Plumbing Installation Work

LEVEL II

Learning Guide # 33

Unit of Competence: Weld using arc welding equipment

Module Title: Welding using arc welding equipment

LG Code: EISPLI2 M08 Lo1- LG 33

TTLM Code: EISPLI2TTLM080919 v1

LO 1: Prepare for work.

Instruction Sheet-1	Learning Guide #33

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Identify Plans and specifications.
- ***Safety (OHS)*** and workplace ***environmental*** are ***required*** to the work.
- ***Assurance Quality*** workplace requirements.
- Tasks are planning and sequencing conjunction with others involved in or affected by the work..
- . Checking ***tools and equipment,*** including personal protective equipment and serviceability.
- . Preparing Work area to support efficient performance of arc welding.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Identify Plans and specifications.
- ***Safety (OHS)*** and workplace ***environmental*** are ***required*** to the work.
- ***Assurance Quality*** workplace requirements.
- Tasks are planning and sequencing conjunction with others involved in or affected by the work.
- . Check ***tools and equipment,*** including personal protective equipment and serviceability.
- . Prepare Work area to support efficient performance of arc welding.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4, Sheet 5 and Sheet 6”.

4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3, Self-check 4 , Self-check 5 and Self-check 6” **in page -8, 18, 21,23,28 and 30** respectively.

Information Sheet-1	**Identify Plans and specifications.**

1.1 Identify Plans and specifications

Welding Symbols on Drawings or plan

Engineering drawings are descriptions of manufactured objects in terms of shape, surface, finish and material. In many industries it is customary to draw the shape of the component without indicating how that shape is achieved.

The drawing is a description of a requirement produced by the designer for the instruction of the manufacturer. In theory, the manufacturer knows best how to produce an object with the resources he has. In practice, of course. The designer compromises and produces designs which are capable of production by the techniques, of which he is aware. For example, a round hole can be drilled, bored or punched. And can be finished by reaming, but which ever method is used, the lines on the drawing are the same and whichever method is used, the material is not changed in its characteristics.

A welded joint offers a range of considerations which do not arise in other forms of manufacture. **Firstly,** there are far more techniques for making a welded joint than in many other manufacturing operations. This means that the designer has far less chance of foreseeing the manufacturer’s methods.

Secondly, the properties and integrity of the joint will depend on the manner in which the weld is made despite this; the designer can still indicate the type of Joint he requires. Provided that he is prepared to accept that he may not be able to completely define the joint in the earlier stages of a design.

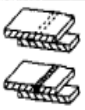
In some industries it is customary for the manufacturer to produce shop drawings which contain details of weld preparations and reference to established welding procedures not shown in detail on the designer’s drawings. The range of British Standard symbols which can be used on a drawing to indicate a weld detail are described here.

Symbolic representation of welds on drawings

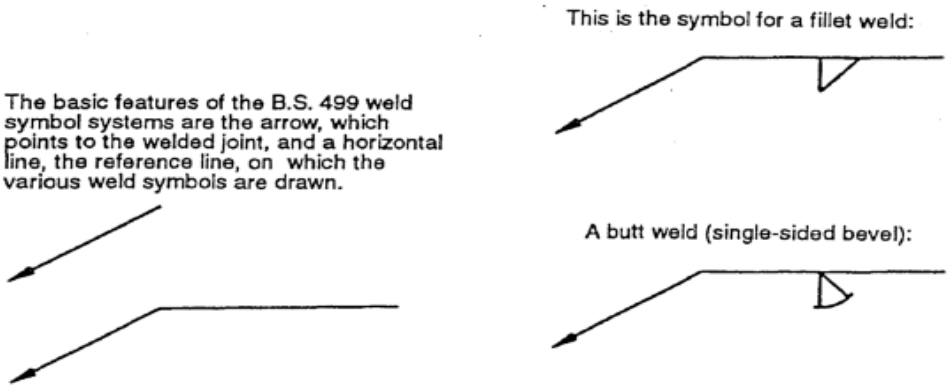
A welding symbol on a drawing consists of:

- An arrow line (1)
- One or two reference lines (2)
- An elementary symbol (3)
- Possible supplementary symbols
- Dimensions of the weld

No	Designation	Weld	Symbol
1	Weld in plates with raised edges		
2	Square butt weld		
3	Single V-butt weld		
	Singel-bevel butt weld		
5	Single-V butt weld with broad root face		
6	Single-bevel butt weld with broad root face		
7	Single-U butt weld (parallell or sloping sides)		

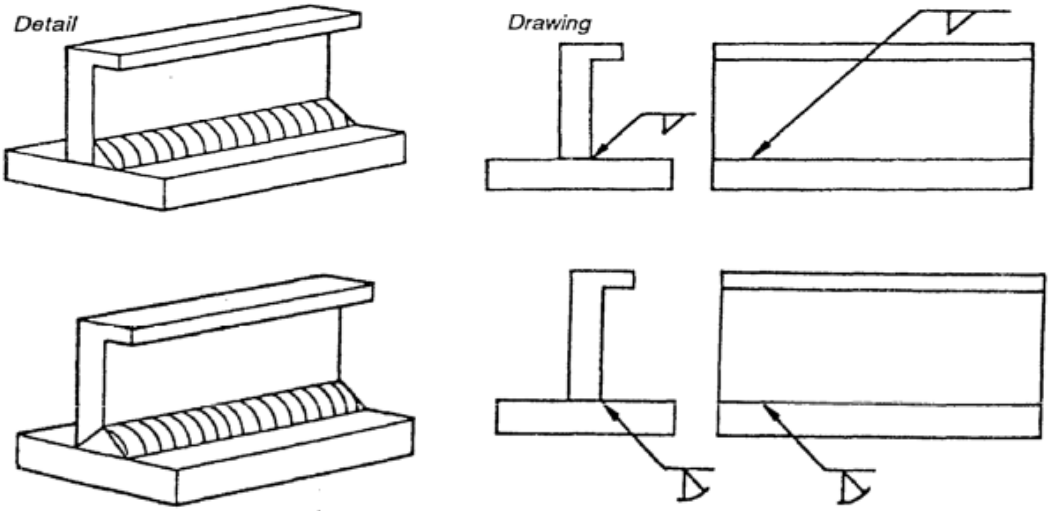
No	Designation	Weld	Symbol
8	Single-J butt weld		
9	Backing run		
10	Fillet weld		
11	Plug weld		
12	Spot weld		
13	Seam weld		

Welding Standards Drawing Notation



Basic B.S. 499 weld features

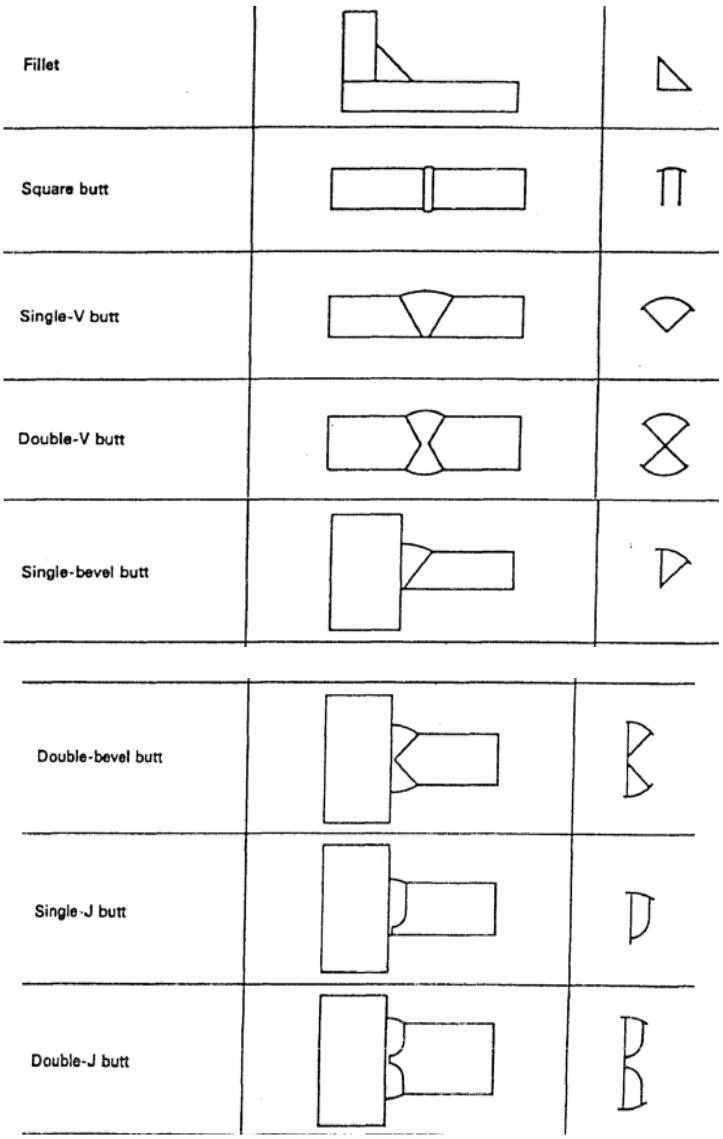
In practice, the two symbols shown above right would be used as follows:



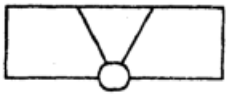
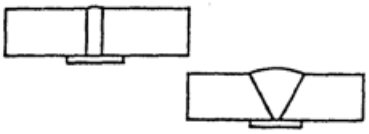
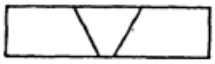
NOTE: The arrow points towards the prepared edge

Basic B.S. 499 weld features applied

Explanation for Standard Weld Symbols

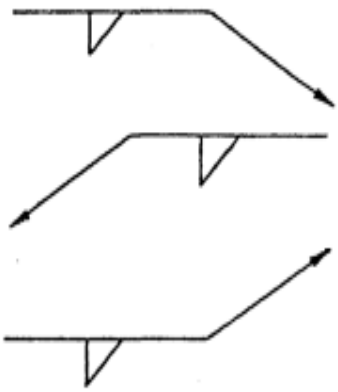


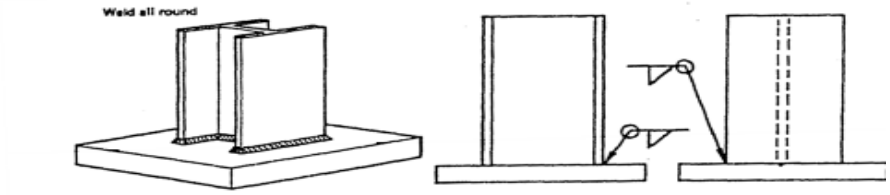
B.S weld symbols 1.

Sealing run		
Backing strip		
Dressed flush		
– and a very useful symbol Full penetration butt weld by a welding procedure to be agreed		

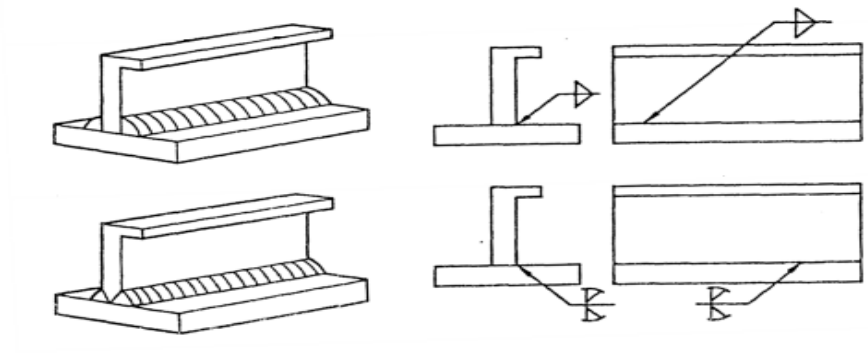
B.S weld symbols 2.

The weld symbol is always drawn the same way round regardless of the layout of the arrow and the reference line. The position of the symbol on the reference line has significance. A symbol below the reference line means that the weld is made from that side of the joint indicated by the arrow. A symbol above the reference line means that the weld is made from the opposite side of the joint to the arrow.



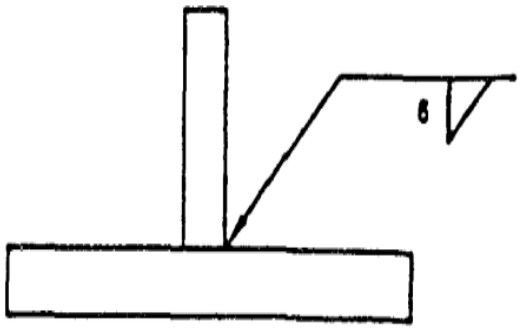


A joint made from both sides has a symbol on each side of the reference line.

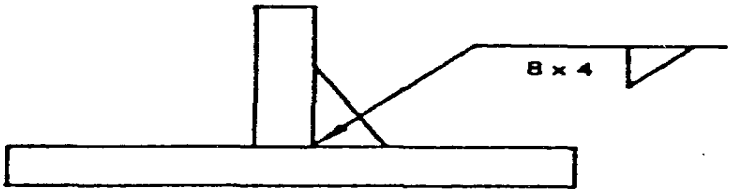


B.S weld symbols example 2.

Weld size can be indicated on the symbol. 6 mm fillet weld. The drawing must state whether a Throat or leg dimension is quoted. Unequal leg fillet weld. This must be defined by leg length. Diagram of weld) shape is required here.

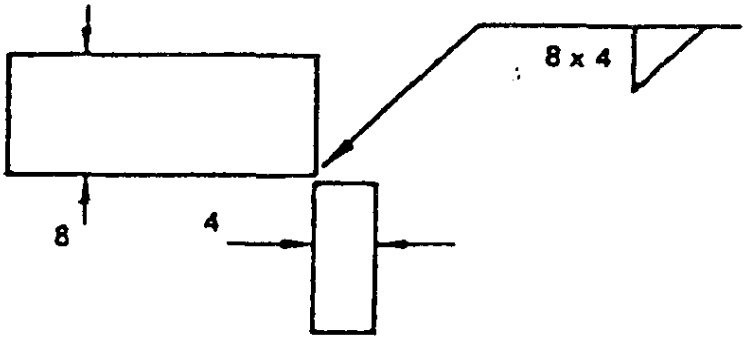


6mm fillet weld



Unequal leg fillet weld

A diagram is not required here because the size of the members indicates the weld orientation.

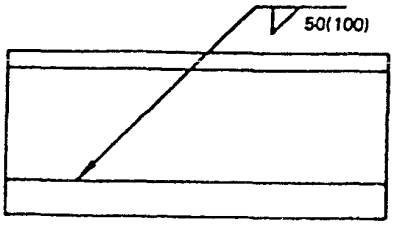


Size of the members

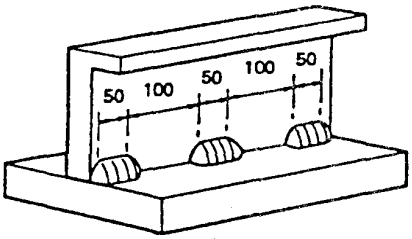
Intermittent Welds

Information other than weld size may be written to the right of the symbol.

The figure in brackets is the space length. 50 before (100) indicate that the weld is at the beginning. (100) 50 would indicate a space first then a weld although such an arrangement would not represent good practice.



Information on side of the symbol



Intermittent welds

Self-Check -1	Written Test

Directions: Answer all the questions listed below

1. Symbolic representation of welds on drawings consists of:---------- .(5 points)

A) An arrow line (1)

B) An elementary symbol (3)

C) Possible supplementary symbols

D) Dimensions of the weld

E) all

Note: **Satisfactory rating – 2.5 and 5 points** **Unsatisfactory - below 2.5**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet- 2	Safety (OHS) and workplace environmental are required to the work

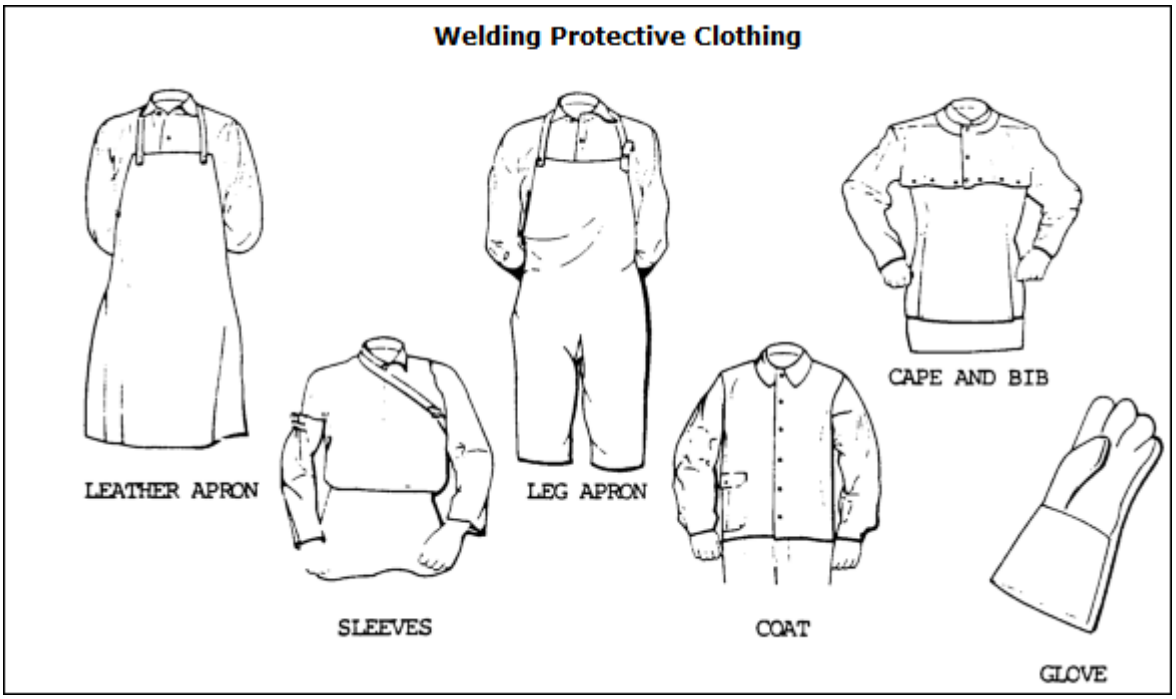
1.2 Safety *(*OHS*)* and workplace environmental are required to the work

Personal protective equipment (PPE) Arc welding, like most welding processes, requires operators to protect themselves from the radiated heat and rays associated with the process. Perhaps the most efficient way of doing this is by the wearing of protective clothing. The use of all protective clothing is dictated by the nature of the work and the comfort of the operator. Ideally, clothing for the operator should consist of:

- long-sleeved cotton shirt sleeves
- rolled down and buttoned
- strong trousers without cuffs
- strong leather shoes or work boots
- aprons
- gloves
- spats (leather)
- caps
- leather capes or jackets


Cloth cap for hair and scalp protection
Face and head protection
Flame-proof jacket
Flame-proof trousers or overalls
Flame-proof mitts or gloves
Spats
Safety boots


Welding Safety Goggles


Welding Protective Clothing
LEATHER APRON
SLEEVES
LEG APRON
COAT
CAPE AND BIB
GLOVE


Welding Jacket

1.2.1 The working environment

There are work situations which present increased hazards to the health and safety of The welding operator. These are:

- confined spaces
- hazardous locations
- Working on tanks and containers.

