Mechanics

Level-III

Learning Guide-04

Unit of Competence: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Title: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO 1: Prepare welding materials for gas tungsten welding

Instruction Sheet	Learning Guide #04

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

- Identifying weld requirements.
- Determining correct size, type and quantity of materials/ components.
- Alignment of materials to the specification

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**:

- Identifying Weld requirements from specifications and/or drawings.
- Determining Correct size, type and quantity of materials/ ***preparing*** components for compliance with the job specifications
- Aligning Material assembles/ to specification require.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 1 to 3.
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3 and Sheet 4".
4. Accomplish the "Self-check 1, Self-check t 2, and Self-check 3" **in page -7, 14, and 18** respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 " **in page -18-.**
6. Do the "LAP test" **in page – 21** (if you are ready).

INFORMATION SHEET-1	IDENTIFYING WELD REQUIREMENTS

INTRODUCTION

Gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding, is an arc welding process that uses a non consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by a shielding gas (usually an inert gas such as argon), and a filler metal is normally used.

GTAW is most commonly used to weld thin sections of stainless steel and light metals such as aluminum, magnesium, and copper alloys. The process grants the operator greater control over the weld than competing procedures such as shielded metal arc welding and gas metal arc welding, allowing for stronger, higher quality welds. However, GTAW is comparatively more complex and difficult to master, and furthermore, it is significantly slower than most other welding techniques.

Schematic Illustration for GTAW Process

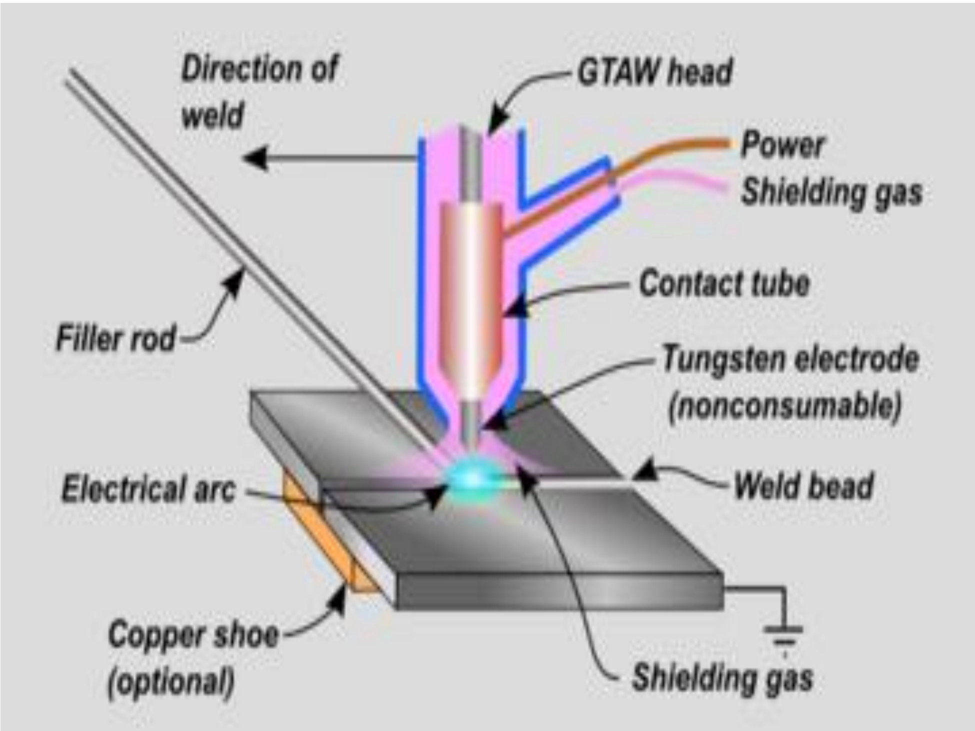


Figure 1.1 Schematic Illustration for GTAW Process

Welders often develop a technique of rapidly alternating between moving the torch forward (to advance the weld pool) and adding filler metal.

The filler rod is withdrawn from the weld pool each time the electrode advances, but it is never removed from the gas shield to prevent oxidation of its surface and contamination of the weld.

Filler rods composed of metals with low melting temperature, such as aluminum, require that the operator maintain some distance from the arc while staying inside the gas shield. If held too close to the arc, the filler rod can melt before it makes contact with the weld puddle.

2.Principle of TIG Welding

TIG welding is an electric arc welding process in which the fusion energy is produced by an electric arc burning between the work piece and the tungsten electrode.

During the welding process the electrode, the arc and the weld pool are protected against the damaging effects of the atmospheric air by an inert shielding gas.
By means of a gas nozzle the shielding gas is lead to the welding zone where it replaces the atmospheric air.
TIG welding differs from the other arc welding processes by the fact that the electrode is not consumed like the electrodes in other processes such as MIG/MAG and MMA.

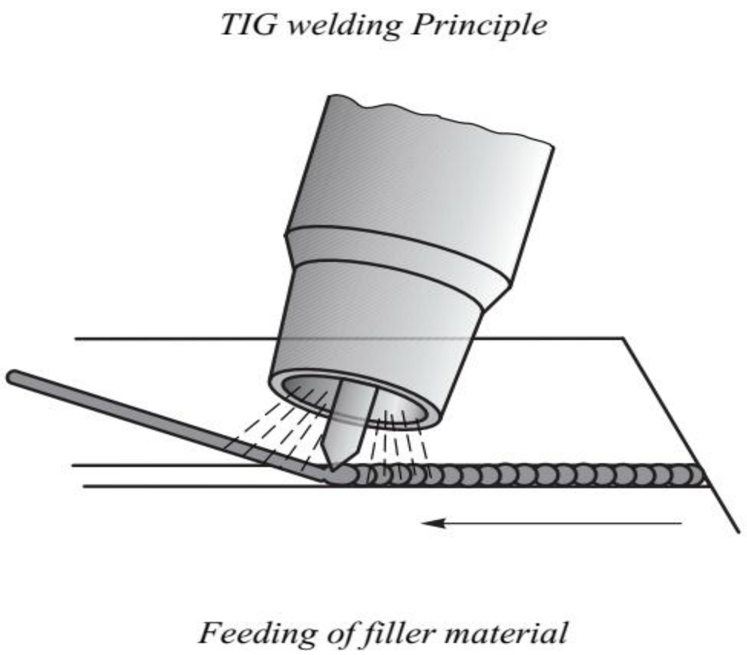


Figure 2.1 TIG welding principle

3. Application

The lower limit of the application of the TIG process is about 0.3 mm for steel and 0.5 mm for aluminum and copper. Towards the top, economic limits are set for the application. The deposition rate is not very high in this process. For this reason, only the root passes are TIG welded, and the remaining layers are welded using other processes (E, MAG), which have a higher power.

When selecting the welding parameters, it must be noted that only the current is set on the welding device. The arc voltage is determined by the arc length, which is maintained by the welder. Therefore, the greater the arc length, the higher the arc voltage.

A welding current of 45 amps per mm of wall thickness is used as the reference value for a current sufficient for welding steel with a direct current to full penetration. For AC welding aluminum, a current of 40amps/mm is required.

GTAW has a wide range of applications, particularly its use on ferrous materials (such as plain carbon, carbon-manganese and alloy steels), and non-ferrous metals (such as aluminum and its alloys) and also copper and copper-based alloys (such as brass and bronze). It can be used to weld a wide variety of metal thicknesses in all types of applications, including:

- ✓ general engineering applications
- ✓ transport industries
- ✓ sheet metal industries
- ✓ marine and transport industries
- ✓ boiler and pipe welding

4. Advantages and Limitations of TIG welding

4.1 Advantages of TIG welding

The TIG welding process has a very large area of application due to its many advantages, e.g.:

- It provides a concentrated heating of the work piece.
- It provides an effective protection of the weld pool by an inert shielding gas.
- It can be independent of filler material.
- The filler materials do not need to be finely prepared if only the alloying is all right.
- There is no need for after treatment of the weld as no slag or spatters are produced.
- Places of difficult access can be welded.

4.2 Limitations

Some limitations of the GTAW process are as follows.

- Equipment is relatively expensive and to make full use of the process a high degree of skill is required from the operator.
- The process is not suitable for use on dirty material and does not like a windy environment.
- It is not really suitable for thicker sections or high productivity work, although it can be mechanized to improve quality and efficiency.
- It has more intense arc radiation and fume safety hazards, dependent on the material being welded.

Self-Check -1	Written Test

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

Multiple choose

1. ________________ is an electric arc welding process in which the fusion energy is produced by an electric arc burning between the work piece and the tungsten electrode. (2 points)
   A. TIG welding C. Plasma welding
   B. MIG welding D. SMAW welding

Identification

1. Write at List five advantage of TIG welding points.(5 points)
2. Write the limitations of the GTAW.(5 points)

Note: **Satisfactory rating - 12 points Unsatisfactory - below 15 points**

n ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: ___________________________ Date: ________________

Short Answer Questions

INFORMATION SHEET-2	DETERMINING CORRECT SIZE, TYPE AND QUANTITY OF MATERIALS/ COMPONENTS.

1 Materials for TIG welding

The most important area of application is:

- Welding of thin materials in stainless steels
- Aluminum
- **Magnesium**
- copper

The increasing demands to the weld quality has made TIG welding very popular for welding of smaller tube dimensions as well as root runs in both non-alloyed and alloyed materials in heavier plates.

1.1 Aluminum

Nonmeat-treatable wrought aluminum alloys in the 1000, 3000 and 5000 series are readily weldable. The heat-treatable alloys in the 2000, 6000 and 7000 series can be welded but higher welding temperatures and speeds are needed. Elimination of weld cracking in these alloys can often be achieved with a rod having higher alloy content than that of the base metal.

While welding can be performed in any position the task is simplified and the quality of the completed joint is more satisfactory if the weld is done in a flat position. Copper back-up blocks should be used wherever possible especially on plates *1/8"* or less in thickness. In most cases, the torch should be moved in a straight line without a weaving motion. Best results are obtained by using ACHF current with argon as a shielding gas. See Table 24-5 for recommended welding requirements of gas flow, current, etc.

TABLE 24-5. GTAW WELDING—ALUMINUM.

STOCK THICKNESS (inches)	TYPE OF JOINT	AMPERES, AC CURRENT FLAT	HORIZONTAL & VERTICAL	OVERHEAD	ELECTRODE (inches) dia	ARGON FLOW 20 psi lpm	cfh	FILLER ROD (inches) dia
1/16	Butt	60-80	60-80	60-80	1/16	7	15	1/16
	Lap	70-90	55-75	60-80	1/16	7	15	1/16
	Corner	60-80	60-80	60-80	1/16	7	15	1/16
	Fillet	70-90	70-90	70-90	1/16	7	15	1/16
1/8	Butt	125-145	115-135	120-140	3/32	8	17	1/8
	Lap	140-160	125-145	130-160	3/32	8	17	1/8
	Corner	125-145	115-135	130-150	3/32	8	17	1/8
	Fillet	140-160	115-135	140-160	3/32	8	17	1/8
3/16	Butt	190-220	190-220	180-210	1/8	10	21	5/32
	Lap	210-240	190-220	180-210	1/8	10	21	5/32
	Corner	190-220	180-210	180-210	1/8	10	21	5/32
	Fillet	210-240	190-220	180-210	1/8	10	21	5/32
1/4	Butt	260-300	220-260	210-250	3/16	12	25	3/16
	Lap	290-340	220-260	210-250	3/16	12	25	3/16
	Corner	280-320	220-260	210-250	3/16	12	25	3/16
	Fillet	280-320	220-260	210-250	3/16	12	25	3/16

1.2 Stainless steel

Stainless steels, especially those in the 300 series, are very easy to weld using the gas tungsten-arc process. Either direct current straight polarity or alternating current with high-frequency stabilization can be used. The gas tungsten-arc process is particularly adaptable for welding light gauge stainless steel.

The procedure for welding martens tic stainless steels is the same as for welding austenitic stainless steels. If a filler rod is used it should have a slightly higher chromium content. Danger of cracking is greatly reduced if the metal is preheated to a temperature of 300° to 500°F (145° to 260°C). See Table 24-6 for specific welding requirements

1.3 Copper and copper alloys.

Deoxidized copper is the most widely used type for gas tungsten-arc welding.

Copper alloys such as brass, bronze, and copper alloys of nickel, aluminum, silicon and beryllium are also readily welded with the gas tungsten-arc process. DCSP is generally used for welding these metals. However ACHF or DCRP is often recommended for beryllium copper or for copper alloys less than 0.040" thick. Work pieces thicker than 1/4″ should be preheated to approximately 300-500°F (145° to 260°C) prior to welding. A forehand welding technique will usually produce the best results. See Table 24-7 and 24-8 for specific welding requirements.

Always be sure that there is good ventilation when welding copper or copper alloys. The fumes of these metals are highly toxic; therefore, a high-velocity ventilating system is absolutely necessary.

1.4 Magnesium.

The welding characteristics of magnesium are somewhat comparable to those of aluminum. Both, for example, have high heat conductivity, low melting point, high thermal expansion, and oxidize rapidly.

With gas tungsten arc several current variations are possible. DC reverse polarity with helium gas produces wider weld deposits, higher heat, larger heat-affected zone, and shallower penetration. AC current with superimposed high frequency and helium, argon, or a mixture of these

TABLE 24-6. GTAW WELDING—STAINLESS STEEL.

STOCK THICKNESS (inches)	TYPE OF JOINT	DC CURRENT STRAIGHT POLARITY amperes flat	horizontal & vertical	overhead	ELECTRODE (inches) dia	ARGON FLOW 20 psi lpm	cfh	FILLER ROD (inches) dia
1/16	Butt	80-100	70-90	70-90	1/16	5	11	1/16
	Lap	100-120	80-100	80-100	1/16	5	11	1/16
	Corner	80-100	70-90	70-90	1/16	5	11	1/16
	Fillet	90-110	80-100	80-100	1/16	5	11	1/16
3/32	Butt	100-120	90-110	90-110	1/16	5	11	1/16
	Lap	110-130	100-120	100-120	1/16	5	11	1/16
	Corner	100-120	90-110	90-110	1/16	5	11	1/16
	Fillet	110-130	100-120	100-120	1/16	5	11	1/16
1/8	Butt	120-140	110-130	105-125	1/16	5	11	3/32
	Lap	130-150	120-140	120-140	1/16	5	11	3/32
	Corner	120-140	110-130	115-135	1/16	5	11	3/32
	Fillet	130-150	115-135	120-140	1/16	5	11	3/32
3/16	Butt	200-250	150-200	150-200	3/32	6	13	1/8
	Lap	225-275	175-225	175-225	3/32	6	13	1/8
	Corner	200-250	150-200	150-200	3/32	6	13	1/8
	Fillet	225-275	175-225	175-225	3/32	6	13	1/8
1/4	Butt	275-350	200-250	200-250	1/8	6	13	3/16
	Lap	300-375	225-275	225-275	1/8	6	13	3/16
	Corner	275-350	200-250	200-250	1/8	6	13	3/16
	Fillet	300-375	225-275	225-275	1/8	6	13	3/16

gases, will join material ranging in thickness from 0.20" to over 0.25".

2. TIG welding machine components

Four major components make up a GTA welding station. They are the welding **power supply**, often called the welding machine; the welding torch, often called a **TIG torch**; the work clamp, sometimes called the **ground clamp**; and the shielding **gas cylinder**, Figure 1.There are a variety of hoses and cables that connect all three of these components together .

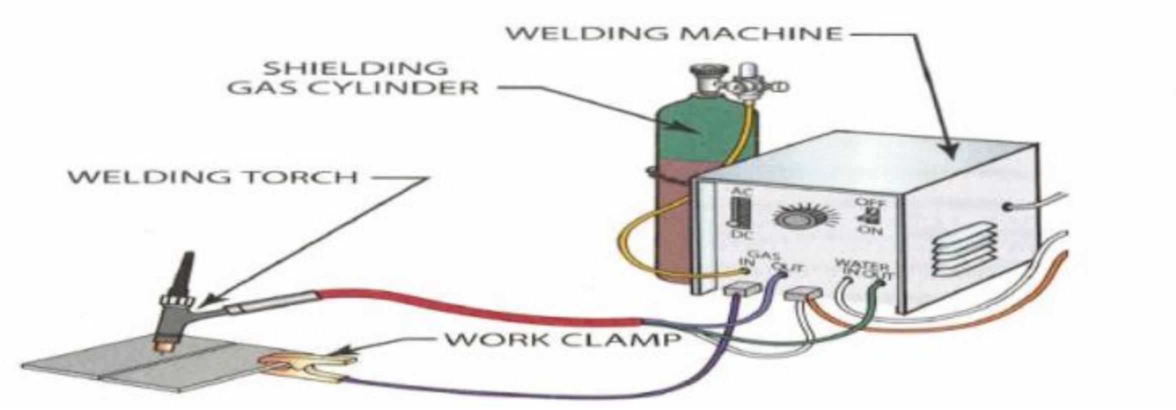


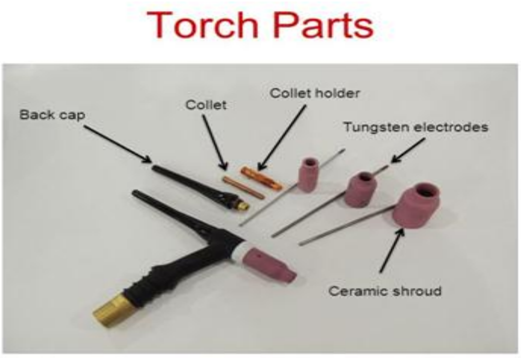
Figure 2.1 - Tungsten inert gas welding components.

2.1 TIG welding torches

TIG welding torches are available water-cooled or air-cooled, Figure 6. The heat transfer efficiency for TIG welding may be as low as 20%. This means that 80% of the heat generated does not enter the weld. Much of this heat stays in the torch. To avoid damage to the torch, the heat must be removed by some type of cooling method.

2.2 TIGW Torch Components

Collet Body: The collet body screws into the torch body. It is replaceable and is changed to accommodate various size tungstens and their respective collets. Collets: The welding electrode is held in the torch by the collet. The collet is usually made of copper or a copper alloy. The collet‟s grip on the electrode is secured when the torch cap is tightened in place. Good electrical contact between the collet and tungsten electrode is essential for good current transfer.



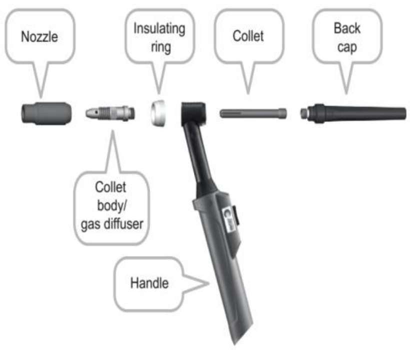


Figure 2.2 - Torch components.

2.3 Nozzles

Gas nozzles or cups as they are better known, are made of various types of heat resistant materials in different shapes, diameters and lengths. The nozzles are either screwed into the torch head or pushed in place.

Nozzles can be made of ceramic, metal, metal-jacketed ceramic, glass, or other materials. Ceramic is the most popular, but are easily broken and must be replaced often. Nozzles used for automatic applications and high amperage situations often use a water-cooled metal design. Gas nozzles or cups must be large enough to provide adequate shielding gas coverage to the weld pool and surrounding area. A nozzle of a given size will allow only a given amount of gas to flow before the flow becomes turbulent

Figure 2.3 - Ceramic cup or nozzle

Back Caps **-** The back cap is the storage area for excess tungsten. They can come in different lengths depending on the space the torch may have to get into (e.g. long, medium and short caps)**..**

2.4 Regulators

The function of the gas regulator is to reduce bottle pressure gas down to a lower pressure and deliver it at a constant flow. This constant flow of gas flows down through the TIG torch lead to the TIG torch nozzle and around the weld pool. The pressure in the steel cylinders is between 200 and 300 bar. In order to use the shielding gas the high pressure must be reduced to a suitable working pressure.

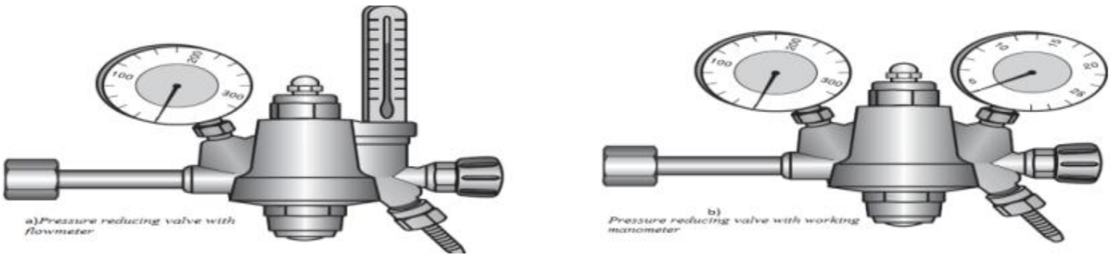


Figure 2.4 - Pressure regulators

2.5 TIG Welding Machine Ground

Welding machines that utilize a flexible cord and plug arrangement or those that are permanently
wired into an electrical supply system contain a grounding conductor. The grounding conductor connects the metal enclosure of the welding machine to ground. If we could

trace the grounding wire back through the electrical power distribution system we would find that it is connected to earth, and usually through a metal rod driven into the earth.

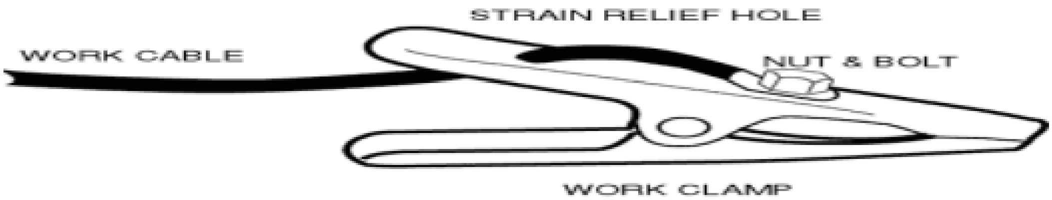


Figure 2.5 – TIG welding machine

Self-Check -2	Written Test

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

Multiple choose

1. Nozzles can be made of ________, ________and _______________. (2 points)

A. Ceramic C. Metal-jacketed ceramic

B. Metal D. All

2.Welding machines that utilize a flexible cord and plug arrangement or those that are permanently wired into an electrical supply system contain a grounding conductor. (3 points)

A. T B. F(2 points)

Identification

3. Write four major components TIG machine. (5 points)

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

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

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

INFORMATION SHEET-3	ALIGNMENT OF MATERIALS TO THE SPECIFICATION

1. Preliminary Steps

Before starting to weld, follow these steps:

1. Check all electrical circuit connections to make sure they are tight.

2. Check for the proper diameter electrode and cup size. (Follow manufacturer's recommendations.)

3. Adjust the electrode stick out so it extends about 1/8" to 3/16" beyond the end of the gas cup for

butt-welding and approximately 1/4″ to 3/8″ for fillet welding. See Figure.

4. Check the electrode to be certain that it is firmly held in the collet. If the electrode moves in the

nozzle, tighten the collet holder or gas cup. Be careful not to over tighten the gas cup because this

will strip the threads very easily.

5. Set the machine for the correct welding amperage. (See Tables 24-4 to 24-9.) 6. If a water-cooled

torch is to be used, turn on the water.

7. Turn on the inert gas and set to the correct flow. Set the after flow (post purge) timer.

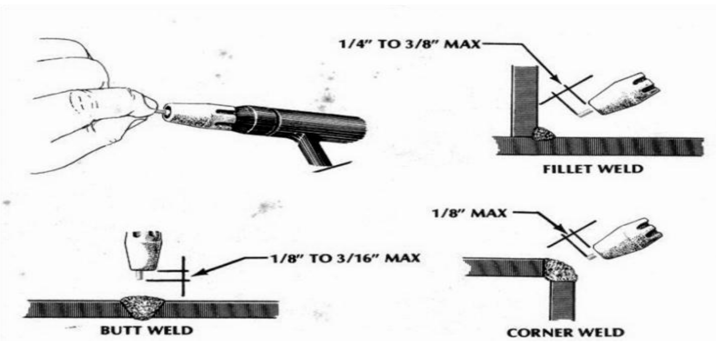


Figure 1.1 - Materials alignment

2 Materials specification

- The process uses a non-consumable tungsten electrode that delivers the current to the welding arc. The tungsten and weld puddle are protected and cooled with an inert gas, typically argon. TIG welding is similar to oxy-acetylene welding in that you use a filler material for build-up or reinforcement.

- Gas Tungsten Arc Welding is most commonly used to weld stainless steel and nonferrous materials, such as aluminum and magnesium, but it can be applied to nearly all metals, with a notable exception being zinc and its alloys. Its applications involving carbon steels are limited not because of process restrictions, but because of the existence of more economical steel welding techniques, such as gas metal arc welding and shielded metal arc welding. Furthermore, GTAW can be performed in a variety of other-than-flat positions, depending on the skill of the welder and the materials being welded.

3.Material Preparation:

3.1 Butt joint

For light materials the square butt joint as shown Figure 3.1, is the easiest to prepare and can be welded with or without a filler rod. If the weld is to be made without a filler rod, extreme care must be taken to avoid burning through the metal.

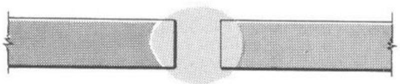


Figure .3.1 The square butt joint is the easiest to prepare and can be welded with or without a filler rod.

