thumb certain screws may bring in the levels much quicker.

3.4. Leveling and alignment task completion

Task Alignment is the capacity to demonstrate a positive relationship between planned tasks and accepted measures of performance. A positive relationship means assigned employees perform tasks at expected performance levels to deliver required results that are lined up with task goals.

Steps to a Proper Machinery Alignment:-

1. **Pre-Alignment**

Gather all applicable tools, such as wrenches, feeler gauges, your favorite Easy Laser system, or dial indicators and consumables such as shims and prepare for the upcoming alignment job.

Research all of the required specifications, or technical specifications, such as the appropriate specifications that the equipment should be aligned to be based on the RPM of the equipment, and any thermal growth issues.

2. **Safety & Work Area Preparation**

Lock-Out/Tag Out the asset. Also, make sure any surrounding equipment that could cause a safety hazard is LOTO as well.

Clean up any corrosion or debris around the equipment that will be aligned. This will ensure a proper visual inspection can take place, and that there will be minimal interference from debris during the alignment process.

Perform a visual inspection of the equipment bases, grout, foundation and mounting bolts. If any of the components appear to be damaged or worn, they must be repaired/replaced before moving forward with the alignment.

Check for Mechanical Looseness in the system. If any looseness exists, the equipment should be repaired before moving on to alignment.

Replace damaged shims if this is not a new installation. Don't jeopardize the asset reliability for a few dollars in shims.

3. **Measure**

Correct for any thermal growth. This may be done through manual calculations or by entering the offset into the Easy Laser equipment.

As-Found measurements should be taken for an existing installation. This will be used to compare the before and after.

Measure & correct machine stress such as pipe stress, and deformed machine bases. This may require additional work such as repairing the base plates or correcting pipework. While this work can add to the job significantly, it will make the alignment process easier, and reduce the likelihood of premature failure.

Check for soft foot using either feeler gauges or your Easy Laser system. Soft foot must be corrected before a meaningful alignment can take place. Soft foot must be corrected to < 0.05mm.

4. **Align**

Using a minimum of 2 measurement points (if using an Easy Laser system, more will be required if using dial indicators), take readings to understand the current angular and offset misalignment.

Make minor adjustments to correct the offsets. Depending on the RPM of the equipment, the acceptable alignment tolerances will vary.

5. **Final Soft foot Check & Alignment**

Once everything appears ok, tighten all bolts to the proper torque specification. Perform a final soft foot and alignment check. This will ensure that nothing moved during the bolt tightening.

6. Document

Documentation is critical in every aspect of the machinery installation process. All installation activities should be documented as it allows for Acceptance Testing, Verification and assists in root cause analysis. Documentation should collect enough of the right data while minimizing unnecessary information.

7. Acceptance & Verification

Acceptance Testing to Standards, regardless of who performs the machinery installation, there should be a 3rd party validation of the installation. This does not have to be a specialized contractor but could be an internal tradesman validating the work of a contractor, or another internal employee. The goal here is not to be punitive, but to ensure that all standards are met, and if not, learn why not and improve the process in the future.

Verification after Break-in/Run in is required even if there was an acceptance test performed, the equipment installation needs to be verified after it has had time to start, run and stop. Any defects in the installation process can be caught at this point, which is still very early on the I-PF curve and corrected to prevent premature failures. This process is very similar to the Acceptance Testing, as the installation is verified against both the standard and the As-Left measurements. Also, various CBM technologies can be used as an additional method to verify the proper installation. For example, ultrasound or vibration can be used to verify that the machinery was aligned properly.

Self-check-3

Directions: Answer all the questions listed below.

Part I: say true or false

1. Machine setup time refers to the period of time that is required to prepare a machine for its next run.

2. Task Alignment is the capacity to demonstrate a positive relationship between planned tasks and accepted measures of performance.

3. Leveling is crucial to check if floors, ceilings, and other surfaces are perfectly horizontal.

4. Machine Adjusters are responsible for setting up, adjusting, troubleshooting and operating folding machines.

5. Purpose of specification is to highlight the necessary information which cannot be obtained from drawing.

Part II: Choose

1. Which one of the following hazard type will at workplace?

A. Safety hazard B. chemical hazard E. none

C. physical hazard D. all

2. What you consider when you set up a machine?

A. workflow B. timber storage E. none

C. tools D. all

3. Which of the following is the last step for machine/equipment alignment?

A. pre-alignment B. measure

C. documentation D. acceptance and verification

Part III: Short answer

1. List the Steps to a Proper Machinery Alignment.

2. What is the use of foot clamp?
3. Define machine leveling.
4. List the machine level procedure.
5. Why we need leveling?

