Education and Culture

Leonardo da Vinci

Course: Health, Safety and Environment

Module 3

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MODULE 3

Objective:

Know how to perform a cutting operation for cutting plates and the health environment and safety topics related to use of this process

Scope:

Handling gas cylinders
Handling exhaust devices for cutting
Handling of material to and from the cutting table

Expected results:

Know safe handling of gas cylinders.
Know the need for fume extraction
Know the risk of explosions

The working environment of the fabrication shop, general hazards, dust, heavy and hot material, cables .

The welding processes are characterized by high temperatures, extensive fumes, light and heat radiation and risks from electric power. All these phenomena can endanger welder health, and potentially they are also dangerous for the environment.

The basic task for health and safety is to eliminate these dangerous aspects of welding.

General Hazards

The general hazards in welding and cutting are:

- Fire from sparks and spatter
- Explosion and fires from reaction with welding gases
- Asphyxiation
- Electric shock
- Inhaling toxic fumes and gases
- Eye injuries from heat rays

There are many regulations regarding safety in welding, which are derived from more general safety regulations, like 'General rules for hygienic and technical safety measures at work' and 'Regulations for personal safety means'. Every welder has the right and obligation to be protected under these regulations.

The owner/operator is obliged to have a safety inspection performed on the welding equipments at least once every 12 months.

A safety inspection, by a trained and certified electrician, is prescribed:

- after any alterations
- after any modifications or installations of additional components
- following repairs, care and maintenance
- at least every twelve months.

Measures - technical devices and equipment

When planning a workplace, the working height plays an important part in creating the correct working position. In this context, positioners and lifting tables can be very useful. The working position is partly determined by the welder's need to have his/her eyes close to the workpiece to be able to see the molten pool clearly while welding. If the working height is too low, the welder has to bend to see properly. A chair or stool might then be very useful. Working with the hands in a high position at or above shoulder level should be avoided whenever possible.

In conjunction with heavier welding, the gun and hoses are also heavier and the load on the body is more static. A balanced load-reduction arm is very useful in this situation. Lifting the hoses off the floor also protects them from wear and tear, as well as facilitating wire feed.

It is also a good thing if the workpiece is placed in a positioner and is positioned to ensure the best accessibility and height. A more comfortable working position can be created and, at the same time, welding can be facilitated as the joint is in the best welding position.

Roller beds can be used for welding tubes or other cylindrical items. A hook or some other device on which the welding gun can be placed when it is not in use is another valuable piece of equipment.

Hot work exposes workers to:
- Molten metal
- Toxic gases
- Fumes and vapors
- Harmful radiation
- Excessive noise
- Electrical shock
- Fire hazards.

Appropriate personal protective equipment (PPE) must be selected to protect the worker from these hazards. Fire watches in the area are required.

Hot work operations include:
- Gas Welding and Cutting
- Electric Arc Welding
- Carbon Arcing or Plasma Arc Cutting

Each of these operations may present unique hazards.

Electro- magnetic effects

Current gives rise to a magnetic field around the conductor. The magnetic field is stronger closer to the conductor and rapidly subsides as the distance increases. A magnetic field is created around the welding cable and earth cable when welding is in process.

Studies have indicated that one should not be exposed to strong magnetic fields. However, there is no evidence of any injuries. No limits have been yet set.

Recommendations: You should make sure that as little as possible of the welding cable is directly adjacent to your body when welding. If you are right-handed, the welding machine should be placed on your right-hand side to avoid laying the welding cable on your lap or around your body. It is not a good idea to rest the welding cable around your body while erection welding (with the welding machine on the ground).
Do not forget that MAGNETIC FIELDS can affect pacemakers and hearing aids.

Recommendations:
- Pacemaker wearers keep away.
- Wearers should consult their doctor before going near arc welding, gouging, or spot welding operations.

Ancillary measures for preventing EMC problems:
a) Mains supply
- If electromagnetic interference still occurs, despite the fact that the mains connection is in accordance with the regulations, take additional measures (e.g. use a suitable mains filter).

b) Welding cables
- Keep these as short as possible
- Arrange them so that they run close together (to prevent EMI problems as well)
- Lay them well away from other leads.

c) Workpiece grounding (earthing)
- where necessary, run the connection to ground (earth) via suitable capacitors.
d) Shielding, where necessary
- Shield other equipment in the vicinity
- Shield the entire welding installation.

Oxyacetylene cutting and heating

The oxyacetylene process produces a high temperature flame, over 3000 degrees C, by the combustion of pure oxygen and acetylene. It is the only gas mixture hot enough to melt steel; other gases (propane, LPG or hydrogen) can be used for lower melting point non-ferrous metals, for brazing and silver soldering and as a preheating/piercing gas for cutting.