Working in confined spaces usually entails difficult access and cramped conditions. The workplace is often poorly ventilated, and the welder is often completely surrounded by a conductor which forms part of the welding circuit. Under these circumstances the welding operator is at increased risk from:

- a build-up of fumes
- Electric shock.

The possibility of a build-up of dangerous fumes whilst welding in a confined space must be allowed for and adequate ventilation be provided through:

- Exhaust fans
- An additional supplementary air supply.

The possibility of an electric shock is greater because the operator can easily make contact with the job, and awkward and enclosed workplaces often lead to higher levels of perspiration. The operator should keep themselves as dry as possible and use the necessary

- protective clothing to prevent electrocution. Additionally:
- an all-insulated electrode holder should be used
- high-frequency attachments should not be used
- portable electric lamps exceeding 32 V supply should not be used.
- Electronic leakage breakers (ELB) devices are acceptable.

Provision must be made, close to the work area, for the power to be switched off by an assistant when:

- the welder is not prepared for welding
- the electrode is being changed
- the operator leaves the job.

1.2.2.1 Confined space regulations

The following regulations are specified as mandatory when working in a confined space.

- Adequate ventilation must be provided.
- A lifeline must be attached.
- A semi-skilled operator who is trained in rescue and resuscitation must be
- stationed at the manhole to monitor the work space at all times; to adjust
- oxy-acetylene gear and the welding machine, whilst continually observing the
- operator.
- All leads and hoses are to be kept clear of the floor, dampness and falling metal
- sparks. Circular vessels must be prevented from rolling.
- General tidiness and care is essential, equipment should not be allowed to
- contact hot work or sharp objects.
- Oxy-flame cutting equipment should not be left inside the confined space when

- not in use, and it should always be lit by the assistant outside and then passed to
- the operator inside.
- Oxygen should never be used for dusting down or any purpose other than for the
- oxy-flame.

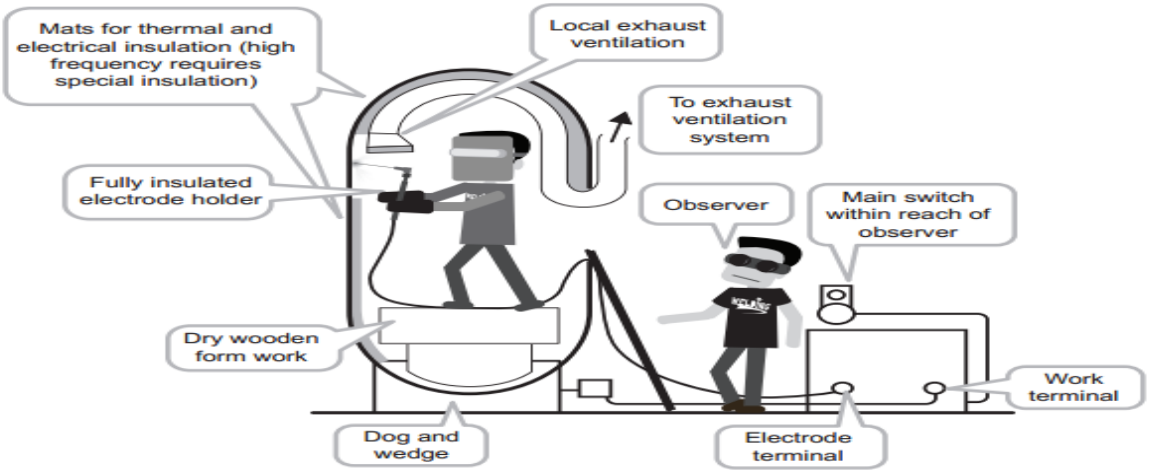


Fig 1.11 – Precautions for welding in confined spaces

1.2.2.2 Hazardous locations

Although many workplaces may be described as hazardous, **a hazardous location** is defined as 'An area where flammable dust, fibers or gases may be present so as to pose a fire or explosion hazard'. Hazardous locations may be classified into four main groups typically, as follows.

1. in locations where flammable liquids are manufactured, used, handled or stored, or where vapours may be present.

- refineries, fuel stores
- dry cleaning plants
- spray painting premises
- varnish and paint manufacturing plants.

2. In locations where combustible dust is thrown into suspension in the air and quantities may be sufficient to produce explosive mixtures.

- sections of flour mills
- grain elevators
- cocoa and coal pulverizing plants
- iron ore or aluminum plants
- metal grinding plants
- charcoal grinding plants.

3. In locations where easily ignitable fibers are produced, handled, used or stored.

- eg cotton or cotton seed mills
- wood working plants
- Sections of clothing factories.

4. In any location or part of a ship

1.2.2.3 Protect yourself and others from potential hazards including:

- Fumes and Gases
- Electric Shock
- Arc Rays
- Fire and Explosion Hazards
- Noise
- Hot objects

Electric Shock

- Electric shock can kill
- Do not touch live electrical parts
    - Primary Voltage –230, 460 volt input power

- Secondary Voltage – 6 to 100 volts for welding

➢ Insulate yourself from work and ground

➢ Follow all warnings on welding equipment

Fire and Explosion Hazards

➢ Welding sparks can cause fires and explosions

➢ Sparks and spatter from the welding arc can spray up to 35 feet from your work

➢ Flammable materials should be removed from the welding area or shielded from sparks and spatter

➢ Have a fire extinguisher ready

➢ Inspect area for fires 30 minutes after welding

Noise

➢ Loud noises can damage your hearing

➢ Keep loud noises at a safe level by using proper hearing protection such as:

- Ear plugs
- Ear muffs

PERSONAL PROTECTIVE EQUIPMENT

	Safety glasses must be worn at all times in work area!
	Respirator with HEPA filters must be worn when working with asbestos containing materials. Workers must be fit tested prior to performing any asbestos work.
	Work Boots must be worn at all times when working in an area where there is risk of serious foot injury due materials falling onto the foot.
	Welding work gloves should be worn when there is a risk of hand injury during the course of work tasks.
	Hard hats must be worn when working in an environment where there is a risk of objects falling from above or where there is a high risk of striking your head on objects.

	Welding helmets must be kept in good shape and have protective lenses meeting shade selection requirements for the task.
	Protective clothing must be worn whenever cutting, welding and grinding is done. This includes welding jacket, welding gloves, and respirator is required.

Potential health & safety hazards

HAZARD		TO PROTECT YOURSELF
PINCH POINTS **There are gears and exposed moving parts on machinery.**		Use LOCK-OUT procedures when performing maintenance or conducting any work within 12" of an exposed pinch point. NEVER put your hands or feet near an exposed pinch point or gears!
ELECTRICAL HAZARD		Ensure all electrical equipment and machines have plugs and wires that are in good condition.
EXPLOSIVE		Make sure cylinders are stored and handled correctly. Proper grounding must be used.
HIGH SOUND LEVELS **Sound levels exceed 85 dB**		**HEARING PROTECTION** is required when working in designated areas.

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. Arc welding Protective clothing for the operator should consist of: ---------- (5 points)

A) long-sleeved cotton shirt sleeves
B) Rolled down and buttoned
C) Strong trousers without cuffs
D) Strong leather shoes or work boots
E) Aprons
F) All

2. Classifications of Hazardous locations are _____(5 points)

A) Flammable liquids are manufactured
B) Combustible dust is thrown
C) Part of a ship
D) Easily ignitable fibers are produced
F) All

Note: **Satisfactory rating – 5-10 points** **Unsatisfactory - below 5 points**

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	*Assurance Quality* workplace requirements

1. 3 Assurance *Quality* workplace requirements

Welding Quality Assurance Inspectors are needed to inspect welds to be sure they have been performed according to contract requirements and are up to the specific state codes and standards in the industry. The inspector does this by performing visual inspections on the welded steel pieces, as well as testing them for possible defects. The inspector uses specific testing and measuring devices.

Weld quality assurance is the use of technological methods and actions to test or assure the quality of welds, and secondarily to confirm the presence, location and coverage of welds. In manufacturing, welds are used to join two or more metal surfaces. Because these connections may encounter loads and fatigue during product lifetime, there is a chance they may fail if not created to proper specification

Weld testing and analysis

Methods of weld testing and analysis are used to assure the quality and correctness of the weld after it is completed. This term generally refers to testing and analysis focused on the quality and strength of the weld, but may refer to technological actions to check for the presence, position and extent of welds. These are divided into destructive and non-destructive methods. A few examples of destructive testing include macro etch testing, fillet-weld break tests, transverse tension tests, and guided bend tests.

[1] Other destructive methods include acid etch testing, back bend testing, tensile strength break testing, nick break testing, and free bend testing.

[2] Non-destructive methods include fluorescent penetrate tests, magnaflux tests, eddy current (electromagnetic) tests, hydrostatic testing, tests using magnetic particles, X-rays and gamma ray based methods and acoustic emission techniques.

[3] Other methods include ferrite and hardness testing

Weld monitoring

Weld monitoring methods are used to assure the quality and correctness of the weld during the process of welding. The term is generally applied to automate monitoring for weld-quality purposes and secondarily for process-control purposes such as vision-based robot guidance. Visual weld monitoring is also performed during the welding process.

On vehicular applications, weld monitoring has the goal of enabling improvements in the quality, durability, and safety of vehicles – with cost savings in the avoidance of recalls to fix the large proportion of systemic quality problems that arise from suboptimal welding. Quality monitoring in general of automatic welding can save production downtime, and can reduce the need for product reworking and recall. Industrial monitoring systems encourage high production rates and reduce scrap costs.

Job Requirements of Quality Assurance/Quality Control Inspectors

Basically, inspectors need to know about everything related to welding. They need to be knowledgeable about applicable codes and how to quickly look up any section when they need to verify and substantiate that a weld needs to be reworked. They need to know how to engage in nondestructive testing, be cognizant of the terminology applicable to the welding process and how different materials react when combined during the welding process. Just a few of the job requirements recently listed in an advertisement for a welding inspector include:

- Dedication to the quality control/quality assurance process.
- Ability to read complex fabrication plans.
- Ability to efficiently multi-task.
- Excellent verbal, written and computer communication skills.
- Certification as a welding inspector.
- Knowledge of how to properly interpret relevant codes and regulations.
- Be detail-oriented and have the ability to conduct visual inspections as well as knowledge of how to use proper equipment when circumstances require it.

- Environment Protection Authority (EPA)
- internal company quality assurance policy and risk management strategy
- International Standards Organisation
- site safety plan

Workplace operations and procedures

Self-Check -3	Written Test

Directions: Answer all the questions listed below.

1. _____ is the use of technological methods and actions to test or assure the quality of welds, and secondarily to confirm the presence, location and coverage of welds. (**3 points**)

B. Weld quality assurance

C. Data

C. Weld monitoring D. Gathering information

2. Write down the two methods of Weld testing and analysis.(**4 points**)

Note: **Satisfactory rating – 3.5and 7 points** **Unsatisfactory - below 3.5 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	Tasks are planning and sequencing conjunction with others involved in or affected by the work.

1.4 Tasks are planning and sequencing conjunction with others involved in or affected by the work

The risks associated with a manual electric arc welding operation should be assessed and appropriate safety measures should be established and implemented before commencing the operation. Preparation planning and sequencing of welding before the operation should include the following:

- (a) to assess the risks associated with the operation, to establish appropriate safety measures, safe working procedures and emergency response procedures, and to pay special attention to specific work conditions such as handling of large and/ or heavy work pieces, working at height, working in confined spaces;
- to ensure that appropriate equipment and safety devices are used, necessary control measures are implemented and suitable personal protective equipment is available and in use;
- to provide appropriate information, instructions and training to the welding workers and supervisors;
- to ensure cleanliness of the work area and that measures have been taken to prevent outbreak of fire;
- to conduct pre-use equipment check; and
- To ensure that no work that gives off flammable gases, vapors, liquids or dust would be conducted in the vicinity.

Self-Check -4	Written Test

Directions: Answer all the questions listed below.

1. Write down the preparation planning and sequencing of welding (5point)

Note: Satisfactory rating – 3 points **Unsatisfactory - below 3 and 4 points**

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-5	Checking tools and equipment, including personal protective equipment and serviceability

1.5 Checking tools and equipment, including personal protective equipment and serviceability

1.5.1 Power Tools

- Angle grinder with a paddle switch
- Sawzall (optional)
- Metal Band Saw

Hand Tools

- Welding pliers
- Steel wire brush - specifically a steel brush, not a stainless steel
- Hack saw

1.5.2 Arc welding equipment

Arc welding equipment is listed below. The equipment's are categorized as facilitator, Consumable and protecting equipment.

Facilitator Equipment Welding

(a) Power source (welding machine)

(b) Electrode holder

(c) Work table

(d) Cables (for connection)

(e) Finishing devices like chipping, hammer, wire brush, etc.

Consumable Equipment

(a) Electrode

(b) Flux

(c) Work piece

(d) Filler metal

Protecting Equipment

(a) Welding shields

(b) Goggles

(c) Screens

(d) Gloves

(e) Apron

Power Source

Both AC (Alternative Current) and DC (Direct Current) can be used for welding. AC machines are recommended for ferrous metal and DC machines are recommended for other metals for better result. Main constituent of welding machine is transformers which convert the supply to low voltage and high current. For AC welding power is required at 80 to 110 volt and 50 to 80 ampere. For sustaining the established are power factor is kept low.

In case of DC welding power is required at 8 to 25 volts and 50 ampere. Polarity is also are significant factor. Two types of polarities are possible in case of DC welding. Straight Polarity Electrode is made negative pole and work piece is made positive pole. It is also called as electrode negative. Reversed Polarity Electrode is made positive pole and work piece is made negative pole. It is called electrode positive too. As we know that two third of the total heat is generated at positive pole and only one third at negative pole. Polarity is decided according to the requirement of heat at either pole.

Welding Electrodes

These are also called welding rods. Two types of welding electrodes are generally used. Consumable electrodes and non-consumable electrodes. Consumable electrodes are the sources of filler metal in case of are welding. Consumable electrodes can further be classified into two categories coated and bare electrodes.

Bare electrodes are simple rods mode of filler metal with no coating over them. In case of bare electrode flux is required additionally. These electrodes are rarely used. Bare non-consumable electrodes are used in case of gas shielded welding processes (MIG and UIG).

Non-consumable Electrodes

They are made of tungsten or carbon. These do not melt in the process of welding and so called non-consumable electrodes. Their depletion rate is very low. In case of non-consumable electrodes metal and flux is supplied
additionally. Generally non-consumable electrodes are used in MIG and TIG welding processes.

Coated Consumable Electrodes

These are the most popular arc welding electrodes. No additional filler metal and flux are required with them. In general these electrodes have core of mild steel and coating over them of flux material. Coating on the electrode performs many functions. It develops a reducing atmosphere and prevents oxidation, forms separable slag from metal impurities, establishes ac providing necessary alloying elements to the weld pool. The common ingredients act as flux which help in sla-g formation are asbestos, mica,silica, fluorspar, stealite, titanium dioxide, iron oxide, metal carbonates, etc.Ingredients used to produce reducing atmosphere are cellulose, dalomine, wood flour, starch. Iron powder provides higher deposition rate. Manganese oxide and potassium silicate and titanate are the alloying elements and stabilizers.

1.5.3 Personal protective equipment

Engineering and administrative controls should be the primary method used to control the hazards. Personal protective equipment should be considered as the last line of defence. Personal protective equipment should be used to provide the following types of protection:

(a) electric shock protection;

(b) eye and face protection;

(c) respiratory protection;

(d) skin and body protection; and

(e) hearing protection.

Electric shock protection

Personal protective equipment that help to reduce the risk of electric shock during manual electric arc welding operation would include protective clothing, insulated welding gloves, safety shoes or boots, and insulation

mats. The equipment should always be kept dry.

Eye and face protection

Suitable eye and face protectors should be provided to and used by the welding worker and other affected workers. Goggles, welding helmets, handheld shields, or other suitable eye protectors having the proper lens

shade for the welding work being done should be worn or used by workers during the welding operations. Electric arc welding usually produces intense electromagnetic radiations, filters of high shade levels are usually required. Welding helmet is preferred to handheld screen as the latter may be improperly held. Welding of metals by means of an electric arc is a specified process under the Factories and Industrial Undertakings (Protection of Eyes) Regulations (Cap. 59 sub. leg. S). Regulation 4 of the said Regulations empowers the Commissioner for Labour to approve specifications for eye protective equipment by notice in the Gazette. The approved specifications should be referred to in selecting eye protective equipment.

Respiratory protection

The primary defence against respiratory hazards is to control the contamination at source and prevent it from entering the breathing zone of workers. Respiratory protection should only be used when engineering controls are not feasible to control exposure to airborne contaminants. For selecting an appropriate respirator, an exposure assessment should be conducted to determine the type and amount of hazardous exposure, with factors such as the welding task, the worker characteristics, the working environment, and the equipment characteristics and its limitations taken into account. As wearing of non-powered filtering type respiratory protective equipment would pose a physical burden, the proprietor should

ensure that the wearer is fit for the purpose.

Skin and body protection

Skin and body protection includes protection to the head, face, hands, feet, body and personal clothing. The major objective is to provide workers protection against burns by the flame, hot slag, spatters or work piece. The protective gears should be made of flame retardant materials and should be selected according to the nature, volume and location of the welding work. These include facemasks, hats/ helmets, aprons, gloves,

gauntlets, spats, safety shoes, etc.

Hearing protection

In manual electric arc welding operations, high level of noise may come from associated work processes such as cutting, grinding and chipping. The Factories and Industrial Undertakings (Noise at Work) Regulation (Cap.59 sub. leg. T) aims at protecting the hearing of workers who are exposed or likely to be exposed to hazardous noise levels while at work. Noise should be controlled at the source whenever feasible. If the noise hazard cannot be reduced to acceptable levels by engineering control methods, such as shielding the noise source, approved ear protectors should be provided to and used by all affected workers.

Self-Check -5	Written Test

Directions: Answer all the questions listed below.

