TRADE OF

Industrial Insulation

PHASE 2

Module 1

Sheet Metal and Insulation Fundamentals

UNIT: 3

Measuring, Marking & Cutting Out

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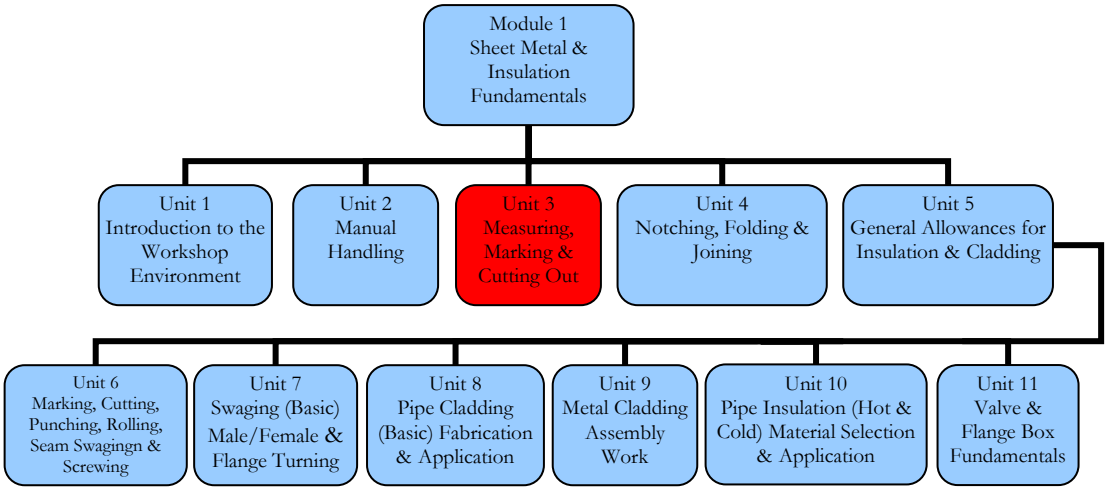
Unit Objective

By the end of this unit **each apprentice** will be able to:

- Identify and name a selection of machinery.
- State the use of each tool and machine.
- Identify the hazards associated with each piece of equipment.
- Mark out and cut a sheet metal blank.
- De-burr a sheet metal blank
- Check measurements using a steel rule.



Introduction

One of the characteristics of the skilled worker is the way in which he selects and uses his tools. For this reason, it is essential that you know how to select and use both hand and machine tools correctly. If you do this you will save time and the work will be much easier. When you have selected the correct tool for the correct operation you have taken the first step in becoming a successful craftsman.

1.0 Hand Tools

Key Learning Points

- Location and identification of tools, equipment and machinery.
- Description of the application of the tools, equipment and machinery.
- Interpretation of tool, machinery and equipment manuals.

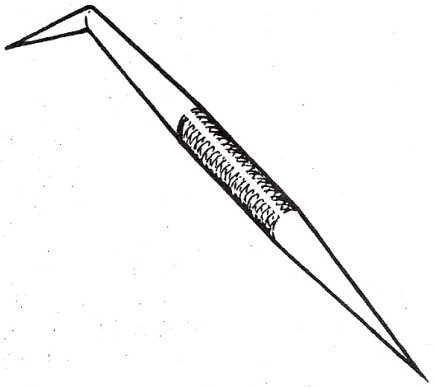
Sheet metal hand tools are used to scribe or measure lines, perform layout operations and shape or cut metals. Some of the hand tools in the following notes actually perform these operations while others, such as stakes and punches, serve as aids in performing them.

It is important to keep tools in good shape. Avoid tools going rusty by giving steel tools an occasional oiling. Tools with a sharp point should be stored carefully.

1.1 Marking Out Tools

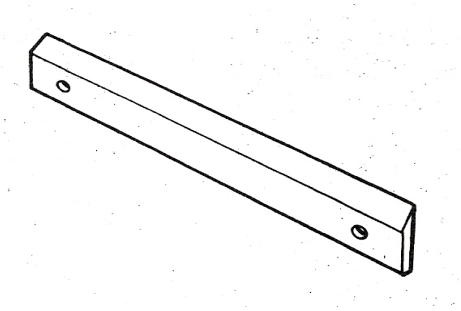
Scriber

This is used to mark lines on metal. It can be used in conjunction with a straight edge and square.



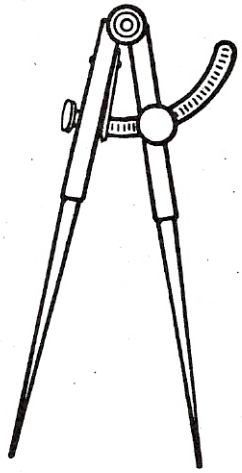
Straight Edge

The Straight Edge is used as a guide for a scriber or pencil when marking or drawing a straight between two points. It is also used in conjunction with square to draw lines at right angles.



Dividers

This is made with each straight leg tapered to a needle point. Dividers are manufactured in various sizes and types and are used to space off equal distances, to divide lines into equal parts and to scribe arcs and circles. Spring loaded screw dividers are also available. Supplied in lengths from 150mm to 500mm. Spring dividers are also available in sizes from 75mm to 300mm.

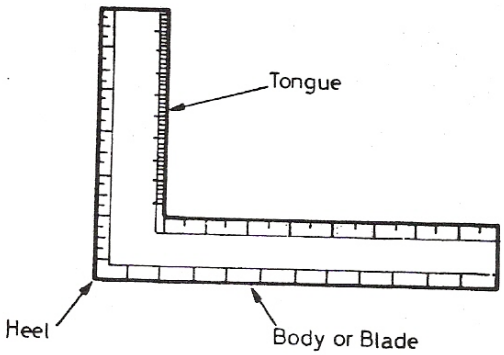


Steel Square

The flat Steel Square is used to layout right angles (90°) and can also be used as a scale. It is an invaluable tool for accurate layout work in pattern drafting.

The long arm is known as the body or blade, the short arm is known as the heel or tongue.

