

Trade of Sheet Metalwork

**Module 1: Sheetmetal
Fundamentals**

**Unit 3: Marking Out and
Cutting**

Phase 2

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Document Release History

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Module 1 – Sheetmetal Fundamentals

Unit 3 – Marking Out and Cutting

Duration – 3.5 Hours

Learning Outcome:

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

- Carry out a review of sheet metal machinery and safety from Phase 1
- Use and care of guillotine (Power/treadle)
- Mark out and cut sheet blanks square and to a tolerance of $\pm 1\text{mm}$
- De-burr blanks using file
- Check measurements using steel rule

Key Learning Points:

P	Work unassisted or with other learner.
Sk	Use and care of sheet metal tools, machinery and equipment, especially the power/treadle guillotine.
Rk	Safety regulations (Review).
P	Housekeeping (Review).
Rk	Sheet metals – types, costs, economy of use, sheet sizes, thickness and weights.
Rk	Fundamentals of sheet metal work.
Rk	Work planning and communication.
Sk M	Use of steel rule and tape measure – Metric and Imperial, Fractions, Decimals.
H Sk	Safe use of marking out and cutting tools.
H Sk	Safe use of power and treadle guillotine.
D	Parallel line development.
M	Calculation of blank sizes by addition, subtraction, multiplication and division.
M	Economical use of materials by proper calculation, and nesting of patterns.

Training Resources:

- Toolkit
- Tools and machinery/equipment
- Video
- 0.6 mm galvanised mild steel
- Safety equipment and protective clothing

Exercise:

Mark out and cut metal – Exercise 2.1.2A and 2.1.2B.

Key Learning Points Code:

M = Maths **D** = Drawing **RK** = Related Knowledge **Sc** = Science
P = Personal Skills **Sk** = Skill **H** = Hazards

Sheet Metal Worker

Trade Description

The Sheet Metal job involves laying out of patterns on flat metal up to 4mm thick and uses metals such as galvanised mild steel, stainless steel, aluminium, copper and brass.

Patterns when processed are used in many applications such as:

- Heating, ventilation and air-conditioning ductwork for the construction industry
- Canopies for hotels and restaurants
- Catering equipment
- Aircraft
- Sign manufacture
- Transportation
- Safety equipment

Core Skills

- Use, care and setting of guillotine, press brake, folders, rolling, crimping, notching, drilling, swaging, stretching, shrinking and self secured joints
- Drawing and pattern development
- Fabrication and installation of items manufactured from sheet metal

Specialist Skills

- Fabrication and installation of ductwork
- Stainless steel work
- Precision sheet metal using CNC equipment
- Aircraft sheet metal
- Metal cladding
- Metal finishing
- Copper roofwork
- Maintenance sheet metal

Common Skills for Engineering Trades

Workshop practice including:

Safe use, care and operation of sheet metal tools and equipment, reading and interpreting drawings, planning of production sequence, measurement, marking out, calculations, cutting, drilling, forming, assembly, riveting, bolting, welding, quality. Safety.

Work Planning

It is important to think a job through before you actually start work on it. Factors such as:

1. Joint design – should you weld, rivet or groove the metal?
2. Type of material – will it be 1.00 mm thick or heavier? Would galvanised steel do instead of stainless?
3. Is the equipment available for the option chosen?

Having established the above, bend sequence, order of work (consideration must be given to drilling holes, if needed, before bending metal).

Working as part of a team must also be considered. The piece that is made first should be the piece that is wanted now and not in six weeks.

Nesting

When planning a job it is important to minimise the amount of scrap. A bit of thought as to how the blanks are arranged may increase the amount produced per sheet.

If a saving on metal means extra working time involved – one aspect must be considered against the other in the final analysis.

Sheetmetal Types

Sheetmetal Types/Uses/Special Sections

Not only is it essential for the sheetmetal 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 sheetmetal, 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.

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.

