MEM05005B

Carry out mechanical cutting

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Conditions of Use:

Unit Resource Manual

Manufacturing Skills Australia Courses

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Aims of the Competency Unit:

This unit covers setting up and operating a range of mechanical cutting and holing equipment and applies to sawing, shearing, cropping and/or holing and includes setting up and operating a range of equipment. Examples of machines that could be covered include guillotines, croppers, cold saws, band saws, automatic saws etc. Typical applications of this unit may include cutting for manufacture, production cutting and cutting of materials selected from stores in a maintenance environment.

The unit does not cover hand or hand held power tools used for cutting e.g. circular saws, nibblers and side grinder. These skills are covered by Unit MEM18001C (Use hand tools) and Unit MEM18002B (Use power tools/hand held operations).

This unit does not include the skills required for operational maintenance of the equipment used; these skills are covered by Unit MEM07001B (Perform operational maintenance of machines/equipment).

For repair and welding of band saw blades where blade repair unit is not attached to the machine, refer to Unit MEM05013C (Perform manual production welding). .

Unit Hours:

18 Hours

Prerequisites:

MEM12023A - Perform engineering measurements.

MEM18001C – Use hand tools

Elements and Performance Criteria

1.	Determine job requirements	1.1	Job requirements and specifications are determined from job sheets and/or instructions.
		1.2	Appropriate method/machine is selected to meet specifications.
		1.3	Machine is loaded and adjusted for operation consistent with standard operating procedures.
2.	Select/set up machine tooling.	2.1	Tooling is selected to match job requirements.
		2.2	Report environmental incidents to appropriate personnel.
		2.3	Machine is set up and adjusted using standard operating procedures.
3.	Operate mechanical cutting machine	3.1	Appropriate stops and guards are set and adjusted as required.
		3.2	Make suggestions for improvements to workplace practices in own work area.
		3.3	Material is secured and correctly positioned using measuring equipment as necessary.
		3.4	Machine is operated to cut/hole material to specifications using standard operating procedures.
4.	Check material for conformance to specification	4.1	Material is checked against specification. Machine and/or tooling is adjusted as required and in process adjustments carried out as necessary.
		4.2	Material is cut and/or holed to within workplace tolerances.
		4.3	Material is used in most economical way.
		4.4	Codes and standards are observed.

Required Skills and Knowledge:

Required skills include:

- loading and adjusting cutting machines
- selecting machines and tooling
- installing cutting tool
- setting up and adjusting cutting machine
- securing and correctly positioning materials
- cutting and holing materials
- applying relevant codes and standards
- reading and interpreting routine information on written job instructions, specifications and standard operating procedures
- following oral instruction
- measuring materials to specified workplace tolerances and within the machine range
- clarifying routine task-related information

Required knowledge includes:

- the characteristics of cutting methods and machines
- effect of materials on the machine tooling, tooling defects and adjustments
- effect of adjustments on the dimensions of the cut material
- applicable tolerances
- methods of marking out materials to ensure minimum wastage
- any applicable industry standards, national/Australian standards, NOHSC guides, State/Territory regulatory codes of practice/standard
- use and application of personal protective equipment for mechanical cutting
- safe work practices and procedures

Lesson Program:

Unit hour unit and is divided into the following program.

Topic	Skill Practice Exercise
Topic 1 – Cutting Methods:	MEM05005-RQ-0101
Topic 2 – Metal Turning:	MEM05005-RQ-0201
Topic 3 – Drill Press:	MEM05005-RQ-0301
Topic 4 – Metal Shears	MEM05005-RQ-0401 MEM05005-SP-0402 MEM05005-SP-0403
Topic 5 – Cold Saw:	MEM05005-RQ-0501 MEM05005-SP-0502
Topic 6 – Band Saw:	MEM05005-RQ-0601 MEM05005-SP-0602
Practice Competency Test	MEM05005–PT-01

Contents:

Topic 1 – Cutting Methods:

Required Skills:

On completion of the session, the participants will be able to:

- Identify the metal, thermal and hydraulic methods of cutting metal.