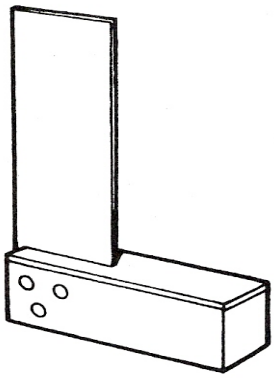
These squares come in various sizes.



Steel Try Square

It is used for marking and checking right angles (90°).

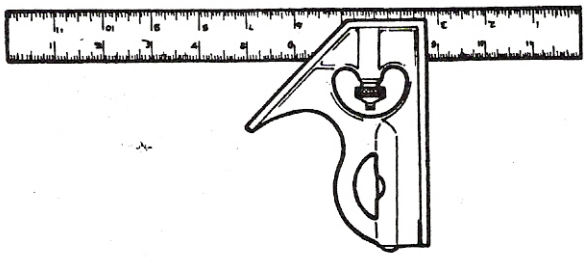
These squares come in various sizes from 75mm to 300mm.



Combination Square

This is one of the most useful and convenient tools for laying out small work. It is used as a square for measuring or laying out 90° or 45° angles.

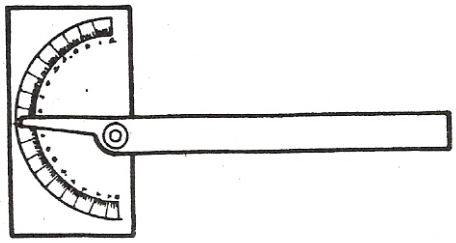
A spirit level is mounted in the stock. Available in 300mm lengths.



Protractor

This is a device for measuring and laying out angles from the edge of the work. This protractor consists of a head and a movable blade.

The head of the protractor has a semicircular scale graduated from zero to 180°.

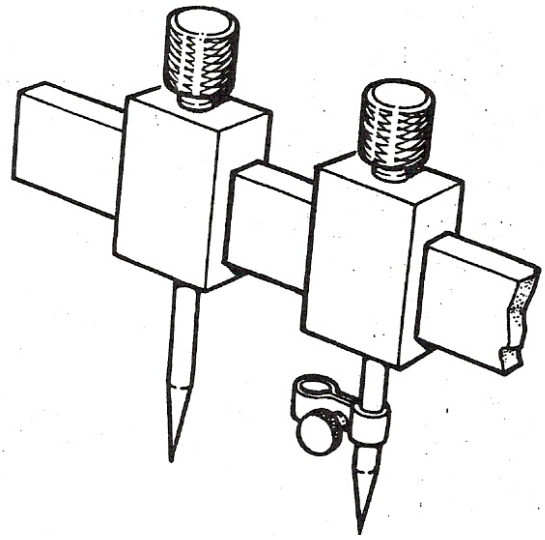


Trammel Points

These are used for scribing large arcs and circles.

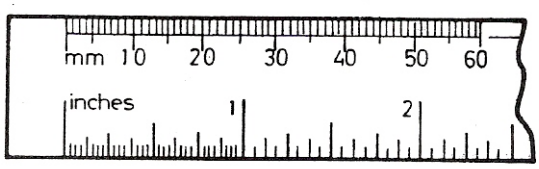
They are manufactured in various types with two straight, removable legs tapered to needle points and attached to separated heads or holders.

The heads or holders slide on wood or steel beams and are held in place by thumb screws. Either of the points can be removed and often one point has adjustment for fine settings. A special clamp for a pencil can be attached to one of the points.



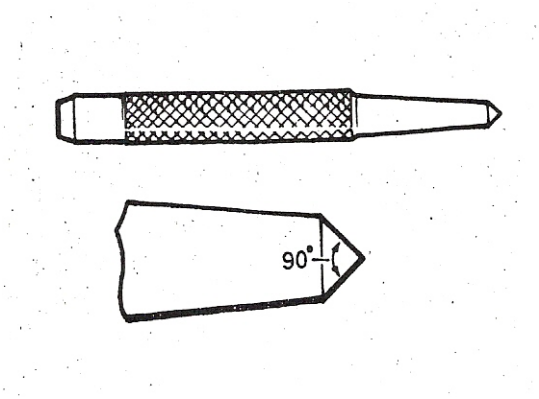
Steel Rule

Steel rules are manufactured in a variety of types and lengths; each of which is designed for measuring or laying out different work. Available in lengths from 100mm to 1000mm.



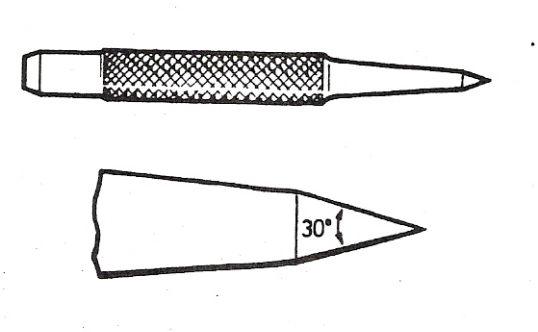
Centre Punch

Similar in design to the prick punch except that the tapered point is ground to an angle of 90° included. They are available in various shapes and sizes and are used for locating centres for drilling etc.



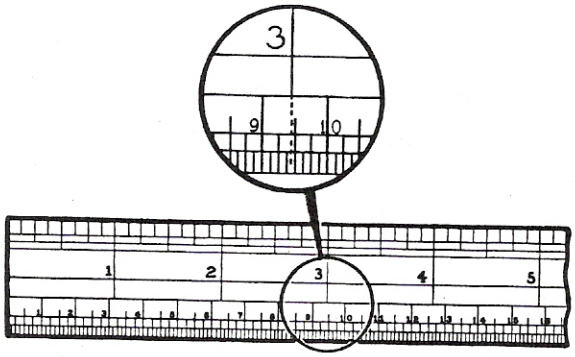
Prick Punches

Prick Punches are made of tool steel and having a tapered point ground to approximately 30° included angle. These punches are used for making small dents or indentations and/or establishing points for dividers and trammel points.