Coated and Solid Sheets

Sheet steel may be coated or uncoated (solid). Commonly used coated sheets are galvanised and tin plate. 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. For example, the coatings on galvanised sheets and tin plate are 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.

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 hold paint.

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 etc.

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

It solders well but welding is complicated by the fact that the zinc gives off toxic fumes and a residue which makes the weld more difficult. In addition, welding destroys the coating on the sheet, and for this reason it is not used where welding applications are required.

Galvanised metal can be obtained in 6' x 3' (1828 x 914 mm) or 8' x 4' (2438 x 1219 mm) sheets. It is also available in roll form.

Because of the coating, galvanised sheets will measure slightly thicker than uncoated sheets. Since the difference is so slight the gauge numbers for the sheet remain the same as for the solid sheets.

Stainless Steel

Stainless steel is one of the most important materials in the sheet metal trade. 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. These items are usually fabricated in the shop.

Types of Stainless Steel

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. weldability, 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 sheet metal worker 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 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.

Tin Plate

This is mild steel coated with pure tin. It was once used widely in roofing, dairy equipment, food processing equipment and food canning, but has been replaced largely by stainless steel, aluminium and other materials.

Non-Ferrous Sheet Metals

Non-ferrous metals are those which have no iron or steel content. The most common non-ferrous metals used in the sheet metal shop are copper, aluminium, lead and zinc.

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, costing about three times the price of galvanised iron. 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 $\frac{1}{3}$ 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.

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 to the sheet metal worker. 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.

The sheet metal worker should know the following steps about lead:

1. Lead is the heaviest metal that the sheet metal worker will use. It's approximately 1 ½ times heavier than iron.
2. Lead is very soft and easy to bend. Bending in a brake is seldom necessary since it can be bent by hand.
3. Lead is chemically the most inactive of metals. Exposure to the air or burial in the ground will not affect it. Lead is resistant to most acids.
4. Lead is gauged by the number of pounds per sq. ft.
5. Lead can be soldered easily using rosin, tallow or patented fluxes. The melting point of lead is 621°F so close to that of 50-50 solder that beginners may have difficulty avoiding burning a hole in the lead. To prevent this, the soldering point should be somewhat colder than normal. The surface of the lead should be scraped before soldering to remove most of the lead oxides.

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.

Special Sections

Metals are produced and supplied in many different forms, as shown below:

