MEM05 Metal and Engineering
Training Package

MEM05 Cluster Learner Resource:

MEM18001C Use hand tools
MEM18002B Use power tools/hand held operations
MEM05005B Carry out mechanical cutting

3 Learner guides

Version 1

Training and Education Support
Industry Skills Unit
Meadowbank

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MEM05 Metal and Engineering Training Package

MEM18001C Use hand tools

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Topic 1: Hand tools

Introduction

Tools are common place in our lives today and it is easy to overlook that they can cause injury in untrained hands. With the introduction of the Work Health and Safety Laws (WHS) all tools are manufactured with the operator's safety in mind.

Some hand tools are common to a number of occupations while others are generally only used in specific fields. As a number of common hand tools are used across a broad range of occupations and trades in manufacturing and engineering it is important to learn their purpose and application. It is also necessary to know how to select and safely use them for a given task. Quality hand tools are often expensive so it is also important that users know how to properly maintain them.

Workshop safety

The Work, Health and Safety Act 2011 (WHS Act) and WHS Regulations are enforced throughout all Australian States and Territories. This legislation is aimed at providing consistency, certainty and clarity across Australia making it easy to understand workplace health and safety responsibilities. Consequently this act and its regulations requires both employers and employees to take every reasonable step to work safely and responsibly in the workplace.

There are no "short cuts" to working safety, its everyone's responsibility to manage and minimise potential risks in the workplace, report faulty equipment as well as unsafe environments. Detailed information relating to the WHS Act and regulations can be found on:

- WorkCover Authority of NSW website; www.workcover.nsw.gov.au

  Or on

- Safe Work Australia; www.safeworkaustralia.gov.au

Hammers

Hammers are impact tools used to impart a force either directly, or indirectly through another tool such as a chisel or punch, to a workpiece The most common hammers used by the mechanical tradesperson are the ball pein (engineers), cross pein and soft faced hammers.

Ball pein hammers

The Ball Pein or engineers hammer is the most common of the hammers used by mechanical tradespeople. It has a slightly convex face for striking tools such as punches, chisels, centre punches or the workpiece itself.

The opposite end of the hammer head is a hemispherical ball pein used to dome or shape the shanks of rivets or to stretch the surface of a metal workpiece to straighten it.

Ball pein hammer

All hard faced hammers are made from tool steel by a drop forging process. After forging, the hammer is carefully heat-treated so that the face and the pein are hardened and tempered while the metal around the eye is left soft.

Because the hammer head has been heat treated it must not be subjected to high temperatures, otherwise the hardness of the face and pein will be lowered.
The engineer's hand hammer is made in a range of sizes. The smallest weighs around 100 g and the largest 1500 g. The hammer size best suited to a fabricator's work weighs about 600 g while a 200 g hammer would suit most marking-off purposes.

The weight of the hammer must be chosen to suit the job. For example, where a heavy blow is required in a confined space, a heavy hammer should be used because its larger mass will be able to deliver a greater amount of energy to the workpiece or tool without being made to move fast. But for normal conditions the heavy hammer would be too tiring to use.

Hammer handles should be in good condition and of a size that is comfortable to use. It should be square with the head and fit tightly into the head.
The hammer should not be used if either the head or the handle is damaged, because it may cause injury to either the user, or the people around the user.

Cross pein hammers

This is a special purpose engineering hammer that comes in a variety of masses up to 450 g (1 lb) metal. The cross pein hammer is used in confined spaces or for straightening or stretching when the is peined at right angles to the direction of stretch or curve.

Cross pein hammer

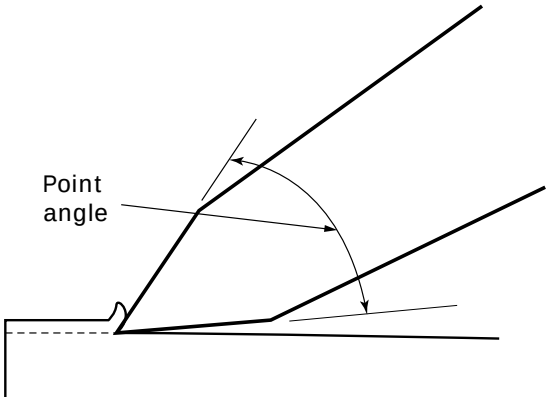
Cutting tools

Chisels

Cold chisels are forged from medium carbon steel. Only the point of the chisel is hardened and tempered, the body being left soft. If the head of the chisel were hard it would chip or shatter as a result of hammer blows.

