Education and Culture

Leonardo da Vinci

Course: 141 - TIG WELDING OF STAINLESS STEEL

Module 3

List of content

MODULE 3

Personal protective equipment and clothing (A3)

Personal protective equipment especially designed for the task at hand must always be used when arc welding. Protective clothing must not be heavily soiled or torn.

1. Head Protection

This provides protection
a) against falls (e.g. crash helmets, cycle helmets, climbing helmets)
b) against falling objects or against striking fixed objects
c) against striking fixed objects (e.g. objects in confined spaces).

2. Eye Protection

Welding helmet

A welding helmet must always be worn when welding to protect the eyes and face from radiation and welding spatter.
The welding helmet can be lowered in front of the face. The lens should be lowered using one hand instead of the "chin-up" method as repeated nodding can cause neck injuries.

Welding lenses

Welding helmets and welding lenses both have dark glass, so-called welding lenses. The welding lens is used to filter out UV and IR radiation. Only visible light is allowed to pass the lens.

Lens protector

Lens protectors are used in welding helmets and shields to protect the welding lens from spatter.

Automatic welding lenses

Automatic anti-dazzle welding lenses are also available. This type of welding lens darkens automatically the moment the arc is ignited and becomes lighter again when the arc is extinguished. Automatic welding lens can be set to different densities.

Welding helmet with fresh-air supply

Equipment is available for supplying fresh and cool air to the welding helmet. The positive pressure created inside the welding helmet prevents weld smoke from mixing with the air the welder inhales. Comfort is also enhanced and mist is prevented from forming on the welding lens.

Relevant standards:
a) EN169 welding filters
b) EN175 welding eye protectors
Always choose eye protection appropriate to the hazard and ensure that fits properly and is comfortable.
Dirty lenses impair vision, causing eye fatigue and leading to accidents. The plastic lenses of eye protectors should be wet cleaned to avoid scratching; scratched lenses should be replaced, as should face shields if they become crazed or brittle with age.
Safety spectacles and goggles should be issued on a personal basis and should be thoroughly

cleaned before issue to someone else.

3. Foot Protection

Safety footwear should comply with EN 345 (with toe protection of 200 or 100 joules). Footwear with anti-static or slip resistant properties should conform to EN 347.
The choice of safety footwear should first be made on the basis of the protection required, but comfort is a significant issue and should not be ignored. Care should be taken in the choice of anti-static and conductive footwear. Both give protection against the hazard of static electricity and anti-static footwear also gives some protection against electric shock. However conductive footwear provides no protection against electric shock and must not be used where this is a risk.
Footwear should be checked for wear or damage and replaced if necessary.

4. Gloves

Gloves may be used to give protection against toxic or corrosive chemicals, microbiological or radiological contamination, cuts and abrasions, impact, vibration or extremes of heat and cold.
Standards for protective gloves are complex and basic standards are listed below. Gloves may additionally be described as of simple, intermediate, or complex design (a measure of their suitability for risks ranging from minimal to high); a performance level (usually on a scale from 0 to 4) may also be quoted.
a) EN 407 for protection against heat and/or fire
b) EN 421 for protection against ionizing radiation/radiation contamination
c) EN 659 for protection against heat and flames
Choose gloves appropriate for the job and consider whether long cuffs, gauntlets, or sleeve protectors may be required. Ensure that they offer good fit, comfort, and dexterity.
Gloves rarely provide complete protection against hazards and this protection is much diminished by wear, damage, and chemical contamination. They should be checked before wear for cuts or pinholes and replaced if necessary.

5. Protective Clothing

Protective clothing should be maintained as specified by the manufacturer.

Welder equipped with personal protection equipment.

In addition to the general protective clothing for welding and cutting operations, arc welding requires the following extra clothing:

W ear clothes made of materials heavy enough to protect against ultraviolet rays.
W ear dry welder's gloves to protect against shock and electrocution.

Noise hazards (A3)

Noise is usually defined as undesirable sound and is a health hazard. Noise can cause hearing damage. Disturbing noise levels in combination with requisite ear defenders can make it difficult to communicate, which may lower the level of enjoyment in the workplace. Psychological well-being is also affected by noise.

Noise abatement

Sources of noise in a welding workshop are grinding, slagging and beating. This kind of work must be minimized. When grinding or hammering must be performed the use of equipment and aids that give the lowest possible noise levels is requested.

Clang dampers

It is the workpiece that generates most noise during grinding, slagging and beating. Using clang dampers will reduce the noise level considerably. Clang dampers are elastic dampers with a magnetic layer for fastening on the workpiece.

Silenced machines

Quieter hand-held machines have been developed during the last few years. Pneumatic slag picks and grinding machines are now fitted with silencers. Quieter grinding discs have been developed. Using modern equipment will reduce the noise level considerably.

Noise absorbing screens

Screens made of porous material such as mineral wool erected between the welding areas can limit the noise in many cases. The screen must be high and wide and located as close as possible to the source of the noise. By erecting absorbers above and beside the screen, noise can be reduced at longer distances.

Ear defenders

In many welding shops the noise level is so high that ear defenders must always be used. Wearing ear defenders of down or earplugs will provide basic protection against background noise and unexpected sound. The noise level when slagging and beating is so high that ear cups are required. It is essential to wear ear defenders all the time in extremely noisy environments. Even short periods without protection can risk damaging your hearing. A hearing impairment cannot be cured.

Resume: Noise of 85 db (A) or higher might lead to hearing damage

Safety measures:

- noisy techniques to be substituted by quieter ones
- protection from sound waves - isolation
- spatial division
- marking noisy areas
- personal safety equipment (ear phones)
- medical prevention and ambulance

If the 85 db (A) level is reached - one must posses personal hearing protection equipment
Above the level >90 db (A), standard noise protection is required for all employees.

Suitable cutting processes for different types of steel to achieve a suitable cutting surface (A8)
The three thermal cutting methods: flame cutting, plasma cutting and laser cutting are widespread and well known to most people.
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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 (A3)

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.