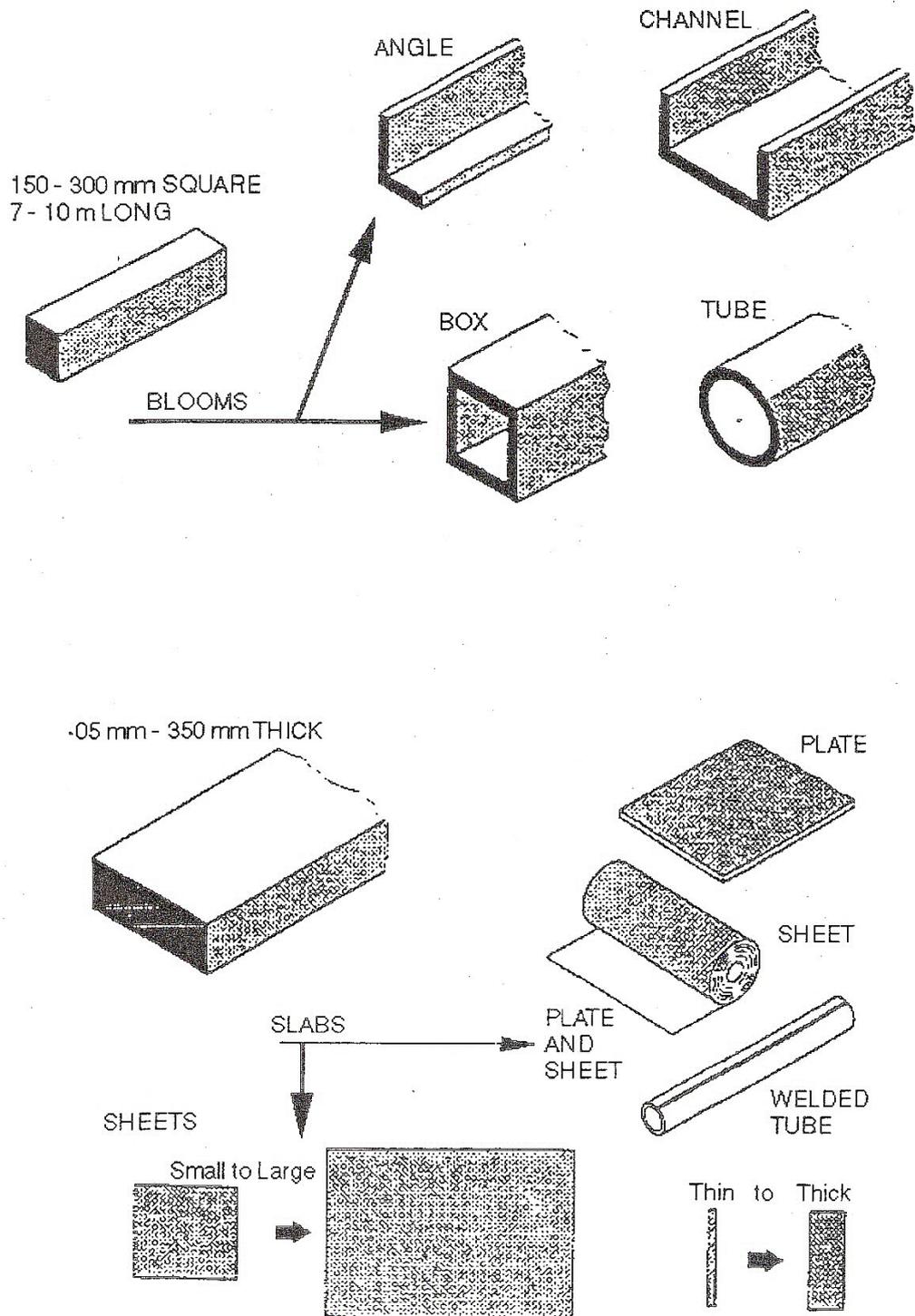


Figure 1 - Different Forms of Metals

Section A – Craft Calculations

A.1. – Addition, Subtraction, Multiplication and Division

Whole Numbers:

$$3 + 57 + 42 = 102$$

$$379 - 134 = 245$$

$$321 \times 201 = 64,521$$

$$558 \div 6 = 93$$

Fractions:

$$4 \frac{1}{3} + 1 \frac{1}{5} = \frac{13}{3} + \frac{6}{5} = \frac{65 + 18}{15} = \frac{83}{15} = 5 \frac{8}{15}$$

$$3 \frac{1}{2} - 1 \frac{2}{7} = \frac{7}{2} - \frac{9}{7} = \frac{49 - 18}{14} = \frac{31}{14} = 2 \frac{3}{14}$$

$$\frac{2}{3} \times \frac{7}{8} = \frac{2 \times 7}{3 \times 8} = \frac{14}{24} = \frac{7}{12}$$

$$\frac{3}{4} \div \frac{5}{7} = \frac{3}{4} \times \frac{7}{5} = \frac{21}{20} = 1 \frac{1}{20}$$