The point of the chisel should be formed into a cutting edge similar in nature to other cutting edges in that it requires the edge to be sharp.

Cold chisel



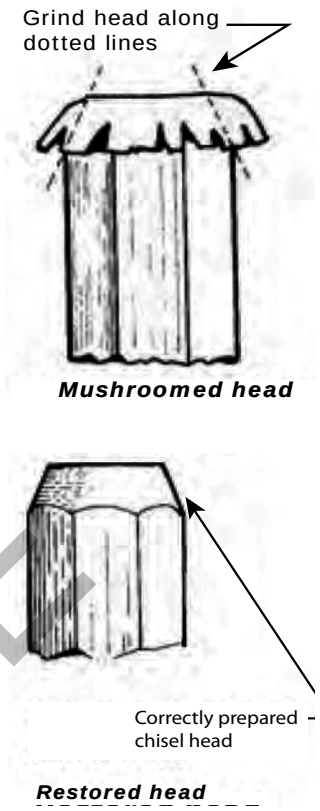
Correct cutting position and angle

Because chisels are subjected to continual impact loads, they are likely to show signs of metal fatigue or cracking after a period of use. In this condition they can become dangerous as small pieces of metal or splinters may fly off at high speed causing injury to the operator or to people standing nearby.

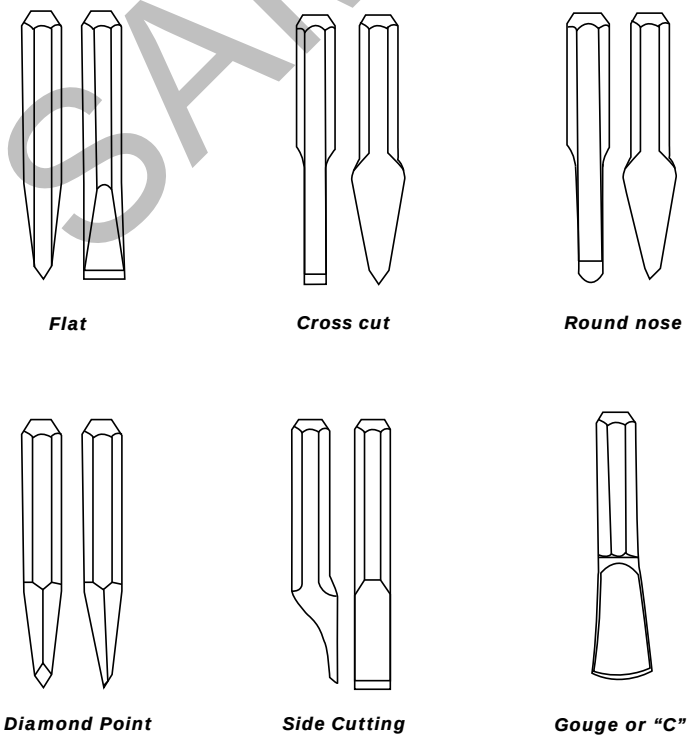
A new chisel should be used lightly until it is proved to be sound and only then should heavy blows be used on it.

A major problem associated with the use of chisels is the mushrooming of the head due to the fact that the head is soft and constant hammering on the head distorts the metal as shown opposite. The head of the chisel should be kept in good repair by keeping the chamfer ground cleanly as shown.

When resharpening a chisel care must be taken not to raise the temperature of the cutting edge above the tempering temperature. Ideally when grinding a chisel's cutting edge no tempering colours should show on the surface other than a very light straw colour, otherwise the intergrity of the chisel may be compromised. Depending upon the type of chisel used a general guide is to use a 60° point angle as illustrated above.