3.2 The **single-V butt joint** is preferable on material ranging in thickness from 3/8” to 1/2 “in order complete penetration. The included angle of the V should be approximately 60° with a root face of about 1/8″ to 1/4″. See Figure 3.2

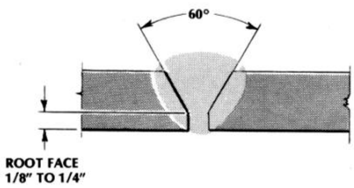


Figure 3.2. The single-V butt joint has an included angle of approximately 60° and a root face of 1/8” to 1/4"

3.3 Double-V butt joint is needed when the metal exceeds ½" in thickness and the design is such that the weld can be made on both sides. With a double-V there is greater assurance that penetration will be complete. See Figure 3.

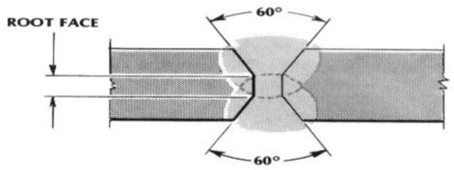


Figure 3.3. The double-V butt joint can be welded on both sides assuring complete penetration

3.4 Lap joint:- The only special requirement for making a good weld is to have the pieces in close contact along the entire length of the joint. See Figure 24-17. On metal 1/4" or less in thickness, the weld can be made with or without filler rod. As a rule, the lap joint is not recommended for material exceeding 1/4" in thickness.

Self-Check -3	Written Test

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

Multiple choose

1. _________________ is preferable on material ranging in thickness from 3/8” to 1/2 “in order complete penetration. (**2 points**)

   A. Lap joint C. Double-V butt joint

   B. Single-V butt joint D. Butt joint

2. **Double-V butt joint** is needed when the metal exceeds ½” in thickness and the design is such that the weld can be made on both sides. (**3 points**)

   A. Lap joint **C. Double-V butt joint**

   B. Single-V butt joint D. Butt joint

Identification

3.Write at list three joints

Note: **Satisfactory rating – 2 and 3 points** **Unsatisfactory - below 2 and 43points**

Answer Sheet

Score = ____________

Rating: ______________

Name: ___________________________ Date: ________________

OPERATION SHEET 2	DETERMINING CORRECT SIZE, TYPE AND QUANTITY OF MATERIALS/ COMPONENTS.

1. Preparing material and equipment for TIG welding.

Steps 1- Wear PPE

Steps 2- Select material for the work

Steps 3- layout the work pieces

Steps 4**-** cut the work pieces.

Operation Sheet 3	Alignment of materials to the specification

3.1 Align the TIG welding machine Material;

Steps 1- wear PPE

Steps 2- Before align check machine body.

Steps 3- Arrange TIG welding machine equipment

Steps 4- Assemble TIG welding machine equipment

LAP Test	Practical Demonstration

Name: _______________________________ Date: _________________

Time started: __________________________ Time finished: _________________

Instructions: Given necessary TIG machine equipment, tools and materials you are required to perform the following tasks within 3-5:30 hours.

Task 1: determining correct size, type and quantity of materials/ components.

Task 2: Alignment of materials to the specification

List of Reference Materials

1. *en.wikipedia.org/wiki/GTAW*
2. www.weldwell.co.nz/site/weldwell
3. http://www.azom.com/article.aspx?ArticleID=1446
4. Karunakaran, N. (2012). Effect of Pulsed Current on Temperature Distribution, Weld Bead Profiles and Characteristics of GTA Welded Stainless Steel Joints.
5. http://www.ijser.org
6. www.PDHcenter.com
7. *FordAluminumGMA(MIG)WeldingQualificationTestBOOK*
8. **www.weldability.com |**
9. **support@weldability.com**
10. http://www.ijser.org

Mechanics

Level III

Learning Guide-05

Unit of Competence: Perform Plate and Tube Welding Using Gas Tungsten Arc welding (GTAW)

Module Title: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO 2: Set-up welding machine /equipment, accessories and fixtures

Instruction Sheet	Learning Guide #05

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

- Positioning and setting welding machine to the polarity indicated.
- Adjusting current and voltage consistent.
- Providing braces, stiffeners, rails and other jigs.
- Selecting appropriate distortion prevention measures.
- Making routine maintenance

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:

- Indicating welding polarity ***and Welding machine*** procedures / specifications or Recommending by the filler wire manufacturer
- Adjusting Current and voltage fine-tune/ consistent with job requirements based on instruction material
- Providing Braces, stiffeners, rails and other jigs in conformity with job requirements
- Welding machines and ***accessories*** are made ***routine maintenance*** as per client requirements
- Selecting Appropriate distortion prevention measures for weld and material type in according to 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, Sheet 3, Sheet 4 and Sheet 5”.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3, Self-check 4 and Self-check 5” **in page -33, 41, 45, 48 and 51** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1 and Operation Sheet 2” **in page -52.**
6. Do the “LAP test” **in page – 53** (if you are ready).

INFORMATION SHEET-1	POSITIONING AND SETTING WELDING MACHINE TO THE POLARITY INDICATED.

1.TIG Welding Equipment

1.1 Power source

Gas tungsten arc welding power sources can be obtained to operate on domestic or industrial mains supply voltages. Most industrial machines operate on a 440 volt supply and provide current in the range 200–500 amperes with a 60 per cent duty cycle. Any AC or DC manual metal arc welding machine (constant current) can be used to supply the current for GTAW. It is important, however, that the machine has a good current control for low amperages in order to maintain a steady arc when welding thin material. When using DC for welding, a high-frequency unit is desirable but not essential. With AC a high-frequency unit is definitely required. This will be discussed later. The ideal power source for GTAW is one that has been specially designed for the process (Fig 1.1)

These welding machines are typically transformer rectifiers or inverters which supply both AC and DC and have a high-frequency unit incorporated in them. They usually have other controls peculiar to the GTAW process, such as the following.

- Remote current control – usually foot operated which enables the welder to alter the amperage whilst welding.
- Soft start switch – which reduces the current when starting the arc. This is an advantage when welding aluminum or magnesium.
- High-frequency spark intensity control – which is useful when welding aluminum and magnesium.
- Pre-gas timer – to allow the gas to flow before the arc is started and a post gas timer which allow the gas (and water if used) to flow for a set time after the arc is extinguished. This prevents atmospheric contamination of the weld pool and assists in tungsten electrode cooling.

A better GTAW power source will provide the ability to control upslope and down slope on the main current as well as a pulsing option.

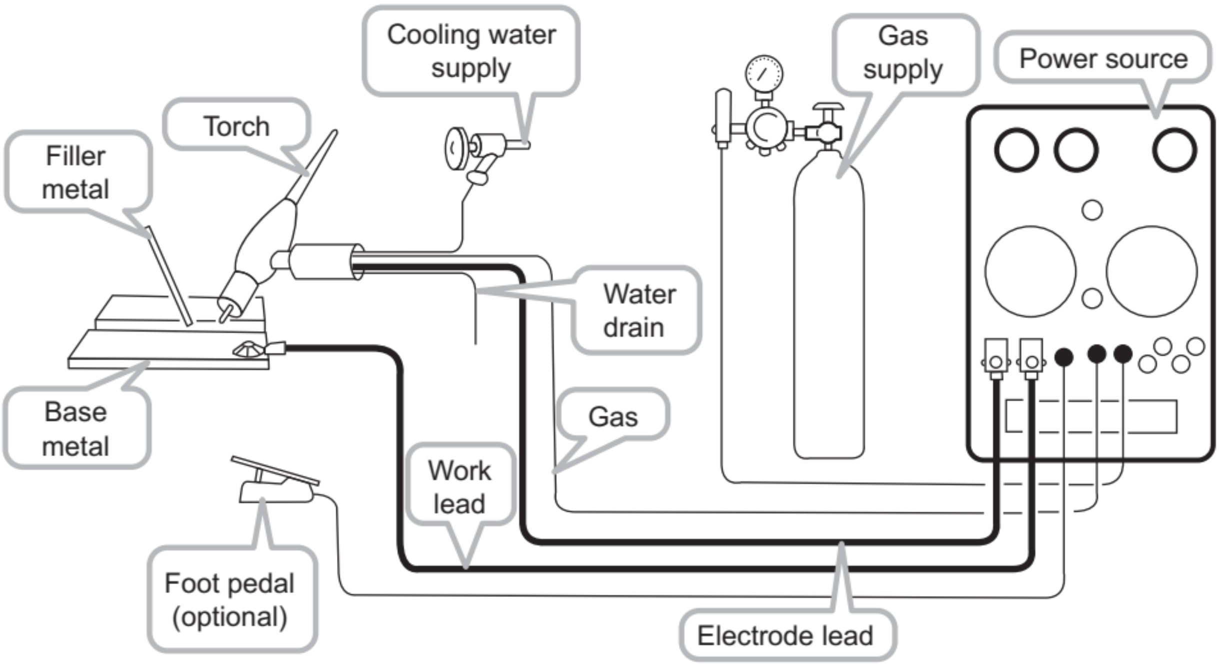


Fig 1.1 Equipment used in gas tungsten arc welding

1.2 Shielding gases

Generally an inert gas is used as the shielding medium to protect the weld zone from contamination by the atmosphere. Argon is the inert gas most commonly used in Australia. It is preferred to helium because of its lower cost and its general suitability for a wide variety of metals. Argon is an electron carrier and also exhibits better oxide removal characteristics than helium and aids the welding operation, as heat input to the weld puddle is less affected by variations in arc length. On the other hand, helium as an insulator gas provides higher arc voltages and greater heat input which increases penetration and travel speeds.

Term	Definition
argon	a colourless, odourless inert gas
inert	having only a limited ability to react chemically; chemically inactive

Mixtures of the two gases, in some special applications, and also other brews (or combinations of gases) will prove advantageous, particularly in mechanized applications. Those seeking further information should contact the local supplier.

Fixed pressure reduction regulators are used to supply gas to the torch, together with a flow meter to give a precise indication of the gas flow rate being used. Gas flows are adjusted between five and 14 liters per minute to suit the particular application.

Fig 1.2- Shielding gases

Argon vs. Helium

1.3 Welding torches

Handheld GTAW welding torches may be air cooled for low to medium amperage applications (these are also gas cooled by the gas supply). Water cooled torches are required for industrial operations involving higher amperages and longer welding periods. The electrode is held by a collet in a collet body/gas diffuser which allows the removal and setting of the electrode in relation to the torch nozzle, or gas shroud.

Projection of the electrode should not be excessive as it may touch the work and contaminate the electrode. Minimum projection of the electrode, normally 2 mm to 5 mm, will provide good welding conditions and satisfactory gas coverage of the electrode and work. The collet is tightened by screwing in the torch back cap which also provides insulation for the electrode.

Term	Definition
collet	grips electrode and passes electric current to tungsten electrode
gas diffuser	fits into torch and distributes gas flow evenly (also retains electrode collet)

Table. 1.3.1 Collet body/gas diffuser

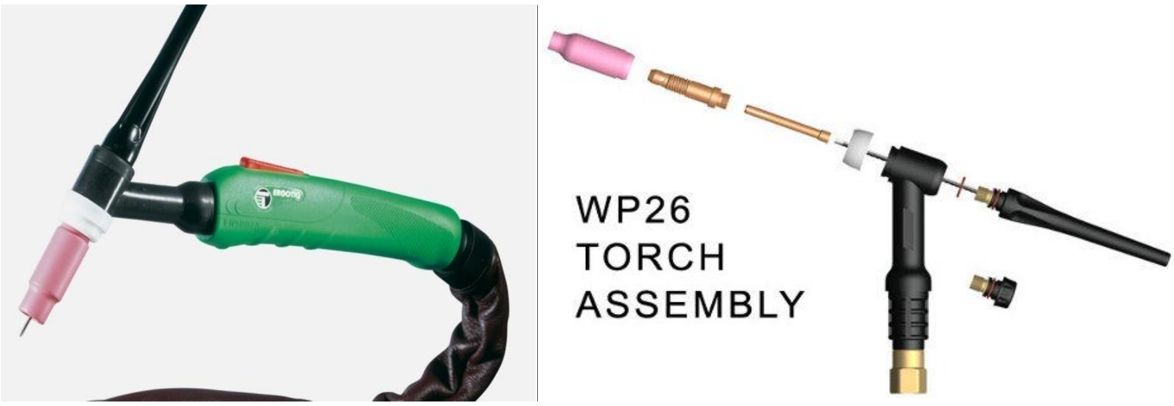


Fig .1.3-Welding torch parts

A control for gas flow is located on the torch and this may incorporate a current on/off switch. Some equipment allows gas to flow for short periods before the arc is struck (pre-purge) and after welding current is switched off (post-purge), which provides gas coverage of the electrode and work as they cool

Term	Definition
pre-purge	flow of gas before the arc starts to ensure shielding gas is around arc zone and to facilitate arc starting
post-purge	flow of gas after the arc is stopped to allow time for tungsten electrode and weld area to cool

Table.1.3.2 (pre-purge) and after welding current is switched off (post-purge),

1.4 Gas nozzles

Gas nozzles or gas cups are used to protect the tungsten electrode from the atmospheric gases and to deliver the shielding gas to the weld area. They may be made from cheap alumina-type material, ceramic material or even metal or fused silica (glass). The gas cup is available in a variety of sizes ranging from 8 mm to 20 mm.

The general rule for the gas cup size is four to six times the electrode diameter. This may be altered however depending on the joint type and material being welded. For example, an outside corner weld may require a larger gas cup size to give more shielding, while an inside corner can be achieved easily with a small gas cup because the gas will be trapped in the corner. Typically, aluminum or stainless steel may also need a one size larger cup to give better gas coverage.

1.5 Electrodes

Different types of tungsten electrodes are available and provide a comprehensive range for specific applications. Tungsten electrodes are identified by their tip color.

This color tip should be preserved, as identification of a tungsten electrode that has lost its code can be difficult.

1.5.1 Pure tungsten electrodes (green tip)

Tungsten has the highest melting point of all metals – typically 3400 °C for pure tungsten. These electrodes are recommended chiefly for use with balanced wave alternating current power sources on the welding of aluminum, where other electrode types are not generally used due to their emission characteristics. When used with standard power sources, pure tungsten electrodes provide good stability with direct current and high-frequency, stabilized alternating current with argon, helium or a mixture of both as a shielding gas.

Pure tungsten electrodes have a lower current carrying capacity and poorer arc starting characteristics than other electrodes, but have a reasonably good resistance to contamination and maintain a clean balled end (which is preferred for aluminum and magnesium welding). They are a general purpose electrode for less critical work.

1.5.2 2% Thoriated tungsten electrodes (red tip)

These electrodes contain one to two per cent thorium as an alloy and this gives the electrode a greater ability to resist transfer across the arc and thus help to maintain the sharpened point (when used chiefly for direct current electrode negative). This is because they offer increased life, compared with pure tungsten type, due to their higher electron emission. They have better arc starting, particularly at low open circuit voltages, and good arc stability.

The throated tungsten range of electrodes has a higher current carrying capacity and greater resistance to weld pool contamination. Throated tungsten electrodes are generally used when DC electrode negative is selected for welding of ferrous materials and alloys such as mild steel, alloy steel and stainless steel. They may be used on high-frequency, stabilized alternating current work, but there can be difficulty maintaining the satisfactory balled end required for good arc stability (when welding aluminum and magnesium). This condition frequently produces arc wander and tungsten emission, resulting in contamination of the weld metal.

1.5.3 0.8% Zirconiated tungsten electrodes (white tip)

These electrodes are treated with zirconium and are preferred for applications where tungsten contamination of the weld metal must be minimized. They are recommended for use with high-frequency, stabilized alternating current for the welding of aluminum and magnesium due to the fact that they retain a clean balled end during welding and have a high resistance to contamination. They have a longer life and higher current carrying capacity than that of pure tungsten electrodes.

The chart below sets out general recommendations for choosing operating conditions.

Electrode diameter	Gas cup size	AC(hf)	DC(–)
0.5 mm	6 mm	5–15	5–20
1.0 mm	6 mm	15–40	15–70
1.2 mm	6 mm	20–60	40–90
1.6 mm	6 mm or 10 mm	20–90	65–120
2.4 mm	10 mm	60–160	140–250
3 mm	12 mm	120–220	250–380
5 mm	15 mm	160–340	300–550
6 mm	15 mm	280–470	500–700

Table 1.5.3 Typical operating conditions for tungsten electrodes

Before assembling the electrode in the torch, one end should be prepared to suit the type of welding current being used. For DC(-) it should be ground to a taper with the nose section having an approximately 30° included angle; do not grind to a sharp point but leave approximately ⅓ of the electrode diameter ungrounded as a sharp point can be lost from the electrode into the weld pool during welding. For AC welding, grind with a chamfer to provide rapid formation of the balled end necessary for AC welding.

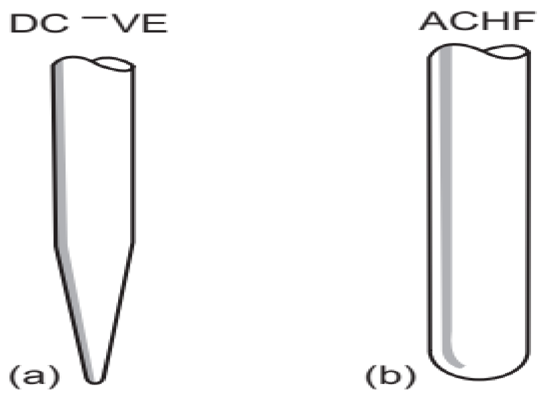
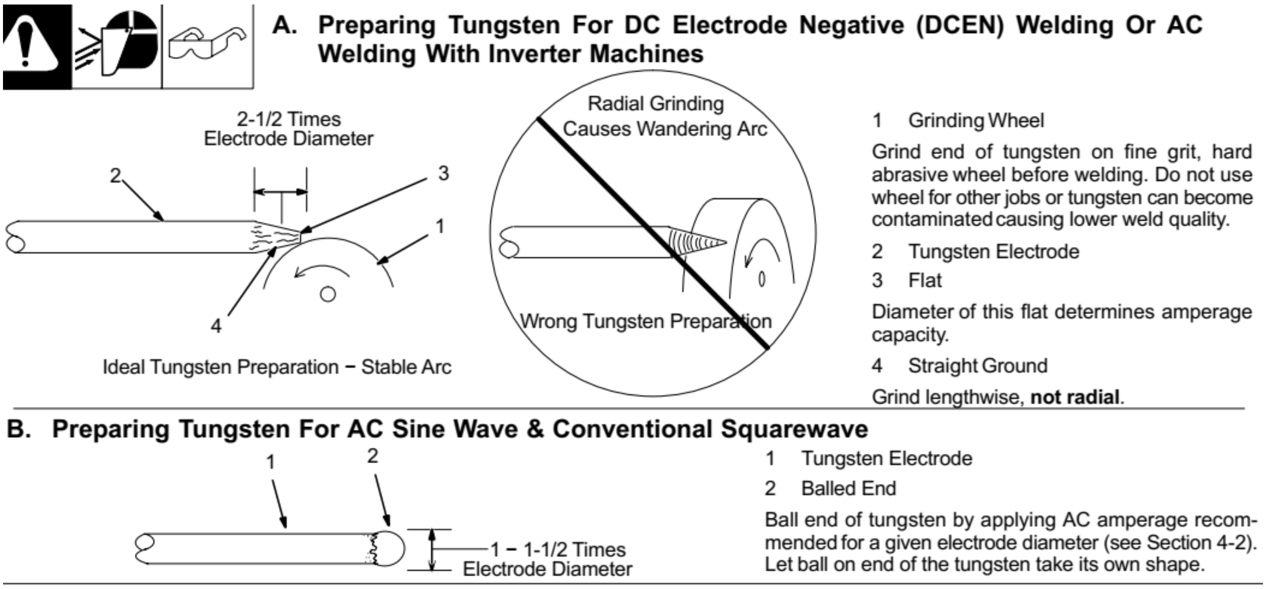


Fig1.5 4.3- Electrode tip preparation (a) and (b)



.2 setting welding machine

2.1 TIG Welding Machine Set-Up

When setting up a TIG welder there are two main settings. They are **amperage** and **gas flow**. Amperage settings vary depending on the type and thickness of the metal to be welded. Gas flow rates also vary depending on draft conditions, cup size, and sometimes the position of the weld. The gas flow rate could range from 5 CFH to 60 CFH for a large cup and drafty conditions.

Some basic guidelines for machine set-up are as follows:

- **1/16 Tungsten** - Require an amperage rage between 50 to 100 amps. The recommended cup sizes are 4, 5, or 6. Gas flow rate should be between 5 to 15 CFH.

- **3/32 Tungsten** - Require an amperage rage between 80 to 130 amps. The recommended cup sizes are 6, 7, or 8. Gas flow rate should be between 8 to 20 CFH.
- **1/8 Tungsten** - Require an amperage rage between 90 to 250 amps. The recommended cup sizes are 6, 7, or 8. Gas flow rate should be between 8 to 25 CFH.

Self-Check -1	Written Test

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

Part I multiple choose

1. ________________ used to protect the tungsten electrode from the atmospheric gases and to deliver the shielding gas to the weld area (**3 points**)
   A. **Gas nozzles** C. Welding torches
   B. Electrode D. Regulator
2. Tungsten has the highest melting point of all metals – typically __________ °C for pure tungsten.(**6 points**)

Part II Identification

3. ________________ arc welding power sources can be obtained to operate on domestic or industrial mains supply voltages **.5 points**)

4.________________ - Require an amperage rage between 50 to 100 amps. The recommended cup

sizes are 4, 5, or 6. Gas flow rate should be between 5 to 15 CFH. (**3 points**)

Note: **Satisfactory rating - 17 points** **Unsatisfactory - below 17 points**

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

Answer Sheet

Score = ____________
Rating: _____________

Name: _________________________ Date: _______________

Short Answer Questions

INFORMATION SHEET-2	ADJUSTING CURRENT AND VOLTAGE CONSISTENT.

1. Types of welding current used for TIG:

- DCSP - Direct Current Straight Polarity - (the tungsten electrode is connected to the negative terminal).This type of connection is the most widely used in the DC type welding current connections. With the tungsten being connected to the negative terminal it will only receive 30% of the welding energy (heat). This means the tungsten will run a lot cooler than DCRP. The resulting weld will have good penetration and a narrow profile.
- DCRP **-** Direct Current Reverse Polarity **-** (The tungsten electrode is connected to the positive terminal).This type of connection is used very rarely because most heat is on the tungsten, thus the tungsten can easily overheat and burn away. DCRP produces a shallow, wide profile and is mainly used on very light material at low amps.
- AC – Alternating Current **–** is the preferred welding current for most white metals, eg aluminum and magnesium. The heat input to the tungsten is averaged out as the AC wave passes from one side of the wave to the other.

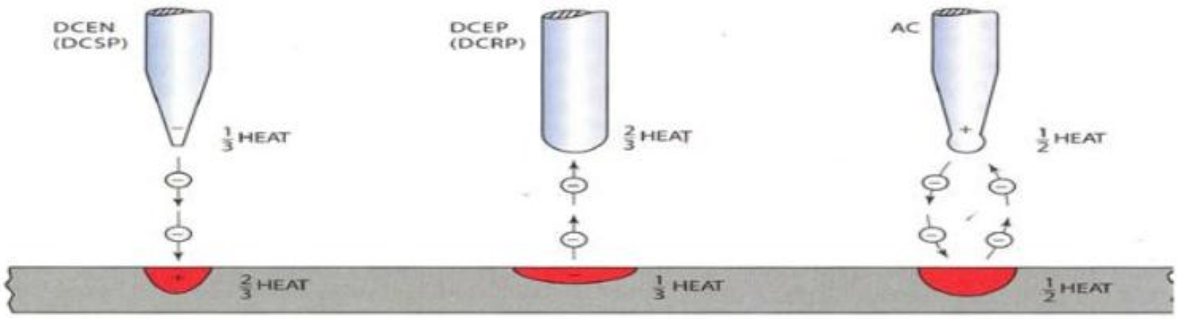


Figure 1 - Heat distributions between the tungsten electrode and the work with each type of welding current.

2. Characteristics of current types for gas tungsten arc welding

All three types of welding current can be used for GTA welding. Each current has individual features that make it more desirable for specific conditions or with certain types of metals. The current used affects the heat distribution between the tungsten electrode and the weld and the degree of surface oxide cleaning that occurs. A look at each type and its uses will help the operator select the best current type for the job.

The type of current used will have a great effect on the penetration pattern as well as the bead configuration. In Figure 2 above shows the heat distribution for each of the three types of currents.

2.1Direct-current electrode negative

DCEN, which used to be called direct-current straight polarity (DCSP), concentrates about two-thirds of its welding heat on the work and the remaining one- third on the tungsten. The higher heat input to the weld results in deep penetration.

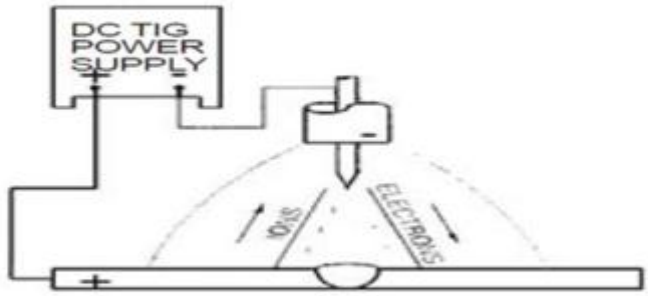


Figure 2 Direct-current straight polarity

2.2 **Direct-current electrode polarity**

DCEP, which used to be called direct-current reverse polarity (DCRP), concentrates only one-third,-of the heat on the plate and two-thirds of the heat on the electrode. This type of current produces wide welds with shallow penetration, but it has a strong cleaning action upon the base metal. The high heat input to the tungsten indicates that large-size tungsten is required, and the end shape with a ball must be used. The low heat input to the metal and the strong cleaning action on the metal make this a good current for thin, heavily oxidized metals.