Decimals:

$$2.6 + 26 + 0.26 + 0.026 = 28.886$$

$$2.6 - 1.732 = 0.868$$

$$3.24 \times 4.6 = 14.904$$

$$\frac{17.1}{3.8} = \frac{171}{38} = 4.5$$

Self Assessment

Questions on Background Notes – Module 1. Unit 3

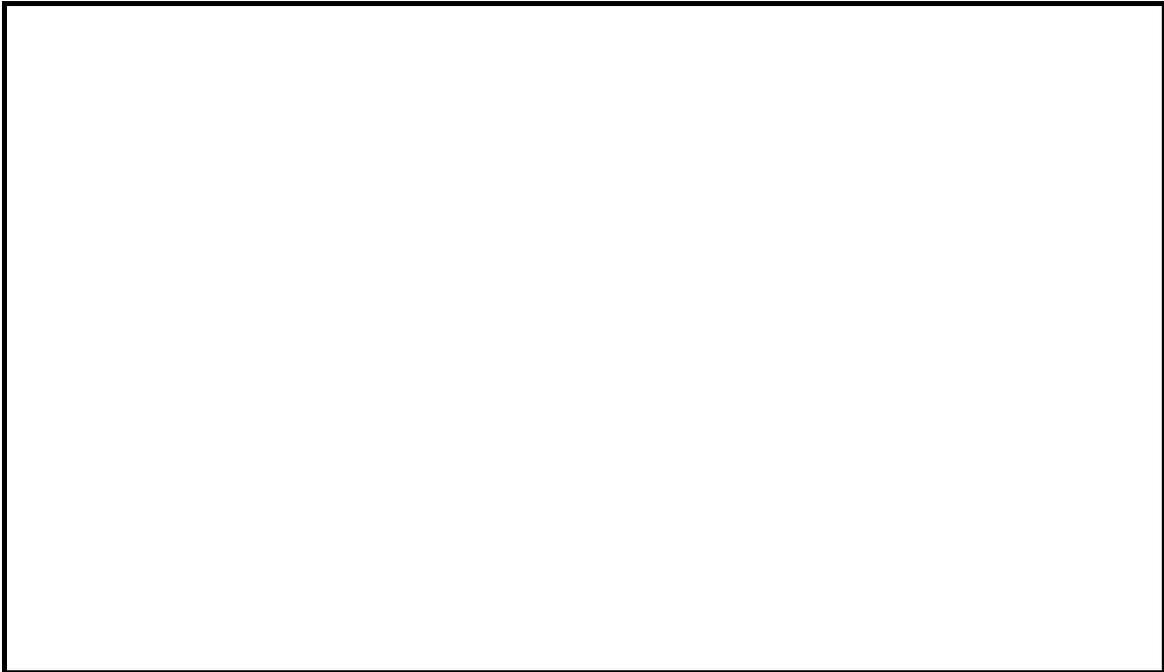
1. List four machines used in a sheetmetal shop.

2. What two things should you never bend in a folding machine?

3. Bend allowance depends on four factors. List at least two of them.



4. Describe the neutral line and approximately what distance it is from the edge/outside of the metal?



5. Name two self secured joints.

6. What is the grooving formula?

7. Name three kinds of edge in sheetmetal.

Answers to Questions 1-7. Module 1. Unit 3

1.

- Pittsburgh Lock
- Guillotine
- Press Break
- Spot Welder
- Rollers
- Corner Notcher

2.

Round Bar

Metal beyond the capacity of the machine.

3.

- The degree of bend.
- The radius of bend.
- Thickness of metal.
- Type of metal used.

4.

Bending a piece of metal compresses the material on the inside and stretches the material on the outside at some distance between these two extremes lies a space unaffected by either force. This is known as the Neutral Line and is approximately 4.45 times the material thickness from the inside of the bend.

5.

- a. Grooved Seam
- b. Paned – Down Joint (or Pein Joint)
- c. Knocked – Up Joint
- d. Lock formed

6.

Width of groove multiplied by 1.5 and then subtract 2 metal thickness. We do this calculation for each end of the metal being fabricated.

Width of groove x 1.5 – 2 metal thickness, for both sides of job.

7.

- a. Raw Edge
- b. Single Hem
- c. Double Hem
- d. Wired Edge
- e. Capped Edge

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