Unit Four: Assure Quality and Clean Up

This unit to provide you the necessary information regarding the following content coverage and topics:

- First-off samples
- Documentation and report
- Clear work area
- Check, clean, oiled, maintain tools and equipment of plant

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:

- Measure first-off samples
- Prepare and complete reports and documentation
- Clear work area and dispose of, reuse or recycle materials
- Check, clean, oiling, maintain and store Plant, tools and equipment.

4.1. First-off samples

First-off means the first time product is produced in conformity with a particular combination of bom and specifications. Any replication, assembly or distribution following a change in bom or specifications shall give rise to first-off copy obligations under this section 8(b). Company shall, upon request, provide msli samples of all company literature which uses product name(s)."

We have business process of First Off Inspection (FOI), that is first component produced in the first operation will undergo through inspection if the all measurements are within the specification then the operation will be continued from remaining quantity of the production order.

First Article Inspection (FAI) is the process of planning, manufacturing, and verifying a production process. A First Article Inspection Report (FAIR) is the document that certifies that each sample was produced and inspected according to the customer's specifications.

In the aerospace and defense industries in the US, most companies conduct AS9102 First Article Inspections. AS9102 is a standard updated by the SAE to emphasize the value of the FAI process, and is a common reporting format for aerospace and defense manufacturers. AS9102 isn't a formal requirement – it is a guidance document that doesn't require certification.

4.2. Documentation and report

Here's how you can create a First Article Inspection Report in five steps.

Step 1: Pre-plan your FAI

Before beginning, gather the documentation needed for your First Article Inspection:

- ✓ Engineering drawings
- ✓ Digital product definition data sets
- ✓ Bill of materials/raw materials list
- ✓ Specifications
- ✓ Manufacturing planning/routing/traveler/work order
- ✓ Source/supplier information

There are three forms in an AS9102 FAIR:

- ✓ Form 1 (part number accountability) - Form 1 identifies the part for the FAI and associated sub-assemblies or detailed parts.
- ✓ Form 2 (Product Accountability) - Form 2 accounts for all material and process specifications, as well as any special processes and functional testing defined as design requirements.
- ✓ Form 3 (Characteristic Accountability) - Form 3 accounts for all product characteristics, including dimensions, tolerances, notes, etc. An inspection drawing or model is required, with all inspection characteristics (defined using CAD annotations) clearly identified with uniquely numbered inspection balloons. The numbers on the balloons must correspond to the characteristic numbers on Form 3.

Step 2: Create an inspection plan

Balloon your part drawing: identify the requirement to be inspected with a balloon number. Prepare your AS9102 forms for the inspection.

- Fill out the AS9102 Form 1 (Part Number Accountability) and Form 2 (Product Accountability) with information from the Bill of Materials and Specifications List.
  - ✓ Document reference location of the balloon
  - ✓ Requirements including units of measure, variable requirements with tolerances
  - ✓ Classifications (Critical, Major, Key)
- Fill out the AS9102 Form 3 (Characteristic Accountability) with dimensions, tolerances, notes, and inspection tools to reduce work at the end of the processtype of tool and the serial number of the tool are often required.

Step 3: Manufacture the part

Build the product and ensure you are documenting processing and inspection results for the requirements during the manufacturing process.

Note: First articles are not necessarily the first part produced, but from the first production run. Learn more about when a first article is required.

Step 4: Collect data

Inspect the part according to the inspection plan created in Step 2.

- ➢ Keep track of calibrated, certified inspection tools so that they are traceable back to the person certified to use the tool to perform the inspections/manufacture accurately. Learn about choosing the right measurement tools for each job.

Step 5: Create report

Enter your measurement result data into AS9102 Form 3.

- ✓ Measured result(s)
- ✓ Serial numbers of the tools used to measure the part
- ✓ Non-conformance information, if any
- ✓ Certificate of Conformance (C of C)
- ✓ Functional Test Report

4.3. Clear work area

Cleaning even if things are not dirty. A regular cleaning schedule prevents things from having the chance to get dirty. Maintaining the workplace in high standard of housekeeping.

- **Reuse of second-hand products**
  - ✓ repairing broken items instead of buying new
  - ✓ designing products to be refillable or reusable
  - ✓ Encouraging consumers to avoid using disposable products
  - ✓ Designing products that use less material to achieve the same purpose

Surface preparation can take the form of chemical or mechanical methods, including the use of solvents, abrasive blasting materials, heat, acids and jets of water. There are also more traditional techniques using hand or power tools.

Surface preparation is the most critical aspect of a coating system's performance, in which coating performance is determined by the coating's ability to adhere to the substrate material. Surface preparation removes uncontrolled impurities like mill scale and grease to create an appropriate coating profile.