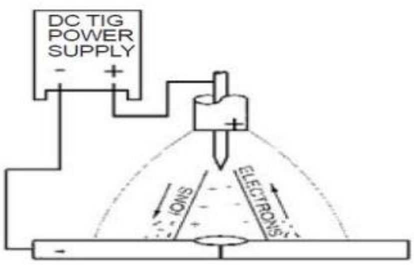


Figure 3 - direct-current reverse polarity

2.3Alternating Current:

Alternating current (AC) concentrates about half of its heat on the work and the other half on the tungsten. Alternating current is continuously switching back and forth between DCEN and DCEP.

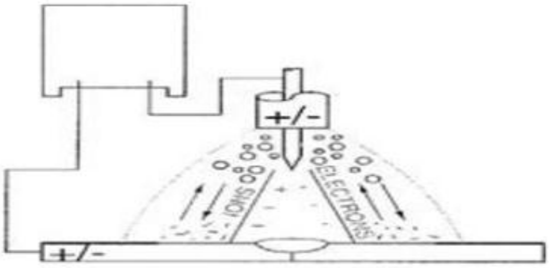


Figure- 4 AC current

Parts Control GTAW

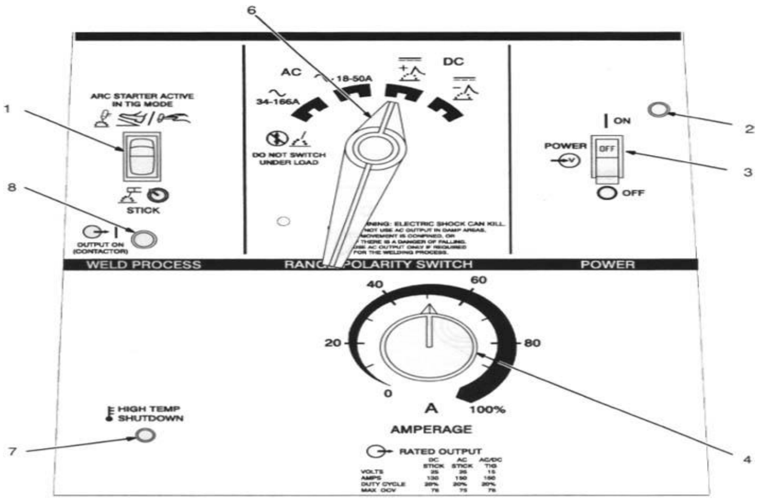


Figure -5 Control board

	Parts	Function
1	Weld process switch	Use switch to select weld process. In stick position (down), weld output goes ON and OFF with power switch. In GTAW (TIG) position (UP), remote control device turns ON and adjusts weld output of unit as limited by amperage control. Built–in arc starter comes ON when needed to start or stabilize welding arc. No adjustment needed for arc starter.
2	Pilot Light	Housing of tungsten electrode Connect receptacle as shown
3	Power Switch	Use switch to turn unit, fan and pilot light ON and OFF flowing
4	Amperage control	For stick (SMAW), use control to adjust amperage within range selected by the range/polarity switch.
	GTAW Remote control	For remote amperage control used when TIG (GTAW) welding front panel amperage controls setting is the maximum amperage percentage available to the remote control device.
6	Reverse polarity switch	Use switch to select range and polarity of weld output. For direct current electrode negative (DCEN), use electrode negative position. For direct current electrode positive (DCEP), use electrode positive position. For alternating current (AC). Use range needed appropriate AC low or AC high position.
7	High temperature shutdown	Light when unit overheats and shuts down
8	Output on (contactor) light	Light when output (contactor) and unit arc ON.

Table .1 Parts Control GTAW

3. The Power Source

The power sources for TIG welding generally have an open circuit voltage of about 70 to 80 V.

For welding with direct current a power source is used that rectify the alternating current of the

mains supply of 400 V to the suitable output for the TIG process and at the same time changes the

current intensity to the level set by the welder on the welding machine.

Modern welding machines are capable of welding of welding either in a DC mode or

some units
provide both AC and DC modes.

3.1TIG Boxes

The control system of the TIG equipment can be either very simple or very advanced with many
different functions. In its most simple version only the welding current is controlled and the shielding gas is turned on/off by a small valve on the TIG torch.

The more advanced TIG boxes are capable of controlling the shielding gas so it is lead to the welding place before the arc is ignited, and delaying the interruption of the shielding gas after the welding current is cut off.

This means that the tungsten electrode and the weld pool are also protected from the atmospheric
air during the cooling period. Furthermore, the TIG box usually has an ignition facility in order to avoid having to scratch the electrode against the work piece and thus damaging the electrode point.

This ignition facility can be a high frequency unit (HF) which increases the frequency to 2 to 4 million periods per second and the voltage to several thousand volts.

The high frequency and the voltage make it possible to produce a spark between the electrode
point and the surface of the work piece that transfers the arc.

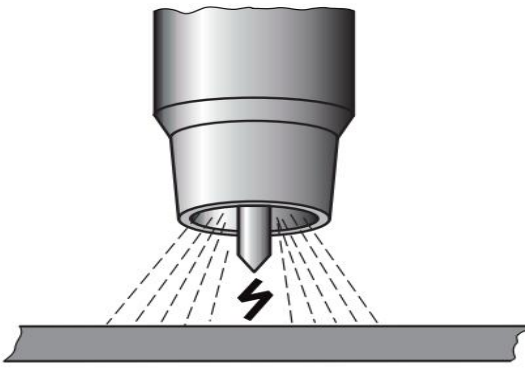
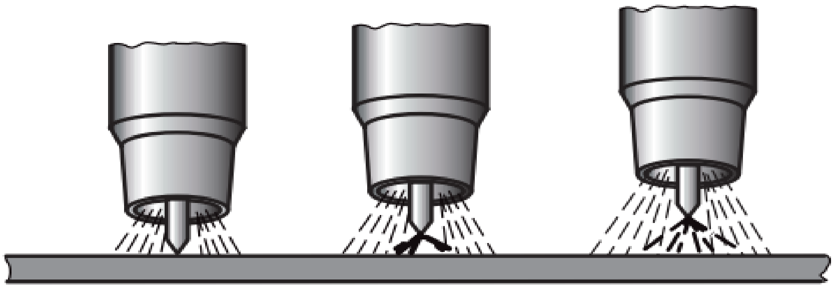


Figure -3.1 High frequency ignitions.

Another type of control of the ignition can be an incorporated unit which is capable of limiting the short-circuit current at the moment of ignition, so that when welding starts the point of the tungsten electrode can be placed directly on the work piece without sticking.

The control then increases the welding current intensity when the electrode is lifted from the work piece thus igniting the arc.

This kind of control has several names as for instance LIFTARC or LIFTIG.



Ignition with the LIFT method.

Figure -3.2 Ignition with the LIFT method

Other possibilities for control of the ignition are

• Slope control that makes it possible to preprogram the increase of the welding current when welding starts and the decrease of the welding current when welding stops. Slope control is especially important at the end of welding to help eliminate porosity and shrink holes.

Figure -3.3 Slope facility

Current pulsation means that two welding current levels are pre-programmed. These are pulse
current and base current.

The base current is only large enough to maintain the arc. The fusion of the base material then takes place when the pulse current is present and the weld pool cools when the base current is present but the arc is maintained. The pulse and base current periods are also controllable.

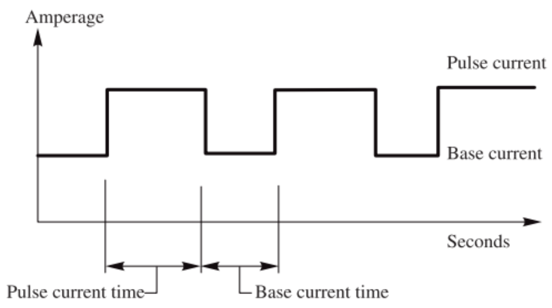


Figure -3.4 bases current and pulse

When welding is done with pulsing welding mode the weld is in principle a row of spot welds
overlap ping to a larger or smaller extent depending on the welding speed.
Example of a weld with pulsing arc Figure -3.5

Figure -3.5 pulsing arc

Many double-current machines are equipped with a control function which makes it possible to
modify the curve of the alternating current in order to make more square, and also modify the
balance between the positive and the negative semi-periods.
Example of a modified AC curve

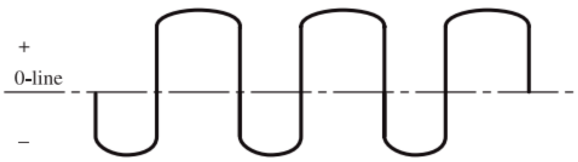


Figure -11 AC curve

These control possibilities are very advantageous when TIG welding aluminum, magnesium and their alloys.

Self-Check -2	Written Test

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

Part I multiple choose

1. The power sources for TIG welding generally have an open circuit voltage of about __________ V. (**3 points**)

   A .60 to 80 V C. **70 to 80 V**

   B. 70 to 90 V D. 50 to 80 V

Part II Identification

2. ______________________ (The tungsten electrode is connected to the positive terminal).**6 points**)

3.____________________ is the preferred welding current for most white metals, e.g. aluminum and magnesium. **5 points**)

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

INFORMATION SHEET-3	PROVIDING BRACES, STIFFENERS, RAILS AND OTHER JIGS.

1. Stiffening

Longitudinal shrinkage in butt welded seams often results in bowing, especially when fabricating thin plate structures. Longitudinal stiffeners in the form of flats or angles, welded along each side of the seam (Fig. 1) are effective in preventing longitudinal bowing. Stiffener location is important: they must be placed at a sufficient distance from the joint so they do not interfere with welding, unless located on the reverse side of a joint welded from one side.

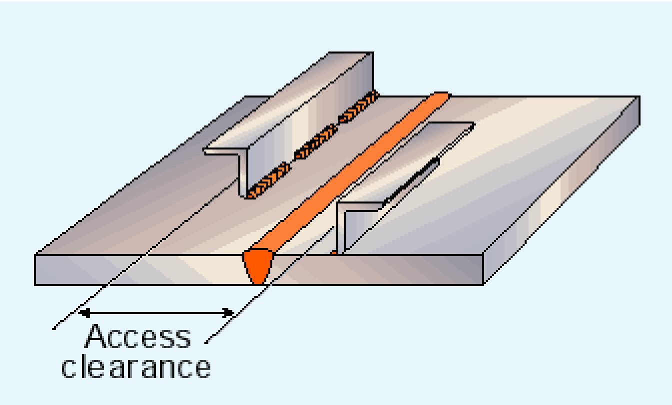


Fig. 1. Longitudinal stiffeners prevent bowing in butt welded thin plate joints

1.1 Weld Iron Railings

Let's face it, when it comes time to weld iron railings there are as many techniques as there are balcony's in Barcelona. No matter if you have an Arc welder, a TIG welder or an easy to use MIG welder like mine, when welding railings it is simply a matter of setting and holding everything in place until it is welded.

Use the information contained within these videos as a reference and make adaptations to find what works best for you.

Fig. 1.1 **Rails**

1.2 Jigs and Fixtures

Jigs and fixtures. The use of jigs and fixtures will help prevent distortion, since holding the metal in a fixed position prevents excessive movements. A jig or a fixture is any device that holds the metal rigidly in position during the welding operation. Figure 2-4 illustrates a simple way to hold pieces firmly in a flat position. These heavy plates not only prevent distortion but they also serve as heat sinks to avoid excessive heat building up in the work. Special chill blocks made of copper or other metal having good conductivity are particularly effective in dissipating heat away from the weld area

1.3 Jig

A jig is a large brace that keeps a welding project stable in the face of pressure, heat, motion, and force. A quality jig will streamline welding work by keeping parts together in a vice grip. Whether the welding is entirely manual, partially automatic, or fully robotic, a jig moves the work piece while the tool remains stationary

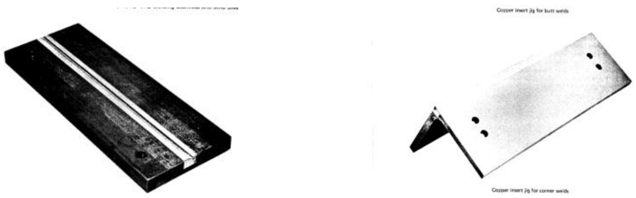


Fig. 1.3 Jig

While a jig is somewhat similar to a welding fixture, a fixture allows for both tool and work piece to be moved together. Some jigs are attached to welding tables and have the function of a frame welding fixture; these may be known as frame welding jigs. The ergonomic design of all jigs minimizes the work needed to complete a task.

1.4 Fixtures

Positioning product parts for welding

In every production process where welding or robotic welding is necessary, high-quality, accurate welding fixtures determine the quality of the final product. A welding fixture is used to position product parts for welding.

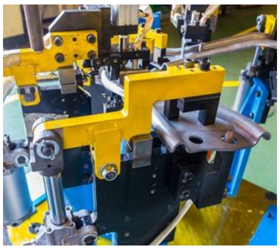


Fig. 3 fixtures

Jigs and fixtures are used extensively in production welding since they permit greater welding speed while reducing to a minimum any form of distortion. By and large, industrial jigs and fixtures are designed to accommodate the specific production work being done.

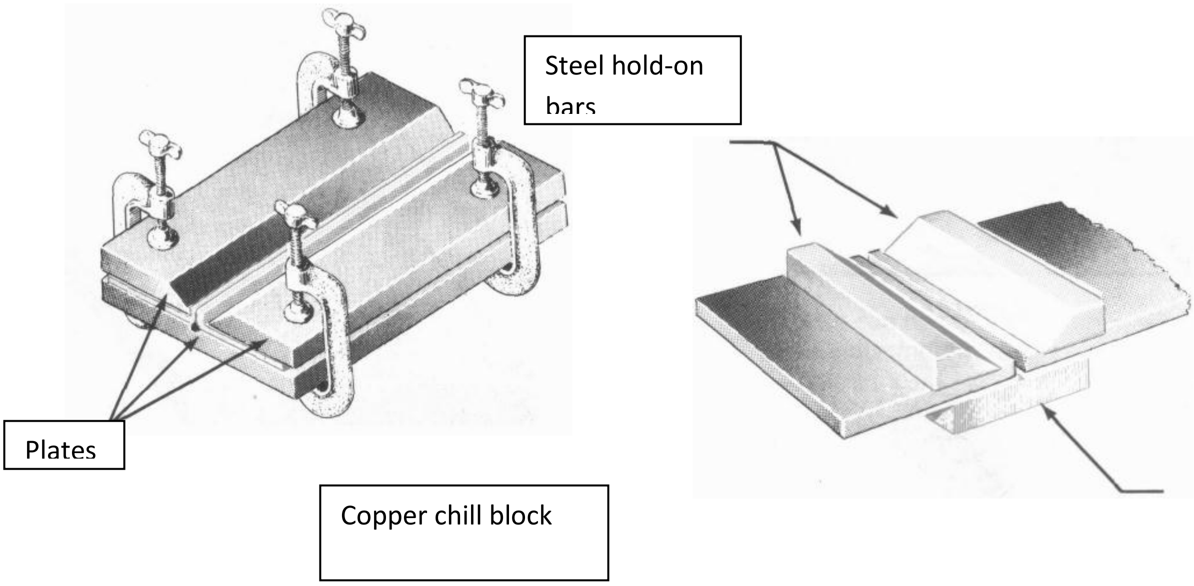


Figure1 .4 shows such a device.

Self-Check -3	Written Test

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

Part I Multiple choose

1. A ___________________ is any device that holds the metal rigidly in position during the welding operation. (**3 points**)

   A. **Jigs and fixtures** C. Vice

   B. pliers **D. All**

Part II Identification

2. A welding __________________ is used to position product parts for welding. **(4points**)

3.___________ and __________ are used extensively in production welding since they permit greater welding speed while reducing to a minimum any form of distortion.(**3 points**)

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

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

Answer Sheet

Score = ____________
Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

INFORMATION SHEET-4	SELECTING APPROPRIATE DISTORTION PREVENTION MEASURES

1 Welding distortion

Warping is a common problem experienced in the welding fabrication of thin walled panel structures. Several factors that influence distortion control strategy may be categorized into design-related and process-related variables. Significant design-related variables include weld joint details, plate thickness, and thickness transition if the joint consists of plates of different thickness, stiffener spacing, and number of attachments, corrugated construction, mechanical restraint conditions, assembly sequence and overall construction planning. Important variables are welding process, heat input, and travel speed and welding sequence.

1.1How to avoid Distortion

There are several methods for avoiding distortion in your work:

- Pre-setting
- Pre-bending
- Weld Sequencing
- Skip Welding
- Back Stepping
- Tack Welding
- Pre and Post Weld Heat Treatment
- Joint Design
- Balanced Welding
- Intermittent Welding
- Chills
- Restraint
- Clamping Jigs
- Back-to-back assembly

Types of distortion

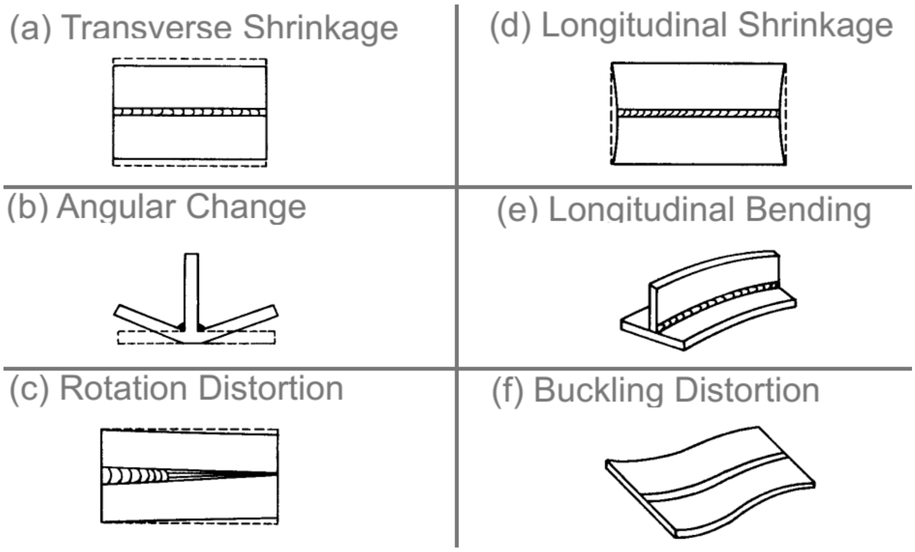


Figure .1.1 distortions

Self-Check -4	Written Test

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

Part I I Multiple choose

1.__________ is a common problem experienced in the welding fabrication of thin walled panel structures. (**3 points**)

A. Distortion C. A and B

B. **Warping** D. All

Part II Identification

2. Write several methods for avoiding distortion. (**6 points**)

Note: **Satisfactory rating - 9points** **Unsatisfactory - below 9 points**

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

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

INFORMATION SHEET-5	MAKING ROUTINE MAINTENANCE

1. Routine maintenance

Welding machines must be blown out regularly to maintain reliable performance.

1. Power sources.-Approximately every six months use clean, dry air to blow out the inside of the machine.
2. Load bank testing.
3. Cable connections, cables and electrode holders.
4. Guns.
5. Cables and liners.
6. Drive rolls.
7. Water coolers.
8. Gas hoses.

2. Welding Equipment Maintenance

Whether you’re talking about an arc, gas, MIG or TIG welder, a little preventive maintenance will go a long way toward getting a long and productive life out of your welding equipment. With so many shops today having one or more welders, and most industrial plants employing welding equipment for maintenance and production, the need to maintain that equipment is greater than ever.

Welders can often costs thousands of dollars or more, and replacement parts can be scarce and quite expensive. So the maintenance of welding equipment is essential to keeping costs down and production going at optimum levels.

The maintenance of welding equipment will differ depending on the type of welder in question. Arc welder maintenance, for example, will depend on whether it’s an AC or DC unit. And an oxyfuel welder will require an entirely different maintenance program to keep it in good working order.

It’s a good idea to set up a regular welder maintenance schedule and stick to all year round. This will ensure that your machine is kept in good operating condition at all times, and the equipment should last longer and need fewer costly repairs.

A good place to start is by thoroughly inspecting your equipment at least every 3 months. Clean all dust and dirt from the welding and other accessories, clean and lubricate the bearings with the proper grease, and check brushes to make sure they're making contact with the commutator. Also clean switches, connectors and relays on a regular basis.

2.1 A.C. Arc Equipment Maintenance

Here the type and level of maintenance of welding equipment depends on whether the motor generator is a transformer. With a transformer unit, the transformer will need to be cleaned at least twice per year by blowing it out with low pressure air hose. Then you'll want to tighten any loose electrical connections, and oil the bearings on the ventilating fans if never force the contact arms apart.

Figure2 .1 TIG welding machine

2.2 D.C. Arc Equipment Maintenance

With DC motor generator arc welders, a more extensive maintenance program is needed due to the fact that these units have more moving parts that are subject to additional wear.

At least once per week you'll want to inspect the brushes on the unit for wear. Replace any brushes that are short, cracked or brittle or worn. Always make sure the replacement brushes are of the same grade as recommended by the manufacturer. Also check the brush springs for to make sure they're not cracked or worn out.

Another item to check is the color of the commutator a reddish or bluish tint indicates overheating. A deep brown color indicates a commutator in good operating condition. If the commutator is too badly worn, it may be necessary to turn the component on a lathe to bring it back into good operating condition.

Next you'll want to blow out the machine with a low-pressure air hose. Blow out the field coils, motor coils and the armature. Try to remove all dust, debris and metal filings from the machine. Lubricate any bearings or any other moving parts that require grease or oil. Replace any frayed or defective wiring, connections or insulation. Also check all the controls on the welder, making sure they're well adjusted and functioning correctly.

Self-Check -5	Written Test

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

Part II Multiple Choose

1.__________ approximately every six months use clean, dry air to blow out the inside of the

machine. (**3 points**)

A. Guns. C. Cables and liners.

B. Drive rolls D. **Power sources**

Part II Idntification

2. Welding equipment depends on whether the motor generator is a ___________. **3 points**)

A. Guns. C. Cables and liners.

B. Drive rolls D. **transformer**

3.___________ generator arc welders, a more extensive maintenance program is needed due to the fact

that these units have more moving parts that are subject to additional wear. **3 points**)

Note: **Satisfactory rating - 9points** **Unsatisfactory - below 9points**

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

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

OPERATION SHEET 1	POSITIONING AND SETTING WELDING MACHINE TO THE POLARITY INDICATED

.1 setting welding machine to the polarity;

Steps 1- wear PPE

Steps 2- prepare TIG welding machine equipment.

Steps 3- ground cable insert in the machine body.

Steps 4- check the machine power.

OPERATION SHEET 2	ADJUSTING CURRENT AND VOLTAGE CONSISTENT.

.1 Adjusting current and voltage;

Steps 1- wear PPE

Steps 2- On the machine power.

Steps 3- Add /adjust current and voltage

Steps 4- weld on the work pieces.

OPERATION SHEET 4	SELECTING APPROPRIATE DISTORTION PREVENTION MEASURES.

.1 prevent distortion measures.;

Steps 1- Wear PPE

Steps 2- Prepare material /work pieces..

Steps 3- Weld two work pieces

Steps 4- Check distortion on the work pieces

LAP Test	Practical Demonstration

Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary TIG set-up welding machine / equipment required to perform the following tasks within 3-5:30 hours.

Task 1: Positioning and setting welding machine to the polarity indicated

Task 2: Adjusting current and voltage consistent.

Task 2**:** Selecting appropriate distortion prevention measures.

List of Reference Materials

1. *en.wikipedia.org/wiki/GTAW*
2. www.weldwell.co.nz/site/weldwell
3. http://www.azom.com/article.aspx?ArticleID=1446
4. Karunakaran, N. (2012). Effect of Pulsed Current on Temperature Distribution, Weld Bead Profiles and Characteristics of GTA Welded Stainless Steel Joints.
5. http://www.ijser.org
6. www.PDHcenter.com
7. *FordAluminumGMA(MIG)WeldingQualificationTestBOOK*
8. **www.weldability.com |**
9. **support@weldability.com**
10. http://www.ijser.org

Mechanics

Level-III

Learning Guide-06

Unit of Competence: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Title: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO 3: Perform tack welding

Instruction Sheet-1	Learning Guide #06

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

- Making Joints free from foreign materials
- Performing root gap
- Checking alignment within acceptable code and standard.
- Installing backing plate, stiffener and running plate.
- Performing tack welding
- Making tack weld free from stress

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**:

- Joining made free from rust, paints, grease and other foreign materials prior to fit up or tacking base on Welding Procedure Specification (WPS)
- Performing root gap in accordance with the requirements of WPS
- Checking Alignment is within the range of acceptability of code and standard.
- Installing Backing plate, stiffener and running plate.
- Performing tack welding in accordance with the requirements of WPS
- Tack weld is made dimensionally acceptable and visually free from stresses

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 and Sheet 4".
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 -60, 66, 72, 75, 79 and 82** respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 " **in page -83.**
6. Do the "LAP test" **in page – 85** (if you are ready).