Required Knowledge:

- Types of cutting processes.

1.1 Cutting Methods:

Mechanical cutting consists of a various number of processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process. Mechanical and laser cutting machinery are common fabricating processes used in today's manufacturing industries. Each method employs its own distinct equipment, and has its own advantages and disadvantages. Preference among the two usually depends on a range of factors, such as application requirements, cost-effectiveness, and production capabilities.

1.1.1 Mechanical Cutting:

Mechanical cutting, which includes tooling and machining, is a process that uses power-driven equipment to shape and form material into a predetermined design. Some common machines used in mechanical cutting include lathes, milling machines, drill presses, metal shears, croppers and saws and will be covered individually in the following topics.

1.1.2 Thermal Cutting:

Laser cutting uses an energy emission device to focus a highly-concentrated stream of photons onto a small area of a workpiece and cut precise designs out of the material. Lasers are typically computer-controlled and can make highly accurate cuts with a quality finish. The most common laser cutters are of the gaseous CO_2 or Nd:YAG variety.

1.1.2.1 Gas:

Oxyacetylene is a process that uses fuel gases and oxygen to cut metal. Pure oxygen, instead of air, is used to increase the flame temperature to allow localized melting of the workpiece material (e.g. steel) in a room environment. A common propane/air flame burns at about 2,000 °C, a propane/oxygen flame burns at about 2,500 °C, and an acetylene/oxygen flame burns at about 3,500 °C.

Oxy-fuel is one of the oldest welding processes, besides forge welding and is still used in industry; in recent decades it has been less widely utilized in industrial applications as other specifically devised technologies have been adopted. It is still widely used for welding pipes and tubes, as well as repair work and is also suitable, and favoured, for fabricating particular types of metal-based artwork. Oxy-fuel has an advantage over electric welding and cutting processes in situations where accessing electricity (e.g., via an extension cord or portable generator) would present difficulties; it is more self-contained, or, "more portable".

In oxy-fuel cutting, a torch is used to heat metal to its kindling temperature. A stream of oxygen is then trained on the metal, burning it into a metal oxide that flows out of the kerf as slag.

1.1.2.2 Electrical Gas Discharge:

Electrical Gas Discharge is a manufacturing process where a shape is obtained using electrical discharges or sparks. Material is removed from the workpiece by a series of rapidly recurring current discharges between two electrodes, separated by a dielectric liquid and subject to an electric voltage. One of the electrodes is called the tool-electrode, or simply the 'tool' or 'electrode', while the other is called the workpiece-electrode, or 'workpiece'.

Decreasing the distance between the two electrodes reduces the intensity of the electric field in the volume between the electrodes becomes greater than the strength of the dielectric which breaks, allowing current to flow between the two electrodes. This phenomenon is the same as the breakdown of a capacitor; as a result, material is removed from both the electrodes. Once the current flow stops (or it is stopped – depending on the type of generator), new liquid dielectric is usually conveyed into the inter-electrode volume enabling the solid particles (debris) to be carried away and the insulating properties of the dielectric to be restored. Adding new liquid dielectric in the inter-electrode volume is commonly referred to as flushing; also, after a current flow, a difference of potential between the two electrodes is restored to what it was before the breakdown, so that a new liquid dielectric breakdown can occur.

1.1.2.3 Beams:

Laser beam machining involves using laser beam technology to perform functions typically accomplished by conventional cutting machines. The type of lasers most often used include the carbon dioxide (CO_2) and the neodymium doped:yttrium aluminium garnet (Nd:YAG). The adaptability of these tools allows them to perform more than one function, and the wide range of industries that often use laser beam machining technology includes automakers and jewellers.

A CO_2 laser is one of the more powerful types of laser used in laser beam machining. These lasers can generate 400 to 1,500 watts of power, which can cut through 25 mm thick carbon steel. The tool uses mirrors that direct the proton laser beam to the desired cutting location. The laser generally makes a tapered cut as it moves along the z-axis while the work surface travels along the x and y-axes. Industries generally use the power of the CO_2 laser for cutting and profiling.