1. Which one of the following are not arc welding power tools (5 points)

A) Metal Band Saw

B). Renewing and updating information

C) Seawall (optional

D) Angle grinder with a paddle switch

2. Which one of the following is not arc welding facilitator Equipment Welding? (5point)

A) Power source (welding machine)

B) Electrode holder

C) Work table

D) Angle grinder with a paddle switch

Note: **Satisfactory rating – 5-10 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Name: _____ Date: _____

Information Sheet-6	**Preparing Work area to support efficient performance**

1.6 Preparing Work area to support efficient performance

A welding area must be provided with good ventilation, sufficient light, fire extinguisher, and first aid kits. The workshop designed for welding should not be constructed from combustible material**.** The work area also is kept clean and free of combustible and flammable materials

Tips for preparing your material before welding

The welding process is a very important step in a variety of manufacturing and fabrication processes. All different types of metals are welded for many different types of fabrication. However, for any welding process to be accurate and effective the first time around, it is universally true that the parent material must be properly prepared.

Material preparation is so critical that it is often documented to ensure consistency in the procedure, regardless of the material. Removing coatings such as paint, oils, greases, and rust (oxides) ensures that the area to be welded is in the best possible condition.

When working with carbon steels, it is critical to remove any rust and other impurities such as mill scale. Oil-based coatings and acidic pickling chemicals also must be removed before welding takes place. Removing chromium oxide to produce a decorative finish on stainless steel alloys often is achieved in a direct process. But the subsequent cleaning of the welded area to remove any surface oxide (often seen as the discoloration next to a weld) allows for the re-formation of a protective layer that is very important in the stabilization of stainless steel alloys. This stabilization is known as passivation.

Nonferrous materials present their own challenges in the weld preparation process. With metals such as aluminum and titanium, there is a shorter window of time between the surface cleaning and the welding, as oxidation can form very quickly. Cleaning large areas too early before welding often leads to the need for rework.

Self-Check -6	Written Test

Directions: Answer all the questions listed below.

1. Preparing arc welding area provides us _____. (5 points)

A. sufficient light

C. first aid kits

B. good ventilation

D. fire extinguisher

Note: **Satisfactory rating – 2.5-5 points** **Unsatisfactory - below 2.5 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

List of Reference Materials

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2. http://www.angelfire.com/my/welding/test.html
3. http://www.clemex.com/pdf/reports/WeldingAnalysis692.pdf Welding Analysis – Image Analysis Report #692, Clemex Technologies Inc.
4. http://nvlpubs.nist.gov/nistpubs/jres/109/2/j92den.pdf Spot Weld Analysis with 2D ultrasonic Arrays Journal of Research of the National Institute of Standards and Technology Volume 109, Number 2, March–April 2004 A.A. Denisov, C.M Shakarji, B.B. Lawforfd, R. Gr. Maev J.M Paille
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6. Sun, A. S. (2001). "Time-frequency analysis of laser weld signature". Proceedings of SPIE. 4474. p. 103. doi:10.1117/12.448639. "Reliable monitoring methods are essential for maintaining a high level of quality control in laser welding. In industrial processes, monitoring systems allow for quick decisions on the quality of the weld, allowing for high productions rates and reducing overall cost due to scrap."
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Plumbing Installation Work LEVEL II

Learning Guide # 34

Unit of Competence: Weld using arc welding equipment

Module Title: Welding using arc welding equipment

LG Code: EISPLI2 **M08 Lo2- LG 34**

TTLM Code: EISPLI2**TTL**M08**0919** v1

LO 2: Identify welding requirements

Instruction Sheet	Learning Guide # 34

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identify for Welding requirements specifications.
- Identifying and Selected Materials to be welded accordance with workplace procedures.
- Identifying of welds in accordance with workplace procedures and job specifications

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Identify for Welding requirements specifications.
- Identify and Selected Materials to be welded accordance with workplace procedures.
- Identify of welds in accordance with workplace procedures and job specifications.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2 and Sheet 3”.
4. Accomplish the “Self-check 1, Self-check t 2 and Self-check 3” **in page -36, 43 and 46** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet and Operation Sheet ”**.**
6. Do the “LAP test” **in page –** (if you are ready).

Information Sheet-1	Identify for Welding requirements specifications.

2.1 **Identify for Welding requirements specifications**.

Welding procedure specifications that satisfy the requirements specified in the applicable standard are stamped accepted Welding procedure specification submitted for approval shall include, as a minimum, the applicable essential variables of the governing design or manufacturing standard.

All arc welding processes have a few basic requirements for their operation. They must Have a safe voltage available that is sufficient for the operator to get the arc started and Be maintained. They also require sufficient amperage to provide the heat for melting of The parent metal and filler material

Arc welding processes have been a popular and widely applied method of welding for many years. They offer sound and reliable weld, simple operation and low capital cost. There are a lot of arc welding processes used in the metal fabrication and welding industries. Some of these are commonly used and others are used in specialist applications. This section introduces some of the most commonly used arc welding processes; which are:

- manual metal arc welding (MMAW)
- gas metal arc welding (GMAW)
- flux cored arc welding (FCAW)
- submerged arc welding (SAW)
- gas tungsten arc welding (GTAW).

All welding processes depend on three main requirements for their operation.

- A heat or energy source – needed for fusion.
- Atmospheric shielding – to prevent oxygen and nitrogen in the atmosphere from contaminating the weld.
- Filler metal – to provide the required weld build-up.

Welding Procedure

The welding shall be done by the Submerged-Arc Process using either automatic or semi-automatic equipment, with single or multiple arcs as indicated on the Welding Data Sheets. Joints shall be made following the procedural stipulations indicated in CSA Standard W59, and may consist of single or multiple passes in accordance with the accepted Welding Procedure Data Sheets to which this specification refers.

Base Metal

The base metal shall conform to the specifications of steel groups 1, 2, 3 as per Table 11.1 or Table 12.1 of CSA Standard W59. Other groups may be welded providing Welding Procedure Data Sheets are accepted by the Canadian Welding Bureau.

Base Metal Thickness

Base metal thicknesses from 3 mm (1/8") to UNLIMITED THICKNESS inclusive may be welded under this specification providing the respective Welding Procedure Data Sheets have been supplied and ac

Filler Metal/Flux

The electrode and flux to be used in combination shall conform to the requirements of CSA Standard W48. Any combination of electrodes and fluxes not certified by the CWB shall be subject to procedure qualification. accepted for the appropriate weld size

Self-Check -1	Written Test

Directions: Answer all the questions listed below

1. Which one of the following is not the most commonly used arc welding processes .(**3 points**)
   A) manual metal arc welding (MMAW)
   B) gas metal arc welding (GMAW)
   C) flux cored arc welding (FCAW)
   D) submerged arc welding (SAW)
   E) gas tungsten arc welding (GTAW).
   F) electrode
2. write down the three main requirements arc welding.(**6 points**)

Note: **Satisfactory rating - 14 points** **Unsatisfactory - below 14 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Identifying and Selected Materials to be welded accordance with workplace procedures.

1.1. Identifying and Selected Materials to be welded accordance with procedures.

1.2. Welding Materials

Rod electrodes can be used to join almost all weld able ferrous materials, nickel and nickel alloys. These include structural, boiler and pipe steels, and also cast steel, stainless steel and hard-facing steels. The most important application fields are steel constructions, pipeline construction work and industrialized buildings.

1.3. materials welded by mma/smaw

When the steel composition is easily identifiable, rutile electrodes can be used as they are easier to strike and to weld and give a good-looking seam.

In practice, welding of medium, high carbon steels (>0.25%) can cause the formation of structural defects; application of the electrode procedure is recommended mainly for welding medium to thick joins using basic electrodes: in these cases a high quality weld is obtained with good breakage resistance.

The commonly used electrodes are classified based on the material from which they are made; and are classified in to five. These are: -

1. Mild steel electrodes
2. Cast iron electrodes
3. High carbon steels electrodes
4. Special alloy steel electrodes
5. Non-ferrous metal electrodes

Steel pipe welding is carried out using cellulose electrodes, where high penetration and good electrode workability are required. Beveling is always recommended, with a bevel angle that is sufficient to allow almost complete electrode insertion into the welding gap.

For special materials such as stainless steel, aluminum and its alloys, cast iron, specific electrodes for the particular material are used.

Stainless steels are welded with direct current (DC) with reverse polarity; special electrodes are used and are differentiated by the metallurgical composition of the material to be welded (presence of chrome (Cr) and of Nickel (Ni) in variable proportions).

Aluminum and light alloys are welded with direct current (DC) with reverse polarity. The machine should be equipped with rather a high strike dynamic to guarantee electrode strike. Also in this case special electrodes are used and are differentiated by the metallurgical composition of the material to be welded (presence of Magnesium (Mg) and of Silicon (Si) in variable proportions).

Cast iron is welded with direct current (DC) with reverse polarity; the majority of cast iron structures and machine members are obtained by casting, so that welding is used to correct possible casting defects or for repairs. Special electrodes are used and the base material should be heated sufficiently before use.

An electrode is a coated or bare metal rod that conducts the current between the holder and the work. The current from the welding machines flows through the electrode and creates an electric arc at its end, melting both the electrode and the work to form a weld pool, which solidifies to form the weld bead. The electrode must be the same metallic composition to the parent material to be welded.

A good electrode provides good arc stability, a fast buildup of the weld, minimum spatter, maximum weld strength and slag that is easy to remove.

Electrodes are classified with the letter E, followed by four or five digits-E-xxxx (x).

Forexample-E-6011

- E, stands for electrode
- 60,stands for tensile strength (60,0001b/in^2)
- 1,stands for any welding position
- 1,stands for either AC or (DC for DCRP)
- (X), stands for flux (type of flux)

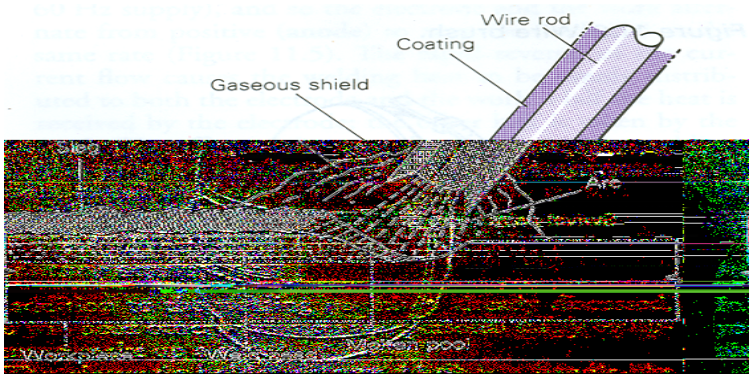


Figure 2.4.1.1 welding electrode

Welding Technique

Successful MMA welding depends on the following factors:

- Selection of the correct electrode
- Selection of the correct size of the electrode for the job
- Correct welding current
- Correct arc length
- Correct angle of electrode to work
- Correct travel speed
- Correct preparation of work to be welded.

Arc-welding variables

To help you understand and operate the techniques and procedures for electric arc welding, you need to be aware of some of the variable that is likely to affect your work and how to control or avoid them. They include:

Electrode selection

The use of the wrong type or wrong size of electrode will result in the production of unsatisfactory work. They may affect:

- the strength of the weld
- The welding penetration
- The welding/production time
- Excessive overlap of the weld

Name	AWS Classification	Application
BOC Smootharc 13	E6013	A premium quality electrode for general structural and sheet metal work in all positions including vertical down using low carbon steels
BOC Smootharc 24	E7024	An iron powder electrode for high speed welding for H-V fillets and flat butt joints. Medium to heavy structural applications in low carbon steels
BOC Smootharc 18	E7018-1	A premium quality all positional hydrogen controlled electrode for carbon steels in pressure vessel applications and where high integrity welding is required and for free-machining steels containing sulphur
BOC Smootharc S 308L	E308L	Rutile basic coated low carbon electrodes for welding austenitic stainless steel
BOC Smootharc S 316L	E316L	
BOC Smootharc S 309L	E309L	Rutile basic coated low carbon electrode for welding mild steel to stainless steel and difficult to weld material

Recommended Electrode Sizes

Average Thickness of Plate or Section	Maximum Recommended Electrode Diameter
1.5–2.0 mm	2.5 mm
2.0–5.0 mm	3.2 mm
5.0–8.0 mm	4.0 mm
≥8.0 mm	5.0 mm

Generally Recommended Current Range for BOC Smootharc 13

Electrode Size (mm)	Current Range (Amp)
2.5	60–95
3.2	110–130
4.0	140–165
5.0	170–260

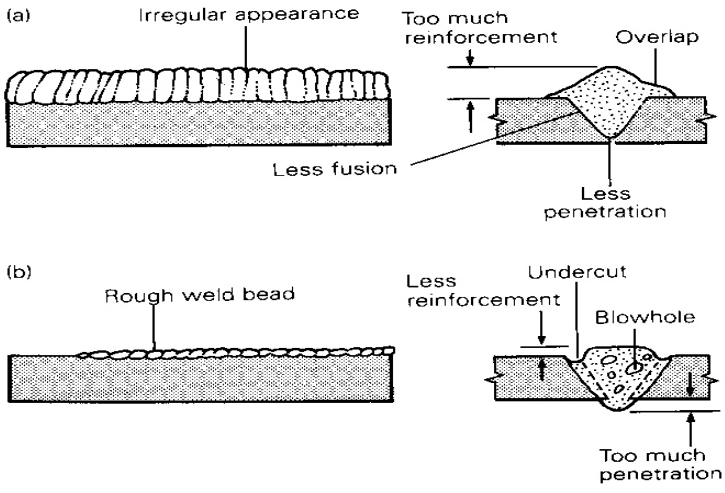
Run Length per Electrode – BOC Smootharc 13

Electrode Size (mm)	Electrode Length (mm)	Run Length (mm)	
		Minimum	Maximum
4.0	350	175	300
3.2	350	125	225
2.5	350	100	225

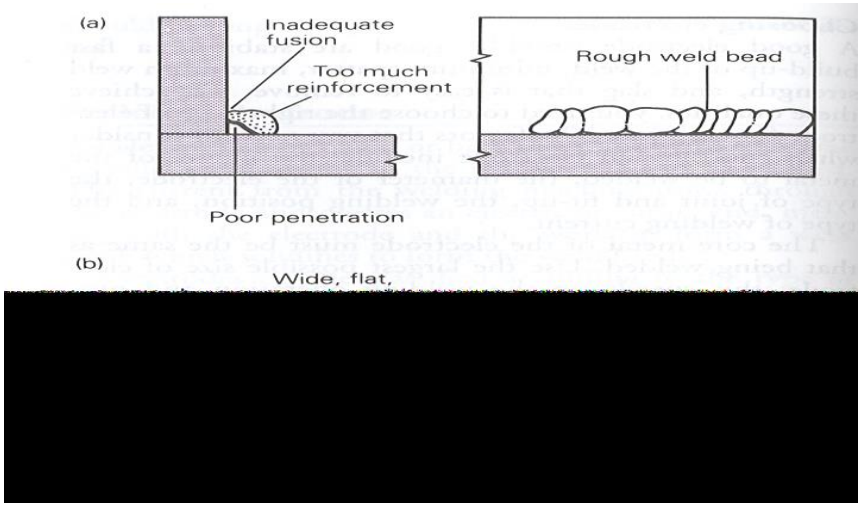
[redacted]

Variations in current

It is essential to set the welding current correctly if it is too low or too high it can have a considerable effect on the weld bead.

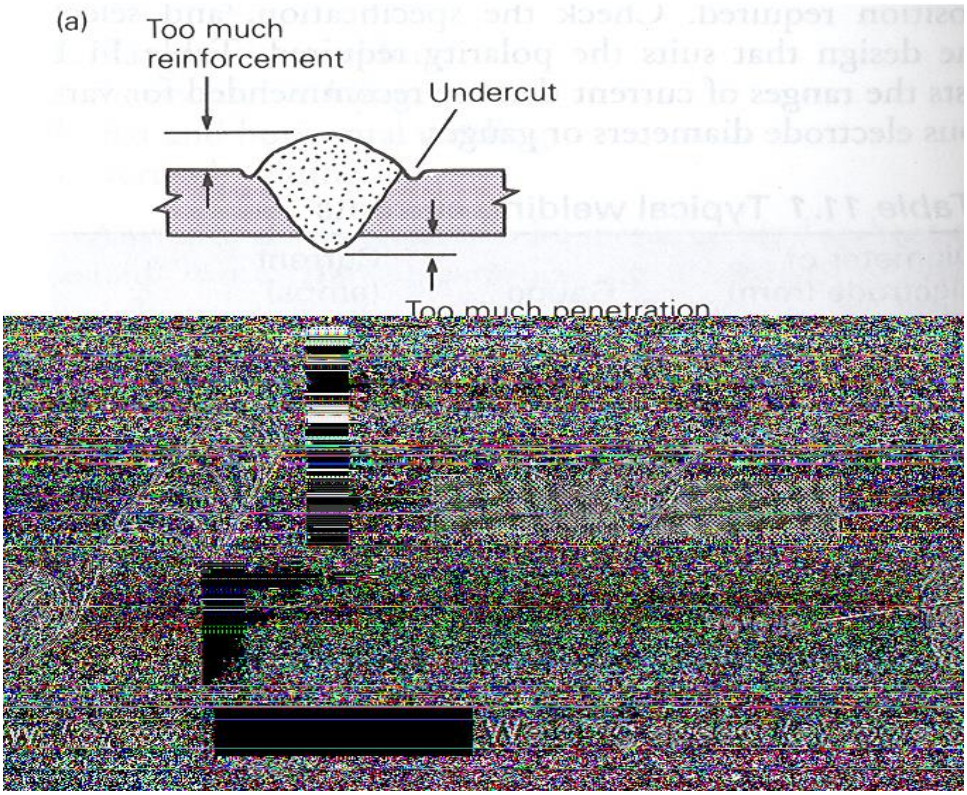


Arc length: - is the distance at which the tip of the electrode held from the surface of the work during welding.

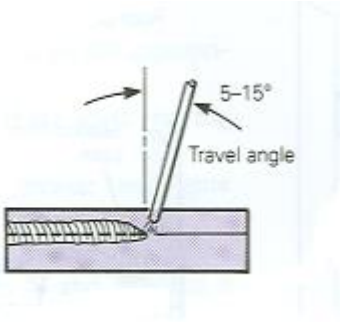


[redacted]

Welding speed: - is the rate at which the electrode is moved from one end to the other end during welding.



Electrode angle: - the angle at which the electrode is held to the axis of the weld during operation. It is also called travel angle



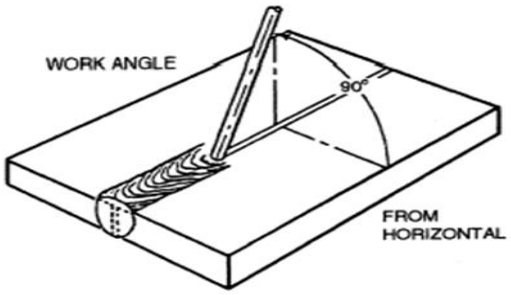


Figure 7-15.—Work angle.