INFORMATION SHEET-1	MAKING JOINTS FREE FROM FOREIGN MATERIALS

1. Welding Joints

There are five basic kinds of welding joints and they are classified according

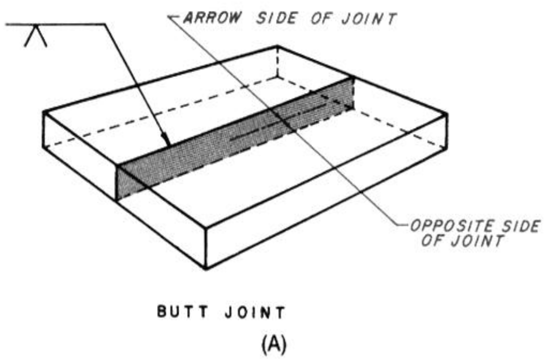
To the position of the parts that are being joined

1.1 **BUTT JOINT**

A joint between two members lying approximately in the same plane. A butt joint may be closed

(no root gap) or open (root gap present)

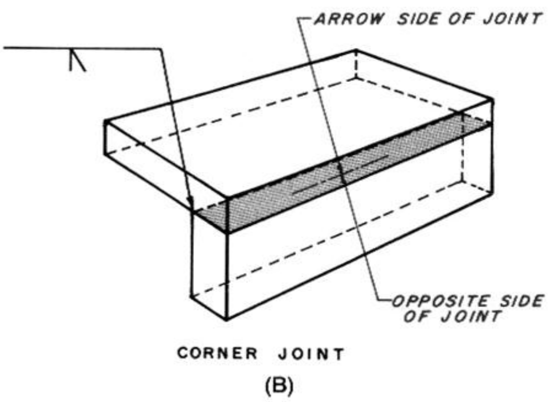
Figure 1 (A) Butt Joint



1.2 **CORNER JOINT**

A joint between two members located approximately at right angles to each other in the form of a corner.

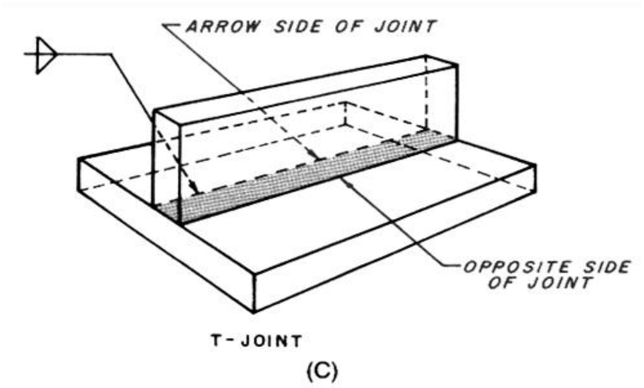
Figure 2 (B) Corner Joint



1.3TEE JOINT

A joint between two members located approximately at right angles to each other in the form of a T.

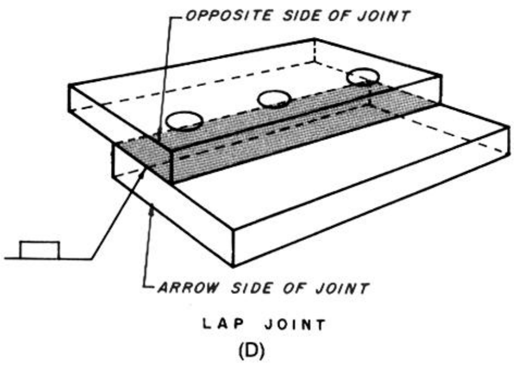
Figure 3 (C) T-Joint



1.4LAP JOINT

A joint between two overlapping members.

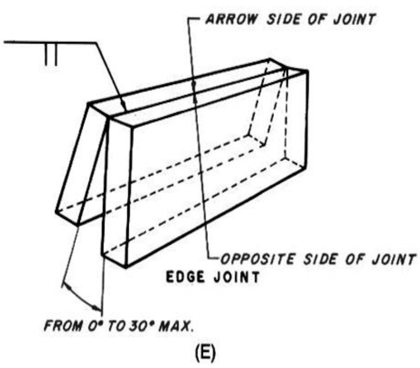
Figure 4 (D) Lap Joint

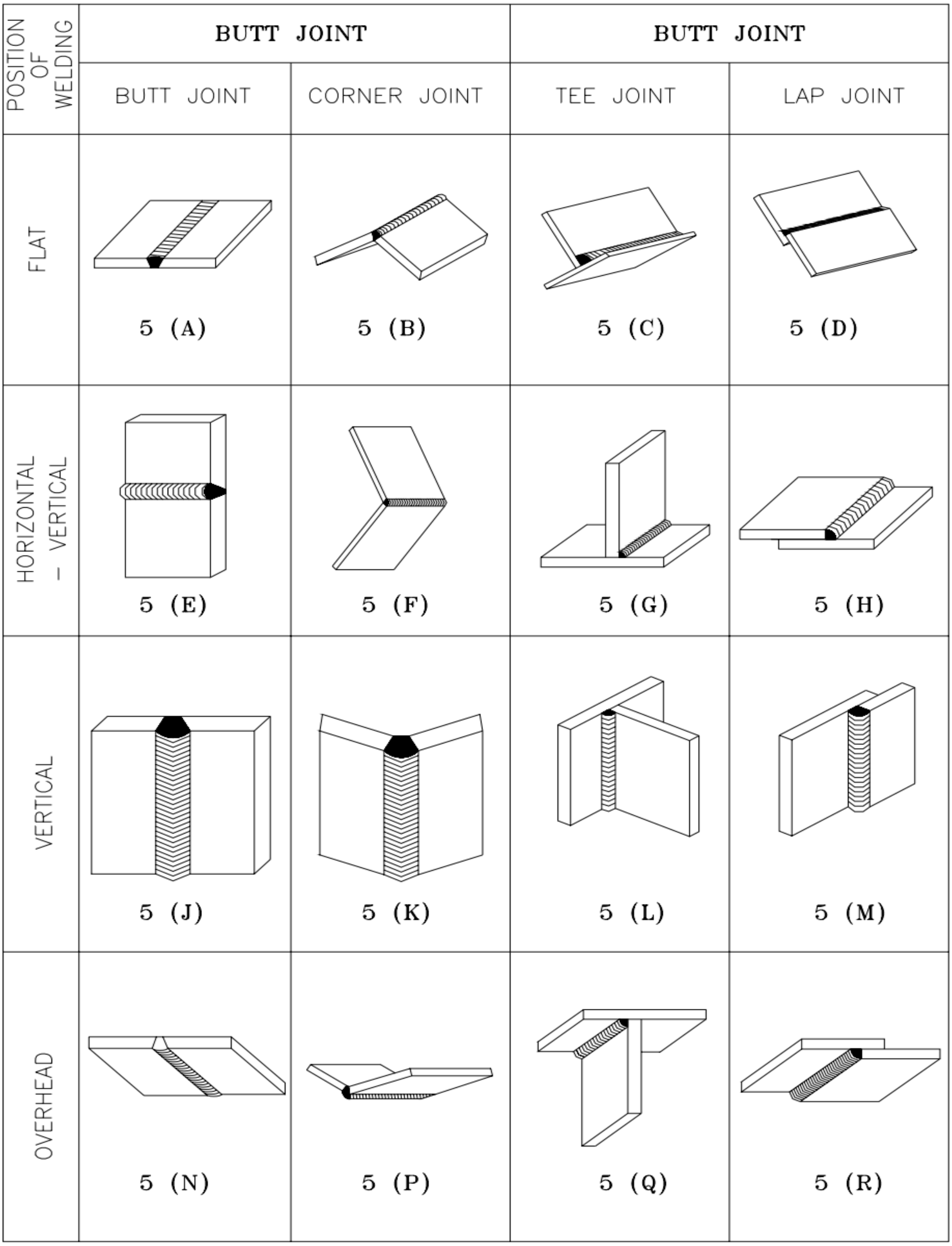


1.5 EDGE JOINT

A joint between the edges of two or more parallel or mainly parallel members.

Figure 5 (E) Edge Joint





POSITION OF WELDING

Figure1 .1 position of welding

Self-Check -1	Written Test

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

Multiple choose

1 A joint between two members located approximately at right angles to each other in the form of a T.

(**3 points**)

A. Butt Joint. C. **Tee Joint**

B. Lap Joint D. Corner Joint

2. A joint between the edges of two or more parallel or mainly parallel members.**3 points**)

A . Butt Joint. C. Edge Joint

B. Lap Joint D. Corner Joint

Answer Sheet

Score = ____________

Rating: _____________

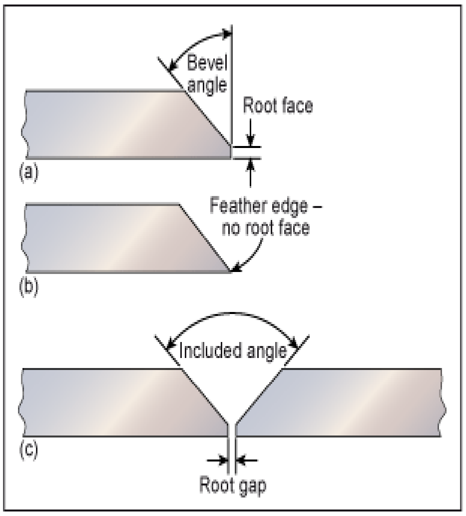
Name: ____________________________ Date: _________________

Short Answer Questions

INFORMATION SHEET-2	PERFORMING ROOT GAP.

1. Root gap

A **root gap** is provided to facilitate the escape of gases generating during the process to avoid defects of blow holes in welding. Also, the narrow opening at the bottom of the mating plates ensures the full penetration of the arc and profiled root bead penetration, which indicates a sound welding joint.



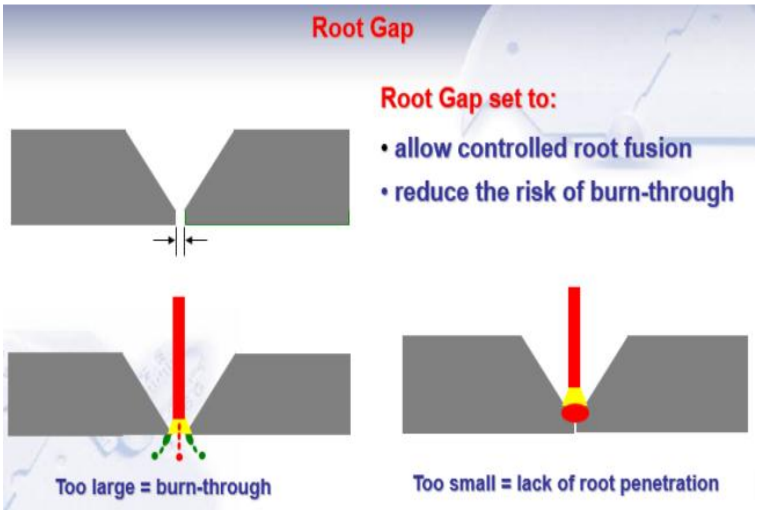


Figure .1 Root gap

Joint preparation terminology

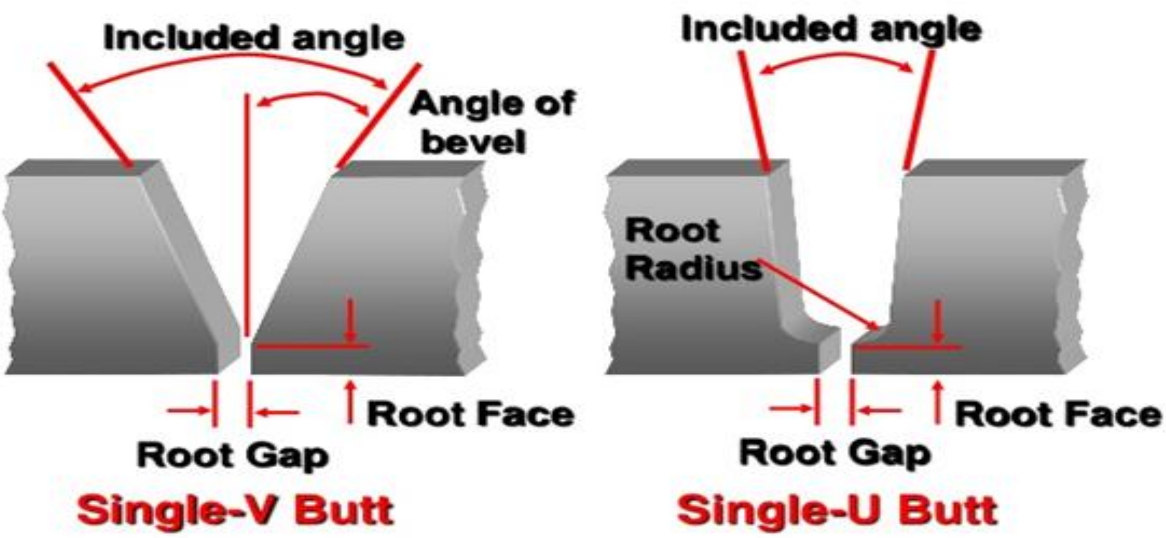


Figure .1 Joint terminology

2. butt weld

The butt weld, typical forms of which are illustrated in Fig. 2, is a simple and easily designed joint which uses the minimum amount of material. Figure 2 also includes definitions of some of the features of a weld preparation such as ‘root face’, ‘angle of bevel’ and ‘included angle’. Butt welds, as illustrated in Fig. 2, may also be classified as full penetration or partial penetration.

With the conventional fusion welding processes of TIG and MIG penetration of weld metal into the surface of a flat plate from a bead-on-plate run is typically 3 mm and 6 mm respectively. To achieve a full penetration butt weld at thicknesses over these it is necessary for the two close square - butted edges to be beveled, although leaving a small gap between the edges will increase penetration. Typical weld preparations for the various processes will be found in the relevant process chapter. Butt joints may be single or double sided - if double sided it is often necessary to back-gouge or back-grind the first side to be welded to achieve a joint that is free of any lack of penetration.

Single – V   Double - V

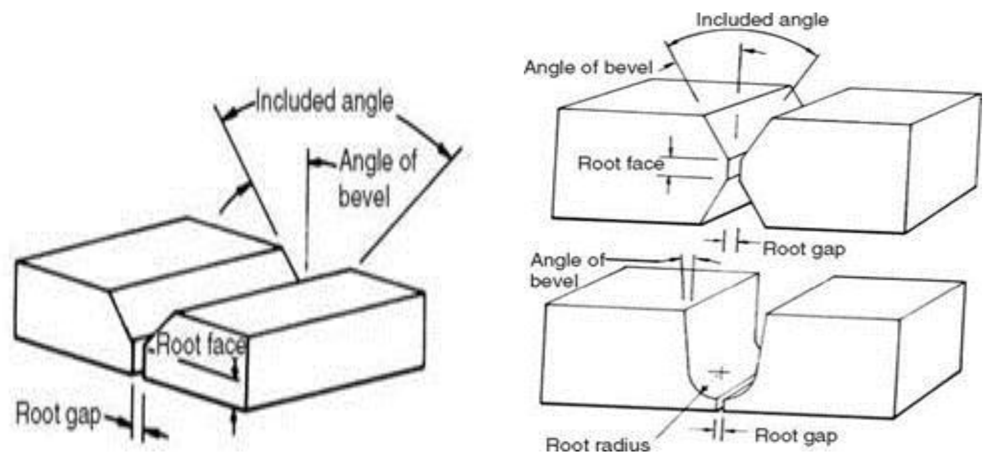
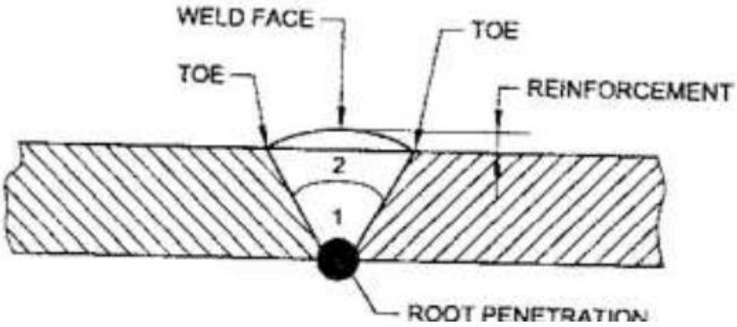
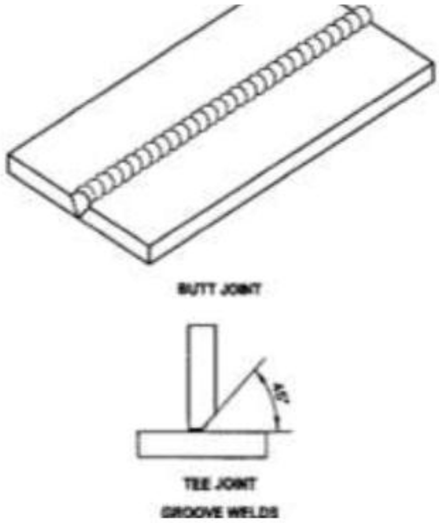


Figure .2 butt weld

2.1 Butt weld (joint)
A joint between two members aligned approximately in the same plane.

Butt weld or groove weld is a weld made in the groove between two members to be joined as butt joint. Groove welds are also done on T fillet joints if the plate thickness is more than 12mm.





Welding preparations of butt joint

Terms	Weld description
1.G	flat butt weld
2.G	horizontal butt
3.G	vertical butt
4.G	overhead butt
5.G	fixed pipe axis horizontal
6.G	fixed pipe axis 45 degrees

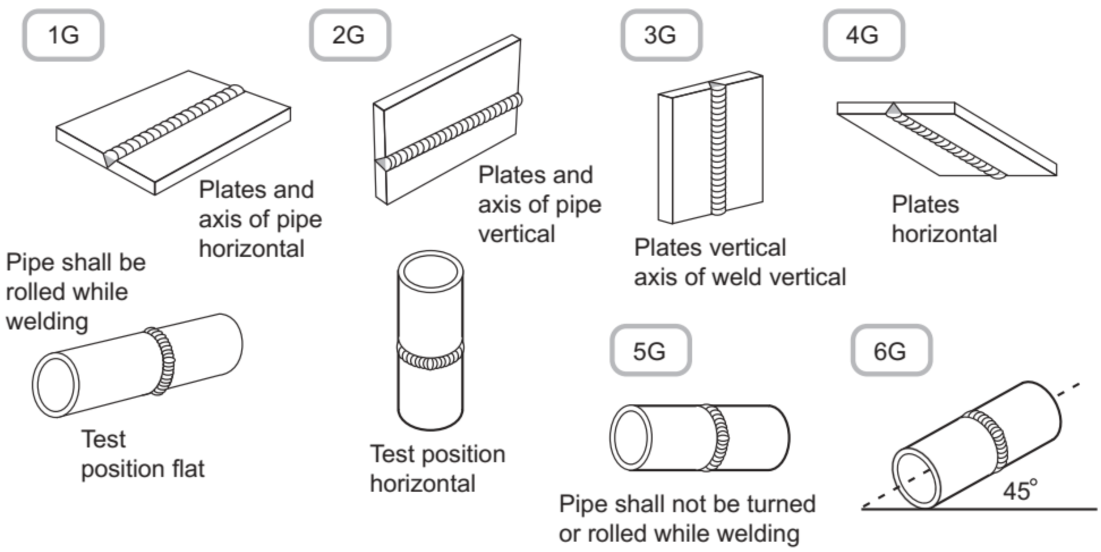


Figure 2.1 Butt weld terms

2.2 Fillet weld

A weld of approximately triangular cross section joining two surfaces at approximately right angles to each other.

Fillet weld is a weld, having a triangular cross-section, joining two surfaces at right angle to each other such as:

- Lap joint
- Tee joint
- Corner joint

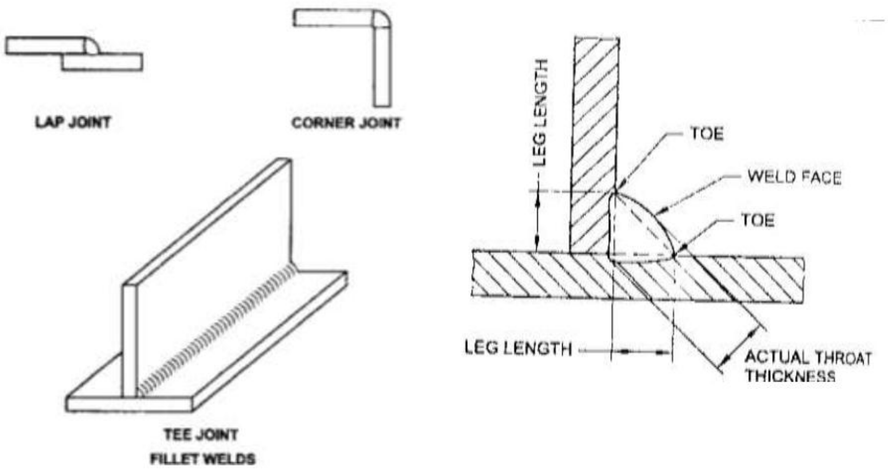


Figure2.2 Fillet weld

Welding preparations of fillet joint

Terms	Weld description
1.F	flat fillet
2.F	horizontal fillet
3.F	vertical fillet
4.F	overhead fillet

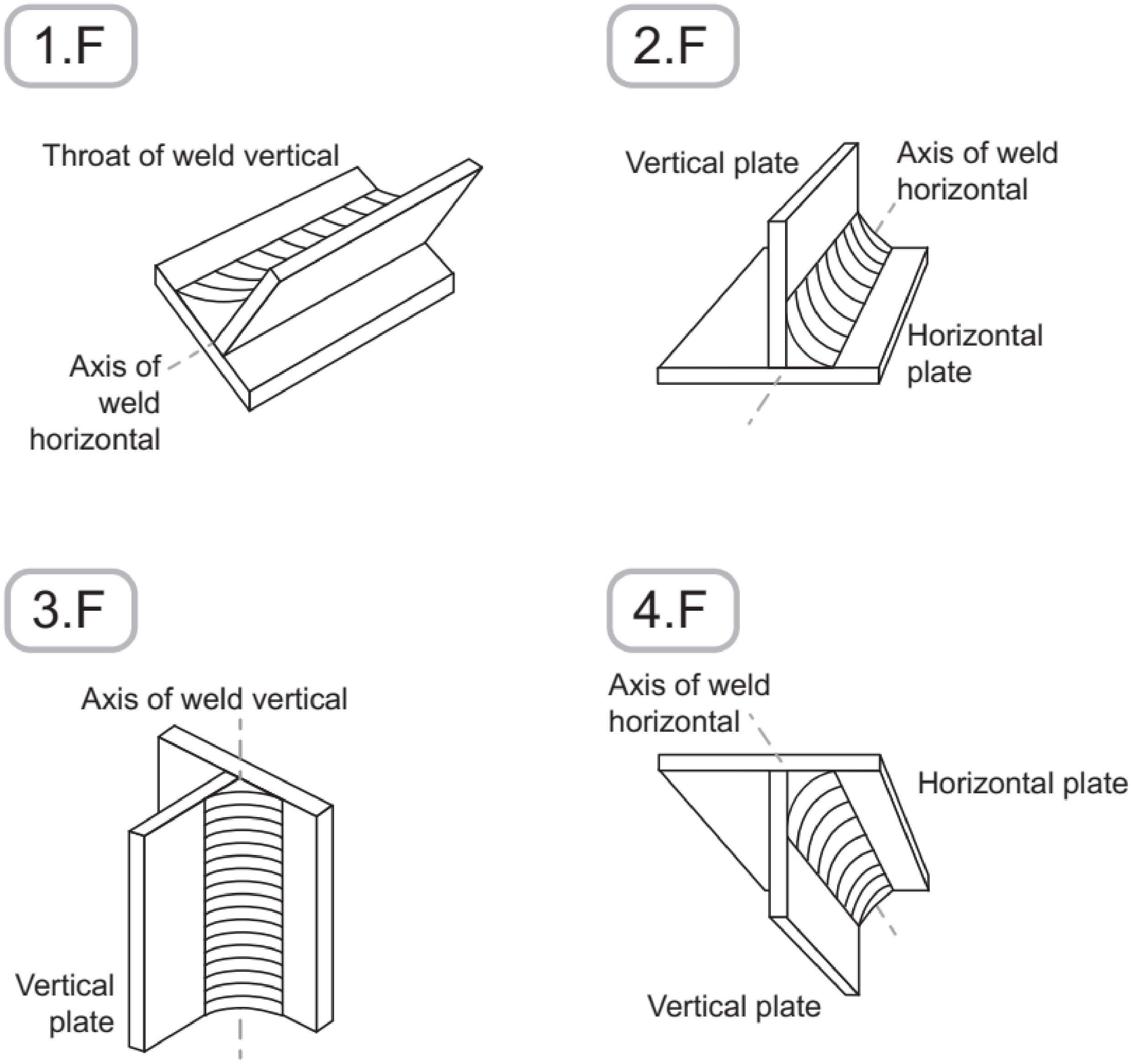


Figure2.2.1. Fillet weld terms

Self-Check -2	Written Test

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

Part I Multiple choose

1 A joint between two members aligned approximately in the same plane. (**2 points**)

A. **Butt weld (joint)** C. A and B

B. Fillet weld D. All

2. A weld of approximately triangular cross section joining two surfaces at approximately right angles

to each other. **(2 points**)

A. Butt weld (joint) C. A and B

B. Fillet weld D. All

Part II Identification

3. A ___________ is provided to facilitate the escape of gases generating during the process to avoid

defects of blow holes in welding. **(2 points**)

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

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

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

INFORMATION SHEET-3	CHECKING ALIGNMENT WITHIN ACCEPTABLE CODE AND STANDARD.

1. **Alignment checks along the way (TIG)**

I would like some input into alignment checks that occur along the way.

What kind of things do you check and in what order to you join the tubes and make the checks?