Chisel types



Common types of chisels

Unsafe or faulty hand tools

Damaged hand tools

Chisels, wedges and drift pins are impact tools and due to constant use these tools form mushroom heads if not maintained. An impact tool must be kept free of mushroom heads as they may cause injury to the user or to others as the head will eventually shatter on impact causing metal fragments to fly off in any direction.

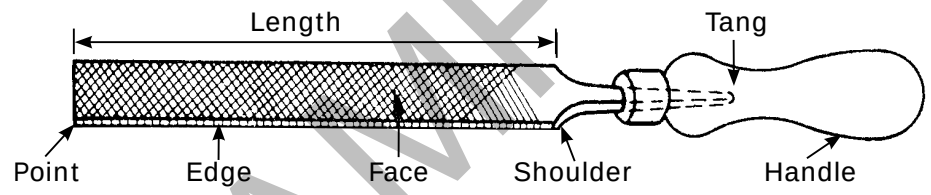
Worn hand tools

A tool with a damaged wooden handle such as a hammer can pose risks to the user or those close by. Should the handle be loose, cracked or splintered the head could fly off causing injury. Equally, a wrench with worn or sprung jaws can cause slipping and result in injury to the user.

Files

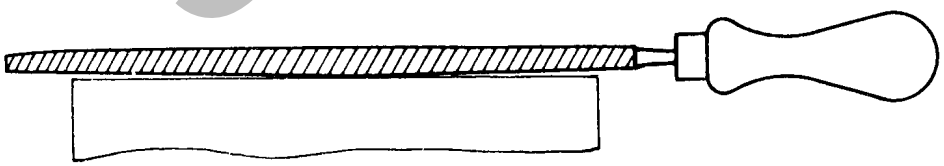
Description of a file

Files are made from a high carbon tool steel and pass through a process which includes forging, dressing of the surfaces by filing or grinding, forming of the teeth and heat treatment. Files are used to reduce or smooth the surface of metal or other material.



Parts of a file

Convexity of a file



Face of file slightly convex along the length

The belly on a file

Most files are made with their faces slightly "bellied" or convex, along the length. In their finished form, files are very hard and brittle and must not be used as levers, packing or wedges, nor should they be hit, because of the danger of shattering. If they do shatter, there is great likelihood of small pieces of the file seriously injuring a person nearby.

MEM05 Metal and Engineering Training Package

MEM18002B Use power tools/hand held operations

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AS 1788.2-1987 Abrasive wheels - Selection, care, and use

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Topic 1: Portable power tools and accessories

Portable power tools

Introduction

Portable hand-held power tools are extensively used by workers in engineering and manufacturing industries. Due to their availability, design, cost and efficiency, many tasks can be completed quickly using modern hand-held power tools.

The most common power tools found in engineering workshops and construction sites include:

- Angle grinders
- Pistol drills
- Hammer drills
- Power hand shears
- Nibblers
- Saws and jig saws.

Personal protective equipment (PPE)

When using portable power tools you will need to wear a combination of the following:

- Safety glasses
- Boots or shoes, with steel cap and rubber soles
- Ear protection (plugs, muffs)
- Hair net if required
- Close fitting heavy drill cotton overalls, shirt or trousers.

Portable power tools can be operated using three types of power sources, they can be:

- Electrically operated
- Battery operated
- Pneumatically operated.

Electric powered tools are the most commonly used; however; battery operated power tools are gaining popularity, especially for pistol drills. An alternative is to use pneumatically powered tools; these can be lightweight for the user but require an air compressor to operate them.

Types of portable grinders

Three types of portable grinders used are:

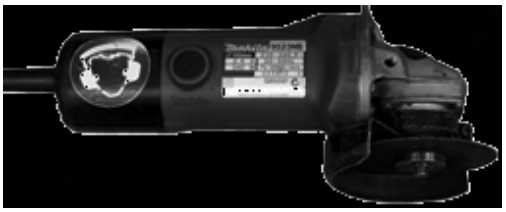
- Angle grinders
- Die grinders
- Straight grinders.