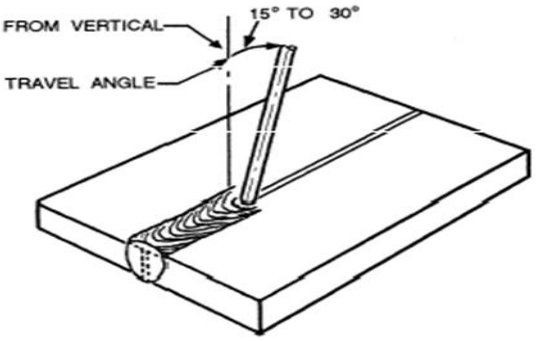


Figure 7-16.—Travel angle.

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. Write down the types of electrodes? (**5 points**)

Note: **Satisfactory rating – 5-10 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	identifying of welds in accordance with workplace procedures and job specifications

2.3 identifying of welds in accordance with workplace procedures and job specifications

2.3.1 Arc welding positions

The welding position is determined by where the welding operator is positioned in relation to the weld face and the joint axis. There are four basic positions on the weld joint; these are flat, horizontal, vertical, and overhead

1. **Flat welding position:** - flat position welds are done from above the joint while its axis is approximately horizontal.

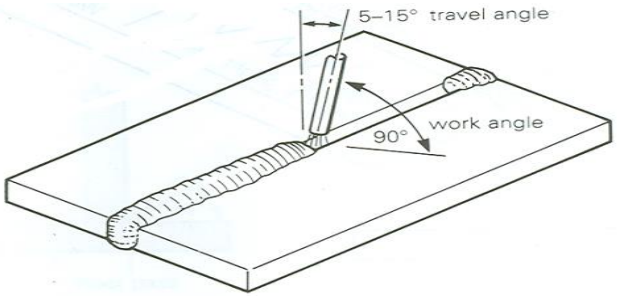


Figure. Flat welding position

2. **Horizontal welding position**:- in horizontal position the weld bead runs horizontally, Although the work piece itself may lie in vertical.

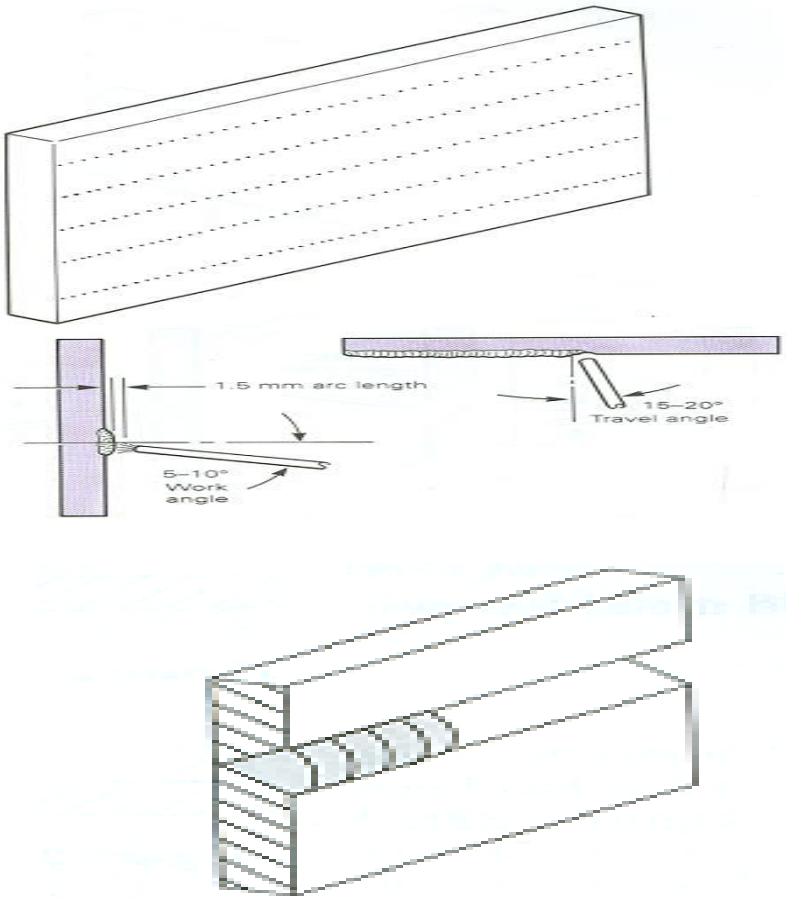


Figure. Horizontal welding position

3. **Vertical welding position**:-both the weld bead and the work piece run vertically. In the vertical welding technique, the axis of the weld is approximately vertical to the surface of the working table. Vertical welding can be accomplished in two ways; from the top of the work down the joint to the bottom; from the bottom of the work up the joint to the top. The work angle, the travel angle and the electrode angle are slightly different each technique.

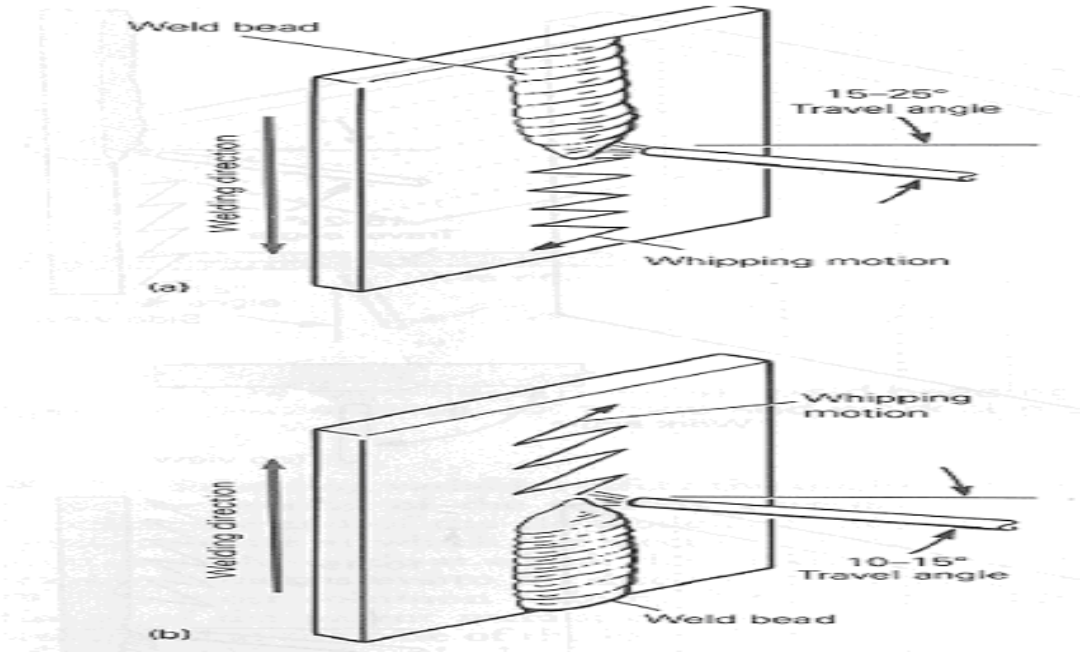


Figure. Vertical welding position; (a) top – down technique (b) bottom-up technique.

4. **Overhead welding position**: - in overhead welding, the joint is underside of the work, and is above the head of the operator. In this process, it is difficult to control the weld pool and keep it from dropping off. To control this, build a small weld pool.

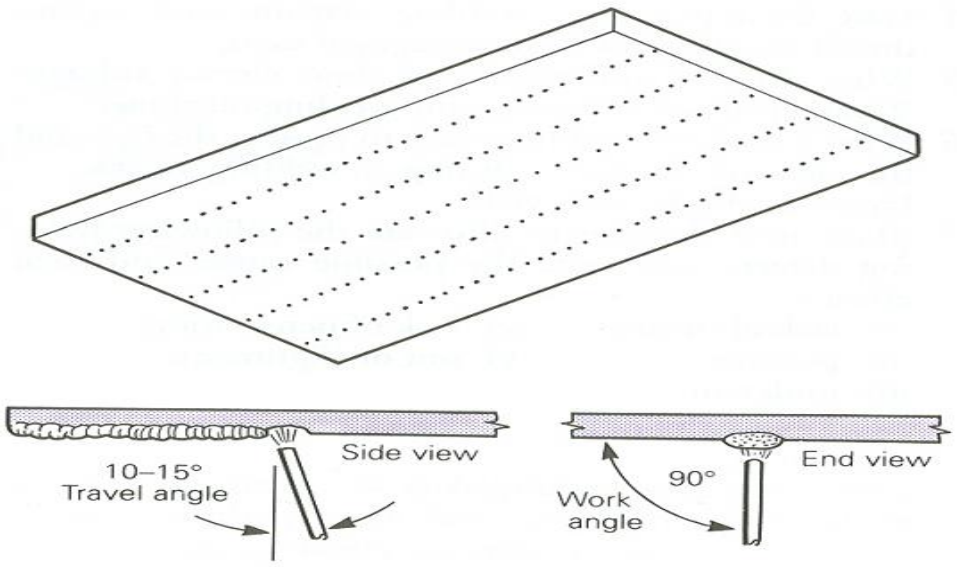


Figure. Overhead welding position

Self-Check -3	Written Test

Directions: Answer all the questions listed below.

1. Write down four basic arc welding positions (**6 points**)

Note: **Satisfactory rating – 3-6 points** **Unsatisfactory – below3 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

List of Reference Materials

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8) http://www.ansys.net/ansys/papers/ARTICLE1.pdf Transient Thermal Analysis of Spot Welding Electrodes by K.S. Yeung and P.H. Thorton January 1999 Supplement to the Welding Journal, American Welding Society and the Welding Research Council
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Plumbing Installation Work

LEVEL II

Learning Guide # 35

Unit of Competence: Weld using arc welding equipment

Module Title: Welding using arc welding equipment

LG Code: EISPLI2 M08 Lo3- LG 35

TTLM Code: EISPLI2TTLM080919 v1

LO 3: Prepare materials and equipment for welding.

Instruction Sheet	Learning Guide # 35

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Cleaning and preparing welding ***materials*.**
- Identifying Tools and techniques.
- Set up Welding and correct electrodes

.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Clean and preparing welding ***materials*.**
- Identify Tools and techniques.
- Set up Weld and correct electrodes

.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2 and Sheet 3”.
4. Accomplish the “Self-check 1, Self-check t 2 and Self-check 3**in page -54, 64 and 68** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet and Operation Sheet ” **in page.**
6. Do the “LAP test” **in page –** (if you are ready).

Information Sheet-1	Cleaning and preparing welding ***materials*.**

3.1 Cleaning and preparing welding materials.

Cleaning may be necessary before welding and during welding (interpass) and is usually essential after welding in order to ensure maximum corrosion resistance.

Pre-weld cleaning involves dressing the cut edge and removing all contaminants such as oil, paint, grease, crayon marks, adhesive tapes, etc. The area on both sides of weld should be cleaned before welding by brushing with a clean stainless steel brush and wiped with a solvent moistened cloth. All moisture must be removed and if a flame is used care must be taken to see that any water (a product of combustion) does not remain on the surface or in

the weld preparation. Liquid petroleum gas particularly creates a large amount of water when burnt.

Each welding run must be thoroughly cleaned to remove slag and spatter before proceeding with the next run. The cleaning method used (chipping, brushing, grinding) will depend on the welding process, bead shape, etc. but care should be taken to see that the weld area is not contaminated in the process. Any cleaning equipment should be suitable for stainless steel and kept for that purpose. During welding, a gas purge on the reverse side may be advantageous.

After welding, weld spatter, flux, scale, arc strikes and the overall heat discolouration should be removed. This can involve grinding and polishing, blasting and brushing with a stainless steel wire brush, or use of a descaling solution or paste. The preferred procedure is usually dictated by end use.

Grinding and dressing is to be carried out with iron-free brushes, abrasives, etc. and should not be so heavy as to discolour and overheat the metal. Rubber and resin bonded wheels are satisfactory. Wheels should be dressed regularly to prevent those becoming loaded thereby producing objectionable scratches. In any blasting process steel shot shall not be used.

3.1.2 Preparation material welding

Before you set up your welder and strike an arc, you'll need to first prepare your metal for welding. Sometimes you'll need to make a quick cut and other times you'll need to make a long cut through thick metal. No matter how long or thick your metal, you'll also need to clean the joint where you plan on welding.

3.1.2.1 Prepare welding materials and equipment

how is metal prepared for welding? One of the most important and most often neglected parts of the welding job is preparation of the metal for welding.

- The metal must be free of dirt, grease, rust, paint, or other impurities with a molten weld bead and cause it to be weakened. Metal should be cleaned by grinding, brushing, filing, or cutting before welding.
- Preparing the correct type of joint for each kind of metal is essential to safe strong welded structures.

There are 8 ways you can prepare metal for welding. Keep in mind that certain tools will be more appropriate than others depending on the situation

Wire Brush

A wire brush is good for removing thick layers of mill scale, slag, or any other thick impurities on a metal work piece. You'll especially want to keep a wire brush handy for stick welding since you'll need to brush off the flux when you're done welding. Keep in mind that certain metals will call for specific brushes. For example: a metal such as aluminum will require a steel brush

Sand Paper

Sand paper is another way to remove impurities and imperfections from metal before welding. However, make sure you use the right kind of sandpaper for the metal and welding application so that you don't leave sand paper residue or damage the metal.

Cloth and Solvent

When you're TIG welding, any impurities or chemicals on the metal can cause weld defects. However, choosing the wrong cleaner can also cause problems. Some cleaners tend to leave an oily residue. Try using acetone or lacquer thinners in order to clean the metal without leaving a residue.

Angle Grinder

An angle grinder is one of the most versatile tools you can own in a welding shop since you can change the wheels in order to clean metal or to cut small or thin pieces of metal. Welders tend to use 4-4.5" angle grinders for metal prep work. While there are larger angle grinders available, they're more useful for applications other than welding. A 4-4.5" angle grinder is a great choice for cutting a small piece of metal, cleaning metal, or smoothing off rough edges.

Chop Saw

A chop saw is typically used for making cuts that an angle grinder can't handle or at least perform neatly. Chop saws are portable and are ideal for cutting metal that is roughly 3/4" thick or less. Thicker metals will be tough to cut, resulting in uneven metal pieces and time lost for the work.

The most important rule for using a chop saw is to switch to a thin blade when cutting thicker metal. Unlike oxy-fuel cutting or plasma cutting, a chop saw will send bits of metal all over, making for a messy cutting process.

Band Saw

Welders are divided over the value of band saws. Some believe that a band saw in a welding shop is ideal since it makes better cuts than a chop saw. However, band saws take up a lot of space and are not portable. In addition, some welders would prefer to use oxy-fuel or a plasma cutter in order to make cleaner cuts.

Oxy-Fuel Cutting

If you cut a lot of thick metal in your shop, an oxy-fuel set up will be highly versatile, quick, and effective. Oxy-fuel can be handy if you already have a supply of propane or another cutting fuel on hand. Oxy-fuel will make cleaner cuts than a chop saw, but it's kerf will be wider than a plasma cutter.

Though oxy-fuel can present safety concerns, it's an ideal cutting set up for the infrequent metal cutter because it doesn't involve a steep upfront investment.

Plasma Cutter

For welders making frequent cuts of thick metal, a plasma cutter is the best way to cut metal prior to welding. Though plasma cutters involve a high investment up front, they save preheating time and eliminate the ongoing expense of cutting fuel. Plasma cutters make clean, fast cuts with a small kerf, making them ideal for busy welding shops that want to save on employee time and to save on material costs

3.1.2.3 Cleaning welding Aluminum

The material or the style of welding, it is important to work using clean base metals. Metals with surface rust, dirt, soot, and other forms of corrosion can make the task of welding more difficult as well as produce weaker welds. Impurities on the surface of a base metal or filler material can increase porosity and even cracking. These impurities include dirt, grease, rust, paint, plastic, and other contaminants. For most materials and equipment, steam cleaning can reliably remove contaminants from the surface. Blast cleaning and solvent cleaning are common alternatives. Power tools like brushes, grinding wheels, and disc grinding can also be used for certain applications. Taking the extra time to clean a base metal surface is recommended to create the strongest, most durable weld possible. Welders should become familiar with the cleaning requirements of different metals, particularly aluminum.

Base Metal Preparation for Welding Aluminum

Aluminum presents a special case for cleaning. In addition to making sure the surface is free of various impurities, aluminum must also be free of oxide or it will result in extensive porosity. Welders must prepare both the base metal and filler material to ensure neither surface contains oxide. To help prevent condensation and water accumulation, welders should store all base metal and filler materials vertically and at room temperature, if possible. Keeping them covered with a cloth while in storage can also help reduce foreign matter from contaminating the surface. The cloth itself should be clean, too. Shop rags can actually transfer more grime and oil then was originally on the metal.

Cleaning Aluminum Joints before a Weld

Materials that arrive from another shop often have a grease or oil coating to protect the metal. These surfaces should be degreased with a solvent and then wiped down with a paper towel (not a shop rag). It is important to clean all surfaces, not just the working surface, because the weld may pull through impurities from the other side of the material. Welders should also avoid using unnecessary lubricants, especially any petroleum-based lubricants, which break down in the welding process and introduce hydrogen into the joint.

Joint Clean-up After a Weld

After a joint is welded, do not use compressed air to blow away excess material from the joint. This contains moisture and oil contaminants that will introduce new impurities to the surface. Instead, another solvent should be applied and then a stainless steel wire brush should be used to clean the weld. This brush should be dedicated only to aluminum base metals or it should be thoroughly cleaned beforehand. If the brush is used on other metals and is not cleaned, it could embed hydrocarbons and other contaminants into the base metal.

Welders can learn proper preparation and clean-up techniques in a welder training program. For more information about learning the skills to become a welder, contact Tulsa Welding School to sign up for vocational training in Oklahoma or Florida.

Preparation and cleaning of Material

The edges or surfaces of parts to be joined by welding shall be prepared by shear or plasma arc cutting. Where hand cutting is involved the edge will be ground to a smooth surface. All

surfaces and edges shall be free from fins, tears, cracks or any other defects which would adversely affect the quality of the weld.

All moisture, grease or other foreign material that would prevent proper welding or produce objectionable fumes, shall be removed. Contact with lead, zinc, or lead or zinc compound shall be avoided due to the potential for hot cracking.

All surfaces to be welded shall be wire brushed prior to welding. In multi-pass welds the weld bead shall be wire brushed between passes. The brushes shall be of stainless steel and be kept exclusively for use on stainless steel and be kept clean and free of contaminants.

All other equipment such as grinding discs shall be kept exclusively for use on stainless steels.