For my current build, the first step is the seat tube to BB joint. For this joint my tacking was short welds in the front and back. This is my third build and I am still trying to refine my process as I grow to understand the impact of weld sequence.

After short tacking welds fore/aft I was 6mm out of alignment when measured at the end of the seat tube. The lean was towards the drive side.

My weld along the non-drive side "pulled" the tube to be about 1mm off (it was off in the same direction). I did a second pass on the non-drive side to bring the seat tube to be 1mm off this time leaning away from the drive side.

When welding the drive side I tried to go fast and after this was complete, the lean was 0.3mm towards the drive side.

Is a 0.3mm alignment at this point in the process typical? I figure some things will change when I put the seat stays and chain stays in place, hopefully keeping an eye on this along the way will allow this bike to be built true.

For my next step, is it better to attach the seat stays first or should I attach the chain stays prior to putting the seat stays on? The other option is to do the down tube/BB joint as the next step, so many options.

2. Drawing of Weld Symbols and Standards

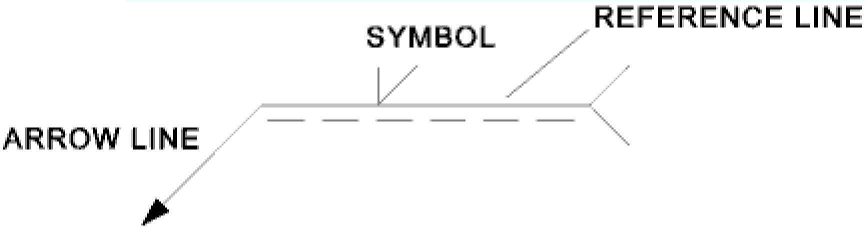
Standards

The British Standard for weld symbols is BS EN 22553. When identification of the weld process is required as part of the weld symbol the relevant weld process code is listed in BS EN ISO 4063.

Basic Weld Symbol

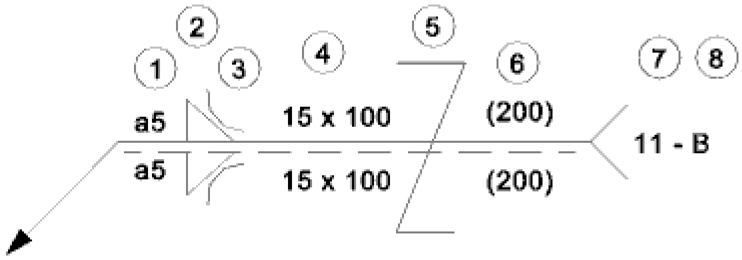
The weld symbol always includes

1. An arrow line
2. A reference line
3. A symbol



Note: Weld symbols on the full reference line relates to welds on the near side of the plate being welded. Weld symbols on the dashed line relates to weld on the far side of the plate. If the welds are symmetrical on both sides of the plate the dashed line is omitted. If the dashed line is above the full line then the symbol for the nearside weld is drawn below the reference line and the symbol for the farside weld is above the dashed line

More Detailed Symbolic Representation of Weld

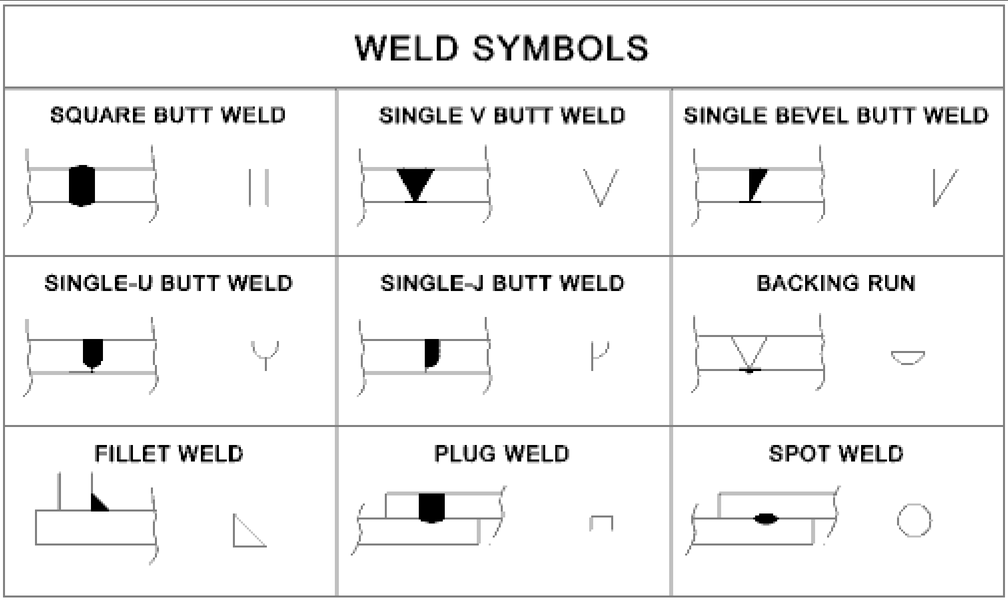


Information above reference line identifies weld on same side as symbolic representation
Information below reference line identifies weld on opposite side to symbolic representation.

1) Dimension referring to cross section of weld
2) Weld Symbol
3) Supplementary symbol
4) Number of weld elements x length of weld element
5) Symbol for staggered intermittent weld
6) Distance between weld elements
7) Welding process reference
8) Welding class

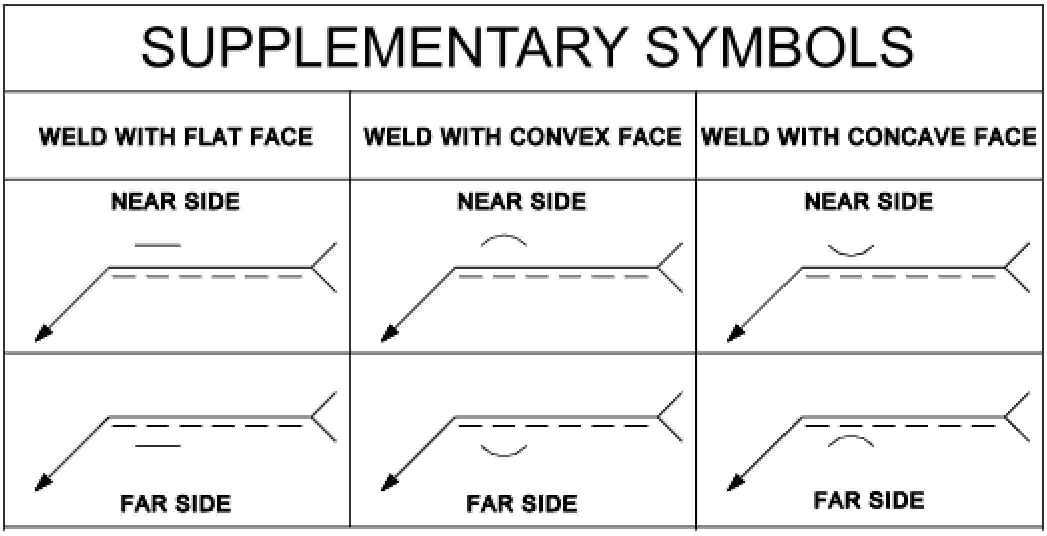
Welding.....Weld process numbers.

Table of Weld Symbols

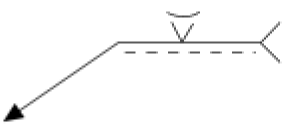


Supplementary Symbols

The weld symbols below are used in addition to the primary weld symbols as shown above. They are not used on their own.

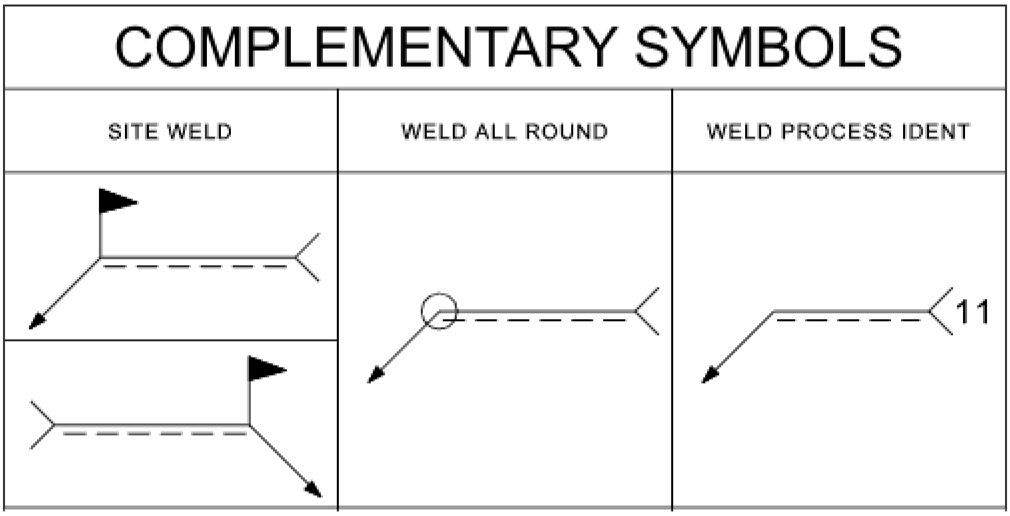


Below is an example of the application of this symbl.

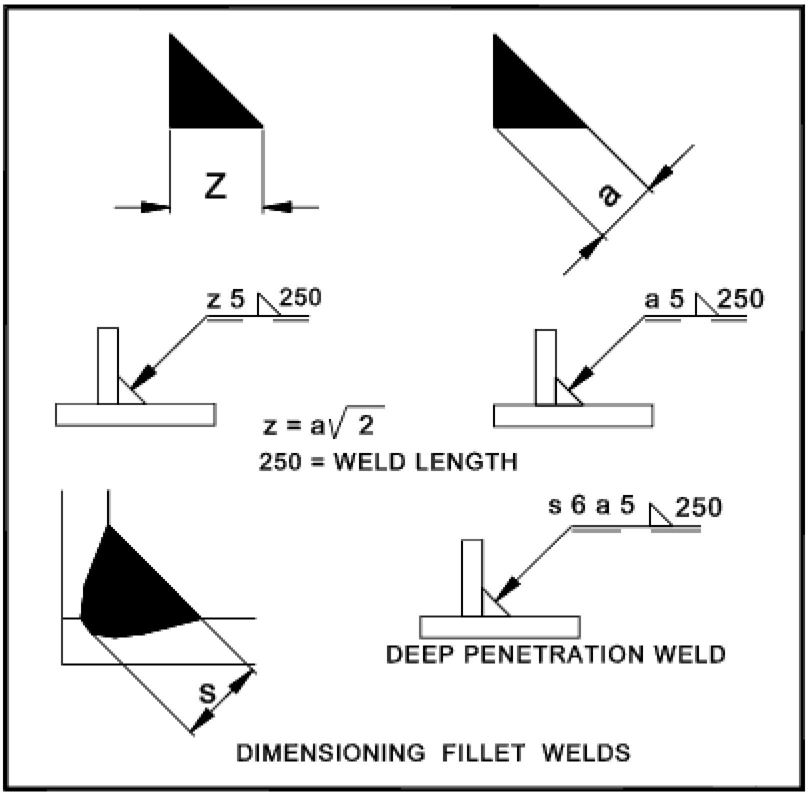


Single V Butt Weld
on nearside
with concave surface

Complementary Indication



Dimensioning Welds



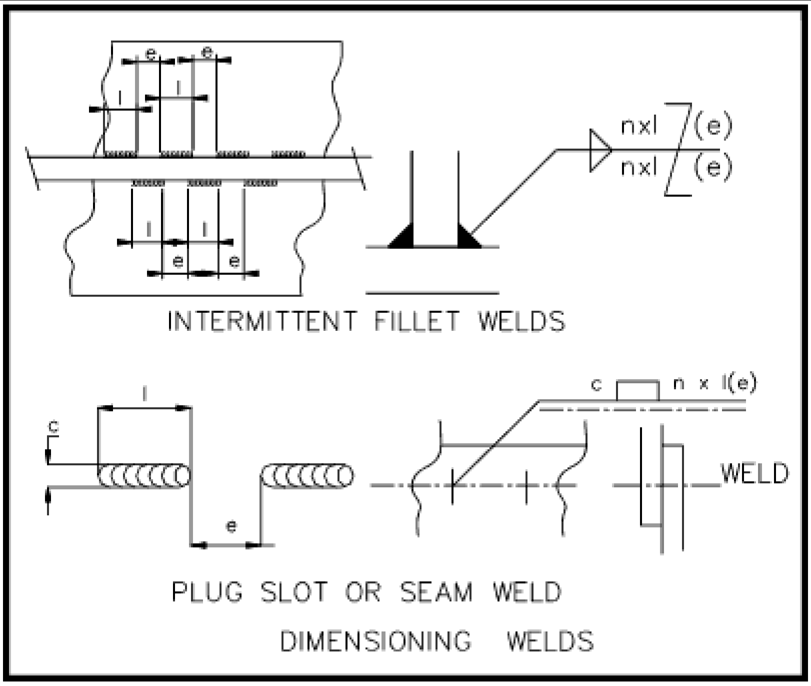


Figure 2 weld symbol

Self-Check -3	Written Test

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

Multiple Choose

1 .Write the alignment of TIG welding machine. (**10points**)

2. Weld symbol always includes. **(2 points**)

A. An arrow line C. A reference line

B. A symbol D. All

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

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

Answer Sheet

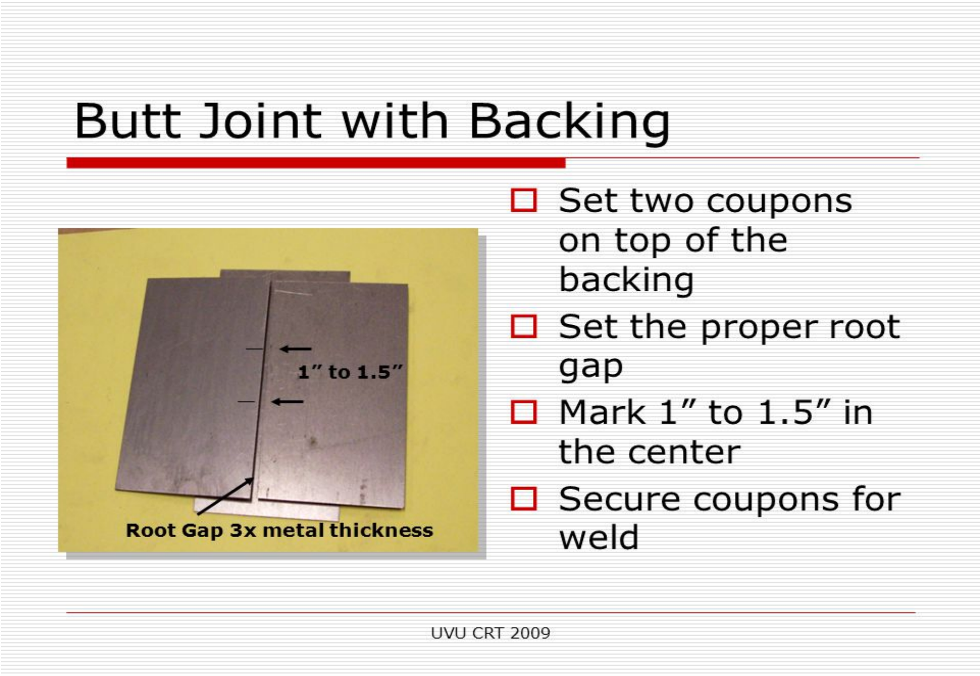
Score = ____________
Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

1. Backing plate

A permanent backing plate is a convenient way to ensure that the joint will have a complete weld through the section when you cannot access the other side or you would be forced to weld overhead.



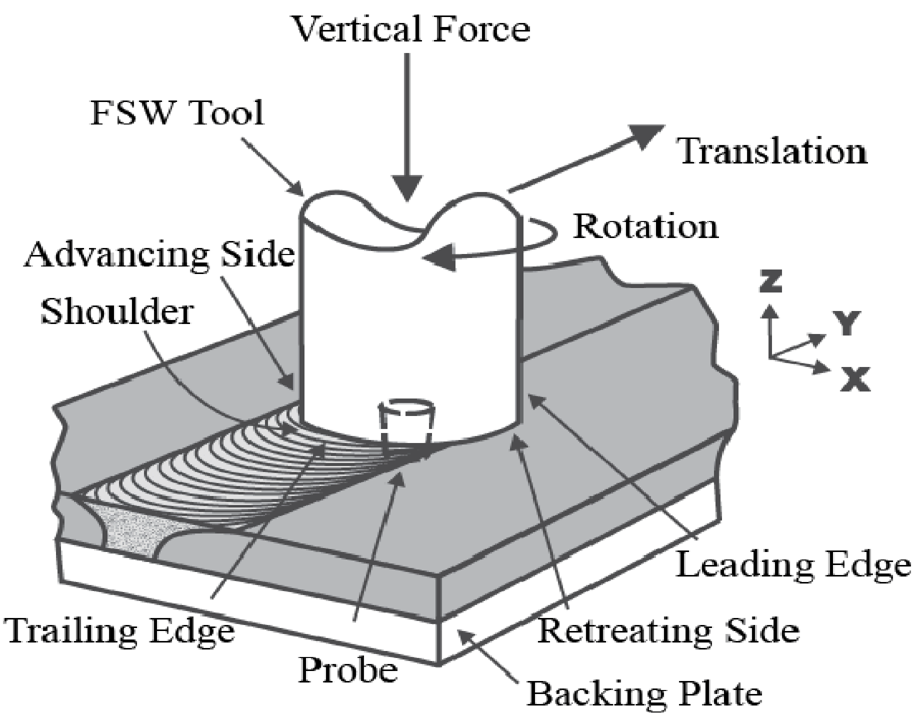
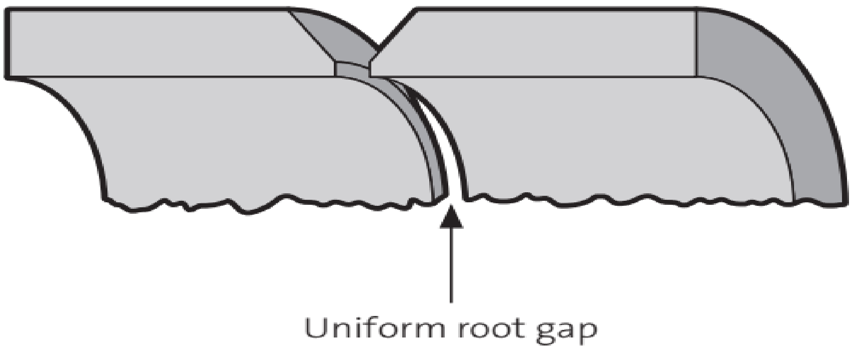


Figure .1 Backing plate

Unbaked butt joint



Backed butt joint

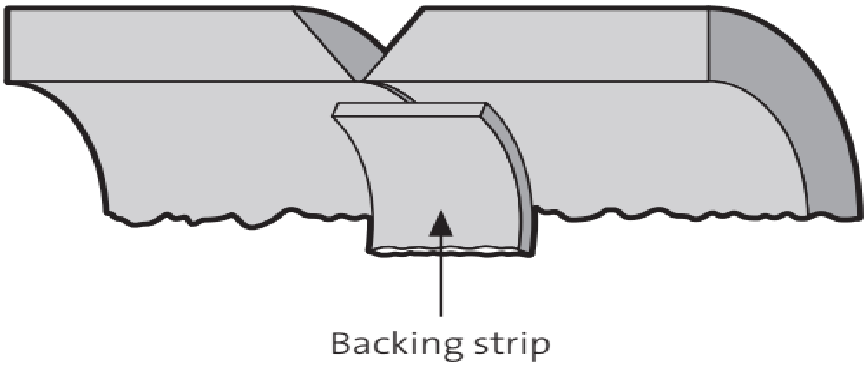


Figure .1.1 Backing strip and uniform

2. Stiffener and running plate

Longitudinal shrinkage in butt welded seams often results in bowing, especially when fabricating thin plate structures. Longitudinal stiffeners in the form of flats or angles, welded along each side of the seam are effective in preventing longitudinal bowing. Stiffener location is important: they must be placed at a sufficient distance from the joint so they do not interfere with welding, unless located on the reverse side of a joint welded from one side.

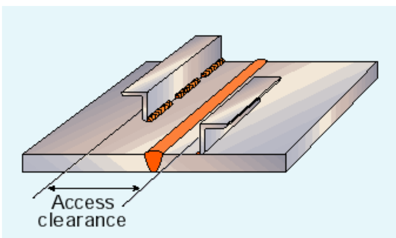


Figure.2 stiffener

3. Backing runs

Backing material is used to support the root run of a butt weld, or to provide a sound weld through the full plate thickness, when access is possible from one side only. To help reduce weld deposition rates complete penetration butt welds are often welded from both sides. The back of the first root run should be gouged and/or ground to clean metal to ensure complete penetration of the other side run.

4.Backing material

Permanent backing material is known as a backing strip. Temporary backing material is known as a backing bar.

Backing strips are fused into the weld and should:

- Be no less than 3 mm thick and be of sufficient size to ensure they do not burn through
- Have weld ability not less than that of the parent metal
- Fit as close as possible with a maximum gap between the parent metal and the backing strip of 1.5 mm.

Self-Check -4	Written Test

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

Multiple Choose

1 . A permanent ______________ is a convenient way to ensure that the joint will have a complete weld through the section when you cannot access the other side or you would be forced to weld overhead. (**5points**)

A. **backing plate** C. stiffener

B. running plate D. All

2.Backing material is used to support the root run of a butt weld, (**5points**)

A. backing plate C. stiffener

B**. Backing material** D. All

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

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

Answer Sheet

Score = ____________
Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

INFORMATION SHEET-5	PERFORMING TACK WELDING

1 .Tack Welding

After items to be welded together have been positioned as required, generally by clamping them on suitable fixtures, tack welds are used as a *temporary* means to hold the components in the proper location, alignment, and distance apart, until final welding can be completed.

In short-production-run manual welding operations, tack welding can be used to set up the work pieces without using fixtures. Typically, tack welds are short welds. In any construction, several tack welds are made at some distance from each other to hold edges together.

An advantage of this *provisional* assembly procedure is that if the alignment for final welding is found to be incorrect, the parts can be disassembled easily, realigned, and tack welded again.

In general, tack welding is performed by the same process that is used for the final weld. For example, aluminum-alloy assemblies to be joined by friction stir welding are tack-welded by the same process using a small tool developed for this purpose. Or electron beam tack welds, created with reduced power, are used to supplement or replace fixture and to maintain the correct shape and dimensions during final electron beam welding.

If the final welding is performed while the elements are still clamped in a fixture, tack welding must keep the elements in place and resist considerable stresses, not sufficiently contrasted by clamping devices that tend to separate the components.

Temporary but very important

- ✓ Small enough to be welded over
- ✓ Strong enough to hold metal in position
- ✓ Position every 3-4 inches
- ✓ Tack all sides if possible.

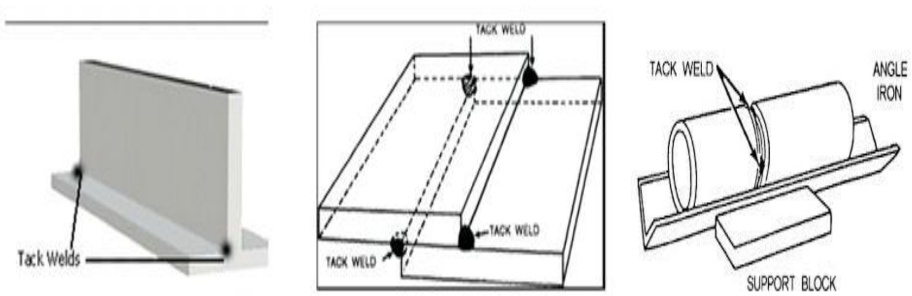


Figure .1 **Tack Welding**

2. Tack Welds Important

The temporary nature of tack welds may give the false impression that the quality of these auxiliary joining aids is not as important as that of final weld and that this operation doesn't have to be properly programmed, performed, and inspected. This is not true.

Tack welding is real welding, even if the welds are deposited in separate short beads. It performs the following functions:

- Holds the assembled components in place and establishes their mutual location
- Ensures their alignment
- Complements the function of a fixture, or permits its removal, if necessary
- Controls and contrasts movement and distortion during welding
- Sets and maintains the joint gap
- Temporarily ensures the assembly's mechanical strength against its own weight if hoisted, moved, manipulated, or overturned

Self-Check -5	Written Test

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

Part I Multiple choose

1 . ____________ is performed by the same process that is used for the final weld. (**5points**)

A .**Tack welding** C. stiffener

B**.** Running plate D. tee joint

Part II Identification

3. _____________ is real welding, even if the welds are deposited in separate short beads.
(**5points**)

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

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

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

INFORMATION SHEET-6	MAKING TACK WELD FREE FROM STRESS

1.Residual stress

Residual stress occurred in welding process generally causes reduction in the strength of welded joints, shortens the fatigue life, and brings about the distortion of the work piece.

Residual stress is the result of structural and metallurgical changes that take place during the welding process

- ✓ Rapid localized heating (melting) and cooling (solidifying)
- ✓ Stresses can be high enough to surpass the yield strength of the base meta

Two major effects

- ✓ Distortion
- ✓ Premature failure

What is the significance?