Safe storage

Gases are normally supplied under high pressure in steel cylinders. The cylinder should also have a label marked with the type of gas. To prevent the interchange of fittings between cylinders containing combustible and non-combustible gases,

oxygen cylinders have a right-hand and acetylene have a left-hand thread. All cylinders are opened by turning the key or knob anticlockwise and closed by turning them clockwise.

Oxygen will cause a fire to burn more fiercely and a mixture of oxygen and a fuel gas can cause an explosion. It is, therefore, essential that the oxygen cylinders are separated from the fuel gas cylinders and stored in an area free from combustible material.

Safe practice and accident avoidance

- Store the cylinders in a well-ventilated area, preferably in the open air
- The storage area should be well away from sources of heat, sparks and fire risk
- Cylinders should be stored upright and well secured
- Oxygen cylinders should be stored at least 3m from fuel gas cylinders or separated by a 30 minute fire resisting barrier
- The store area should be designated 'No Smoking'.

Handling compressed gases

Cylinders are fitted with regulators to reduce the gas pressure in the cylinder to the working pressure of the torch. The regulator has two gauges, a high pressure gauge for the gas in the cylinder and a low pressure gauge for the gas being fed to the torch. The gas flow rate is controlled by a pressure adjusting screw which sets the outlet gas pressure.

Factors to be considered are that the gas system is suitable for the pressure rating and the hoses are connected without any leaks. Valve threads should be cleaned before screwing in the regulator. The valve of an acetylene cylinders can be opened slightly to blow out the threads but the threads in oxygen cylinders are best cleaned using clean compressed air (the threads on hydrogen cylinders must always be blown out using compressed air).

As oxygen can react violently with oils and grease, lubricating oils or sealant for the threads must not be used.

Safe practice and accident avoidance

- Cylinders are very heavy and must be securely fastened at all times
- Cylinder valves or valve guards should never be loosened
- Check the regulator is rated for the pressure in the cylinder
- When attaching the regulator to the cylinder the joints must be clean and sealant must not be used
- Before attaching a regulator, the pressure adjustment screw must be screwed out to prevent unregulated flow of gas into the system when the cylinder valve is opened

Using compressed gases

Gases are mixed in the hand-held torch or blowpipe in the correct proportions. Hoses between regulator and torch should be colour coded red for acetylene and blue for oxygen. Hoses should be kept as short as possible and users should check periodically that they are not near hot or sharp objects which could damage the hose wall. Acetylene cylinders must always be used upright.

When connecting the system, and at least at the start of each shift, hoses and torch must be purged to remove any inflammable gas mixtures. It is essential the oxygen stream does not come into contact with oil which can ignite spontaneously. Purging should also not be carried out in confined spaces.

The torch should be lit with a friction lighter or stationary pilot flame to avoid burning the hands; matches should not be used and the flame should not be reignited from hot metal, especially when working in a confined space.

The cylinders should not become heated, for example by allowing the torch flame to heat locally the cylinder wall. Similarly, arc welding too close to the cylinder could result in an arc forming between the cylinder and workpiece/electrode.

Suitable cutting processes for different types of steel to achieve a suitable cutting surface

The three thermal cutting methods: flame cutting, plasma cutting and laser cutting are widespread and well known to most people.

Flame cutting, Principle and parameters, cutting blowpipes, cutting machines, quality of cut surface

Flame cutting is the traditional and clearly predominant method, but its use is slightly declining because of the increase in laser cutting and plasma cutting. Flame cutting remains a very useful cutting method, partly owing to its versatility. It covers the entire thicknesses range from 3 to 300 mm for unalloyed steels. By using special torches the field of application can be extended to thicknesses of up to 1000 mm or even more. The quality of cut is excellent when the cutting parameters are correctly set. In economic terms, flame cutting is clearly an alternative where numerically-controlled machines are used in conjunction with several torches in order to increase the productivity per employee.

Other cutting processes as: plasma, laser, mechanical cutting

Laser cutting give a high-quality cut, narrow kerfs and low heat transfer to the workpiece. The economic thickness for unalloyed steel is 2 to 3 mm. The use of laser cutting will increase, mainly due to increased laser power output, which will enable thicker material thicknesses to be cut.

The economic material thickness range for plasma cutting is 3 to about 20 mm. In this range plasma is faster then laser, but the quality of cut is not comparable. In an effort to compete with laser cutting, recent developments in plasma cutting have aimed to produce a system which is capable of producing cuts with completely square edges and narrow kerf width to enable higher cutting accuracy to be achieved.

The resulting systems are commonly known as high tolerance plasma cutting and are characterized by torches having high current density cutting arcs.