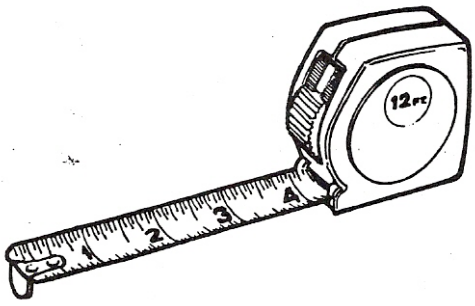
Steel Circumference Rule

This is used much like the common rule. It is invaluable for laying out patterns. It is available in metric or imperial graduations. Its length is 24" or 600mm depending on the type. The purpose of this rule is for finding the circumference of cylinders and for angular measurement.



Tape Rule

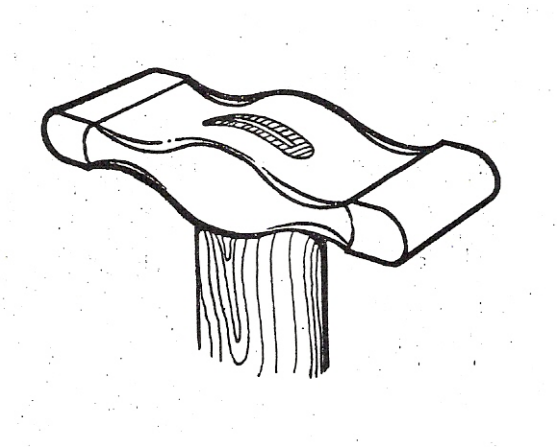
It is very popular for measuring and laying out large jobs. Available in various lengths,



1.2 Hammers and Mallets

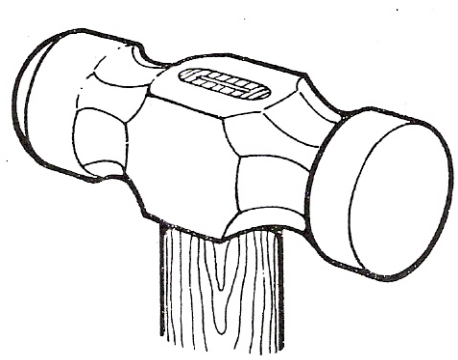
Stretching Hammer

This is used for stretching edges and flanges on curved work. It is normally used in conjunction with a stake.



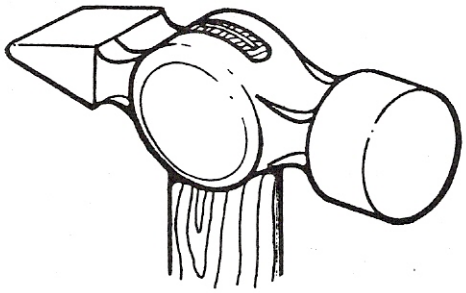
Planishing Hammer

The principal purpose of the Planishing Hammer is for smoothing and finalising a surface after it has been roughed out to the required shape.



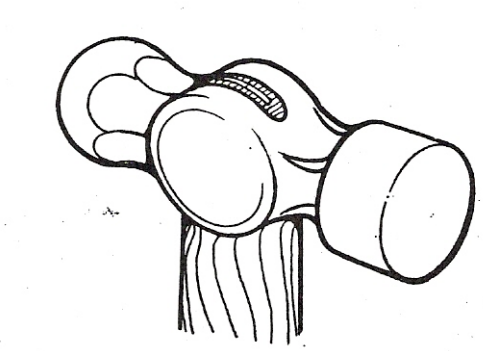
Cross Pein Hammer

This is used by the Industrial insulator for general use in the metal shop and on site.



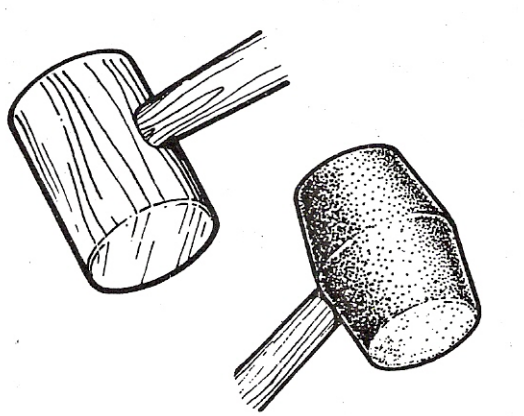
Engineers Ball Pein

This is used for striking chisels, punches, rivets etc. And for general engineering use.



Boxwood and Rubber Mallets

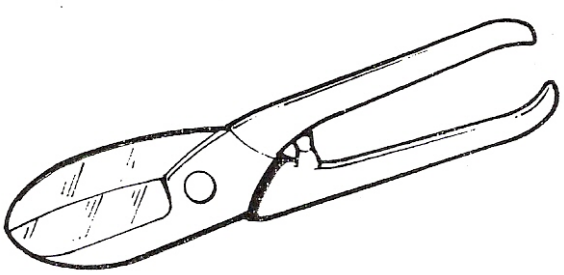
These mallets can be used on mild steel, copper or aluminium to prevent marring the metal.



1.3 Cutting Tools

Straight Snips

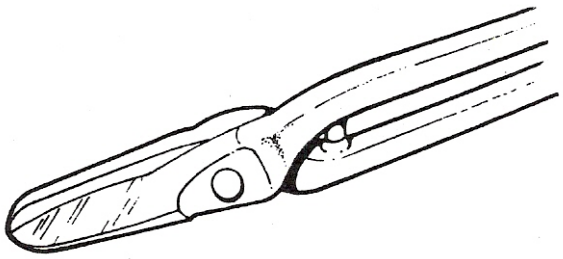
These snips are used for straight line cutting. They are available in many different sizes. Available from 200mm to 350mm long.



Combination Snips

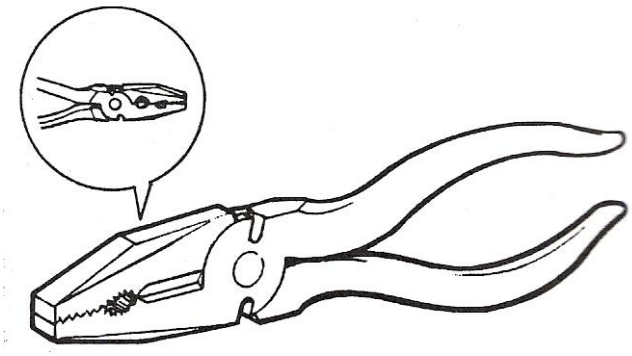
These snips are used to cut straight and irregular lines and curves. These are the snips used most commonly by the industrial insulator. They are available in the same sizes and capacities as straight snips and are also available for right or left hand use.