Angle grinders

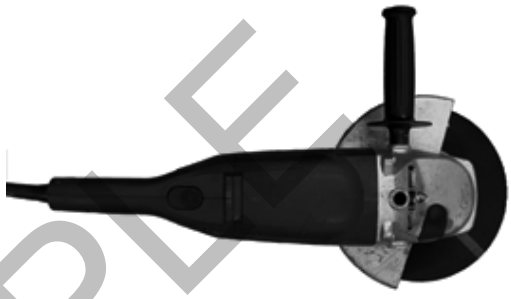
Hand held powered angle grinders are used to grind work where it is easier to take the grinder to the job rather than the job to the grinder. These tools are commonly used by operators to remove defects, rough edges, remove unwanted metal etc, due to their portability and ease of operation.

Unlike the larger fixed bench and pedestal grinding machines, hand held angle grinders have an adjustable guard to assist in streaming sparks and particles away from the operator and the work.

These units have a side-handle which can be located on either the left or right hand side of the machine to suit the operator's needs. There is an extensive range of purpose designed cutting and grinding discs to suit the work and material and should only be used in accordance with the manufacturer's specifications.



Electric angle grinder (100 mm)



Electric angle grinder (230 mm)

Die grinders

When selecting a die grinder it is important to consider its intended use, the attachments to be used and the amount of time that will be spent grinding down materials i.e. thickness of area. Therefore, an incorrectly used die grinder will, more than likely, wear out quickly from unnecessary overuse.

Pneumatic (air) die grinder with burring tool

Typically this tool is used to remove metal spurs and other irregular surface conditions where a cut has been made in metal pipe or tubing. This tool can also be used to deburr, polish and/or buff the inside of cylindrical sections.

A cylindrical grinding/polishing attachment known as a grinding nose is selected by the operator for the task and fitted to the die grinder in a similar fashion to that of a drill bit.

Rotary burrs

Rotary burring (cutting) tools are used on a wide range of pneumatic and electric hand-held grinding tools. Some typical applications include::

- Fast freehand stock removal
- Weld preparation and surface removal
- Dressing metal surfacess
- Gaining access into tubes, pipes and other hollow sections
- Contouring metal profiles.

Selection of rotary burring tools

To achieve optimum performance of the tool it may be necessary to adjust the speed of rotation. For instance if the speed of rotation is below the cutting tool's optimum speed it may cause chipping. Harder metals and extra long burrs will require slower speeds. Running the tool at excessive speed will cause tooth wear and caution should be used to avoid tools from becoming too hot.

Should the braze weld holding the head of the shank become too heated it could loosen, causing the head to detach. An operator should apply a constant light force and movement during use of the tool and replace worn collets as they can cause chipping of the workpiece.

Burring tools can be used to grind and finish many different types of metals, such as:

- Aluminium
- Brass/bronze
- Copper
- Titanium alloys
- Cast Iron
- Carbon and alloy steels
- Bronze
- Nickel and nickel alloys
- Stainless steel
- Zinc alloys.

Straight grinder

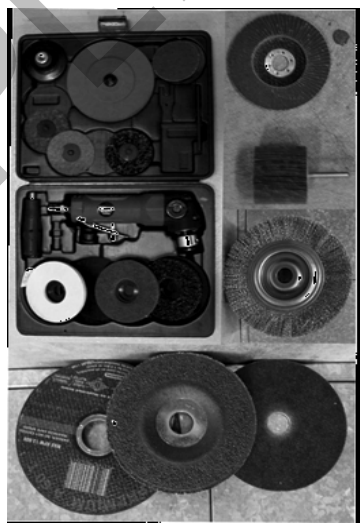
Straight or barrel grinders are ideal for grinding steel pipe and tube and also buffing and polishing applications. Buffing and polishing of stainless steel and aluminium is done using a combination of rag and sisal mops.

Electric straight grinder

Abrasive consumables

A range of abrasive consumables, such as grinding discs, cut-off wheels, sand papers and sanding discs, are commonly available as well as the products listed below:

- Resinoid-bonded cut-off wheels
- Industrial wire brushes
- Flap discs and Flap wheels
- Vitrified grinding products
- Rotary burrs
- Abrasive belts
- Polishing tools
- Sticky back discs.