Back gouging of welds shall produce a groove having a profile and a depth adequate to ensure fusion with the adjacent base metal and penetration into the root of the previously deposited weld metals

Self-Check -1	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List down eight ways you can prepare metal for welding.(**5 points**)

Note: **Satisfactory rating – 2.5-5 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Identifying Tools and techniques.

3.2 Identifying tools, equipment and material

3.2.1 Arc welding tools

Arc welding tools are used to perform a welding operations: some of them are

1. **Chipping hammer**: - is used to remove the slag from the weld. It has two striking ends, a pointed end and a flat end that runs parallel to the handle as shown fig.

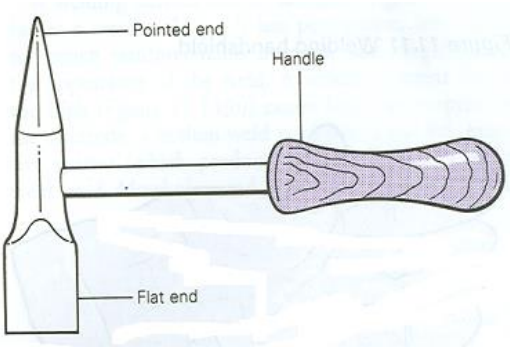


Figure. Chipping hammer

2. **Wire brushes**: - are used to clean the work piece and for further cleaning of the weld bead. This helps to expose any blowholes that might need to be refilled. The bristles are made from steel or stainless steel. See the following fig.

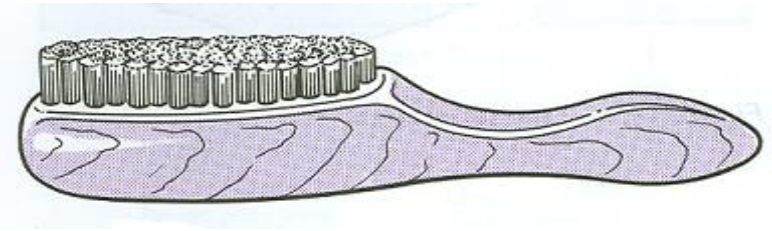


Figure. Wire brush

3. **Tongs**: - are used for holding and picking up hot metals in welding. It is made of wrought iron or mild steel, in lengths from 400 mm to 650 mm in steps increasing by 50 mm, and is sold by weight. It has the following parts:-

1- Handles
2- Pin and

3- Jaws

There are varieties of Tongs designed to grip different types of work pieces with various shapes. The common types are shown in fig

a). **Close mouth**: -you use this type for holding very light rectangular work pieces.

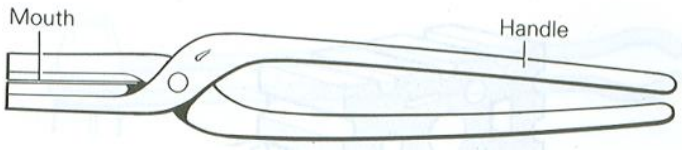


Figure. Close mouth tong

b) **Open mouth**: -this has a flat open mouth that, when closed still has the jaws opened. You Use it for holding thick regular pieces.

Figure. Open mouth tong

c) **Hollow bit**: -the mouth forms acicular hole when closed, which makes it useful for holding round or square bars lengthwise .It is also referred to as a round bit.

Figure. Hollow bit tong

d) **Pick – up or dandy**: -you use this for picking up and holding hot metals, but not for holding work during forging.

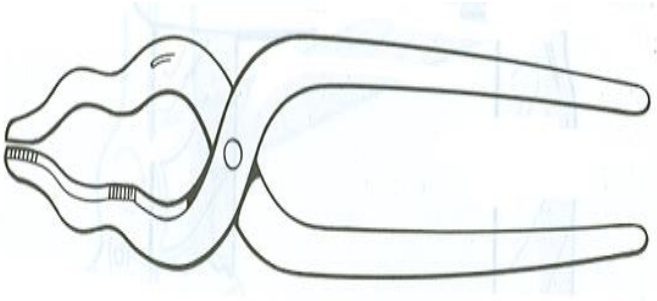


Figure. Pick – up or dandy ton

e) **Vee bit**: -this has a vee mouth for holding square bars lengthwise.

Figure. Vee bit tong

f) **Box or square mouth**: -used for holding heavy square or rectangular pieces.

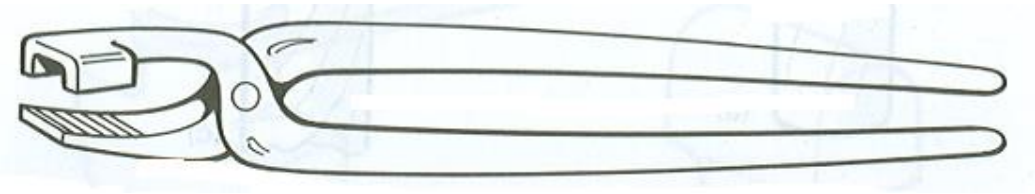
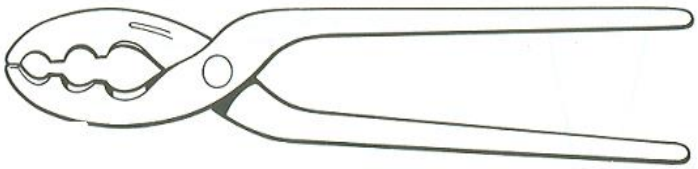


Figure. Box or square mouth tong

g) **Scroll tongs**: - used for these for making scrolls.

Figure. Scroll tong

h) **Universal tongs**: -these have three holes and a grove along the jaws, for general use.



Arc welding equipment

Equipment Used in arc welding

The principal equipment used in manual metal-arc welding includes:

- Welding power source
- Cables
- Electrode holder

Manual metal arc power source and welding leads

- Welding machines
- Welding cables
- Electrode holders
- Ground clamps

Arc welding machines

Arc welding equipment are the basic equipment used for joining two or more work pieces together. Arc welding machines are equipment's that provide current to produce an electric arc when the electrode is struck on the work pieces. The three basic types of arc welding machines are;

1. The generator (engine driven) welding machines
2. The transformer (AC) welding machines
3. The rectifier (motor generator) welding machines

Among the three machines mentioned above, the common one that is mostly applicable in the workshops is the transformer (AC) welding machines; and is explained below

The transformer (ac) welding machines: - the transformer welding machines operate on an electrical supply. The powers supply may be 220 volts or more, which is too high for welding. The transformer therefore reduces the voltage and provides the appropriate current for welding. Transformer welding machines are strongly built light and run quietly. They cannot be used at sites where there is no electricity.

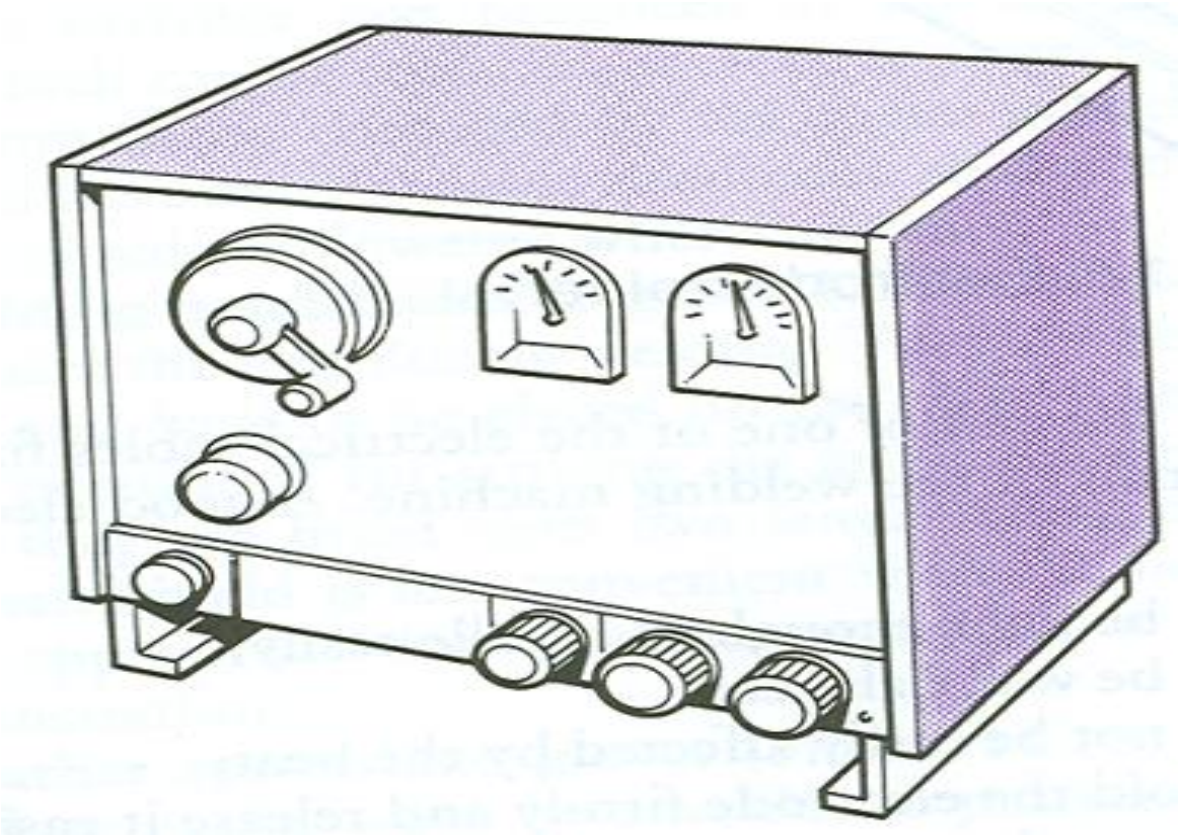


Figure. Arc welding machine

Arc welding cables

Two cables of adequate sizes and well-built are necessary to carry the current from the welder to the work and back to the welder. The ground cable is attached to the work pieces or table and the other cable is attached to the electrode holder.

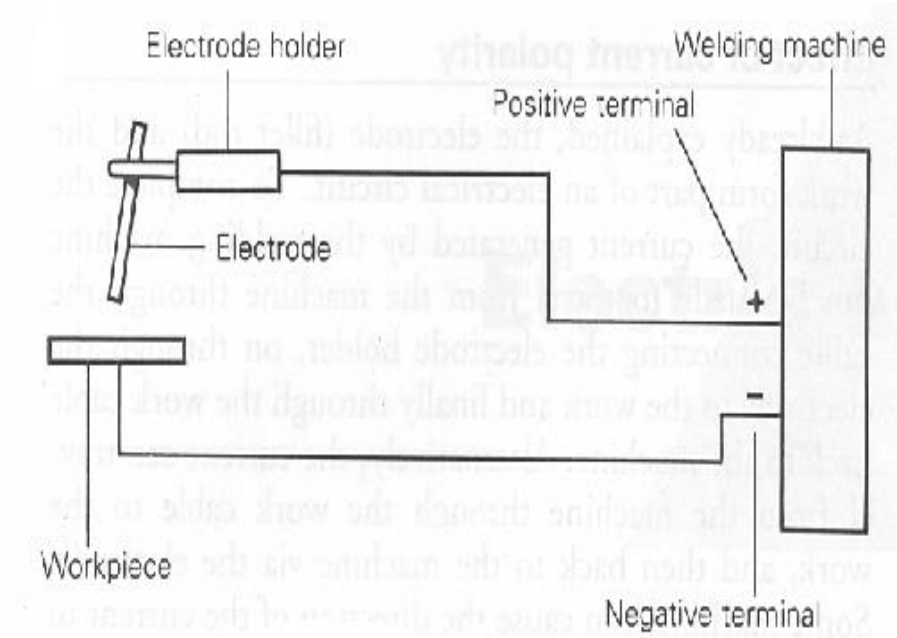


Figure. Arc welding cables

Electrode holder

The electrode holder is the part of the arc welding equipment held by the welder. It is attached to the electrode cable on the welding machine.

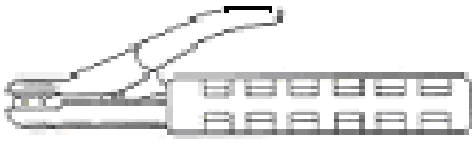


Figure. Electrode holder

Ground clamp

The ground cable from the machine to the work is generally connected to a spring-loaded clamp, which can be easily attached to the work. In order to do a good job of welding, the ground must be solidly connected to the work.

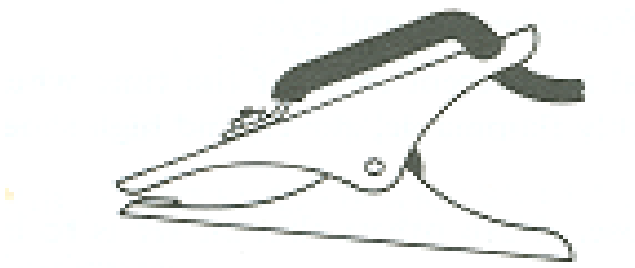


Figure. Ground clamp

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

2. Which one of the following are not arc welding tools? (**5 points**)

   B. Chipping hammer

   C. Wire brushes

   D. Tongs

   E. none:

1. Write down three types equipment used in manual metal-arc welding. (**5 points**)

Note: **Satisfactory rating – 5-10 points** **Unsatisfactory - below 5 points**

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	Set up Welding and correct electrodes

3.3 Set up Welding and correct electrodes

Set up for arc welding

- Make sure that the welding machine is properly setup and in safe condition.
- Fetch (obtain) all the necessary safety equipment and tools.
- Connect the ground clamp to the work or to the worktable if it is a metal top.
- Fix the bare end of the electrode in to the electrode holder.
- Switch the machine on.
- Set the current to suit the size of electrode that you have chosen or the thickness of the metal that you are welding.
- Choose the correct polarity to match the type of electrode you are using.

Basically electrodes are classified into

1. Consumable electrode

   a. Bare electrode

   b. Coated electrode

2. Non-consumable electrode

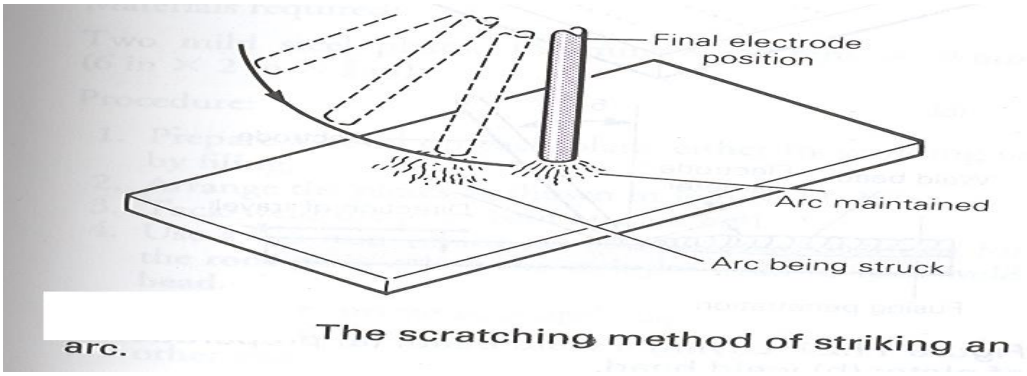
3.3.1 Establishing and maintaining Welding arc

There are two techniques that you can use to create a welding arc: -

a) Scratch

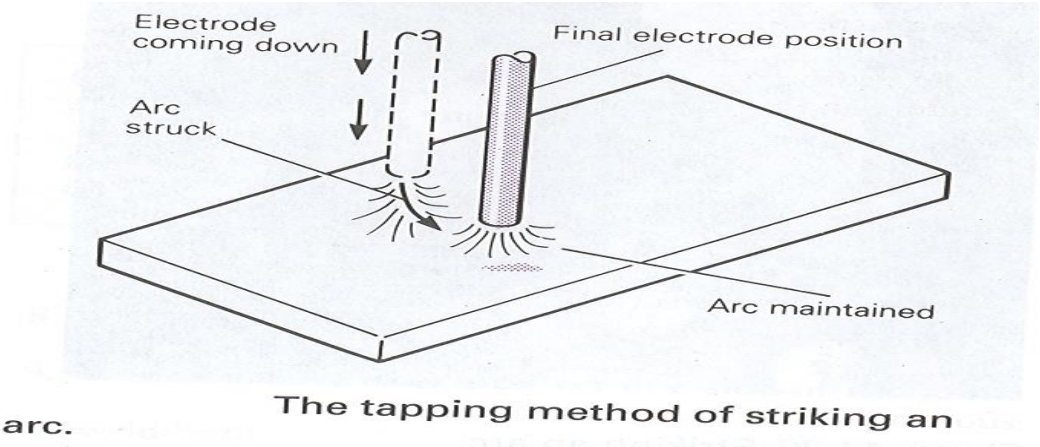
b) Tapping

a) Scratching techniques



The scratching method of striking an arc.

b) Tapping techniques: - the principle of these techniques involves touching the work with the tip of the electrode of exact point where the welding will commence (begin).

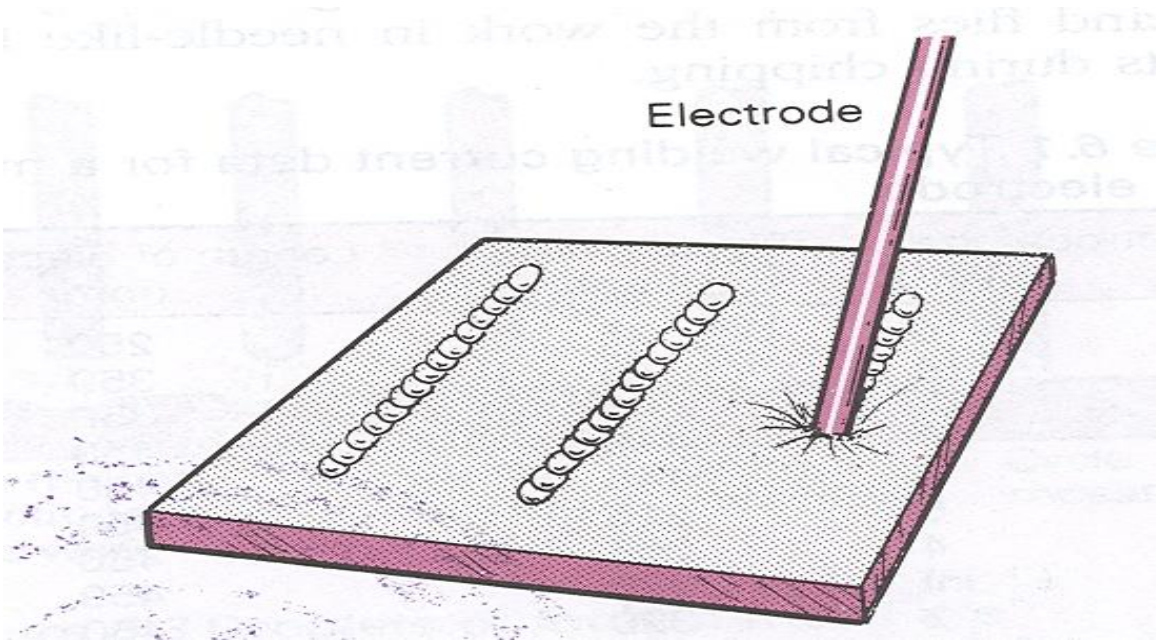


The tapping method of striking an arc.