Spring loaded snips known as aviation snips are very good for cutting light metal and for notching work.



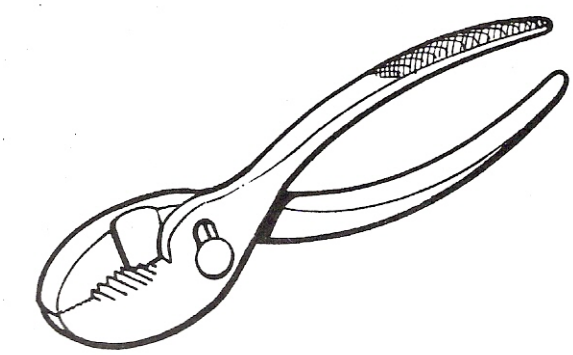
Side Cutting Pliers

These pliers have flat jaws grooved to hold the work, and are sharpened to cut light wire.



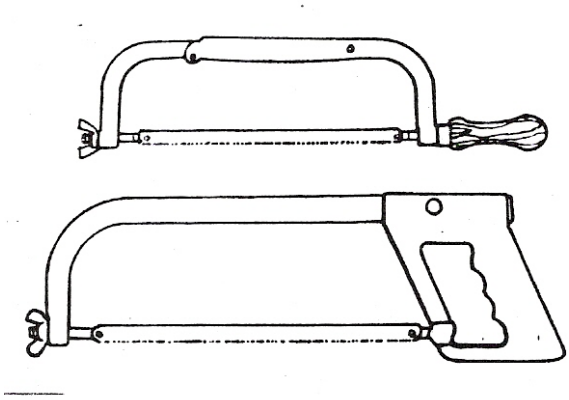
Combination Pliers

These are used for holding, cutting and bending work. The pliers are so constructed that the jaws can be adjusted for holding different sizes of work.



Hacksaw

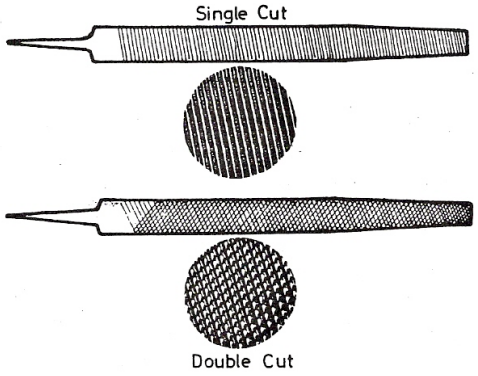
The Hack Saw is used for cutting materials by hand. It consists of a renewable hardened steel saw blade fitted into an adjustable frame, which is usually provided with a screw adjustment for controlling the tension of the blade. It is necessary to have both junior and senior hack saws in your tool kit.



1.4 Files

There are many shapes and sizes of files available with various grades of cut.

Files are used to remove burrs from sheets of metal, to straighten uneven edges and for various other operations that require a small amount of metal to be removed. They should always be used with a handle. Common types used by the industrial insulator are: flat, square, round, half-round.

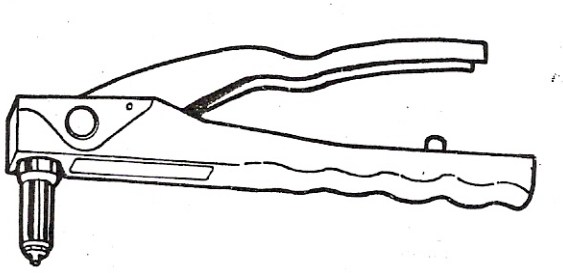


1.5 Pop Riveting Guns

"Pop" Riveting Guns are used extensively with "pop" rivets for the assembly of light fabrications and are particularly useful for the assembly of metal cladding where access is restricted to one side of the work only. There are three different types available: hand "pop" gun, lazy tongs and pneumatic (air).

Hand "Pop" Gun

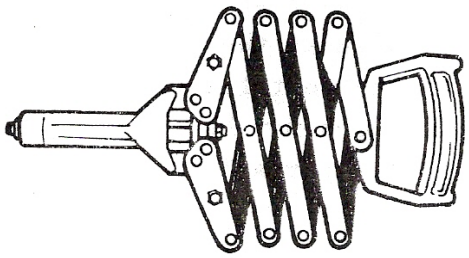
Riveting in confined spaces requires the use of a hand "pop" gun. These are unsuitable for larger dimensions of rivets, due to the reduced amount of leverage available.



Lazy Tongs

Lazy Tongs are used for the larger diameters of rivets, where sufficient working space is available to permit operation of the tool.

The construction of the tool permits a moderate pressure on the handle to provide a strong pulling force on the rivet mandrel.



Note: Always refer to and study the manufacturer's manuals for the safe operating procedures before using any tools or equipment.

2.0 Workshop Machinery

Key Learning Points

- Locate and identify lubrication points on all machines and equipment.
- Identify safety hazards related to tools and equipment in the workplace.
- Work planning and communication. Safe operation and use of power guillotine.

The flat sheet of metal with the layout on it is fabricated through a number of different operations. These steps will vary from job to job. Some of the more common operations are: cutting, folding / bending, edging, making seams, forming, crimping and swaging.

A skilled sheet metal worker is a worker who correctly selects the proper hand and the machine tools to do the job.

2.1 Safety in the Workshop

Always wear the appropriate protection at all times i.e.

- Goggles when grinding and drilling
- Safety shoes and overalls at all times; gloves when needed; also ear protection

Good housekeeping is an important element in accident prevention. Good housekeeping begins with planning ahead. Materials should be neatly stacked and any spillages of oil or grease should be cleaned up immediately.