Selection of abrasives

Angle grinders fitted with abrasive cut-off wheels can be used to cut bar, tube and plate. Thin cut-off wheels are designed to suit either a depressed or flush centre mounting and are generally made from carborundum, which is a compound of silicon and carbon. Typical applications for these cut-off wheels include cutting:

- Thin-walled tube
- Sheet metal items made of steel and stainless steel
- Nonferrous metals
- Composite materials.

Resinoid-bonded cut-off wheels

These wheels are designed for use with hand held grinding machines and are generally suitable for use with a variety of metals and cutting applications, such as steel pipe, bar and plate. They should not be used on non-ferrous metals such as aluminium and brass as soft materials will clog the disc and may cause it to overheat and shatter.

The wheels are fibreglass reinforced for strength and are required to run at cutting speeds of up to 80 m/s (metres per second). Manufacturers recommend a wheel thickness in the range of 2 - 3.2 mm for cutting and depressed centre wheels with a thickness of 4 - 10 mm for grinding.

Abrasive cut-off wheels

Reinforced cutting and grinding discs are generally made of corundum (aluminium oxide), have a medium to hard bond and are less brittle than vitrified wheels. They are also typically flat and are coloured black but are available in a raised hub variety. These discs can also include the following materials:

- Aluminium oxide
- Single crystal aluminium
- Green silicon carbide
- White aluminium oxide
- Zirconia aluminium
- Black silicon carbide.

Industrial wire wheel brushes

Specially designed wire brushes can be fitted to angle grinders. These brushes are used to clean metal surfaces prior to priming or painting.

Wire wheel brushes for angle grinders

Wire cut wheel for angle grinders

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Topic 1: Mechanical cutting and associated safety

The Work, Health and Safety Act 2011 (WHS Act) and WHS Regulations are enforced throughout all Australian States and Territories. This legislation is aimed at providing consistency, certainty and clarity across Australia making it easy to understand workplace health and safety responsibilities. Consequently this act and its regulations requires both employers and employees to take every reasonable step to work safely and responsibly in the workplace.

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Welding operators must know about the principles governing the welding operation, equipment used and workplace health and safety precautions required. The following points need to be taken into account when working in a welding environment.

Mechanical cutting of plates, sheets and rolled sections is an integral part of metal fabrication. Together with forming, welding, and thermal cutting, mechanical cutting plant and equipment play a vital role in fabrication industries.

A wide variety of mechanical cutting equipment is used by fabricators in both the light and heavy industries. Mechanical cutting can be achieved through either a shearing action such as a guillotine, or by a sawing action such as a cut-off saw.

Typical cutting machinery used by fabricators include:

- Guillotines
- Universal metal workers (punch and shears)
- Universal sheet metal nibbling machines
- Hand shears (bench lever type)
- Cold cut-off saws
- Abrasive cut-off saws
- Power hacksaws
- Bandsaws.

Tradespeople and workers in fabrication industries must know how to set up and safely operate mechanical cutting equipment used in their workplaces. To keep machinery in reliable and good working condition, it is important that operators understand the equipment's operating capacity and work within the machine's limits.

Advantages of mechanical cutting

Although mechanical cutting equipment is expensive to purchase, a metal fabrication company would expect equipment to last for many years. Fabricators from such companies make up material or cutting lists of parts to be mechanically cut from job plans and instructions. By setting backstops or back gauges on mechanical cutting equipment such as a guillotine, parts can be cut quickly, accurately and to size.

Machine backstops also allow repetitive work and large quantities of parts to be cut efficiently, to consistent accuracy, saving time and improving productivity.

Unlike thermal cutting processes such as fuel gas and plasma cutting, mechanical cutting equipment does not use heat to cut parts, which means there is little or no distortion.

Mechanical cutting safety and safe operating procedures

Mechanical cutting equipment is extremely dangerous and it is important that operators are provided with training and instruction in the safe and proper use of the equipment.

Safe Operating Procedures

A Safe Operating Procedure (SOP) is a set of written instructions that identifies health and safety issues that may arise from the jobs and tasks associated with the equipment being operated.