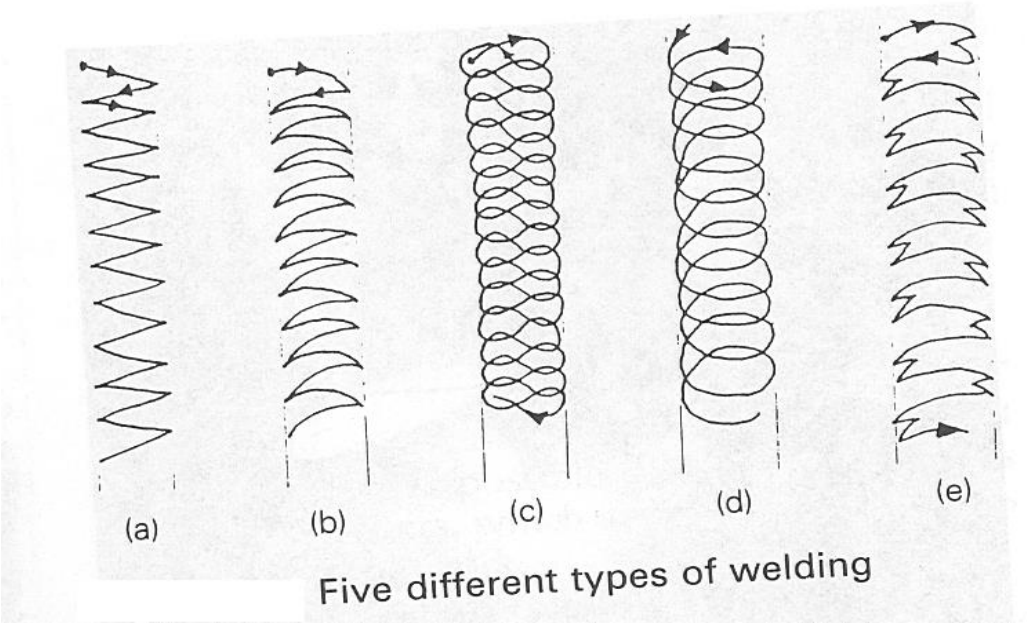
Bead formation

Bead is a term used to signify a run of weld metal. Bead weld is a weld made with one pass of the electrode or welding rod. There are two common types of bead. They are straight bead and weaving.

1. Welding straight bead



2. Weaving: - is the transverse oscillation of an electrode or blowpipe nozzle during the deposition of weld. Some times a wide weld bead will required, this can be done by weaving electrode side to side



WELDING JOINTS

1. Welding lap joint:-two over lapping pieces of base metal forms a lap joint. The top surface of one piece is in contact with the bottom surface of the other.

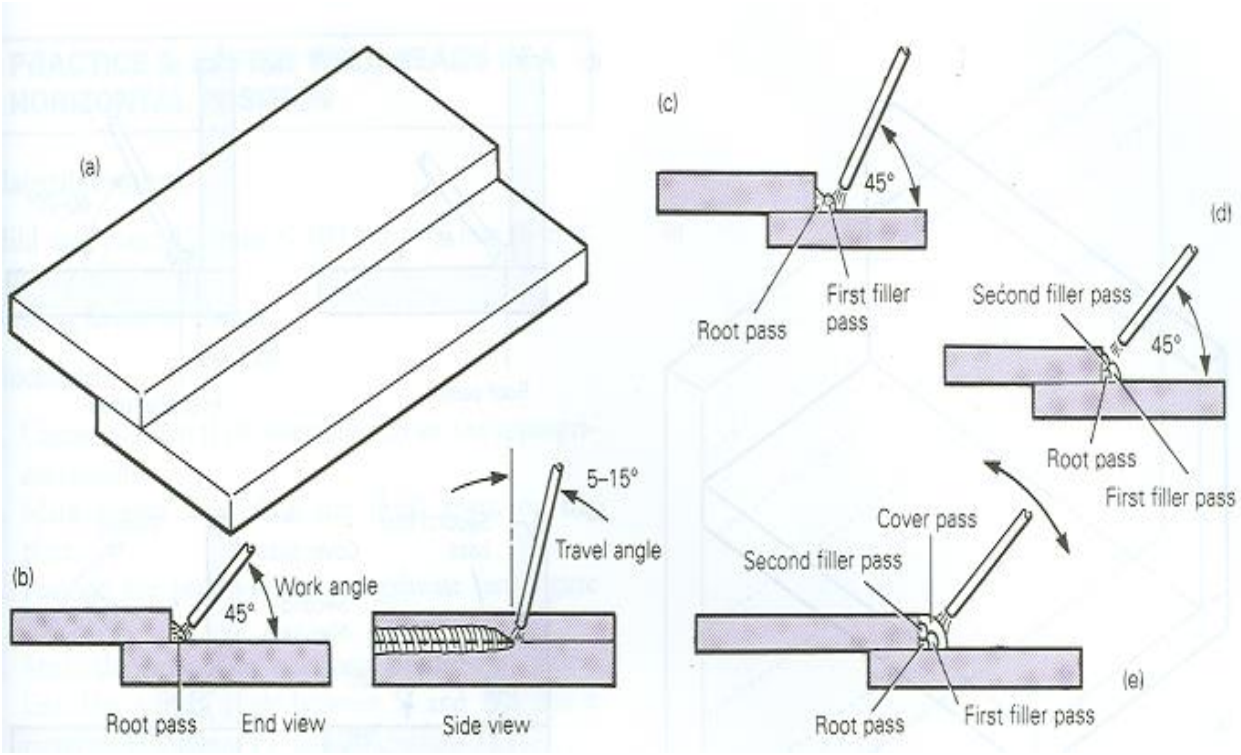


Figure. Welding lap joint

2. Welding butt joint: - is used when parts are joined end to end as a pipeline.

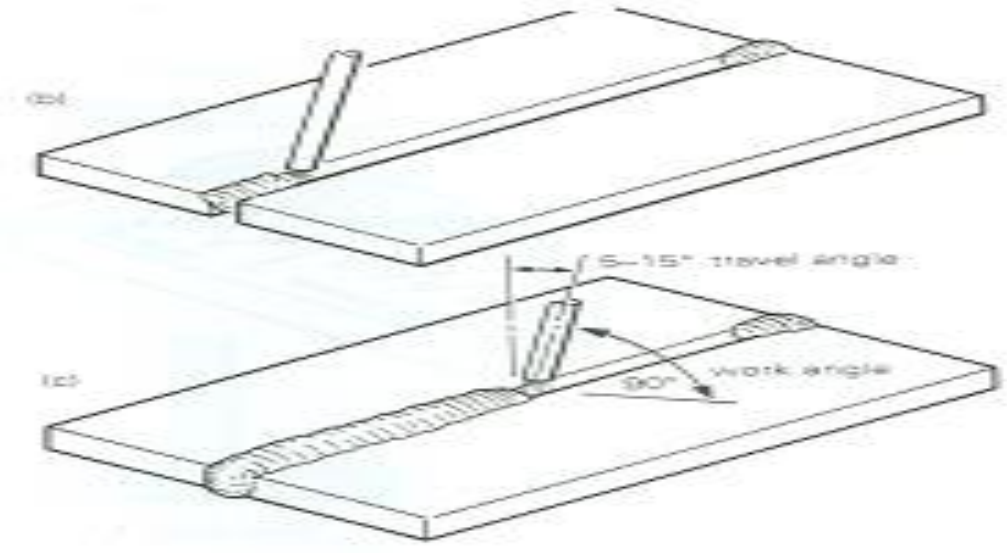


Figure. Welding butt joint

3. Welding corner joint: - is formed by placing one pieces of base metal along the outer edge of another piece. At least one edge of the two pieces exposed. The pieces may be joined at any angle, but they are commonly welded at 90^0 angle. Corner joints may be welded as inside corners, out side corners or a combination of both.

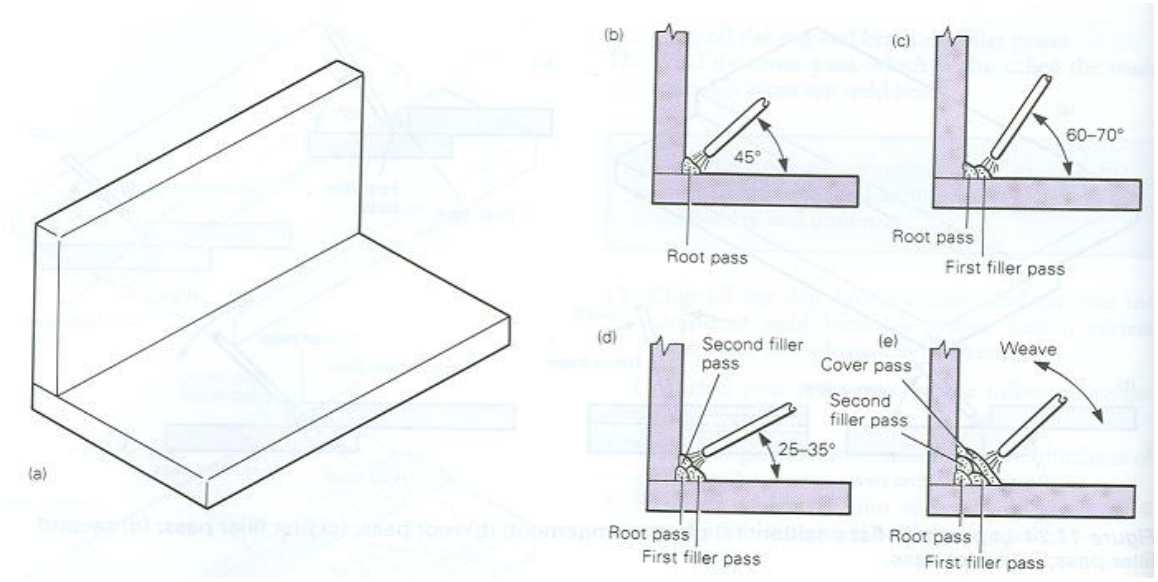


Figure. Welding corner joint

4. Welding T (fillet) joint: - is formed by two pieces of base metal that are at angle of approximately 90^0 to each other. The main difference between a corner and T-joint is that a corner joint is formed along the edge of one piece, while a T-joint is formed anywhere but along the edge.

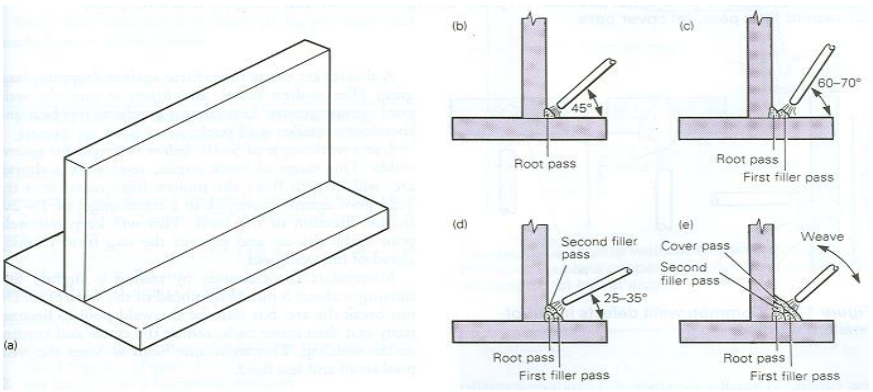


Figure. Welding T- joint

Self-Check -3	Written Test

Directions: Answer all the questions listed below.

1. Write down the two type's *Consumable* electrode? (**6 points**)

Note: **Satisfactory rating –3-6 points** **Unsatisfactory - below 3points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

List of Reference Materials

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Plumbing Installation Work

LEVEL II

Learning Guide # 36

Unit of Competence: Weld using arc welding equipment

Module Title: Welding using arc welding equipment

LG Code: EISPLI2 **M08 Lo4- LG 36**

TTLM Code: EISPLI2**TTL**M08**0919** v1

LO 4: Weld items

Instruction Sheet	Learning Guide # 36

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Welding materials according to job specification and job requirements.
- taking Appropriate action to report faults or remedy defects in materials or welding equipment

.

This guide will also assist you to attain the learning outcome stated in the cover page.
Specifically, upon completion of this Learning Guide, you will be able to:

- Weld materials according to job specification and job requirements.
- take Appropriate action to report faults or remedy defects in materials or welding equipment

.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1and Sheet 2”.
4. Accomplish the “Self-check 1and Self-check 2” **in page -75 and 85** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet and Operation Sheet” **in page -.**
6. Do the “LAP test” **in page –** (if you are ready).

Information Sheet-1	welding materials according to job specification and job requirements

4.1 welding materials according to job specification and job requirements

A Welding Procedure Specification (WPS) is a formal written document describing welding procedures, which provides direction to the welder or welding operators for making a sound and quality production welds as per the code requirements.

It is essential that all the welded joints are sound and have suitable properties for their application when fabricating structures and pressurized items by welding. WPSs control the welding by providing detailed written instructions about the welding conditions that must be used to ensure that welded joints have the required properties.

Although WPSs are shop-floor documents designed to instruct welders, welding inspectors need to be familiar with them because they will refer to them when checking that welders are working within the specified requirements. Welders need to be able to understand WPSs, make non-defective welds and demonstrate these abilities before being allowed to make production welds.

4.1.1 Qualified Welding Procedure Specifications

It is the standard practice for the to use qualified WPSs for most applications. A welding procedure is usually qualified by making a test weld to demonstrate that the properties of the joint satisfy the requirements specified by the applicable standard and the client or the end user. Demonstrating the mechanical properties of the joint is the principal purpose of qualification tests, but showing that a defect-free weld can be produced is also very important. Production welds made in accordance with welding conditions similar to those used for a test weld should have the same properties and therefore suitable for their intended purpose.

A Typical Sequence for Welding Procedure Qualification By Means of A Test Weld.

1. The welding engineer writes a preliminary Welding Procedure Specification (pWPS) for each test coupon to be welded.
2. A welder makes the test coupon in accordance with the pWPS and a welding inspector records all the welding conditions used to make the test coupon (the as-run conditions). An independent examiner/examining body/third party inspector may be requested to monitor the procedure qualification.
3. The test coupon is subjected to NDT in accordance with the methods specified by the Standard – visual inspection, MT or PT and RT or UT.
4. The test coupon is destructively tested (tensile, bend, macro tests). The code/application standard client may require additional tests such as hardness, impact or corrosion tests –depending on the material and application.
5. A WPQR is prepared by the welding engineer giving details of:

1. As run welding conditions.
2. Results of the NDT.
3. Results of the destructive tests.
4. Welding conditions allowed for production welding.

4.1.2 Welding Standards for Procedure Qualification

The European and American Standards have been developed to give comprehensive details about:

- How a welded test piece must be made to demonstrate joint properties.
- How the test piece must be tested.
- Which welding details need to be included in a WPS.
- The range of production welding allowed by a particular qualification test weld.

The principal European Standards that specify these requirements are:

- EN ISO 15614- Specification and qualification of welding procedures for metallic materials, welding procedure test.
- Part 1- Arc and gas welding of steels and arc welding of nickel and nickel alloys.
- Part 2 – Arc welding of aluminum and its alloys.
- The principal American Standards for procedure qualification are:

- ASME Section IX – Pressurized systems (vessels and pipework).
- AWS D1.1 – Structural welding of steels.
- AWS D1.2 – Structural welding of aluminum.

The Qualification Process for Welding Procedures

Although qualified WPSs are usually based on test welds made to demonstrate weld joint properties; welding standards also allow qualified WPSs for some applications to be written based on other data.

Some alternative ways that can be used for writing qualified WPSs for some applications are:

- Qualification by the adoption of a standard welding procedure – test welds previously qualified and documented by other manufacturers.
- Qualification based on previous welding experience – weld joints that have been repeatedly made and proved to have suitable properties by their service record.

Procedure qualification to European Standards by a test weld (similar in ASME Section IX and AWS) requires a sequence of actions typified by those shown below;

The Relationship between a WPQR and a WPS

Once a WPQR has been produced, the welding engineer can write qualified WPSs for the various production weld joints that need to be made.

The welding conditions that are allowed to be written on a qualified WPS are referred to as the qualification range and depend on the welding conditions used for the test piece (as-run details) and form part of the WPQR.Welding conditions are referred to as welding variables by European and American Welding Standards and are classified as either essential or nonessential variables and can be defined as:

- Essential variable – A variable that has an effect on the mechanical properties of the element and if changed beyond the limits specified by the standard will require the WPS to be re-qualified.
- Non-essential variable – A variable that must be specified on a WPS but does not have a significant effect on the mechanical properties of the weldment and can be changed without the need for re-qualification but will require a new WPS to be written.

Because essential variables can have a significant effect on mechanical properties they are the controlling variables that govern the qualification range and determine what can be written in a WPS.

If a welder makes a production weld using conditions outside the range is given on a particular WPS, there is a danger that the welded joint will not have the required properties and there are two options:

1. Make another test weld using similar welding conditions to those used for the affected weld and subject this to the same tests used for the relevant WPQR to demonstrate that the properties still satisfy specified requirements.
2. Remove the affected weld and re-weld the joint strictly in accordance with the designated WPS.

Most of the welding variables classed as essential are the same in both the European and American Welding Standards but their qualification ranges may differ.

Self-Check -1	Written Test

Directions: Answer all the questions listed below.

1. What is the Welding Procedure Specification (WPS). (**6 points**)

Note: **Satisfactory rating – 3-6 points** **Unsatisfactory - below 3points**

You can ask you teacher for the copy of the correct answers.