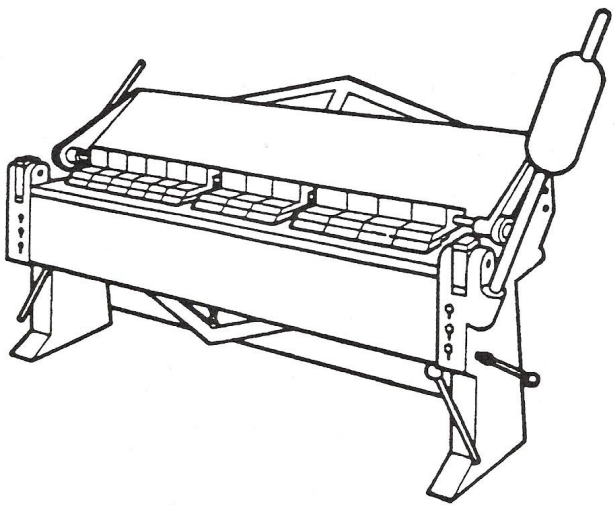
Each person should pay attention to his own work area. A neat work area reflects a worker's approach to his work and equipment.

The apprentice should always think safety. There are too many hazards in the work area to list. The apprentice should cultivate a positive attitude towards safe working habits. Planning your work properly and communicating with others while operating machinery is vital in maintaining a safe work environment.

2.2 The Box and Pan Folding Machine

This type of machine, while suitable for all types of bending operations, has special provision for folding pans, trays or boxes. No rods, wires or metal beyond the capacity of the machine should be bent on this machine.

1. The most important points when using this machine is to set the machine to suit the metal thickness being folded.
2. Never bend beyond the capacity of the machine. This strains the machine and will shorten the life-span and quality of the folders.
3. Never bend round bar etc. in the machine.
4. When removing or inserting the fingers (of machine) take care not to get your own hand or fingers squashed.



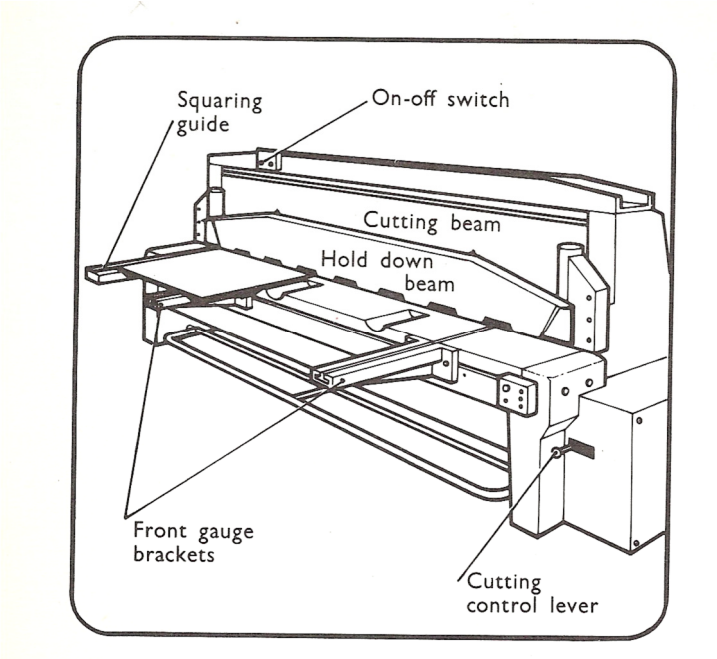
Refer to Module 1 - unit 4 – section 3.2

Hazards:

- Beware of swinging counter-balance weights and bottom leaf (bed) of machine.
- Use the proper manual handling techniques when using this machine or moving metal in or out of benders. This machine can put great strain on your back.
- Refer to module 1-unit 2-manual handling.
- Beware of crushing of fingers when using machine and especially when changing the blades.

2.3 The Guillotine

The principle of shearing is similar to punching except that the area being sheared is a relatively small continuous section, starting at one end of the sheet and ending at the other. A hold-down clamping stop holds the sheet rigid while the blade of the guillotine shears through the sheet.



An important factor in the production of a good cut edge is the clearance between the blades as well as the sharpness of the blade edges. Some machines have provision for altering the blade clearance to suit the thickness of sheet being cut out, usually the clearance is set at manufacture and checked periodically. A reasonable guide is 0.1 mm increase in clearance for every 1 mm of sheet thickness. The shearing capacity of the guillotine should be more than the shearing strength of the material being cut.

Safety Issues

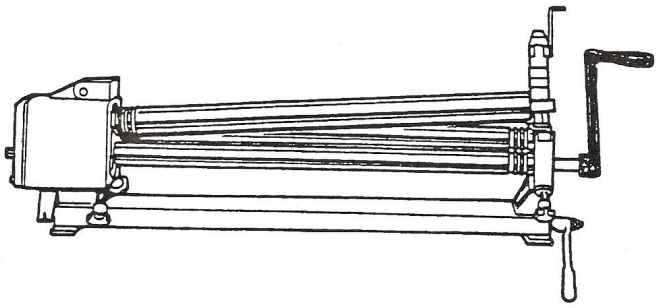
5. Ensure all guards are in place before starting machine.
6. Ensure prescribed personal protection is worn - Overalls, safety boots and gloves.
7. Before using the guillotine its maximum shearing capacity must be understood.
8. Gloves must be worn if there are sharp edges on metal.
9. Scrap behind machine to be cleared up daily and properly disposed of.

2.4 The Bending Rolls

The two types of bending rolls used in sheet metal are the plain bending and slip bending rolls. These machines are for curving sheet metal. On the slip bending rolls the upper roll can be released and this facilitates the removal of the work piece. This can't be done on plain rolls. There are power and manually operated types available.

Hazards:

- Loose clothing e.g. cuffs may get caught up in machine. Always wear tight-fitting overall.
- Exercise caution as fingers may also get caught in the machine.



2.5 Lubricating Machines

It is vitally important to lubricate all machines on a regular basis. A lubricant is used for a number of different reasons:

1. To reduce friction.
2. To prevent wear.
3. To prevent adhesion.
4. To aid in distributing the load.
5. To cool moving parts.
6. To prevent corrosion.

The range of materials used as lubricants has greatly broadened over the years so that in addition to oils and greases many plastics and solids and even gases are now being applied in this role. Because of the wide selection of lubricating materials available, great care is advisable in choosing the right material and the correct method of application. Always refer to the manufacturer's manuals regarding the type of lubricant to use, the correct method of application and the frequency of application.