Residual stress:

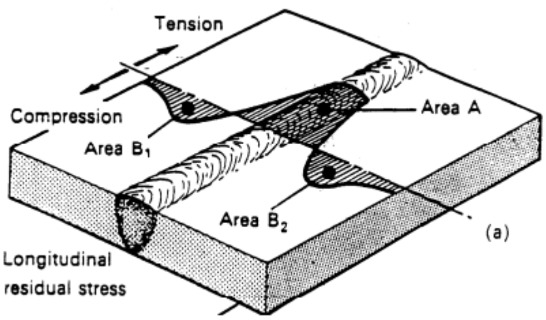
- ✓ Degraded structural performance
- ✓ Reduced service life

Compression

- ✓ Buckling can occur at lower than expected loads

Tension

- ✓ Can lead to higher than expected local stresses, resulting in cracking



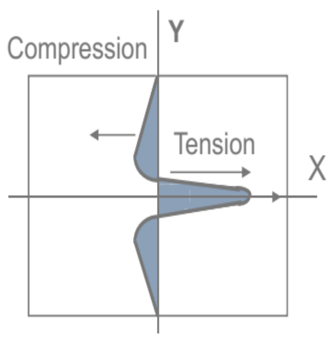


Figure .1 Compression, Tension and Residual stress

Controlling Stress and Distortion

- Several methods exist for better control of residual stress and distortion
  - Reduce the total volume of weld metal through joint design improvements
  - Pre-set the joint prior to welding
  - Preheat the joint
- Post-weld flame heating can be used to remove distortion

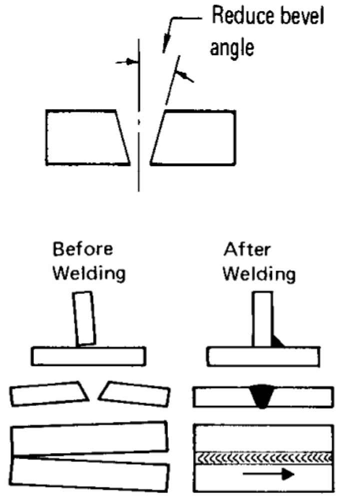


Figure .1.1 stress and distortion

Self-Check -6	Written Test

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

Part II Mutplie choose

1.________________ is the result of structural and metallurgical changes that take place during the welding

Process.(**5points)**

A. **Residual stress** C. Tension

B. Compression D.All

Part II Identification

2. Write the significance stress (**5points)**

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

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

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

OPERATION SHEET 1	Making Joints free from foreign materials

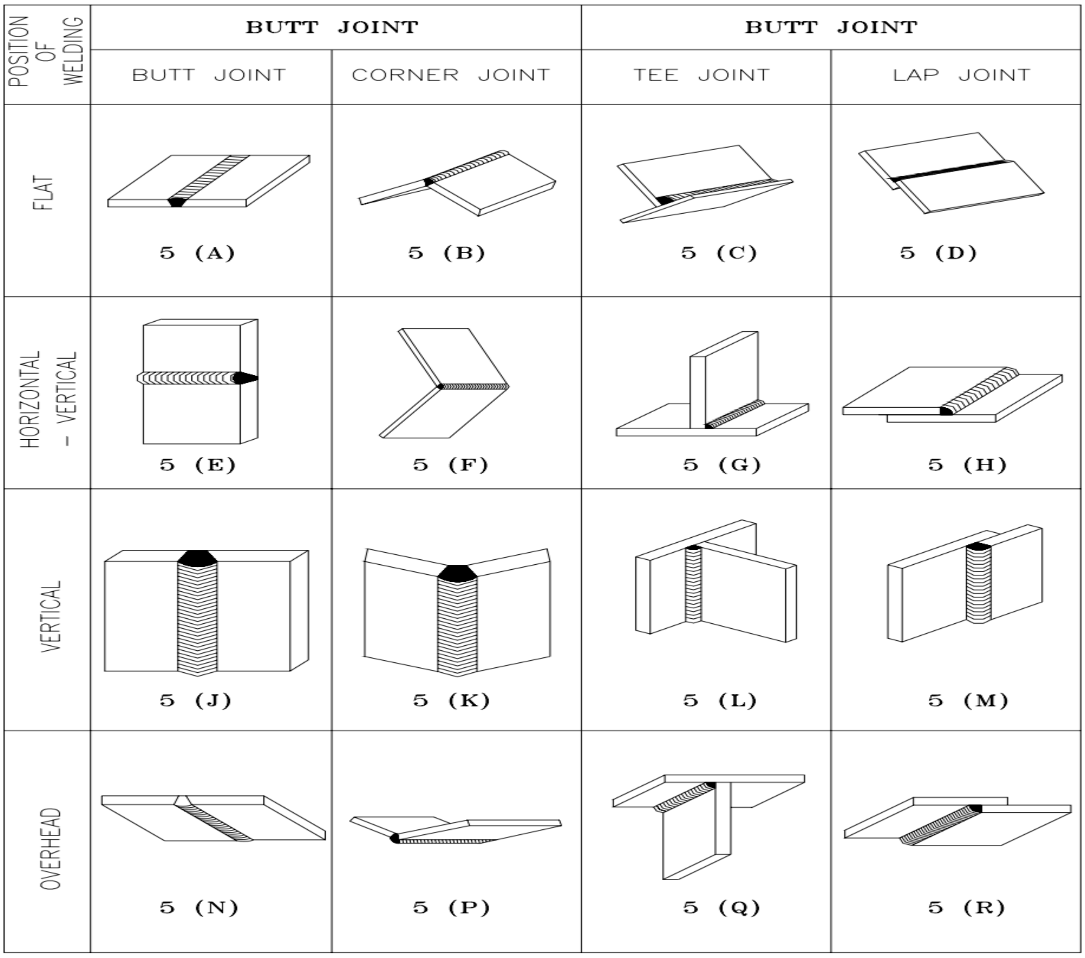
1 prepare welding joint

Steps 1- wear PPE

Steps 2- prepare work pieces.

Steps 3- tack weld two pieces.

Steps 4- weld the work pieces.



POSITION OF WELDING

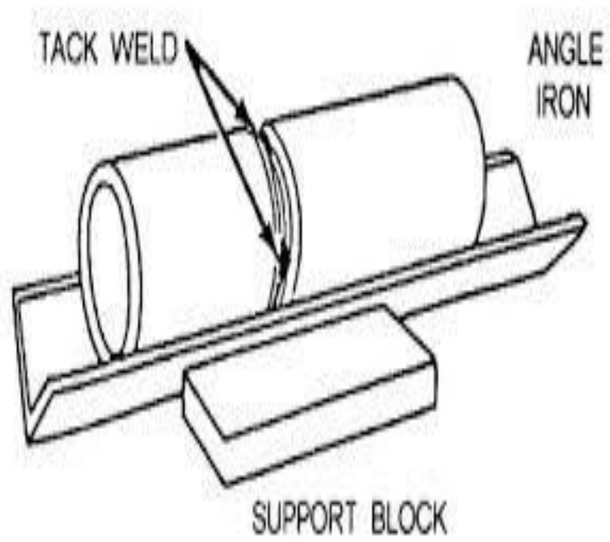
OPERATION SHEET 2	Performing tack welding .

.1 Perform tack welding

Steps 1- Wear PPE

Steps 2- Prepare material /work pieces..

Steps 3- Tack Weld two work pieces



LAP Test	Practical Demonstration

Name: ________________________________ Date: ________________

Time started: __________________________ Time finished: ________________

Instructions: Given necessary materials for tack welding required to perform the following tasks within 3-5:30 hours.

Task 1: prepare welding joint

Task 2**:** Perform tack welding.

List of Reference Materials

1. *en.wikipedia.org/wiki/GTAW*
2. www.weldwell.co.nz/site/weldwell
3. http://www.azom.com/article.aspx?ArticleID=1446
4. Karunakaran, N. (2012). Effect of Pulsed Current on Temperature Distribution, Weld Bead Profiles and Characteristics of GTA Welded Stainless Steel Joints.
5. http://www.ijser.org
6. www.PDHcenter.com
7. *FordAluminumGMA(MIG)WeldingQualificationTestBOOK*
8. **www.weldability.com |**
9. **support@weldability.com**
10. http://www.ijser.org

Mechanics

Level-III

Learning Guide-07

Unit of Competence: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Title: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO 4: Perform root pass

Instruction Sheet	Learning Guide #07

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

- Performing root pass
- Performing task with company requirement.
- Making weld visually acceptable
- Cleaning and making root pass free from defects.
- Performing task with the required standard.

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**:

- Performing Root pass in accordance with WPS and/or client specifications.
- Performing Task in accordance with company or industry requirement and safety procedure.
- Welding made visually acceptable in accordance with applicable codes and standards
- Cleaning Root pass and free from ***defects*** and discontinuities
- performed Task in accordance with the required standard

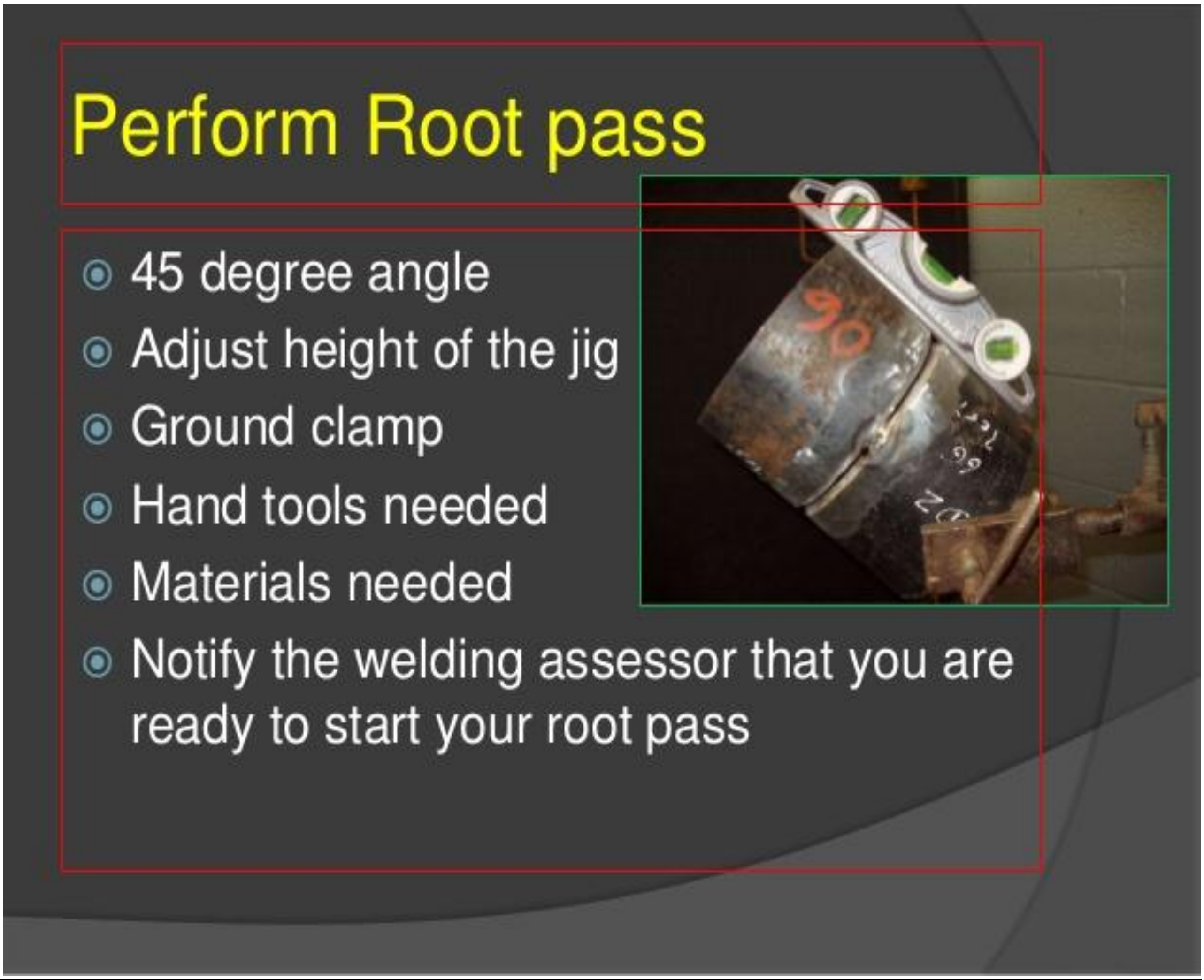
Learning Instructions:

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 and Sheet 4”.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3, Self-check 4, and Self-check 5” **in page -92, 95, 102, 110 and 116** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 ” **in page -118.**
6. Do the “LAP test” **in page – 119** (if you are ready).

Information Sheet-1	PERFORMING ROOT PASS

1. Root pass

Root pass is a first pass welded to start weld. After that all passes are subsequent passes. You need to take smaller diameter electrodes for root pass while welding a bevel edged butt joint to prevent root face melt out. In some cases root pass requires some kind of Non destructive testing.



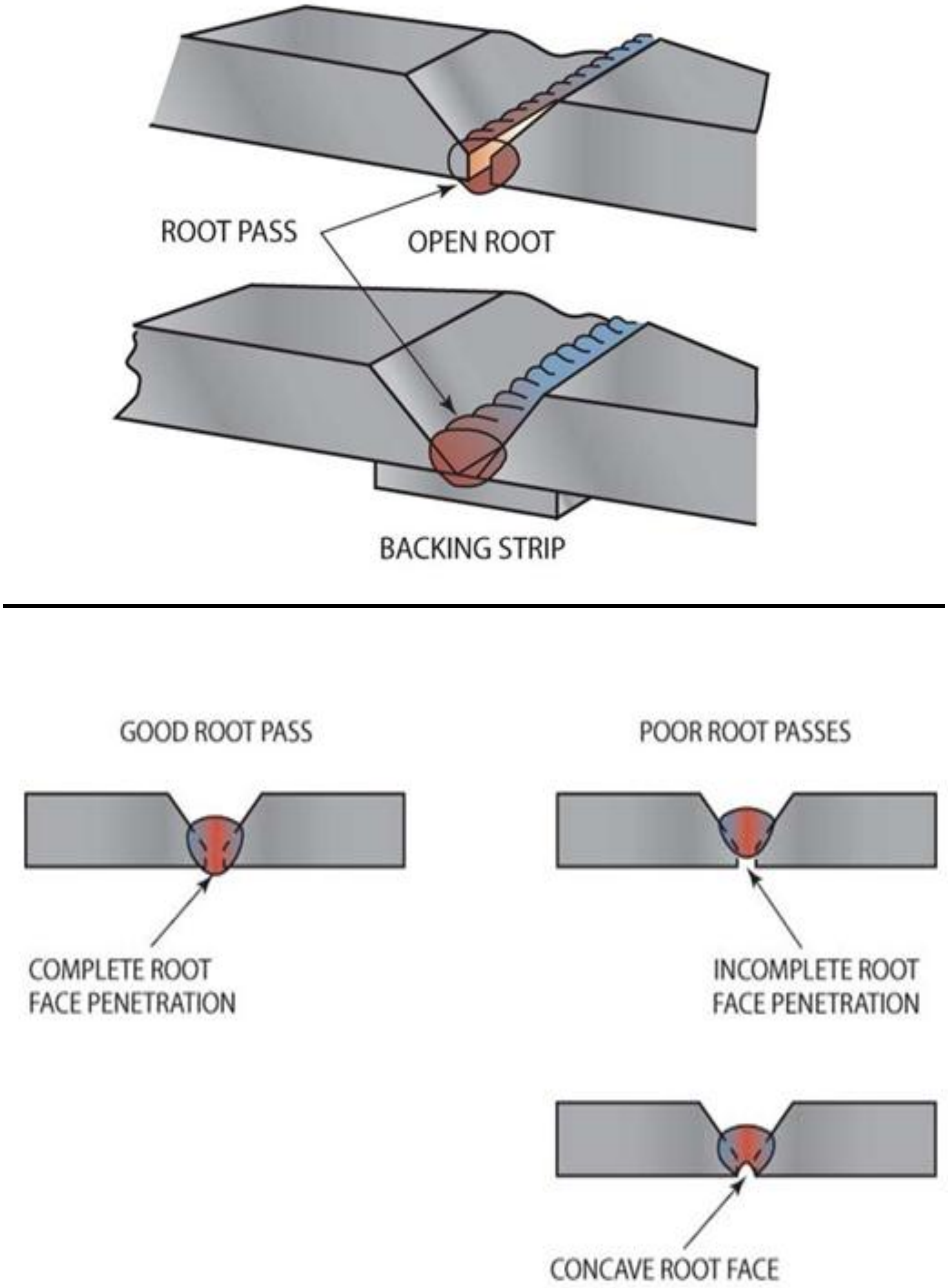


Figure.1.1 Root pass

Tips: in performing root pass

- Make sure you can see the weld puddle
- Maintain a short arc and concentrate on the root gap
- Ensure root pass penetration
- Point your rod to the center of the pipe to melt both edges
- Push the rod inside the pipe so the arc is in the inside when welding

Clean Root Pass

- Using the angle grinder, clean root pass free from slag.
- Clean all trapped slag and porosity
- Redefine the groove face to serve as outline your filling pass
- Repair porosity or pinholes with E6010
- Clean root pass until shines

Self-Check -1	Written Test

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

Identification

1. ______________ is a first pass welded to start weld. After that all passes are subsequent passes. (**5points)**

2. Write root pass clean method.(**5points)**

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

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

Answer Sheet

Score = ____________	
Rating: _____________	

Name: ___________________________ Date: ________________

Short Answer Questions

INFORMATION SHEET-2	PERFORMING TASK WITH COMPANY REQUIREMENT

1. TIG Welder Job Description

TIG welders assemble and weld metal parts, usually for manufacturing or construction projects. The primary method that they use is tungsten inert gas (TIG) welding, which is trickier and much more delicate than the commonly used metal inert gas (MIG) technique, but they should be knowledgeable about different processes as well. A crucial aspect of this job is quality control, as they must inspect both raw materials and finished products for compliance with safety and company standards. TIG welders can work either full or part time, and it's vital for them to have physical stamina along with a willingness to travel to equipment sites.

2. TIG Welder Duties and Responsibilities

TIG welders regularly perform a variety of tasks depending on their employer. We analyzed several online job postings to identify these core duties.

TIG welders regularly perform a variety of tasks depending on their employer. We analyzed several online job postings to identify these core duties:

3.Read Blueprints

TIG welders start all projects by reading and interpreting blueprints, technique sheets, and other specifications, which they must follow accurately. Afterwards, they can plan the procedure, calculating dimensions and preparing the appropriate materials.

4.Perform Welding

It's important for TIG welders to check the quality of all metal parts before assembling them for welding, cutting, or cleaning as necessary. Their welding technique relies on the use of a non cons umable tungsten electrode, and they must maintain dimension, strength, and evenness of surface of the metal parts all throughout.

5.Observe Safety Procedures

TIG welders must observe safety procedures at all times, staying up to date with ISO and FDA regulations and reporting any potential issues to management right away. They're also in charge of keeping their equipment in excellent working condition and following a clean-up routine at the start and end of each workday.

6.Inspect Products

For every product that TIG welders create, they conduct thorough inspections, visually examining it for obvious defects and subjecting it to radiographic and ultrasound testing, bubble testing, and other functionality tests. If the product fails any of these, welders document the error and withhold the product from release.

7.Fix Issues

TIG welders fix products that are defective, whether from production flaws or long-term use. This often means dismantling its parts, reshaping or replacing them, and then fusing them back together. For larger, recurring issues that involve the manufacturing process, they work with a troubleshooting team to determine the best solution.

8.TIG Welder Skills and Qualifications

TIG welders excel at working with their hands and drawing on their knowledge of metallurgy to create safe and high-quality products. Although they specialize in TIG welding, they are also proficient with other welding techniques, such as MIG and arc welding. In addition to certification, employers look for TIG welders with the following skills:

- **Welding** – this is the core skill that all TIG welders must have. They should be knowledgeable about equipment, processes, and materials, and should have a practical proficiency in welding that comes from experience
- **Reading blueprints and schematics** – TIG welders act with minimal supervision and rely on blueprints and schematics for instructions, so it's imperative for them to interpret these accurately
- **Math skills** – TIG welders should be comfortable with numbers, especially trigonometry, as they calculate dimensions based on blueprints and take measurements of materials
- **Hand-eye coordination** – welding is a heavily physical process that requires stamina and perfect hand-eye coordination, since timing, amount of heat, and other variables must be exact in order to yield a usable product
- **Troubleshooting** – TIG welders have a keen eye for details when inspecting products. They spot errors quickly, then analyze them to deduce the root cause and formulate an efficient solution.

9.Tools of the Trade

Aside from standard safety and welding clothing, TIG welders work with the following tools to perform their basic job functions:

- Measurement tools (such as tape measures, calipers, or clamps)
- Metalworking tools (such as grinders, buffers, or sanders)
- Technical documents (such as blueprints, bills of material, or technique sheets)
- TIG welding equipment (such as tungsten electrodes, filler metal rods, or torch holders)
- Metals (such as stainless steel, aluminum, or black iron)

10.TIG Welder Education and Training

Employers focus more on technical experience rather than education when evaluating TIG welders. The minimum educational requirement for this role is a high school diploma or GED, but TIG welders need to undergo technical training, often through a formal program that lasts for less than a year, and then obtain welding certification by passing an accredited test. Two or more years of experience in welding or manufacturing are also an asset.

Self-Check -2	Written Test

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

Multiple choose

1 TIG welders assemble and weld metal parts, usually for manufacturing or construction projects.

(**3 points)**

A. TIG welders C. SMAW welders

C. MIG welders D. PAW welders

2. TIG welders regularly perform a variety of tasks depending on their employer.(**5points)**

A. SMAW welders C. **TIG welders**

C. MIG welders D. PAW welders

Note: **Satisfactory rating - 8points** **Unsatisfactory - below 8 points**

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

Answer Sheet

Score = ____________

Rating: _____________

Name: ____________________________ Date: ________________

Short Answer Questions

INFORMATION SHEET-3	MAKING WELD VISUALLY ACCEPTABLE

1. Visual Inspection during Welding

1. Check electrodes for size, type and storage (low hydrogen electrodes are kept in a stabilizing oven)
2. Watch root pass for susceptibility to cracking.
3. Inspect each weld pass. Look for undercut and required contour. ...
4. Check for craters that need to be filled.
5. Checks weld sequence and size.

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.

2.1Advantages 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

2.2 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.

3.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

4.Visual Weld Equipment

Fillet Weld Gauge

Figure.4 Fillet Weld Gauge

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, inter pass and post-heating temperatures.

- Magnet to indicate the type of material being welded
- Tape measure
- Calipers

Fillet Weld Gauge Diagram

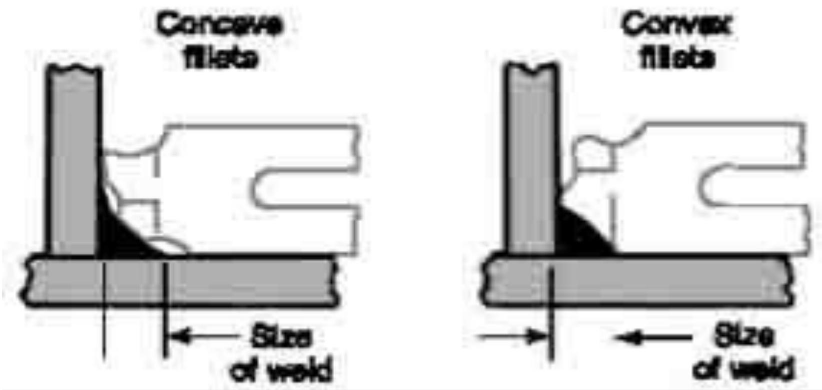


Figure.2 Fillet Gauge

5.Visual Inspection before Welding

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

6.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

7.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

8.Equipment Inspection

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

9.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 welds sequence and size. Gauges are used to check size.

10.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

11.Gas Weld Testing

Inspection weld quality testing criteria for gas welds:

- The weld should be of consistent width throughout. The two edges should form straight parallel lines.

- The face of the weld should be slightly convex with a reinforcement of not more than 1/16 in. (1.6 mm) above the plate surface. The convexity should be even along the entire length of the weld. It should not be high in one place and low in another.
- The face of the weld should have fine, evenly spaced ripples. It should be free of excessive spatter, scale, and pitting.
- The edges of the weld should be free of undercut or overlap.
- Starts and stops should blend together so that it is difficult where they have taken place.
- The crater at the end of the weld should be filled and show no holes, or cracks.

Self-Check -3	Written Test

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

Part I Multiple choose

1. Advantages of non destructive weld quality testing. (**3 points)**

A**.** Inexpensive (usually only labor expense)   C. Low cost equipment

C. No power requirement   **D.All**

Part II Identification

2. Write at list five Visual Inspection (**5points)**

Note: **Satisfactory rating - 8points**   **Unsatisfactory - below 8 points**

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

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________   Date: _______________

Short Answer Questions

INFORMATION SHEET-4	CLEANING AND MAKING ROOT PASS FREE FROM DEFECTS

1. Most Common Welding Defects, Causes and Remedies

Defects are common in any type of manufacturing, welding including. In the process, there can be deviations in the shape and size of the metal structure. It can be caused by the use of the incorrect welding process or wrong welding technique. So below we'll learn about the 7 most common welding defects, their types, causes and remedies.

1.1Weld Crack

The most serious type of welding defect is a weld crack and it's not accepted almost by all standards in the industry. It can appear on the surface, in the weld metal or the area affected by the intense heat.

There are different types of cracks, depending on the temperature at which they occur:

- Hot cracks. These can occur during the welding process or during the crystallization process of the weld joint. The temperature at this point can rise over 10,000C.

- Cold cracks. These cracks appear after the weld has been completed and the temperature of the metal has gone down. They can form hours or even days after welding. It mostly happens when welding steel.