Score = _____
Rating: _____

Name: _____ Date: _____

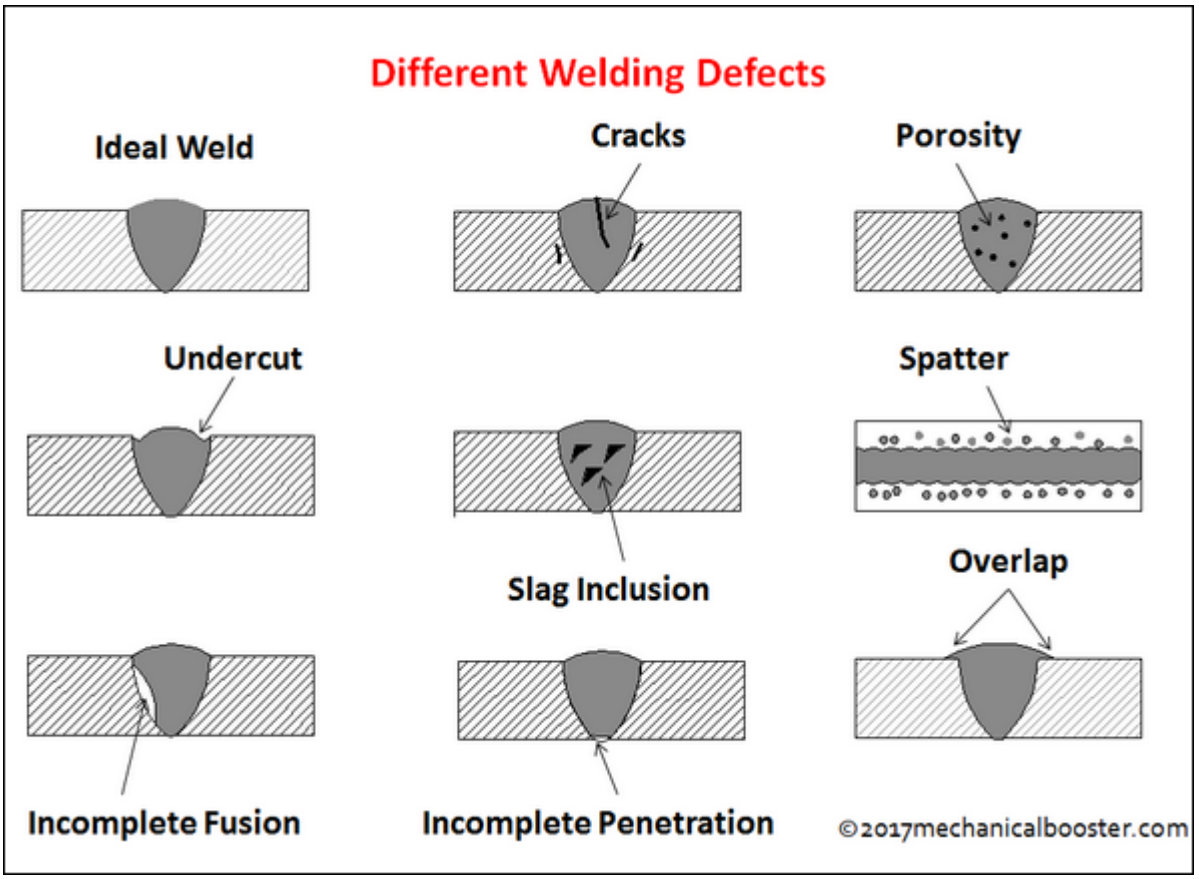
Information Sheet-2	**taking Appropriate action to report faults or remedy defects in materials or welding equipment**

4.1 Taking appropriate action to report faults or remedy defects in materials or welding equipment

The most common Welding Defects

Welding Defects can be defined as the irregularities formed in the given weld metal due to wrong welding process or incorrect welding patterns, etc. The defect may differ from the desired weld bead shape, size, and intended quality. Welding defects may occur either outside or inside the weld metal. Some of the defects may be allowed if the defects are under permissible limits but other defects such as cracks are never accepted.

Types of defects



Welding defects can be classified into two types as external and internal defects:

External Welding Defects:

1. Weld Crack
2. Undercut
3. Spatter
4. Porosity
5. Overlap
6. Crater

Internal Welding Defects:

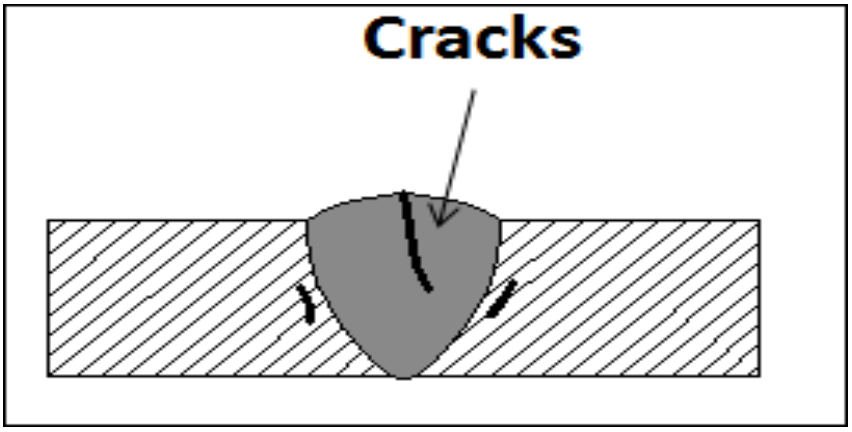
1. Slag Inclusion
2. Incomplete Fusion
3. Necklace cracking
4. Incompletely filled groove or Incomplete penetration

4.2.1 External welding defects

The various types of external defects with their causes and remedies are listed below:

1. **Weld Crack**

This is the most unwanted defect of all the other welding defects. Welding cracks can be present at the surface, inside of the weld material or at the heat affected zones.



Crack can also appear at different temperatures:

Hot Crack – It is more prominent during crystallization of weld joints where the temperature can rise more than 10,000-degree Celsius.

Cold Crack – This type of crack occurs at the end of the welding process where the temperature is quite low. Sometimes cold crack is visible several hours after welding or even after few days.

Causes of Weld Crack:

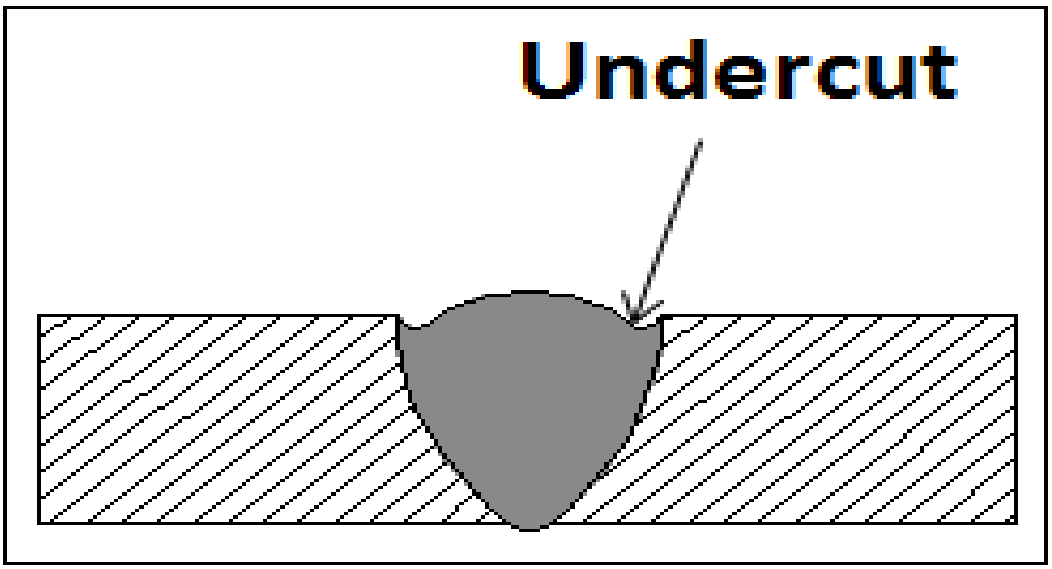
1. Poor ductility of the given base metal.
2. The presence of residual stress can cause a crack on the weld metal.
3. The rigidity of the joint which makes it difficult to expand or contract the metals.
4. If there is high content on sulfur and carbon then also the cracks may appear.
5. Using hydrogen as a shielding gas while welding ferrous materials.

Remedies for Weld crack:

1. Using appropriate materials may decrease the chances of crack.
2. Preheating the weld and reducing the cooling speed joint helps in reducing crack.
3. Reduce the gap between the weld joints by using reasonable weld joints.

4. While welding releases the clamping force slowly which increases fill to capacity of welding material.

2. Undercut



When the base of metal melts away from the weld zone, then a groove is formed in the shape of a notch, then this type of defect is known as Undercut. It reduces the fatigue strength of the joint.

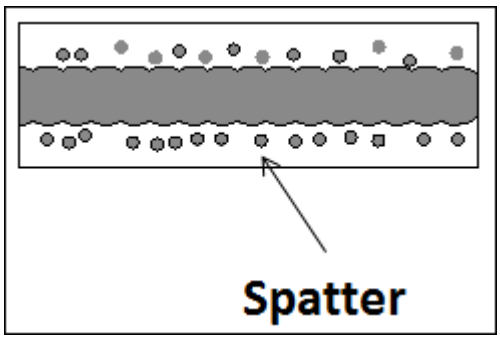
Causes of Undercut:

1. If the arc voltage is very high then this defect may occur.
2. If we use the wrong electrode or if the angle of the electrode is wrong, then also the defect may form.
3. Using a large electrode is also not advisable.
4. High electrode speed is also one of the reasons for this defect

Remedies for Undercut:

1. Reduce the arc length or lower the arc voltage.
2. Keep the electrode angle from 30 to 45 degree with the standing leg.
3. The diameter of the electrode should be small.
4. Reduce the travel speed of the electrode.

3. Spatter



When some metal drops are expelled from the weld and remain stuck to the surface, then this defect is known as Spatter.

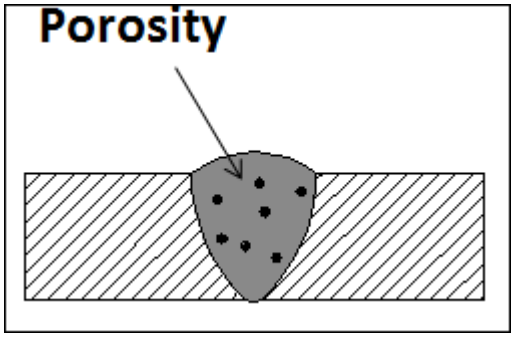
Causes of Spatter:

1. High Welding current can cause this defect.
2. The longer the arc the more chances of getting this defect.
3. Incorrect polarity.
4. Improper gas shielded may also cause this defect.

Remedies for Spatter:

1. Reducing the arc length and welding current
2. Using the right polarity and according to the conditions of the welding.
3. Increasing the plate angle and using proper gas shielding.

4. Porosity



Porosity in the condition in which the gas or small bubbles gets trapped in the welded zone.

Causes of Porosity:

1. It occurs when the electrode is not coated properly.
2. Using a longer arc may also increase its chances.

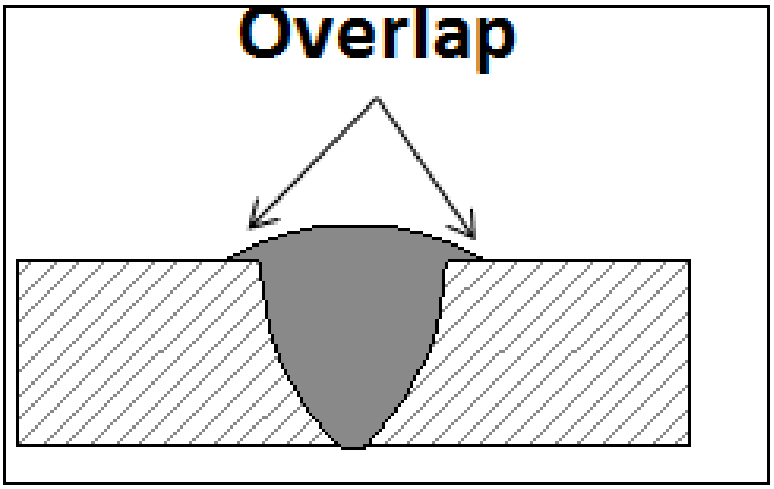
3. Increased welding currents.

4. Rust or oil on the welding surface.

Remedies for porosity:

1. Proper selection of the electrode.
2. Decreasing the welding current.
3. Using smaller arc and slowing the process to allow the gases to escape.
4. Remove rust or oil from the surface and use a proper technique.

5. Overlap



When the weld face extends beyond the weld toe, then this defect occurs. In this condition the weld metal rolls and forms an angle less than 90 degrees.

Causes of Overlap:

1. Improper welding technique.
2. By using large electrodes this defect may occur.
3. High welding current

Remedies for Overlap:

1. Using a proper technique for welding.
2. Use small electrode.
3. Less welding current.

6. Crater

It occurs when the crater is not filled before the arc is broken, which causes the outer edges to cool faster than the crater. This causes a stress and then crack is formed.

Causes of the crater:

1. Incorrect torch angle.
2. Use of large electrode:
3. Improper welding technique

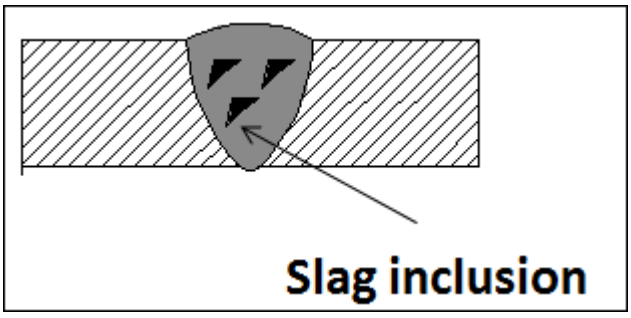
Remedies for crater:

1. Using a proper torch angle may reduce the stress on the metal
2. Using a small electrode may also decrease the crater.
3. Use a proper technique.

Internal Welding Defects

The various types of internal welding defects with their causes and remedies are listed below

2. Slag Inclusion



If there is any slag in the weld, then it affects the toughness and metal walkability of the given material. This decreases the structural performance of the weld material. Slag is formed on the surface of the weld or between the welding turns.

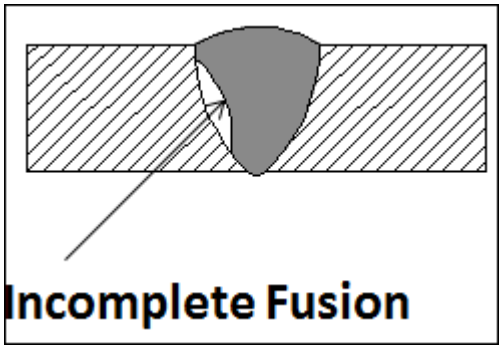
Causes of Slag:

1. Slag is formed if the welding current density is very small, as it does not provide the required amount of heat for melting the metal surface.
2. If the welding speed is too fast then also slag may occur.
3. If the edge of the weld surface is not cleaned properly then also slag may form.
4. Improper welding angle and travel rate of welding rod.

Remedies for Slag Inclusion:

1. Increase the current density
2. Adjust the welding speed so that the slag and weld pool do not mix with each other.
3. Clean the weld edges and remove the slags of previous weld layers
4. Have a proper electrode angle and travel rate.

2. Incomplete Fusion



Incomplete fusion occurs when the welder does not accurately weld the material and the metal pre solidifies which leads to a gap which is not filled with the molten metal.

Causes of Incomplete fusion*:*

3. It occurs because of the low heat input.
   2. When the weld pool is very large and runs ahead of the arc.
   3. When the angle of the joint is too low.
   4. Incorrect electrode and torch angle may also lead to incomplete fusion.
   5. Unproper bead position.

Remedies for Incomplete Fusion:

1. Increasing the welding current and decreasing the travel speed helps in removing the chances of incomplete fusion.
2. Reducing the deposition rate.
3. Increasing the joint angle.
4. Try to position the electrode and torch angle properly so that the edges of the plate melt away.
5. Positioning the bead properly so that the sharp edges with other beads can be avoided.

3. Necklace Cracking

It occurs in the use of electron beam welding where the weld does not penetrate properly. Therefore, the molten metal does not flow into the cavity and results in a cracking known as “Necklace Cracking”.

Causes of Necklace Cracking:

1. Improper welding technique.
2. It occurs in materials such as nickel base alloys, stainless steel, carbon steels and

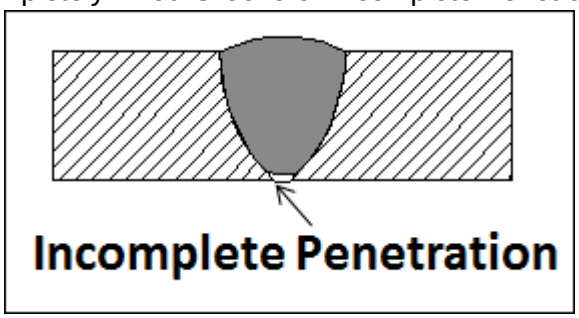
Tin alloys.

3. Using high speed of electron beam welding

Remedies for Necklace Cracking:

1. Using a proper welding technique reduce the chances of necklace cracking.
2. Using proper materials for welding.
3. Using a constant speed during the welding process.
3. Improper welding technique

4. Incompletely Filled Groove or Incomplete Penetration



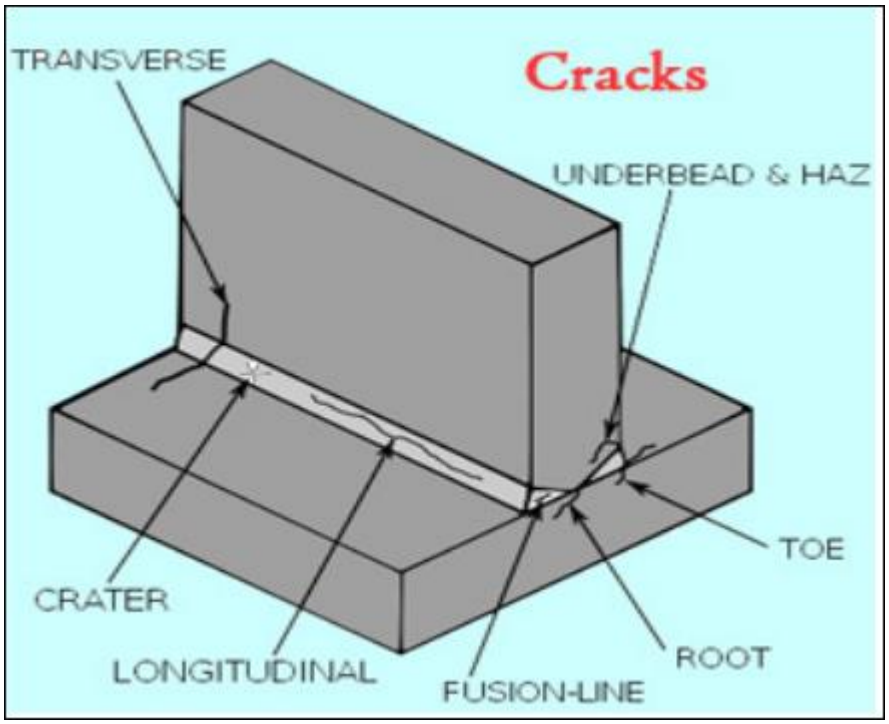
These defects occur only in the butt welds where the groove of the metal is not filled completely. It is also called as incomplete penetration defect.