Note: Always refer to the equipment manuals for safe operating procedures.

3.0 Measurements

Key Learning Points

- Metric system: units of length, mass and force.
- Angle and straight line bisection.

In science, **measurement** is the process of obtaining the magnitude of a quantity, such as length or mass, relative to a unit of measurement, such as a meter or a kilogram. The term can also be used to refer to the result obtained after performing the process.

3.1 SI Units of Measurement

The international system of units consists of a set of units together with a set of prefixes. The units of SI can be divided into two subsets. There are the seven base units. Each of these base units is dimensionally independent. From these seven base units several other units are derived. In addition to the SI units there are also a set of non-SI units accepted for use with SI.

A prefix may be added to units to produce a multiple of the original unit. All multiples are integer powers of ten. For example, "kilo" denotes a multiple of a thousand and "milli" denotes a multiple of a thousandth hence there are one thousand millimetres to the meter and one thousand meters to the kilometre. The prefixes are never combined: a millionth of a kilogram is a milligram not a micro kilogram.

SI Units

Length metre	(m)
Mass kilogramme	(kg)
Volume cubic metre	(m3)
Torque Newton metre	(Nm)

Force Newton	(N)
Temperature Kelvin	(K)
Angle Degrees	(example 90°)

3.2 The Imperial System

Imperial units or the imperial system is a system of units, first defined in the British Weights and Measures Act of 1824, later refined (until 1959) and reduced. By the late 20th century many countries had officially adopted the metric system as their main system of measurement. However, the use of imperial units does persist, with some countries, such as the United Kingdom, Ireland, and Canada, having laws permitting and even mandating them.

12 inches = 1 foot	written as 12" or 1' - 0"
24 inches = 2 feet	written as 24" or 2' - 0"
36 inches = 3 feet	written as 36" or 3' - 0"
42 inches = 3½ feet	written as 42" or 3' - 6"

1 inch = 25.4mm

12 inches = 304.8mm

39.37 inches = 1000mm = 1 meter

3.3 The Metric System

The metric system is an international decimalised system of measurement, first adopted by France in 1791, is the common system of measuring units used by most of the world. It exists in several variations, with different choices of fundamental units, though the choice of base units does not affect its day-to-day use. Over the last two centuries, different variants have been considered the metric system. Since the 1960s the International System of Units ("Système International d'Unités" in French, hence "SI") has been the internationally recognised standard metric system.

The basic unit of length is the metre (m). For small units of length the millimetre (mm) is used. There are 1000 millimetres (mm) in a 1 metre (m). The kilometer (km) is used to measure long distances. 1000 metres (m) = 1 kilometre (km).

10 millimetres (mm)	= 1 centimetre (cm)
10 centimetres	= 1 decimetre (dm) = 100 millimetres
10 decimetres	= 1 meter (m) = 1000 millimetres

3.4 Angle and Straight Line Bisection

Refer to Module 2 – unit1 – section 3.0

4.0 Metals

Key Learning Points

- Metal type, identification and thickness.

Not only is it essential for the industrial insulation apprentice to know the tools and machines of his trade and how to use them safely, but it is also important to know the materials equally well. A finished job may look very well, but it may be useless if the wrong material were used. It is extremely important to know the correct material for a given job.

When you have read through these notes you will learn about the various types of sheet metal, their sizes and characteristics and where they are used. The two main groups are ferrous (steel) and non-ferrous, each group including several types of metal for different uses.

4.1 Sheet Steels

Steel is the most commonly used material in the sheet metal shop. This is because it is relatively cheap and is available in alloys and with special coatings for various uses. The most commonly used types of sheet steels are mild steel, galvanised, stainless and tin plate. Mild steel comes in two forms: hot-rolled commonly known as black iron, and cold-rolled commonly referred to as mild steel. Black iron is a cheaper variety and tends to be softer than mild steel. These two in effect would be classified as plain steel sheets. Black iron looks bluish-black near the sides of the sheet and may have a silvery appearance near the centre, whereby mild steel sheets have a silver grey appearance and are of better quality overall.

4.2 Coated and Solid Sheets

Sheet steel may be coated or uncoated (solid). A commonly used coated sheets is galvanised. Stainless steel is the most commonly used solid sheet.

Plain sheets are seldom used because of their susceptibility to rust and corrosion. Non-ferrous sheets, which we will discuss later, are classified as solid sheets. The apprentice should learn to identify solid and coated sheets by sight and by manufacturer's markings and specifications to ensure that he is using the correct material for the job. The coating on galvanised sheets and is for corrosion resistance. If these metals were used on a job which required welded seams, the product would burn off the protective coating. On the other hand stainless steel may be safely welded because it is resistant to corrosion and has no coating.

4.3 Galvanised Sheet Metal

It is a sheet steel coated with zinc. In the most common one, the steel is dipped in an acid both for cleaning and then is dipped into the zinc. In the other case the coating is done by an electroplating process. Electroplated sheets are recognised by their even grey colour and are mainly used for their ability to resist corrosion.

Galvanised mild steel can be easily recognised by its typical spangled appearance. These spangles are from the molten zinc as it cools on the sheet. Since galvanised is a coated sheet, its corrosion resistance is dependent upon the condition of the zinc coating. Zinc is highly resistant to corrosion and, as long as it remains intact on the sheet, galvanised mild steel will have high corrosion resistance. A good quality galvanised sheet should last 5-10 years in constant contact with water, but if the surface is damaged in any way by welding, grinding or bending the steel will be exposed and the sheet will rust through very quickly.

Of all the sheet metals, galvanised is one of the least expensive and is probably the most commonly used. Air conditioning duct work is made almost entirely of galvanised sheet metal. Roof flashings and gutters are made from galvanised metal, so also are tanks, signs, boxes and cladding.

Good quality galvanised metal can be bent and straightened several times without the zinc peeling away.

Galvanised metal can be obtained in 2000 x 1000 mm and 2500 x 1250 mm sheets. It is also available in roll form.