The flexibility of the YAG laser beam enables manufacturers to use a machine that transmits the beam directly to the cutting surface or through something as small as a fibre optic cable. Lasers transmitted through fibre optics can be incorporated into robotic machines that can move on any axis around a stationary work site. While not as powerful as a CO_2 laser, a YAG laser can drill a hole to a depth of six times the diameter of its beam. Besides laser boring, industries commonly employ YAG lasers for etching and engraving.

Depending on the function required, industries utilize CO_2 or YAG tools for laser beam machining, and computer numerical control (CNC) instrumentation relays desired tasks to the laser. Manufacturers design each tool in sizes ranging from tabletop models to free standing room-sized machines. Small business owners and large industrial factories both use laser beam machining on materials ranging from cardboard, cork, and wood to steel, steel alloys, and stone.

Industrial manufacturing applications include cutting or welding metals in aircraft, automotive, and shipbuilding factories. Jewellers also use laser welding on delicate pieces of jewellery, and machinists use laser beam machining to resurface corroded parts by fusing material to damaged areas. Laser beams perform intricate cuts in plastic and metal sheeting for components installed in household electronics or machinery. Functioning similarly to an ink jet printer, laser beam machining is also used to engrave glass, plastic, and stone.

1.1.3 Hydraulic Cutting:

Hydraulic cutting is also known as water jet and is an industrial tool capable of cutting a wide variety of materials using a very high-pressure jet of water, or a mixture of water and an abrasive substance. The term abrasive jet refers specifically to the use of a mixture of water and abrasive to cut hard materials such as metal or granite. The terms pure water jet and water-only cutting refer to water jet cutting without the use of added abrasives and is often used for softer materials such as wood or rubber.

Water jet cutting is often used during fabrication of machine parts. It is the preferred method when the materials being cut are sensitive to the high temperatures generated by other methods. Water jet cutting is used in various industries including mining and aerospace for cutting, shaping, and reaming.

The water jet cutter is commonly connected to a high-pressure water pump where the water is then ejected from the nozzle, cutting through the material by spraying it with the jet of high-speed water. Additives in the form of suspended grit or other abrasives, such as garnet and aluminium oxide, can assist in this process.

An important benefit of the water jet is the ability to cut material without interfering with its inherent structure, as there is no "heat-affected zone". Minimizing the effects of heat allows metals to be cut without harming or changing intrinsic properties. Water jet cutters are also capable of producing intricate cuts in material; with specialized software and 3-D machining heads, complex shapes can be produced.

The kerf, or width, of the cut can be adjusted by swapping parts in the nozzle, as well as changing the type and size of abrasive. Typical abrasive cuts have a kerf in the range of 1.016 to 1.27 mm, but can be as narrow as 0.508 mm. Non-abrasive cuts are normally 0.178 to 0.33 mm, but can be as small as 0.076 mm, which is approximately that of a human hair; these small jets can permit small details in a wide range of applications. Water jets are capable of attaining accuracies down to 0.13 mm and repeatability down to 0.025 mm.

Due to its relatively narrow kerf, water jet cutting can reduce the amount of scrap material produced, by allowing uncut parts to be nested more closely together than traditional cutting methods. Water jets use approximately one half to one gallon per minute (depending on the cutting head's orifice size), and the water can be recycled using a closed-loop system. Waste water usually is clean enough to filter and dispose of down a drain. The garnet abrasive is a non-toxic material that can be recycled for repeated use; otherwise, it can usually be disposed in a landfill. Water jets also produce fewer airborne dust particles, smoke, fumes, and contaminants, reducing operator exposure to hazardous materials.

Skill Practice Exercises:

Skill Practice Exercise MEM05005-RQ-0101

Investigate the cutting equipment and itemise in three columns the different types of metal cutting machinery in your workplace:

Mechanical	Thermal	Hydraulic