Smaller sets intended for manual cutting are usually air plasma, whilst larger mechanized installation use oxygen, nitrogen or argon mixtures as the plasma gas. Plasma power sources above 300 amps never use air.

In connection with subsequent welding of air-plasma cut edges, weldability problems like pore formation and lack of fusion have been noticed. Investigations have shown that high concentrations of nitrogen in the cut edges are responsible for the problems. There are different ways to avoid the problems. One is to grind off the thin layer of the cut surface that has a high nitrogen concentration. This is an expensive method and it will reduce the productivity. Another way is to cut with oxygen plasma.

An alternative to the thermal cutting methods is water jet cutting. The method emerged during the 1970s, when it was used to cut composites. Since then it has been developed to cut metals. This was made possible by adding abrasives to the jet, a technique known as abrasive water jet cutting. Using water jet cutting without abrasives it is possible to cut, in addition to composites, materials such as leather, rubber, textiles, wood, mineral wool and frozen foodstuffs. Abrasive water jet cutting can be used to cut sheet metal in gouges up to 50 mm, concrete up to 200 mm, stone and ceramics.

Abrasive water jet cutting competes to some extent with the thermal methods, but as figure 1 shows, the cutting speed is very low, so the method is only competitive where some particular technical advantage can be exploited. Examples of such advantages are that the quality of cut is very good and that no heat is transferred into the workpiece the latter feature means that there are no deformation of the workpiece. Abrasive water jet cutting is also a suitable method for cutting surface treated materials like Zn, AlZn or polymer coated sheet metal, since this cutting method will minimize destruction of surface treatment.

Safety precautions for cutting (PSS1)

In the table 1 are presented the representative cutting speed for different cutting methods.

Materials	Plate thicknesses (mm)	Cutting speed (mm/min)			
		Flame cutting	Plasma cutting	Laser cutting	Abrasive water jet cutting
Steel	5	850	4500A	2200 C	200
Steel	20	660	2000A	-	50
Stainless steel	3	-	5000B	6500	200
Stainless steel	40	-	500B	-	10-20
Aluminum	2	-	>6000B	1000 C	800
Aluminum	40	-	1200B	-	80
A - Nitrogen plasma with water injected, 500 A B - Gas plasma (Ar/H_2), 240 A C - Carbon dioxide laser 1000W, with oxygen as cutting gas					

Table 2 shows the cutting methods for different materials.

Table 2

Cutting method	Material			
	Mild steels	Stainless steels	Aluminum	Titanium
Flame	+++			++
Plasma	+++	+++	+++	++
Laser	+++	+++	++	+++
Mechanical	+++	+++	+++	+++
Water jet	+	+	++	+
+++ well suited ++ suited + possible				

Burns and fires, fire prevention, fire fighting

The basic precautions for fire prevention in welding or cutting work are:

Cutting or welding must be permitted only in areas that are or have been made fire safe.

When work cannot be moved practically, as in most construction work, the area must be made safe by removing combustibles or protecting combustibles from ignition sources.

If the object to be welded or cut cannot readily be moved, all movable fire hazards in the vicinity must be taken to a safe place.
If the object to be welded or cut cannot be moved and if all the fire hazards cannot be removed, then guards must be used to confine the heat, sparks, and slag, and to protect the immovable fire hazards.
If these requirements cannot be followed then welding and cutting must not be performed.
Suitable fire extinguishing equipment must be maintained in a state of readiness for instant use.
Such equipment may consist of pails of water, buckets of sand, hose or portable extinguishers depending upon the nature and quantity of the combustible material exposed.
Fire watchers must have fire-extinguishing equipment readily available and be trained in its use.
They must be familiar with facilities for sounding an alarm in the event of a fire. They must watch for fires in all exposed areas, try to extinguish them only when obviously within the capacity of the equipment available, or otherwise sound the alarm.

Before cutting or welding is permitted, the area must be inspected by the individual responsible for authorizing cutting and welding operations. He must designate precautions to be followed in granting authorization to proceed preferably in the form of a written permit.

Cutting or welding must not be permitted in the following situations:

- in areas not authorized by management
- in sprinklered buildings while such protection is impaired
- in the presence of explosive atmospheres (mixtures of flammable gases, vapors, liquids, or dusts with air), or explosive atmospheres that may develop inside uncleaned or improperly prepared tanks or equipment which have previously contained such materials, or that may develop in areas with an accumulation of combustible dusts.
- in areas near the storage of large quantities of exposed, readily ignitable materials such as bulk sulfur, baled paper, or cotton.

Where practicable, all combustibles must be relocated at least 10 m from the work site. Where relocation is impracticable, combustibles must be protected with flameproofed covers or otherwise shielded with metal or asbestos guards or curtains.