4.4 Stainless Steel

Stainless steel is one of the most important materials within industry. As the name indicates, stainless steel has high resistance to foreign or corrosive elements. It is also very easily cleaned. For these reasons, it is widely used in residential kitchens, institutional and restaurant kitchens, for hoods, sinks, splash backs etc. It is also widely used in the dairy industry for milk storage tanks and containers. It is also used for metal cladding where appearance and fire resistance are very important.

Types of Stainless Steeln

An important point to remember is that the term “Stainless Steel” refers to a general class of metals rather than to one particular type. There are a number of different types of stainless steels available.

Each type of stainless steel is designed to meet a particular need. Some are extremely resistant to corrosion, while others are not. Some will resist certain chemicals better than others. Others are designed for special qualities i.e. weld ability, ease of machining and work hardening. A small change in one of the alloys will change the characteristics of the steel.

Stainless steel is classed by type number e.g. type 304. There are a very big number of various grades of stainless steel available, so the industrial insulator would have to look in a handbook to find the type of stainless steel recommended for a specific use. Type 304 is used for catering equipment, containers, tankers, cladding etc. where corrosion is of a mild nature. Type 316 would be used to hold highly corrosive chemicals.

Stainless steel can be designated by a certain type of finish i.e. dull finish, mirror finish etc. The cost of stainless steel is high, running at several times the cost of galvanised mild steel. However in applications where galvanised may last only 5 years, stainless steel will last indefinitely.

4.5 Non-Ferrous Sheet Metals

Non-ferrous metals are those which have no iron or steel content such as copper, aluminium, lead and zinc. The most common non-ferrous metals used in the industrial insulation shop is aluminium – both plain and stucco finish.

Copper

This is a solid sheet easily recognised by its reddish colour.

The great advantage of copper is its high resistance to corrosion. There are many examples of copper roofs on churches and buildings that were installed in the middle ages and still in good condition. Another desirable feature of copper is its beauty.

Copper sheet is very expensive. The greatest use of copper today is in architectural sheet metal work. It is used extensively for high quality roofing, gutter, downpipes, roof flashings and hoods.

Copper sheeting is available in both hot and cold rolled. Cold rolled sheets are sheets that have been through a final process of running through finishing rolls. This gives the metal a smooth finish and work hardens it to a half-hardened condition.

Hot rolled copper is copper that has only the hot rolled process and has not been rolled when cold. It does not have the shiny appearance of cold rolled copper. It is used when the metal will be subjected to stretching when it is formed, since it is soft enough to take severe forming. As it is being formed it becomes work-hardened and approaches the hardness of cold rolled copper. Copper that has been work-hardened can be annealed by heating to a cherry red and then cooling in water or leaving to cool in the open air.

Aluminium

The main properties of aluminium are its light weight, corrosion resistance and appearance. Sheet aluminium weighs approximately one-third as much as sheet steel and is just as strong. For this reason aluminium is used instead of steel for such items as exposed ductwork, gutters etc. where appearance, corrosion, resistance and ease of handling are more important factors than economy.

Pure aluminium is too soft to hold a permanent shape in sheet form so the sheets are manufactured as an alloy. Alloying means that one or more metals are added to the pure aluminium to increase its strength and hardness. Some of the more common alloying metals are manganese, copper, chromium, silicon and magnesium. Very small quantities of these metals are required to give the desired properties. In fact most alloys for sheet metal are almost pure aluminium. Sheets are available in plain, stucco or embossed finishes for the cladding industry.

Lead

In sheet form it has a number of uses, shower pans, flashings, tanks for highly corrosive materials and radiation shields are some of the major applications. The use of sheet lead, for radiation shielding is increasing because of the rapid development in the uses of atomic energy. Lead has proved to be one of the best materials for shielding workers from radiation. In atomic energy plants, whole rooms are lined with sheet lead for this purpose.

The chemical and physical characteristics of lead sheet make it very useful for industry. For example, it is durable and has high resistance to corrosion from most acids and from exposure to air. It is very soft and easy to work. Lead is therefore commonly used on roof flashings on both corrugated and tiled roofs where it can be adapted by hand to contours of the roof.

Zinc

Sheet zinc is highly resistant to corrosion and is used in some instances where galvanised steel cannot provide adequate resistance. Compared to other metals, zinc is rather brittle so care must be taken while bending it. Zinc sheets are usually ordered by specifying decimal parts of an inch for thickness.

4.6 Properties of Metal

Hardness:

This is the property of a metal to resist penetration or scratching.

Malleability:

This indicates the extent to which a metal can be extended in all directions by hammering or rolling without causing the material to crack. Metals are usually more malleable when hot than when cold, therefore it is usual to heat them when forging. Gold is the most malleable metal and may be beaten into very thin sheets.

Ductility:

The degree to which a metal may be expanded in the direction of its length. Ductile metals are easily hammered to shape and will yield to pressure. Ductile metals are used for wire drawing and tubes.

Conductivity:

Can be divided into two types: thermal and electrical.

Thermal Conductivity (lambda or k) is a measure of how well heat will flow though a material. Copper is an example of a material with good thermal conductivity and so is aluminium. These are used to make saucepans where we want heat to be conducted quickly. Materials which do not conduct heat well are called thermal insulators. Thermal insulation is used to slow down heat loss in homes (e.g. fibre glass in roof spaces, plastic foams in cavity walls). Heat always flows from hot to cold.

Electrical Conductivity is a measure of how well electricity will flow through the material. For a material to have good electrical conductivity it must have low resistance (e.g. copper). Some materials are poor conductors and so have a high resistance these are called insulators (e.g. polythene, rubber, and ceramics).

Fusibility:

All metals with the exception of mercury are solid at room temperature.

They are all capable of being melted by heating. Fusibility is the relative ease with which they may be melted.

Elasticity:

This property enables a metal to return to its original shape after external forces which cause distortion are removed. If the force causing distortion is increased without limit, a point is reached when the metal fails to regain its original shape and this point is called the 'elastic limit'.

Brittleness:

The brittleness of a material refers to sudden shattering. Some materials break suddenly in contrast to materials that are ductile and stretch before breaking. Materials that are brittle show only slight permanent distortion before breaking. They are said to have a low resistance to shock.