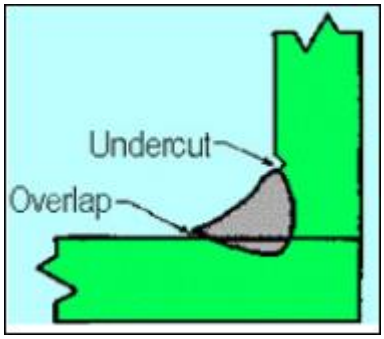
Causes of an Incomplete filled groove are:

1. Less deposition of the weld metal
2. Use of improper size of the electrode
3. Improper welding technique

Remedies for Incomplete filled groove are:

1. More deposition of the weld metal.
2. Use a proper size of the electrode.
3. By using a proper welding technique.





Therefore, we have listed all types of welding defects present during any manufacturing process. While welding, it is very important to remove all the defects of welding present in the workpiece. If there would be defects in the welding material, then in severe conditions the components of the material would fail which may lead to loss of property and sometimes also life.

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. Which one of the following are not external welding defects (**3 points**)

A) Weld Crack
B) Undercut
C) Spatter
D) Porosity
E) Slag Inclusion

2. Write down the two types of defects of welding. (**6 points**)

Note: **Satisfactory rating – 4.5-9 points** **Unsatisfactory – below4.5 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

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2. Matsubara T, Terasaki H, Otsuka H, and Komizo Y (2010) "Developments of real-time monitoring method of welding" (paper RAJU-VE1), Proceedings of the Visual-JW2010
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Plumbing Installation Work

LEVEL II

Learning Guide # 37

Unit of Competence: Weld using arc welding equipment

Module Title: Welding using arc welding equipment

LG Code: EISPLI2 M08 Lo5- LG 37

TTLM Code: EISPLI2TTLM080919 v1

LO 5: Clean up

Instruction Sheet	Learning Guide # 37

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Clearing Work area.
- Checking Tools and equipment accordance with manufacture.
- accessing completed Information and documentation in accordance with workplace requirements

.

This guide will also assist you to attain the learning outcome stated in the cover page.
Specifically, upon completion of this Learning Guide, you will be able to:

- Clear Work area.
- Check Tools and equipment accordance with manufacture.
- Access completed Information and documentation in accordance with workplace requirements

.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2 and Sheet 3”.
4. Accomplish the “Self-check 1, Self-check t 2 and Self-check 3” **in page -91, 98 and 104** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet and Operation Sheet” **in page.**
6. Do the “LAP test” **in page –** (if you are ready).

Information Sheet-1	Clearing Work area.

5.1 Cleaning work area

Tool housekeeping is very important, whether in the tool room, on the rack, in the yard, or on the bench all ways after completing operations. Tools require suitable fixtures with marked locations to provide an orderly arrangement. Returning tools promptly after use reduces the chance of it being misplaced or lost. Workers should regularly inspect, clean and repair all tools and take any damaged or worn tools out of service.

- Ensure sufficient time for materials to cool before handling.
- Switch off machine and fume extraction (if relevant).
- Hang up electrode holder and welding cables.

Practice good housekeeping and ensure the area is clean and tidy.

4.2. Housekeeping in the Welding Shop Environment

Housekeeping in the welding shop environment is a key feature that all shops should possess. Without an organized shop many things we don't want to happen could occur. Cleaning up our shop area is just as important as making a good weld. Someone who takes pride in their work also takes pride in their work environment. Many shops have a lot of stuff stored in and around the shop, it's been there for years and is rarely used. Some shops have so much stuff in it you can barely move around or find anything. Other shops or well-organized and everything has a place and everything is in its place. Which one of these descriptions describes the shop or work environment you populate?

A well organized shop saves time money and effort in many different ways. First, if the materials for fabrication are stored properly, it easy and quick to locate the proper material that we need to fabricate any project that we might want to build. Also if the shops material is well-organized it makes it very easy for the shop supervisor, project manager or plant manager to inventory the materials and see what's present. Understanding what is there what is available and in what sizes and thicknesses will help eliminate duplicate material orders for something we already have in stock. Also when it comes time to build the project the layout person, fitter or welder can easily and rapidly find the material required by the blueprint or technical drawing. Since labor is the most expensive component of fabricating most projects this savings of labor could amount to a large savings for the shop, possibly hundreds or thousands of dollars.

Since safety is a key component of everything we do in the welding world, housekeeping is just as critical to safety as wearing safety glasses, the proper clothing, boots, face and eye protection. Having our tools, equipment, hoses, cords, welding leads and our material well-organized in and around where we're going to do our fabrication, eliminates many of the tripping hazards and other safety issues associated with our welding shop environment. Having an injured shop employee does not help meet deadlines or get work done, its only a setback to the company. Just one injured employee can result in thousands of dollars of cost to the shop or fabricator. If we would just keep our area clean and organized we could use those thousands of dollars of cost on new equipment, more materials, employee benefits or other things that our shop really needs. Just as important as having a well-organized shop at the beginning of the project, cleaning up our mess, returning everything to its proper location and returning the materials to where they belong at the end of the project is just as important in the preparation for the next project is as finishing up the present project.

The best way to organize our welding shop is to think about the flow of work through it and place the materials, machines and equipment in a logical place and manner that meets your requirements and keeps the operation efficient. Look around your shop open up your eyes and think about what you could do to improve your area. In all our shops we can easily find something that we could do better and if we focus on those single items and continue to improve bit by bit, item by item, over the long haul we will see the benefits of having a well-organized shop, improved safety and cost savings.

Self-Check -1	Written Test

Directions: Answer all the questions listed below.

1. Discus the use of cleaning and returning tools promptly after use.(5points)
2. Discus the Importance of Housekeeping in the Welding Shop Environment(5points)

Note: **Satisfactory rating – 5-10 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Checking Tools and equipment accordance with manufacture.

5.2 Checking Tools and equipment accordance with manufacture

All equipment used in manual electric arc welding operations, including Power supply system, welding equipment, ventilation system, the associated safety devices, and personal protective equipment, should be regularly checked for performance and maintained in good working condition. The proprietor should assign competent persons with Appropriate training and experience to undertake the checking and maintenance work. Performance check includes general examination of the equipment as well as pre-use equipment check.

All defective or damaged equipment should be taken out of service Immediately and replaced by suitable ones, and should be repaired or disposed of as appropriate. Equipment or system under maintenance/ repair or found defective should be properly labeled, marked or otherwise highlighted to warn workers not to use it. Equipment or system which has been repaired or maintained should be checked to ensure proper Performance before it is used.

5.2.1 Checking and Maintenance of Equipment

- All equipment used in manual electric arc welding operations, including power supply system, welding equipment, ventilation system, the associated safety devices, and personal protective equipment, should be regularly checked for performance and maintained in good working condition. The proprietor should assign competent persons with appropriate training and experience to undertake the checking and maintenance work. Performance check includes general examination of the equipment as well as pre-use equipment check.
- All defective or damaged equipment should be taken out of service immediately and replaced by suitable ones, and should be repaired or disposed of as appropriate. Equipment or system under maintenance/ repair or found defective should be properly labeled, marked or otherwise highlighted to warn workers not to use it. Equipment or system which has been repaired or maintained should be checked to ensure proper performance before it is used.

- The examinations should be carried out by competent persons having the appropriate training and experience to undertake the checking and maintenance of electric arc welding equipment and the associated engineering control measures for the welding operation.
- All equipment involved in manual electric arc welding operation should be regularly examined according to manufacturer's recommendations for defects and malfunctions and with records kept for the purpose of providing information to facilitate maintenance work. The frequency of examination depends on the frequency of use and the conditions in which it is used, such as the aggressive nature of the working environment.
- The ventilation system of the workplace should be regularly checked to ensure its proper performance, such as the rate of air change in the workplace and quality of air supply.
- Regular examination of the welding equipment includes the inspection for the following defects:
  (a) physical damage to electrode holder, welding cables, cable terminations and connections, welding transformer, primary power supply cables and the power supply system;
  (b) improper connection of welding equipment including the welding cables, the primary supply cables and all earthing connections; and
  (c) faulty or defective equipment of the power supply system, switch, circuit breaker, fuse unit, power socket, RCD, etc.

Pre-use equipment check

Notwithstanding that welding equipment and power supply system are regularly checked for proper performance, it is necessary to check that the equipment and safety devices are in good conditions every time before starting a welding operation.

The pre-use equipment check should be carried out by a competent person or the welding worker involved in the welding operation or his supervisor; all should be suitably trained and possess the necessary knowledge and experience to ensure safety and health at the welding work.

The pre-use equipment check includes the following:

- to ensure that the welding equipment including the welding transformer, the welding cables, the electrode holder and their connections/ terminations are in good conditions;

- to ensure that all welding equipment are properly connected up;
- to ensure that all necessary cable and earthing connections/ terminations are firmly made and properly insulated;
- to ensure that all necessary protective equipment including personal protective equipment required for the welding operation, are available and in good conditions; and
- for the case of MIG welding and TIG welding, to ensure that all gas cylinders and associated instruments including pressure gauges, regulators and gas hoses are in good working conditions.

After-use equipment check

After the welding operation, the worker should:

- properly shut down the power supply to the welding equipment;
- disassemble all welding equipment connections;
- check that the welding equipment including the welding cables are in good conditions and ready for future use;
- return all welding equipment and personal protective equipment to the store;
- report to the supervisor or storekeeper should there be defects found in the welding equipment, protective equipment and the personal protective equipment; and
- ensure that the work piece is cooled down and no hot slag, globules of molten metal or other similar hot residues remain before leaving the welding workplace.

5.2.2 Visual Inspection (VT)

Visual inspection is a non-destructive testing (NDT) weld quality testing process where a weld is examined with the eye to determine surface discontinuities. It is the most common method of weld quality testing.

Advantages of nondestructive weld quality testing:

- Inexpensive (usually only labor expense)
- Low cost equipment
- No power requirement

- Quick identification of defects and downstream repair costs due to issues that weren't caught early

Disadvantages:

- Inspector training necessary
- Good eyesight required or eyesight corrected to 20/40
- Can miss internal defects
- Report must be recorded by inspector
- Open to human error

Visual Weld Quality Testing Steps

1. Practice and develop procedures for consistent application of approach
2. Inspect materials before welding
3. Weld quality testing when welding
4. Inspection when weld is complete
5. Mark problems and repair the weld

Visual Weld Equipment

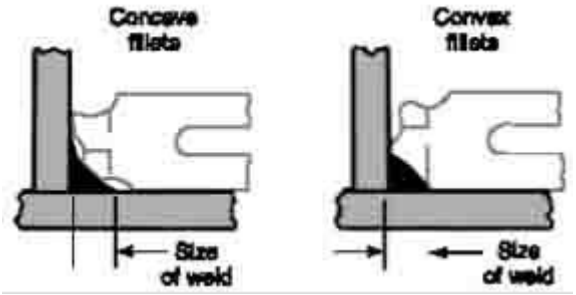
Fillet Weld Gauge

Fillet Weld Gauge is an essential weld quality testing tool. It is used to check fillet leg size, checking fillet throat size

Several pieces of equipment are required for visual weld quality testing:

- Weld hand held fillet gauge: measure -
  - flatness of the weld
  - convexity (how the weld is welded outward)
  - concavity (how the weld is rounded inward)
- Protective lenses with pocket viewer and shade lens for use when observing the welding process
- Magnifying glass per the code in your area
- Flashlight
- Chisel and hammer for spatter and slag removal before the weld is inspected
- Temperature device (Tempelstick, Pyrometer) to determine the preheating, interpass and post-heating temperatures.
- Magnet to indicate the type of material being welded
- Tape measure
- Calipers

Fillet Weld Gauge Diagram



Visual Inspection Before Welding

- Check drawings

- Look at weld position and how ti corresponds to the specification. Watch the vertical direction of travel
- Check welding symbols
- Does procedure align with local codes and the weld specification

Weld Material Inspection

- Do the materials purchased match the specification for base metal size and type? Check electrode size, gas selection and grade.
- Check materials for defects. Look for contaminants such as rust, scale, mill, lamination etc.
- Are materials prepared for correct angles

Assembly Inspection

Follow these weld quality testing steps for assembly inspection:

- Check for fit
- Alignment of fixtures and jigs. Check cleanliness (look for spatter from previous jobs)
- Check quality if tack welds are used. The tack weld must be made with the same electrode as the main weld (s).
- Check use of pre heat to slow the cooling rate and to minimize distortion

Equipment Inspection

- Check for damage (cables, ground clamps, electrode holder).
- Check arc voltage
- Check amperage meter for range against specification

Visual Inspection During Welding

- Check electrodes for size, type and storage (low hydrogen electrodes are kept in a stabilizing oven)
- Watch root pass for susceptibility to cracking
- Inspect each weld pass. Look for undercut and required contour. Ensure the weld is cleaned properly between each pass.

- Check for craters that need to be filled
- Check weld sequence and size. Gauges are used to check size.

Inspection After Welding

- Check weld against code and standards
- Check size with gauges and prints
- Check finish and contour
- Check for cracks against standards
- Look for overlap
- Check undercut
- Determine if spatter is at acceptable levels

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. _____Visual inspection is a non-destructive testing (NDT) weld quality testing process where a weld is examined with the eye to determine surface discontinuities? (**5 points**)

B) Visual inspection

C) outside resources

D) destructive testing

E) none

3. Write down the two method of weld quality testing. (**5 points**)

Note: **Satisfactory rating – 5-10 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Name: _____ Date: _____

Information Sheet-3	accessing completed Information and documentation in accordance with workplace requirements

5.3 accessing completed Information and documentation in accordance with workplace requirements

5.3.1 Weld Record Sheet Information

A weld record sheet is used to track the critical information for each specific weld completed in a piping system. Figure 1 below illustrates a typical weld record sheet which is sub divided into 4 main sections these being:

- Header section
- Weld information section
- Material information section
- Test information section

The weld record sheet is used in conjunction with the weld isometric drawing and is often printed on the back of the drawing or attached to the drawing. Where possible the design office should fill in the common information before printing to increase efficiencies and minimise the risk of error. The pipe fitter can fill out the material information section as the spool is being tacked together. The welder then generally fills out the weld information section and the weld inspector completes the final test information section. Once complete the project engineer reviews it and verifies that all welds are completed, tested and accepted it can then be signed approved and included in the overall handover documentation package.

Client : ______________ FAS Project No.: ______________ System: ______________

Client Project No.: ______________ Machine Serial No.: ______________ Line / Iso. No. : ______________

Approved By : ______________ Machine Model No.: ______________ Sheet : ______ of ______

Weld Information								Material Information				Test Information				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Weld No.	Welders No.	Weld Size	Weld Date	Location		Process		Component /	Component	Cast No. /	Cast No.	NDT Report No.	NDT Type	NDT Date	Accept or Reject	Inspectors Initials
				Shop	F.W.	Auto	Man.									
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																

Figure 1 – Typical weld record sheet

5.1.2 Header Section

Client*:* The company name who the work is being completed for.

Client project No.: A unique number assigned by the client for the work being completed.

Approved by*:* Signature of the person approving the weld record sheet

Project No.: A unique number assigned by the contractor for the work being completed. It is usually used to track costs and progress on a particular project.

Machine Serial No*.:* The serial number of the welding machine used to carry out the welding. It is unique to each machine and if faults are discovered and linked back to this machine, it makes it easier for all welds completed by this machine to be tracked and re-inspected after the fact.

Machine model No.: The type of model of welding machine used to complete the welding.

System: The name of the system being welded, e.g. Pure steam, product etc..

Line/Iso. No.: This is the isometric drawing number or the line number for which the welds that are being recorded are on.

Sheet No.: Sometimes there may be 3 or 4 isometrics for one line therefore they are grouped together as sheet 1 of 5, 2 of 5 etc.

5.1.3 Weld Information Section

Weld No*.:* Unique number given to each weld in sequence so that there is complete traceability for every weld in the system

Welder No.: Unique number given to every welder in a company. This number is recorded on the Welder qualification record after a welder performs and passes their qualification tests. This number is then recorded for every weld completed on both the weld record sheet and marked on the pipe beside each weld completed.

Weld Size*:* Size of the weld being completed. This is used to tie back to weld coupon log to ensure that only these size welds were completed once the correct size weld coupons were completed.

Weld date: The date the weld was completed.

Location: Where the weld was completed, i.e. in the workshop or out on site. Shop welds are usually much easier as they are completed on a bench with good access and minimum purging, while field welds are usually more difficult as access is usually more difficult and the complete system needs to be purged which is harder to achieve. In critical systems a reduced percentage of shop welds may be inspected while the client may insist that 100% of all field welds are inspected.

Process*:* Automatic or manual, most welds should be automatic which are more consistent and therefore more likely to pass inspection. Manual welds are only used where the fitting to fitting distance is reduced to a point where the automatic weld heads will not fit and therefore a manual weld is required. These are only usually allowed by prior approval of the client and usually require 100% inspection.

5.1.4 Material Information Section

Component / Component*:* This identifies the different components either side of a weld, e.g. Pipe/elbow or elbow/tee etc..

Cast No. / Cast No.: Also known as the heat number it identifies the batch of material that the component was manufactured from. It was once a requirement that the cast number had to be the same each side of the weld to ensure consistent welding, however due to improved manufacturing techniques it is now possible for mills to repeatedly produce material which is consistent and which has tightly tolerance ingredient amounts. This consistency in the materials of the components ensures that the finished welds are of a high quality.

5.1.5 Testing Information Section

NDT Report No*.:* Non Destructive Test report No., this allows the weld record sheet to be cross referenced to the independent test report.

NDT type: Usually horoscope (optic fibre with a camera on the end that is pushed down the tube and rotated to record the internal profile of each weld. The horoscope is non hazardous, quick, can be carried out during normal working hours and gives instant feedback and there is generally used for 90% of the welds on a system. The other option is to X-ray the weld to get a radiographic picture of the weld, this is usually done on closing welds where it is not possible to gain access for the horoscope. X-rays are usually done at night out of hours to reduce the risk of exposure to radiation sources and the films have to be developed therefore the results are slower.

NDT date: The date the weld was inspected.

Accept or Reject: The result of the NDT inspection. See Phase 4, module 2 Unit 8 for accept / reject criteria.

Inspector initials: Proof from the welding inspector that each of the individual welds was inspected and that the result is valid.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is a weld record sheet? (**6 points**)

Note: **Satisfactory rating – 3-6 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

List of Reference Materials

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