The cause of this defect is usually deformities in the structure of steel.

- Crater cracks. These occur at the end of the welding process before the operator finishes a pass on the weld joint. They usually form near the end of the weld. When the weld pool cools and solidifies, it needs to have enough volume to overcome shrinkage of the weld metal. Otherwise, it will form a crater crack

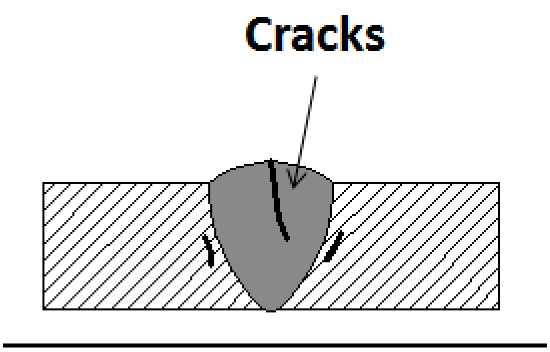


Figure.1.1cracks

1.2Causes of cracks:

- Use of hydrogen when welding ferrous metals.
- Residual stress caused by the solidification shrinkage.
- Base metal contamination.
- High welding speed but low current.
- No preheat before starting welding.
- Poor joint design.
- A high content of sulfur and carbon in the metal.

Remedies:

- Preheat the metal as required.
- Provide proper cooling of the weld area.
- Use proper joint design.
- Remove impurities.
- Use appropriate metal.
- Make sure to weld a sufficient sectional area.
- Use proper welding speed and amperage current.
- To prevent crater cracks make sure that the crater is properly filled.

1.3 Porosity

Porosity occurs as a result of weld metal contamination. The trapped gases create a bubble-filled weld that becomes weak and can with time collapse.

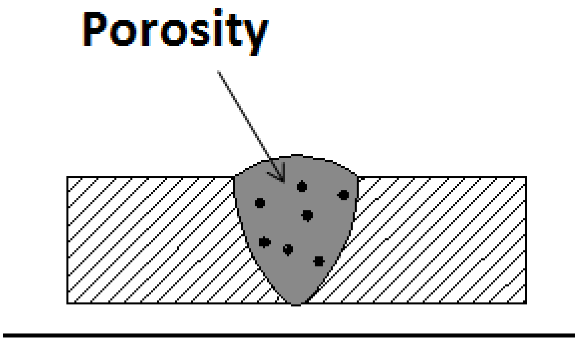


Figure.1.3 Porosity

Causes of porosity:

- Inadequate electrode deoxidant.
- Using a longer arc.
- The presence of moisture.

- Improper gas shield.
- Incorrect surface treatment.
- Use of too high gas flow.
- Use of too high gas flow.
- Contaminated surface
- Presence of rust, paint, grease or oil.

Remedies:

- Clean the materials before you begin welding.
- Use dry electrodes and materials.
- Use correct arc distance.
- Check the gas flow meter and make sure that it's optimized as required with proper with pressure and flow settings.
- Reduce arc travel speed, which will allow the gases to escape.
- Use the right electrodes.
- Use a proper weld technique.

1.4Undercut

This welding imperfection is the groove formation at the weld toe, reducing the cross-sectional thickness of the base metal. The result is the weakened weld and workpiece.

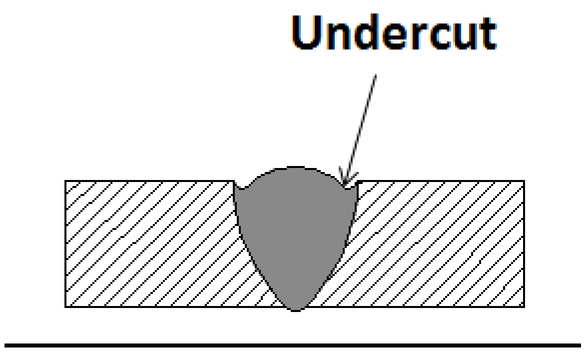


Figure.1.4 Undercut

Causes:

- Too high weld current.
- Too fast weld speed.
- The use of an incorrect angle, which will direct more heat to free edges.

- The electrode is too large.
- Incorrect usage of gas shielding.
- Incorrect filler metal.
- Poor weld technique.

Remedies:

- Use proper electrode angle.
- Reduce the arc length.
- Reduce the electrode’s travel speed, but it also shouldn’t be too slow.
- Choose shielding gas with the correct composition for the material type you’ll be welding.
- Use of proper electrode angle, with more heat directed towards thicker components.
- Use of proper current, reducing it when approaching thinner areas and free edges.
- Choose a correct welding technique that doesn’t involve excessive weaving.

1.5Incomplete Fusion

This type of welding defect occurs when there’s a lack of proper fusion between the base metal and the weld metal. It can also appear between adjoining weld beads. This creates a gap in the joint that is not filled with molten metal.

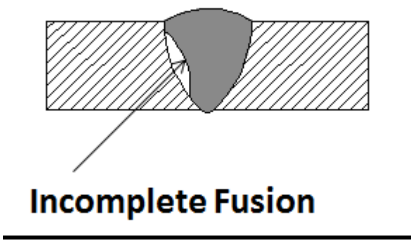


Figure.1.5 incomplete fusion

Causes:

- Low heat input.
- Surface contamination.
- Electrode angle is incorrect.
- The electrode diameter is incorrect for the material thickness you're welding.
- Travel speed is too fast.
- The weld pool is too large and it runs ahead of the arc.

Remedies:

- Use a sufficiently high welding current with the appropriate arc voltage.
- Before you begin welding, clean the metal.
- Avoid molten pool from flooding the arc.
- Use correct electrode diameter and angle.
- Reduce deposition rate.

1.6 Incomplete Penetration

Incomplete penetration occurs when the groove of the metal is not filled completely, meaning the weld metal doesn't fully extend through the joint thickness.

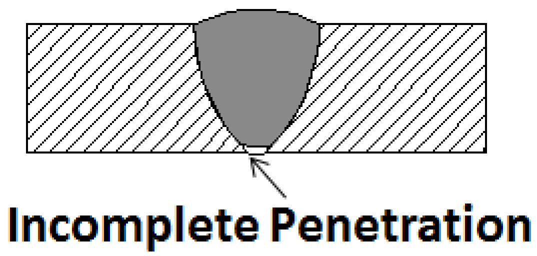


Figure.1.6 incomplete penetration

Causes:

- There was too much space between the metal you're welding together.
- You're moving the bead too quickly, which doesn't allow enough metal to be deposited in the joint.
- You're using a too low amperage setting, which results in the current not being strong enough to properly melt the metal.
- Large electrode diameter.

- Misalignment.
- Improper joint.

Remedies:

- Use proper joint geometry.
- Use a properly sized electrode.
- Reduce arc travel speed.
- Choose proper welding current.
- Check for proper alignment.

1.7 Slag Inclusion

Slag inclusion is one of the welding defects that are usually easily visible in the weld. Slag is a vitreous material that occurs as a byproduct of stick welding, flux-cored arc welding and submerged arc welding. Is can occur when the flux, which is the solid shielding material used when welding, melts in the weld or on the surface of the weld zone.

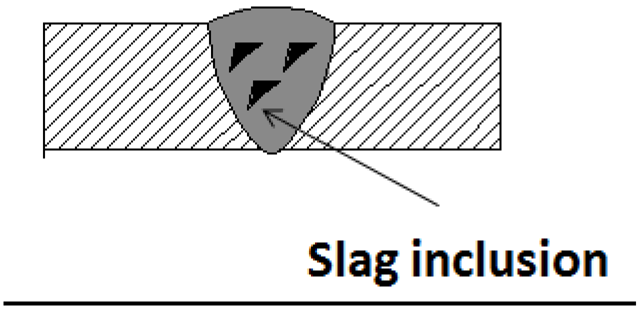


Figure.1.7 Slag inclusion

Causes:

- Improper cleaning.
- The weld speed is too fast.
- Not cleaning the weld pass before starting a new one.
- Incorrect welding angle.
- The weld pool cools down too fast
- Welding current is too low.

Remedies:

- Increase current density.
- Reduce rapid cooling.

- Adjust the electrode angle.
- Remove any slag from the previous bead.
- Adjust the welding speed.

1.8 Spatter

Spatter occurs when small particles from the weld attach themselves to the surrounding surface. It’s an especially common occurrence in gas metal arc welding. No matter how hard you try, it can’t be completely eliminated. However, there are a few ways you can keep it to a minimum.

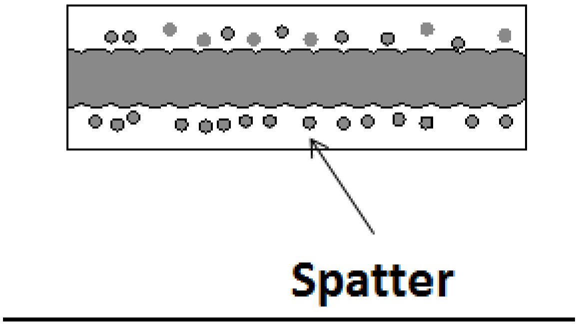


Figure.1.8 Spatter

Causes:

- The running amperage is too high.
- Voltage setting is too low.
- The work angle of the electrode is too steep.
- The surface is contaminated.
- The arc is too long.
- Incorrect polarity.
- Erratic wire feeding.

Self-Check -4	Written Test

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

Advantages of nondestructive weld quality testing:

Part I Multiple choose

1. _______________ is one of the welding defects that are usually easily visible in the weld. (**3 points)**

A. Slag inclusion C. Spatter

C. incomplete penetration D. incomplete fusion

Part II Identification

2. Write Causes incomplete fusion. (**5points)**

3**.** Write Causes Spatter. (**5points)**

Note: **Satisfactory rating - 13points** **Unsatisfactory - below 13 points**

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

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

INFORMATION 5	PERFORMING TASK WITH THE REQUIRED STANDARD

1. Application standards

Application standards and codes of practice ensure that a structure or component will have an acceptable level of quality and be fit for the intended purpose. and codes of practice ensure that a structure or component will have an acceptable level of quality and be fit for the intended purpose. The requirements for standards on welding procedure and welder qualification are explained together with the quality levels for imperfections.

Application standards and codes

There are essentially three types of standards which can be referenced in fabrication:

- Application and design
- Specification and qualification of welding procedures
- Qualification of welders

There are also specific standards covering material specifications, consumables, welding equipment and health and safety. British Standards are used to specify the requirements, for example, in approving a welding procedure, they are not a legal requirement but may be cited by the Regulatory Authority as a means of satisfying the law. Health and Safety guidance documents and codes of practice may also recommend standards.

Codes of practice differ from standards in that they are intended to give recommendations and guidance, for example, on the validation of power sources for welding. It is not intended that they should be used as a mandatory, or contractual documents.

Most fabricators will be working to one of the following:

- Company or industry specific standards
- National standards 'BS' (British Standard)
- European standards 'BS EN' (British Standard European Standard)
- International standards ‘BS EN ISO’ (International Standards Organization)
- US standards published by AWS (American Welding Society) and ASME (American Society of Mechanical Engineers)

Examples of application standards and related welding procedure and welder/welding operator qualification standards are listed in Table 1.

Table 1 Examples of application codes and standards and related welding procedure, welder and welding operator approval standards

Application	Application standard	Welding standard	
		Procedure qualification	**Welder qualification**
Pressure Vessels	PD 5500 BS EN 13445 series ASME B&PV Section III-NB (Nuclear) ASME B&PV Section VIII	BS EN ISO 15614 ASME B&PV Section IX	BS EN 287 BS EN ISO 9606 ASME B&PV Section IX
Process Pipe work	BS 2633 BS 4677 ANSI/ASME B31.1 ANSI/ASME B31.3	BS EN ISO 15614 ASME B&PV Section IX	BS EN 287 (superseded) BS EN ISO 9606 series ASME IX ASME IX
Structural Fabrication	AWS D1.1 AWS D1.2 AWS D1.6 BS EN 1011 and ISO/TR 17671 (both series) BS EN 1991-	AWS D1.1 AWS D1.2 AWS D1.6 BS EN ISO 15614-1 BS EN ISO 15614-2	AWS D1.1 AWS D1.2 BS EN ISO 9606-1 BS EN ISO 9606-2
Storage Tanks	BS EN 14015 BS EN 12285 API 620/650	BS EN ISO 15614-1, -2 ASME IX	BS EN ISO 9606-1, 2 ASME IX

2.Qualification of welding procedures and welders

An application standard or code of practice will include requirements or guidelines on material, design of joint, welding process, welding procedure, welder qualification and inspection or may invoke other standards, for example for welding procedure and welder approval tests. The manufacturer will normally be required to qualify the welding procedure and welder qualification. The difference between a welding procedure and a welder qualification test is as follows:

- The welding procedure qualification test is carried out by a competent welder and the quality of the weld is assessed using non-destructive and mechanical testing techniques. The intention is to demonstrate that the proposed welding procedure will produce a welded joint which will satisfy the specified requirements of weld quality and mechanical properties.

- The welder qualification test examines a welder's skill and ability in producing a satisfactory test weld. The test may be performed with or without a qualified welding procedure (note, without an approved welding procedure the welding parameters must be recorded).

Examples of ASME

The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) covers all aspects of design and manufacture of boilers and pressure vessels. All sections contain welding specifications, however most relevant information is contained in the following:

Code	Description
ASME BPVC Section I	Rules for Construction of Power Boilers
ASME BPVC Section II	Part C: Specifications for Welding Rods, Electrodes, and Filler Metals.[a]
ASME BPVC Section III	Rules for Constructions of Nuclear Facility Components-Subsection NCA-General Requirements for Division 1 and Division 2
ASME BPVC Section IV	Rules for Construction of Heating Boilers
ASME BPVC Section V	Nondestructive Examination
ASME BPVC Section VIII	Rules for Construction of Pressure Vessels Division 1 and Division 2
ASME BPVC Section IX	Welding and Brazing Qualifications
ASME B16.25	Buttwelding ends
ASME B31.1	Power Piping
ASME B31.3	Process Piping.

3. American Welding Society (AWS) Standards

The American Welding Society (AWS) publishes over 240 AWS-developed codes, recommended practices and guides which are written in accordance with American National Standards Institute (ANSI) practices. The following is a partial list of the more common publications:

Standard Number	Title
AWS A2.4	Standard symbols for welding, brazing, and non-destructive examination
AWS A3.0	Standard welding terms and definitions
AWS A5.1	Specification for carbon steel electrodes for shielded metal arc welding
AWS A5.18	Specification for carbon steel electrodes and rods for gas shielded arc welding
AWS B1.10	Guide for the nondestructive examination of welds
AWS B2.1	Specification for Welding Procedure and Performance Qualification
AWS D1.1	Structural welding (steel)
AWS D1.2	Structural welding (aluminum)
AWS D1.3	Structural welding (sheet steel)
AWS D1.4	Structural welding (reinforcing steel)
AWS D1.5	Bridge welding
AWS D1.6	Structural welding (stainless steel)
AWS D1.7	Structural welding (strengthening and repair)
AWS D1.8	Structural welding seismic supplement
AWS D1.9	Structural welding (titanium)
AWS D3.6R	Underwater welding (Offshore 7 inland pipelines)
AWS D8.1	Automotive spot welding
AWS D8.6	Automotive spot welding electrodes supplement

AWS D8.7	Automotive spot welding recommendations supplement
AWS D8.8	Automotive arc welding (steel)
AWS D8.9	Automotive spot weld testing
AWS D8.14	Automotive arc welding (aluminum)
AWS D9.1	Sheet metal welding
AWS D10.10	Heating practices for pipe and tube
AWS D10.11	Root pass welding for pipe
AWS D10.12	Pipe welding (mild steel)
AWS D10.13	Tube brazing (copper)
AWS D10.18	Pipe welding (stainless steel)
AWS D11.2	Welding (cast iron)
AWS D14.1	Industrial mill crane welding
AWS D14.3	Earthmoving & agricultural equipment welding
AWS D14.4	Machinery joint welding
AWS D14.5	Press welding
AWS D14.6	Rotating Elements of Equipment
AWS D15.1	Railroad welding
AWS D15.2	Railroad welding practice supplement
AWS D16.1	Robotic arc welding safety
AWS D16.2	Robotic arc welding system installation
AWS D16.3	Robotic arc welding risk assessment
AWS D16.4	Robotic arc welder operator qualification
AWS D17.1	Aerospace fusion welding
AWS D17.2	Aerospace resistance welding

AWS D18.1 Hygienic tube welding (stainless steel)

AWS D18.2 Stainless steel tube discoloration guide

Self-Check - 5	Written Test

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

Advantages of nondestructive weld quality testing:

Part I Multiple choose

1 The ______________________(AWS) publishes over 240 AWS-developed codes, (**3 points)**

A. Welding Society C. Society

C . Welding **D. American Welding Society**

2. Standard symbols for welding, brazing, and non-destructive examination (**3points)**

A. AWS A2.4 C. AWS D18.3

B. AWS D16.4 **D.** AWS D16.1

Part II Identification

3. ___________________ and codes of practice ensure that a structure or component will have an

acceptable level of quality and be fit for the intended purpose. (**3points)**

Note: **Satisfactory rating - 9points** **Unsatisfactory - below 9points**

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

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

OPERATION SHEET 4	Cleaning and making root pass free from defects.

1. Clean root pass free from defects

Steps 1- Wear PPE

Steps 2- see visually check the work pieces..

Steps 3- Clean root pass

LAP Test	Practical Demonstration

Name: ________________________________ Date: __________________

Time started: ___________________________ Time finished: __________________

Instructions: Given necessary materials for root pass weld required to perform the following tasks within 3-5:30 hours.

Task 1: Cleaning and making root pass free from defects.

List of Reference Materials

1. *en.wikipedia.org/wiki/GTAW*
2. www.weldwell.co.nz/site/weldwell
3. http://www.azom.com/article.aspx?ArticleID=1446
4. Karunakaran, N. (2012). Effect of Pulsed Current on Temperature Distribution, Weld Bead Profiles and Characteristics of GTA Welded Stainless Steel Joints.
5. http://www.ijser.org
6. www.PDHcenter.com
7. *FordAluminumGMA(MIG)WeldingQualificationTestBOOK*
8. **www.weldability.com |**
9. **support@weldability.com**
10. http://www.ijser.org

Mechanics

Level-III

Learning Guide-08

Unit of Competence: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Title: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO 5: Weld subsequent / filling passes

Instruction Sheet	Learning Guide #08

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

- Performing subsequent/filling passes.
- Making weld visually acceptable with applicable codes and standards.

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**:

- Performing filling passes in accordance with approved WPS
- Welding made visually acceptable in accordance with applicable codes and standards

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 and Sheet 4".
4. Accomplish the "Self-check 1 and Self-check t2" **in page -125, and 128** respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 " **in page -129.**
6. Do the "LAP test" **in page – 130** (if you are ready).

INFORMATION- 1	PERFORMING SUBSEQUENT/FILLING PASSES.

1. Filling passes

The first layer after the root run should be welded with the wire from the front of the electrode. For the other filling passes, the wire can be fed alternately from the front and back. The direction should be changed for each pass.

This procedure can be pre-programmed. When the wire is fed behind the electrode, it is important that the wire in the exact position, otherwise it can touch the molten pool and stick. This can be

avoided by making manual adjustments during the actual welding procedure. It is also possible to take this into account when programming the welding process.

The arc voltage should normally be increased by 0.4 volts. The final filling pass is normally welded with weaving to obtain a low. Smooth transition between the pipes.

Fill – Also referred to as a fill pass, it is the amount of weld bead necessary to fill the weld joint. This pass comes after the root pass and before the cap pass.

1.1Welding sequence

The sequence, or direction, of welding is important and should be towards the free end of the joint. For long welds, the whole of the weld is not completed in one direction. Short runs, for example using the back-step or skip welding technique, are very effective in distortion control (Fig. 1.1).

- Back-step welding involves depositing short adjacent weld lengths in the opposite direction to the general progression.
- Skip welding is laying short weld lengths in a predetermined, evenly spaced, sequence along the seam.Weld lengths and the spaces between them are generally equal to the natural run-out length of one electrode. The direction of deposit for each electrode is the same, but it is not necessary for the welding direction to be opposite to the direction of general progression.

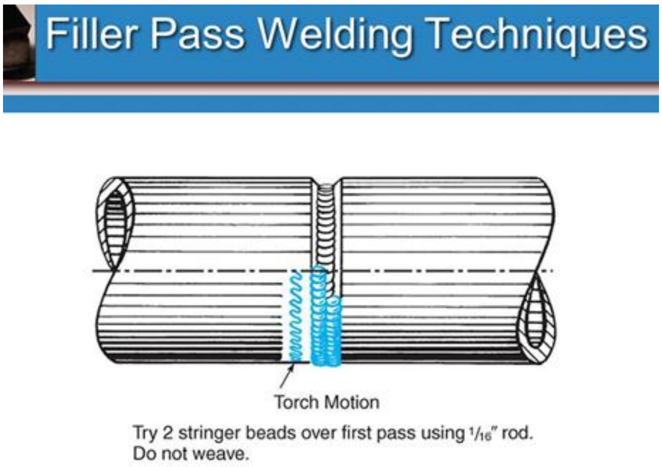


Figure.1.1 Filler pass welding techniques

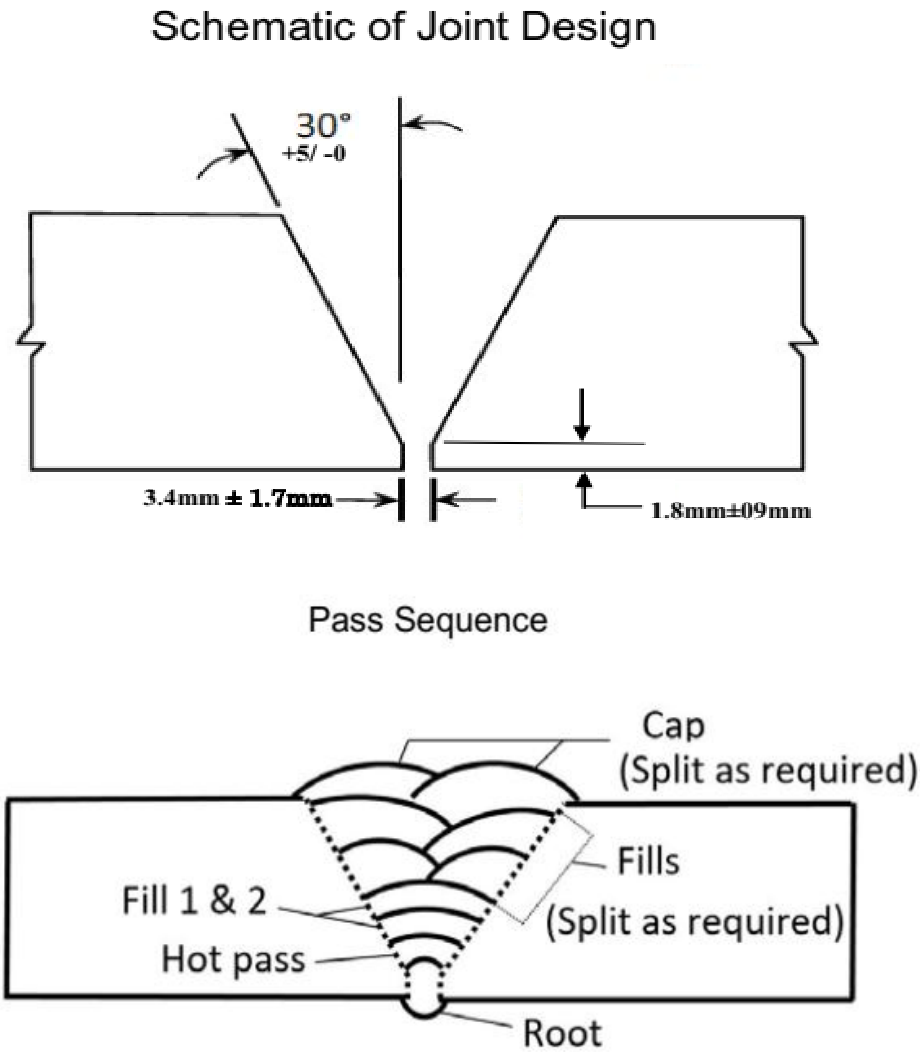


Figure1.2 Fill pass

Self-Check -1	Written Test

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

Advantages of nondestructive weld quality testing:

Part I Multiple choose

1 ______________ Also referred to as a fill pass, it is the amount of weld bead necessary to fill

the weld joint. (**3 points)**

A. Fill C. Root

C . Capping D. Root pass

Part II Identification

2.______________ welding involves depositing short adjacent weld lengths in the opposite

direction to the general progression. (**3points)**

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

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

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

INFORMATION- 2	MAKING WELD VISUALLY ACCEPTABLE WITH APPLICABLE CODES AND STANDARDS

1. **welding codes and standards**

Welding codes are very important to the welding engineer because they govern and guide welding activities to ensure safety, reliability, and quality of the applicable welded structure. Codes and specifications are typically incorporated in the contract for producing a welded fabrication, and therefore, establish important information such as inspection methods and acceptance criteria for a weld, or methods for qualifying welders and weld procedures. American Welding Society (AWS) and American Society of Mechanical Engineers (ASME) are two technical societies that provide the most commonly used welding codes in the United States. The AWS D1.1 Structural Welding Code- Steel is one of the most widely used welding codes. There are three very important records or documents that verify if welding quality is being maintained: the procedure qualification record (PQR), the welding procedure specification (WPS), and the welder performance qualification (WPQ).