Toughness:

Toughness is a commonly used term, but it actually has a very specific meaning. A tough material is resistant to permanent deformation, and at the same time is resistant to breaking after permanent deformation is begun. This means that either a slow or a sudden stress can be applied to a tough material, and this stress can be continuous or frequent. Also, it will deform before it breaks.

5.0 Cutting a Sheet Metal Blank

Key Learning Points

- Measuring and marking out various types of sheet metal using a steel rule, scriber, 'L' square and straight edge.
- Drawing symbols, first and third angle projection, orthographic, free hand sketches on grid paper.
- De-burring sharp edges.
- Dimension checking ± 1mm using rule.
- Vernier callipers operation and reading. Measurement of material thickness using the vernier callipers.

Many experienced workers do many of their layouts directly onto metal. However, for an apprentice it is better to make more difficult layouts on paper so mistakes won't be made thus avoiding costly errors.

5.1 Job Planning & Preparation

Job planning is important prior to starting any task. The drawing should first be studied and understood. The drawing can initially be used to calculate the material requirement for the component to be manufactured. The work piece is marked out using the dimensions and datums as specified on the drawing. A basic level of mathematics is required such as addition, subtraction, multiplication, division, fractions, decimals and percentages.

One of the first steps in preparing to layout a pattern on metal is to square the bottom left hand side of the piece of material. A steel square may be used for this purpose, or a sheet maybe squared using the squaring arm on the guillotine. The next step is to ensure that the sheet lies perfectly flat on the bench as a sheet that is not flat will cause measurements to be inaccurate.

5.2 Drawing Symbols and Orthographic Projections

The drawing is used to convey certain information to the industrial insulator, helping him or her to visualize the shape description and size of a metal part. The ability to build or to form a mental picture of the metal part before it exists is essential. Before an apprentice can read and interpret a drawing, he or she must be able to understand and to interpret correctly the meaning of drawing symbols and different angles of orthographic projections used on different drawings.

Refer to Module 2 – Unit 2 – Orthographic projections

5.3 Marking Out

The measurements for the blank to be cut should be taken from the bottom of the sheet and from a squared up line at the left hand side of the sheet. This practice minimizes the waste of material when cutting out patterns. The tools required to mark out a pattern on sheet metal are the steel rule, scriber, circumference square and a straight edge. Once the apprentice has completed the marking out process the pattern or blank can then be cut out using a guillotine or hand shears.

Refer to section above - 1.1 Marking Out Tools

5.4 Cutting

Refer to Module 1 – Unit 3 – section 2.3 – The Guillotine

5.5 De-Burring

After the material has been cut on the guillotine, an edge or burr may be left on the pattern. This edge or burr is a raised section of metal which needs to be removed for safety reasons. A file or de-burring tool can be used to remove this edge.

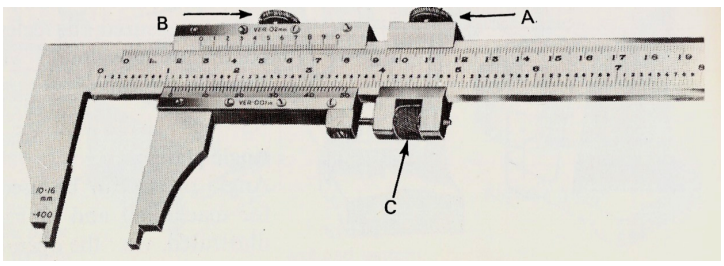
Refer to section 1.4 - Files

5.6 Checking Measurements

Using a steel rule, folding rule or a tape rule, check the measurements of the blank piece of material you have cut. Position the start of the rule on the left hand side of the piece and measure across to the right hand edge. Repeat the same procedure for measuring from the bottom edge to the top edge. Record these measurements and refer back to the drawing to ensure they correspond to the measurements on the drawing. The measurements you have recorded should be within the tolerance specified on the drawing and in general should be ± 1mm.

5.7 Vernier Callipers

Named after its inventor, the vernier scale is incorporated in many measuring instruments, the most commonly used of which is the sliding caliper gauge. It can be used for taking both internal and external measurements. These gauges are made from fine quality alloy steels and are very accurately finished.



When measuring an object externally or the thickness of a particular material, the locking screws A and B are both slackened off and the sliding jaw assembly is moved along, almost onto the object. Locking-screw A is tightened down and then, by turning the knurled screw C, the jaws are gently closed on to the surfaces without putting any pressure on them. Locking screw B is then tightened down and the calipers removed from the work for reading.

The jaw tips are stepped and rounded on the outsides so that internal measurements can be taken and to whatever reading is obtained, the widths of the jaws must be added. This measurement is found engraved on the jaw face for reference.

Reading the Vernier Callipers

In the picture above, we see part of the caliper main scale is divided into centimeters and milimetres. The actual length of the vernier scale is 49mm and this length is divided into 50 parts. Each division of the vernier will therefore be equal to 0.980mm, i.e each will be $1/50^{th}$ mm shorter than each division on the main scale. The reading is taken as follows: reading along the main scale up to the vernier zero, we can see the number of whole mm in the measurement and the line on the vernier which coincides with a line on the main scale indicates the number of $1/50^{th}$ mms to be added on.

Tools incorporating the vernier scale are also available with scales in imperial measure.

Summary

This unit identifies the tools, equipment and machinery used in the workshop. It introduces the apprentice to the risks and dangers associated with working in a workshop environment and the safety precautions needed to work in a safe and responsible manner. Safety is everyone's concern and the apprentice needs to develop this frame of mind early on in his/her apprenticeship.

We have looked at the different tools which are required to measure, mark out, and cut out different materials. Tools, if used incorrectly, can cause harm and injury. It is important that tools are stored properly during and after use. The apprentice should operate a clean as you go policy when working so as to eliminate the possibility of injury due to an untidy work area.

This unit also covers the various metals which are used in the industrial insulation trade. Metals are broken into two groups-Ferrous metals which contain iron and Non-Ferrous metals which don't contain iron. Metals and their alloys form a large part of the industrial insulation trade, so it is imperative that the apprentice understands the importance of each metal, their properties and their uses.

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