SOPs are placed on a machine in a location accessible to the operator and others working in the area. Information found on a SOP sheet would include:

- Tasks to be undertaken that may pose risks
- Equipment and substances used in these tasks
- Control measures that have been built into these tasks
- Training or qualifications needed to undertake the task
- Personal protective equipment to be worn
- Action to be undertaken to address safety issues that may arise while undertaking the task.

Machinery safety (Engineering controls)

Mechanical cutting equipment and machinery are fitted with safety devices designed to allow the operator to use the machine in a safe manner. Safety devices on a machine may include:

- Emergency stop buttons to cut power to the machine in the event of an emergency
- Guards and shields to cover blades and cutting tools
- Guards which cover a machine's moving parts
- Electronic sensors to cut power to a machine if activated by a person entering a restricted area
- Cages to restrict entry to an area whilst a machine is operating.

When hazards associated with mechanical cutting equipment cannot be eliminated or sufficiently reduced by engineering controls or safe working procedures alone, operators must wear Personal Protective Equipment (PPE) to improve protection.

PPE includes safety glasses or goggles, earplugs or earmuffs, protective gloves, respirators and dust masks, overalls or other close-fitting clothing as well as safety shoes or boots with steel toe-caps to protect feet should heavy items accidentally be dropped.

An important safety consideration to people working in fabrication industries is that young workers have a much higher risk of being injured at work than older workers. Therefore safety, supervision and instruction are vital to the training of younger workers.

Safety regulations

Safe guarding of mechanical cutting equipment used in fabrication industries is regulated by statutory authorities such as WorkCover NSW and Australian Safety and Compensation Council (Formerly known as the National Health and Safety Commission). These State and federal government safety authorities will investigate serious workplace accidents and can issue heavy fines if neglect toward workplace safety is proven to be the cause of an accident.

In addition to the types of mechanical cutting equipment used in fabrication and related industries, applications of each machine and specific safety requirements for operating them are listed in this resource.

Safe working procedures (SWP)

You must follow these rules when you enter a fabrication workshop:

- Act safely and responsibly at all times
- Follow all workplace procedures
- You are responsible for tools while in your care
- Use storage facilities as directed
- Observe all safety requirements such as:
    - wearing protective clothing
    - wearing safety footwear
    - wearing eye protection as required
    - using hearing protection as required
    - wearing hair protection if required
    - using any other safety items as required for specific areas
    - ensure all guards are correctly positioned and working
    - consider the safety of others when using tools and equipment
    - **NOT** use any equipment unless you have been trained in its safe and correct use.

- **IF IN DOUBT, ASK** your teacher before attempting to operate any machine or carry out a task
- Work must be held securely before performing any operation
- Identify all relevant WARNING signs – e.g., turn power off at main switch before making any adjustment such as changing speeds on a belt-driven pedestal drill
- Do not use any equipment or machines with signs indicating "DANGER" or "DO NOT USE"
- Note the locations of first aid and nurse stations
- Know emergency exits and evacuation procedures
- Know the locations of fire extinguishers
- Know the position and use of emergency stop buttons
- Clean machines and work areas that have been used. This task includes sweeping the floor
- Remain in the area until all tools and equipment has been accounted for
- Do not leave the area without permission from your teacher.

Review questions

These questions have been included to help you revised what you have learnt in *Topic 1: Mechanical cutting and associated safety.*

1. List four (4) safety control devices (engineering controls) that could be fitted to mechanical cutting equipment that provide safety for the operator and those working nearby.

   - _____
   - _____
   - _____
   - _____

2. State **three** (3) items of personal protective equipment (PPE) that must be worn when using mechanical cutting machines.

   - _____
   - _____
   - _____

3. List **five** (5) types of mechanical cutting machines typically used in fabrication workshops.

   - _____
   - _____
   - _____
   - _____
   - _____

4. Give an advantage associated with mechanical cutting.

   - _____

5. Explain the purpose of an SOP and list **three** (3) items of information you would find on them.

   Purpose: _____

   - _____
   - _____
   - _____