Materials used for the construction of concrete formwork range from traditional materials such as Timber, steel, aluminum, and plywood to nontraditional materials such as fiberglass. The systems used can be a combination of two materials. Wood products are the most widely used material for formwork.

- **Reports and documentation: -**A system of documents being applied to let you know whether something in your workplace should either be operated with extra care or left alone.
- **Purposes of Tag-Out Bill**
  - ✓ To provide a procedure to prevent the improper operation of a component, piece of equipment, a system, or portion of a system that is isolated or in an abnormal condition.
  - ✓ To provide a procedure in operating an instrument that is unreliable or not in normal operation condition.
  - ✓ To provide separate procedures when accomplishing certain planned maintenance system

4.4. Check, clean, oiled, maintain tools and equipment of plant

A. Cleaning

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)
- Post-rinse
- Inspect
- Sanitize
- Dry
- Verification.

B. Lubricating

Lubricating your tools and equipment can also help to minimize corrosion of metal surfaces, keep contaminants out of the system as well as seal and protect the components.

Lubrication is crucial to maintaining the integrity and reliability of your tools. As such, equipment lubrication should be carried out regularly and with care.

Lubrication is essential for keeping your tools and equipment working in top condition for a number of reasons. The primary reasons being:

1. Reducing Friction

The use of a lubricant reduces the heat generated when two surfaces are in motion. It smoothen the process by creating a film between the two surfaces which in turn reduces friction and improves performance and efficiency.

2. Creating Film between Surfaces

Lubricants control friction and wear on your tools and equipment by forming a film that separates contacting surfaces which consequently reduces energy consumption and prolongs machine life.

3. Protecting Against Corrosion

Proper lubrication through regular, preventative maintenance will provide a range of benefits to ensure reliability of your tools and equipment. Among these advantages is the protection from causes of corrosion, including water and rust.

4. Preventing Equipment Wear

To prevent wear, lubricants are specially formulated to form a low-friction, protective layer on the wear surface ultimately creating a barrier between the layers of metal on your tools and equipment.

5. Repel Water on Tools

Designed for high temperatures, silicone is the perfect solution for keeping your power tools working in top condition and repels water.

6. Cooling by Dissipating Heat from Equipment Surfaces

The load-carrying or power-transmitting capacity of many machine parts if decisively affected by the maximum temperatures that occur in the source of frictional heat. Lubricants cool by dissipating heat from equipment surfaces.

7. **Lubrication Ensures Machine Reliability**

Lubrication practices have a direct effect on the reliability of your tools and equipment. When a lubricant is working effectively in a machine with no chemical degradation and with limited contamination within it, wear will be reduced and reliability will be improved.

- Prepare a standard checklist**: -** Checklist should be very detailed and stringent based on the set of standard values for inspection implement a periodic clean-up schedule; and an award and sanction scheme.

Evaluate workstations according to the standard checklist.

Example

- ✓ Is flooring clear of obstacles and spilled substances
- ✓ Are aisles, exits and traffic areas clear?
- ✓ Are walls clear and clean?
- ✓ Are tools stored in proper storage areas when not in use?
- ✓ Are defective hand and power tools/attachments removed from storage area for repair?

Self-check-4

Directions: Answer all the questions listed below.

Part I: <u>say true or false</u>

1. First Article Inspection (FAI) is the process of planning, manufacturing, and verifying a production process.

2. Lubrication is crucial to maintaining the integrity and reliability of your tools.

3. A regular cleaning schedule prevents things from having the chance to get dirty.

4. Check, clean, oiled, maintain tools and equipment of plant is not necessary.

5. Lubrication Ensures Machine Reliability.

Part II: Choose

1. Why you lubricate a machine or equipment?

A. to reducing friction B. to creating film between surfaces E. none

C. to repel water on tools D. all

2. Cleaning principle includes

A. dry B. wash C. sanitize D. verification E .all

3. What is the Purposes of Tag-Out Bill?

A.To provide a procedure to prevent the improper operation of a component

B.To provide a procedure in operating an instrument that is unreliable or not in normal operation condition.

C. To provide separate procedures when accomplishing certain planned maintenance system

D. all

4. When you Evaluate workstations according to the standard checklist, what things are considered?

A. Is flooring clear of obstacles and spilled substances

B. Are aisles, exits and traffic areas clear?

C. Are walls clear and clean?

D. all

E. none

Part III: Short answer

1. What principle you follow to clean workplace?

2. How do you evaluate workstation?

3. The primary purposes of lubrication are?

4. What are the First Article Inspection Report steps?

5. Define First-off?