What is Code, Standard & Specification ?
• Why Standard is required ?
– Standards are documents that establish engineering or technical requirements for products, practices, methods or operations.
– Build confidence about quality in users
– Lower the cost of production as requirements are standardize
Why?

Self-Check -2	Written Test

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

Multiple choose

1.AWS D1.1 Structural Welding Code- Steel is one of the most widely used welding codes.

(**3 points)**

A**. True** B. False.

2. Welding codes are very important to the welding engineer because they govern and guide welding activities to ensure safety, reliability, and quality of the applicable welded structure.

(**3points)**

A. True B. False

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

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

Answer Sheet

Score = ____________
Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

OPERATION SHEET 1	Performing subsequent/filling passes

.1. Make filling passes

Steps 1- Wear PPE

Steps 2- prepare work pieces.

Steps 3- weld groove/hole 1st pass, 2nd pass go on

OPERATION SHEET 2	Making weld visually acceptable with applicable codes and standards

1. Make weld by codes and standards

Steps 1- Wear PPE

Steps 2- prepare work pieces.

Steps 3- weld material 1F-3F

LAP Test	Practical Demonstration

Name: ________________________________ Date: ________________

Time started: ___________________________ Time finished: ________________

Instructions: Given necessary materials for filling pass weld required to perform the following tasks within 3-5:30 hours.

Task 1: Make filling passes

Task 1: Make weld by codes and standards

List of Reference Materials

1. *en.wikipedia.org/wiki/GTAW*
2. www.weldwell.co.nz/site/weldwell
3. http://www.azom.com/article.aspx?ArticleID=1446
4. Karunakaran, N. (2012). Effect of Pulsed Current on Temperature Distribution, Weld Bead Profiles and Characteristics of GTA Welded Stainless Steel Joints.
5. http://www.ijser.org
6. www.PDHcenter.com
7. *FordAluminumGMA(MIG)WeldingQualificationTestBOOK*
8. **www.weldability.com |**
9. **support@weldability.com**
10. http://www.ijser.org

Mechanics

Level III

Learning Guide-09

Unit of Competence: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Title: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO 6: Perform capping

Instruction Sheet	Learning Guide #09

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

- Performing Capping with WPS.
- Weld is visually acceptable with applicable codes and standards.

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**:

- Performing Capping in accordance with WPS and/or client specifications
- Welding made visually acceptable in accordance with applicable codes and standards

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 and Sheet 4".
4. Accomplish the "Self-check 1 and Self-check t 2" in page -135 and 137respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1" in page -135.
6. Do the "LAP test" **in page – 16** (if you are ready).

INFORMATION: 1	PERFORMING CAPPING WITH WPS

1.Capping with WPS

- Cap welding is the common term used for the projection spot welding of the caps (or lids) on electronic packages. The process seems to be fairly straightforward: place components in a metal package and seal.
- **Cap -** the last bead of a groove **weld**, it can be made with a weave motion back and forth, or with stringer beads tied into each other. Also what you need to wear on your head when **welding** Mig vertical, or any process overhead, to keep hot sparks off of your head.

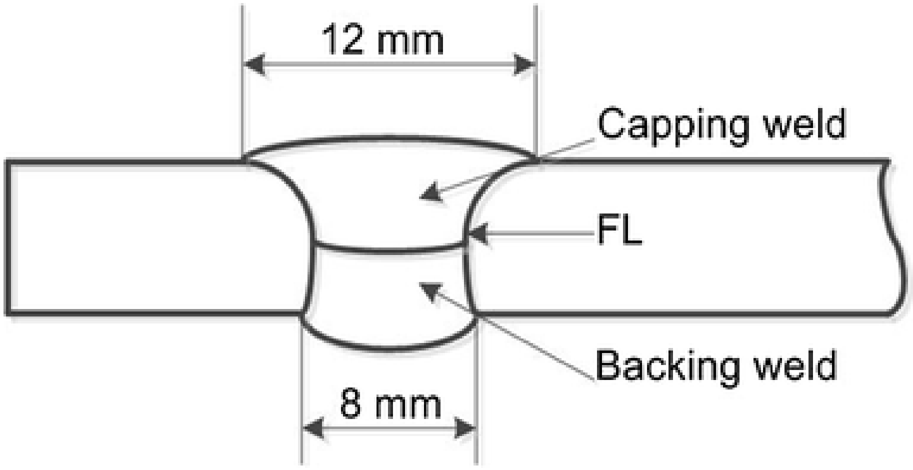


Figure 1.1 Capping

Self-Check -1	Written Test

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

Multiple choose

7. ________ welding is the common term used for the projection spot welding of the caps (or lids) on electronic packages. (3 points)

   A. Cap B.Root C.Fill D.All

2.Cap welding is the common term used for the projection spot welding of the caps (or lids). (3 points)

A. **True** B. False

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

OPERATION SHEET 1	PERFORMING CAPPING WITH WPS

1 . Perform capping.

Steps 1- Wear PPE

Steps 2- prepare work pieces.

Steps 3- Make Cap weld

LAP Test	Practical Demonstration

Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary materials for cap weld required to perform the following tasks within 3-5:30 hours.

Task 1: Perform capping

INFORMATION sheet 2	Weld is visually acceptable with applicable codes and standards.

1.Code

The most commonly used codes for qualifying welders are the American Society of Mechanical Engineers (ASME) Section IX and American Welding Society (AWS) D1.1. ... ASME is specifically for welde**r** and welding procedure qualification

American Welding Society (AWS) Standards

Standard Number	**Title**
AWS B2.1	Specification for Welding Procedure and Performance Qualification
AWS D1.1	Structural welding (steel)
AWS D1.2	Structural welding (aluminum)
AWS D1.3	Structural welding (sheet steel)

Self-Check -2	Written Test

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

Part I Multiple choose

2. __________Specification for Welding Procedure and Performance Qualification. (5 points)

A. AWS B2.1 C. AWS B2.30

B. AWS B2.40 D. AWS B2.45

2. Write the American Welding Society (AWS) Standards. (5 points)

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

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

Answer Sheet

Score = ____________
Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

List of Reference Materials

1. *en.wikipedia.org/wiki/GTAW*
2. www.weldwell.co.nz/site/weldwell
3. http://www.azom.com/article.aspx?ArticleID=1446
4. Karunakaran, N. (2012). Effect of Pulsed Current on Temperature Distribution, Weld Bead Profiles and Characteristics of GTA Welded Stainless Steel Joints.
5. http://www.ijser.org
6. www.PDHcenter.com
7. *FordAluminumGMA(MIG)WeldingQualificationTestBOOK*
8. **www.weldability.com |**
9. **support@weldability.com**
10. http://www.ijser.org

Mechanics

Level-III

Learning Guide-10

Unit of Competence: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Title: Perform Plate and Tube Welding Using Gas Tungsten Arc Welding (GTAW)

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO 7: Quality assure weld conformance

Instruction Sheet	Learning Guide #10

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

- Checking and Identifying defects/fault visually
- Rectifying welding defect
- Completing and maintaining weld records and completion.
- Performing OHS for GTAW process

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**:

- Checking Weld visually for defects and repair.
- Weld records and completion details are completed and maintain correctly as required
- Performing OHS procedures and measures for GTAW process .

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3 and Sheet 4".
4. Accomplish the "Self-check 1, Self-check t 2, Self-check 3 and Self-check 4" **in page -147, 151, 156 and 160** respectively.

Information: 1	Checking and Identifying defects/fault visually

1. Visual Inspection

- Prior to welding – check that the materials you are using are suitable for the WPS, check that you have all the correct consumables to perform the weld process specified in the WPS, check their no contaminants on the work piece or consumables
- During Welding – Be observant of what is happening and if it appears that the weld isn't conforming to the WPS, stop the process and re-do if necessary if the component can't be rectified
- After welding – check the weld using measuring equipment to ensure it meets the requirements set out in the WPS and ensure that it is finished aesthetically to the required standard
- Measuring Equipment – Fillet Gauge, micrometer, steel ruler, protractor
- Optical Aids – Magnifying glass, Magnified Safety glasses, Magnifying Scope etc.

1.2 Destructive Testing

Destructive Testing sometimes has to be used to test the tensile strength and other features of a weld. These types of destructive testing can include:

- Face (of the joint), Side (of the joint), Root (of the joint)
- Macroscopic - involves cutting a sample from the joint. Cold cutting methods are best for this, such as a band saw. The surface needs to be polished, file away any burrs and rough marks and use progressively finer grades of emery cloth until you get a smooth even finish. Then, acid solution is applied with a soft clean cloth. The acid used is nitric acid, dissolved in distilled water. The solution is 10% Nitric acid, and 90% water. This is used because it rapidly oxidises. After a time, the parent metal and weld areas will begin to discolour. Afterwards, the sample is rinsed off and carefully dried. The results show a distinctive colour difference between the weld metal and the parent metal. The weld will show up lighter, and the darker material next to it is the rearranged grain structure, due to the heating and cooling cycle. In multiple run welds, the one that is done first shows up slightly darker, due to the root run being reheated during the second pass.
- Nick-Break - you take a sample piece, partially cut through it, then break the remainder off so you can see the 'see inside the weld'.

- Tensile - by gripping the ends of a suitably prepared standardised test piece in a tensile test machine and then applying a continually increasing uni-axial load until such time as failure occurs.

1.3 Non-Destructive Testing (1)

Dye Penetrate - is a widely applied and low-cost inspection method used to locate surface-breaking defects in metals, plastics, or ceramics. This may be applied to all non-ferrous materials and ferrous materials. Dye Penetrate is used to detect casting, forging and welding surface defects such as hairline cracks, surface porosity, leaks in new products, and fatigue cracks on in-service components.

The steps for using Dye Penetrate are as follows:

1. Pre-Cleaning
2. Application of Penetrate
3. Excess Penetrate Removal
4. Application of Developer
5. Inspection of Weld
6. Post-Cleaning

Figure 1.3 Non-Destructive Testing

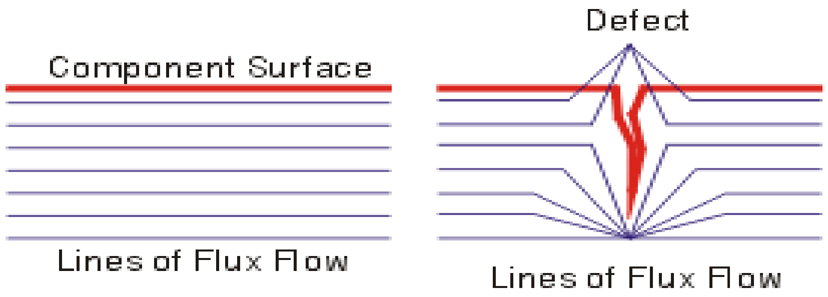
1.4 Non-Destructive Testing (2)

Magnetic Particle Testing - for detecting surface and slightly subsurface discontinuities in ferromagnetic materials and some alloys. You apply a magnetic field into the part. The piece can be magnetized by direct or indirect magnetization. Direct magnetization occurs when the electric current is passed through the test object and a magnetic field is formed in the material. Indirect magnetization occurs when no electric current is passed through the test object, but a magnetic field is applied from an outside source. The magnetic lines of force are perpendicular to the direction of the electric current which may be either AC or some form of DC (rectified AC).

The presence of a surface or subsurface defect in the material allows the magnetic flux to leak, since air cannot support as much magnetic field per unit volume as metals. Ferrous iron particles are then applied to the part. The particles may be either dry or wet. If an area of flux leakage is present, the particles will be attracted to this area. The particles will build up at the area of leakage and form what is known as an indication. The indication can then be evaluated to determine what it is, what may have caused it, and what action should be taken, if any.

Non-Destructive Testing (3)

Magnetic Particle Testing –



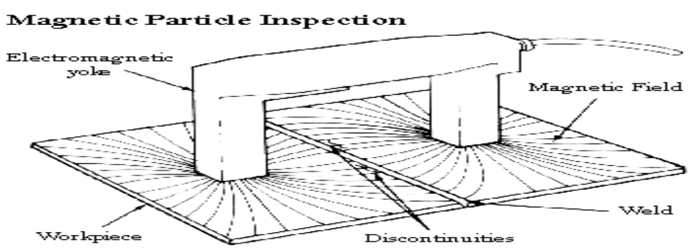


Figure .1.4.Magnetic Particle Testing

1.5 Non-Destructive Testing (4)

- Ultrasonic Testing - In most common UT applications, very short ultrasonic pulse-waves with centre frequencies ranging from 0.1-15 MHz, and occasionally up to 50 MHz, are transmitted into materials to detect internal flaws or to characterize materials. A common example is ultrasonic thickness measurement, which tests the thickness of the test object, for example, to monitor pipe work corrosion.

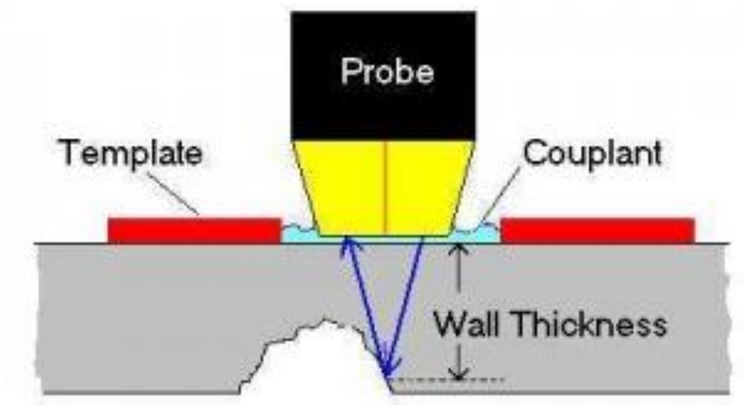


Figure .1.5 Non-Destructive Testing

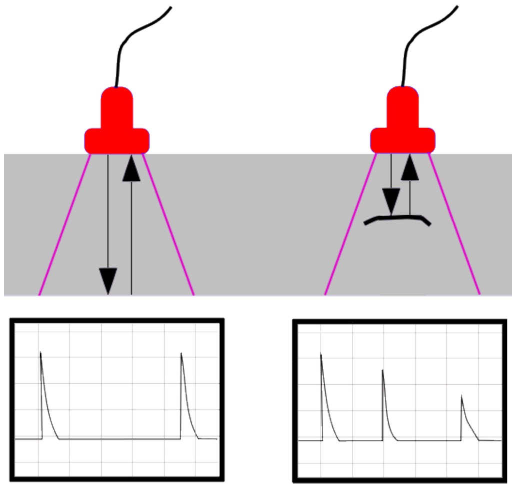


Figure .1.5.1 Non-Destructive Testing

<u>1.6 Non-Destructive Testing (5)</u>

- Radiography/X-Ray Testing - method of inspecting materials for hidden flaws by using the ability of short wavelength electromagnetic radiation (high energy photons) to penetrate various materials.
- There are two different radioactive sources available for industrial use; X-ray and Gamma-ray. These radiation sources use higher energy level, i.e. shorter wavelength, versions of the electromagnetic waves.
- The test-part is placed between the radiation source and film/detector. The material density and thickness differences of the test-part will reduce the penetrating radiation through interaction processes involving scattering and/or absorption. The differences

in absorption are then recorded on film(s) or through an electronic means. In industrial radiography there are several imaging methods available, i.e. Film Radiography, Real Time Radiography (RTR), Computed Tomography (CT),

- Digital Radiography (DR), and Computed Radiography (CR).

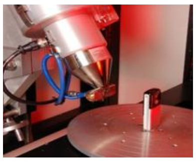


Figure .1.6 Non-Destructive Testing

Self-Check -1	Written Test

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

True or False

1. After welding check the weld using measuring equipment to ensure it meets the requirements set out in the WPS and ensure that it is finished aesthetically to the required standard. **A. True** B.False
2. Magnetic Particle Testing - for detecting surface and slightly subsurface discontinuities in ferromagnetic materials and some alloys. **A.True** B.false

3. Radiography/X-Ray Testing - method of inspecting materials for hidden flaws by using the

ability of short wavelength electromagnetic radiation (high energy photons) to penetrate

various materials. **A.True** B.false

4. Dye Penetrate - is a widely applied and low-cost inspection method used to locate surface-

breaking defects in metals, plastics, or ceramics. **A.True** B.false

Note: **Satisfactory rating – 9 points** **Unsatisfactory - below 9 points**

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

Answer Sheet

Score = ____________

Rating: ______________

INFORMATION: 2	RECTIFYING WELDING DEFECT

1. Welding Defects

In principle, weld imperfections can be divided into two groups.

• External imperfections and deviations, such as undercut, excess weld or excessive convexity, root
imperfections, root concavity and so on.

These imperfections are found during inspections.

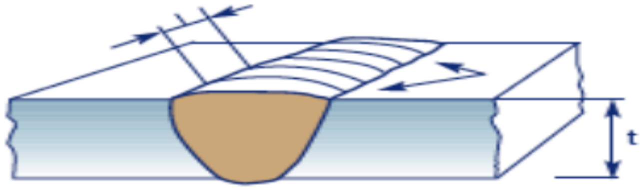
• Internal imperfections, such as pores, oxide and slag inclusions, incomplete penetration and so
on. These imperfections are found by X-ray or ultrasound tests. The rules governing permissible weld imperfections are described below, as specified in the Swedish Standard SS 066101. The quality requirements are described in four weld classes.

These weld classes are known as WA, WB, WC and WD. The highest class is WA, in which basically no imperfections are permitted. The stress a structure must withstand determines the imperfections that are permitted.

Defects and deviations that are identifed using X-rays are evaluated on a fve-point scale. This
scale has been drawn up by the IIW Commission (International Institute of Welding) and is used
all over the world.The scores are shown using different colours, but in Sweden numbers are used instead of colours.

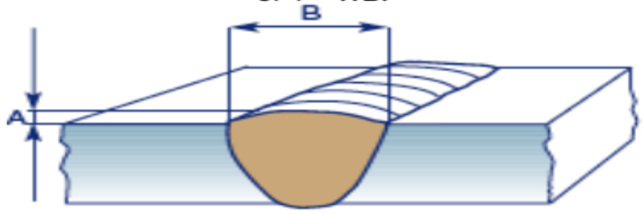
Welding defects in TIG welding

Designations and quality requirements according to SS 066101.



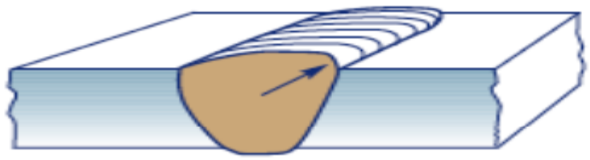
Undercut

Weld class WB:	permitted locally if A ≤ 0.05 x t but nomore than t 0.5 mm, L ≤ 25 mm.
IIW's X-ray atlas:	not permitted for a score of 5, score of 4 = WB.



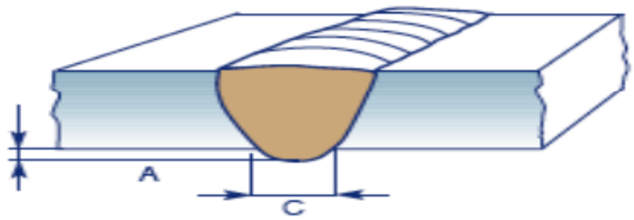
Excess weld metal - uniform bevel

Weld class WB:	A ≤ 1.5 + 0.05 x B.
IIW's X-ray:	approved as WB.



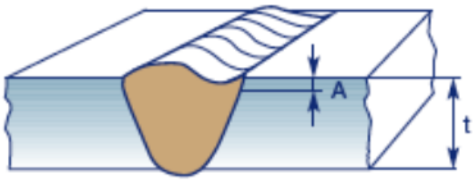
Uneven bevel - indication of fracture

Weld class WB:	not permitted.
IIW's X-ray:	like WB, score ≤ 3.



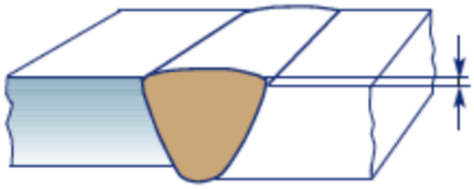
Excessive penetration

Weld class WB:	A ≤ 1.5 + 0.1 x C. IIW's
X-rays:	approved as WB.



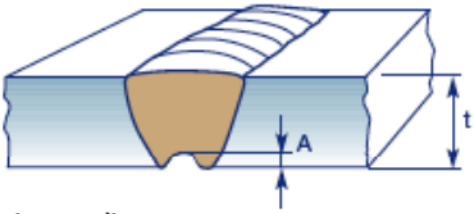
Incompletely filled groove

Weld class WB: A ≤ 0.05 x t, t but max. 0.5 mm.
IIW's X-ray: approved as WB..



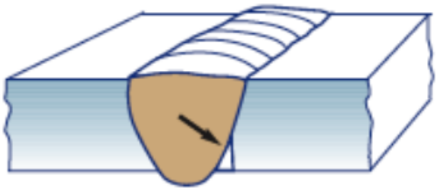
Linear misaligament

Weld class WB: at t ≤ 5 mm 0.5 xt, but no more than 1 mm. At t = 5-10 mm, 0.2 x t is permitted. More than 10 mm 0.1 x t + 1 but no more than 4 mm.
IIW's X-ray: like WB



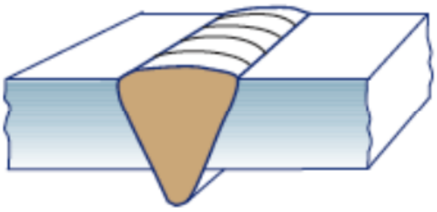
Root concavity

Weld class WB: A ≤ 0.05 x t but t max 0.5 mm.
IIW's X-ray: approved as WB.



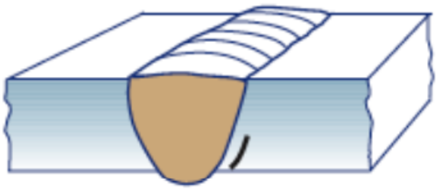
Lack of fusion

Weld class WB: not permitted
IIW's X-ray: like WB



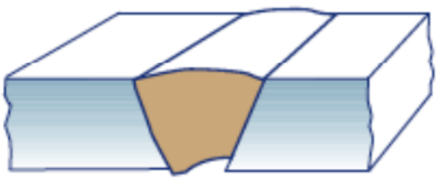
Excessive weld

Weld class WB: not permitted.
IIW's X-ray: like WB, score ≤ 3.



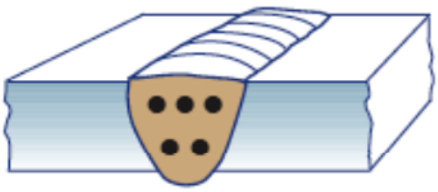
Cracking

Weld class WB: not permitted
IIW's X-ray: like WB



Lack of penetration

Weld class WB: not permitted.
IIW's X-ray: like WB, score ≤ 3.



Pores

Weld class WB: the odd small, rounded pore or groups of pores. Pore distance less than t/3 if the rest of the weld metal is free from imperfections. Long pores are regarded as slag inclusions.
IIW's X-ray: like WB, score 4-5.

.

Self-Check -2	Written Test

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

Multiple choose

1.__________ imperfections and deviations, such as undercut, excess weld or excessive convexity, root imperfections, root concavity (**3 points**)

A. **External** C*.* External and Internal

B. Internal D*. All*

2.Internal imperfections, such as pores, oxide and slag inclusions, incomplete penetration.

(**3 points**)

A. External *C.* External and Internal

B.**Internal** D*. All*

3. Defects and deviations that are identified using X-rays are evaluated on a five-point scale.

A. Two-point scale C*.* **five-point scale**

B. Three-point scale D. All

Note: **Satisfactory rating – 9 points** **Unsatisfactory - below 9 points**

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

Answer Sheet

Score = ___________

Rating: ____________

Information: 3	Completing and maintaining weld records and completion

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																

1.1Header 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.

1.2 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.

1.3 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 toleranced ingredient amounts. This consistency in the materials of the components ensures that the finished welds are of a high quality.

1.4 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 boroscope (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 boroscope 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 boroscope. 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:

Multiple choose

1. _________*:* Size of the weld being completed. (**3 points**)

   C. Tack Size *C.* Root Size

   D. **Weld Size** *D. Webs*

2. __________*:* The date the weld was completed.(**3 points**)

   A. Tack Size *C.* Root Size

   B. Weld Date *D. Webs*

3. __________.*:* Unique number given to every welder in a company.(**3 points**)

   A. Tack Size *C.* ***Welder No***

   B. Weld Date *D. Webs*

Note: **Satisfactory rating – 9 points** **Unsatisfactory - below 9 points**

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

Answer Sheet

Score = ___________

Rating: ____________

Information: 4	**Performing OHS FOR GTAW process**

1. Welding Health & Safety

- Work safely whilst performing welding and welding related activities
- Describe Health and Safety issues associated with Welding related activities
- Describe the safe working practices observed when using the Tungsten Inert Gas (TIG) welding process
- Describe Electrical hazards associated with welding plant and safe working procedures adopted

2 .General health and safety in welding

a).good housekeeping

Good housekeeping, especially the removal of combustible materials, is essential.

b). gas

If you can smell gas – don't light any gas torches or use electric welding equipment, but don't rely wholly on your sense of smell to warn you.

c).eye protection

Wear eye protection and cover bare skin. Be aware that: arc flash can occur through the side of the eye

arc flash can cause 'sunburn' on exposed skin.

d).hot surfaces

Mark hot surfaces as such. Better still, assume everything is hot.

e).first aid

In addition to standard training, first-aiders in welding situations should know about the symptoms of electric shock, arc flash and the consequences of exposure to heated coatings on metals (e.g. when galvanized metal is welded).

1.3 Health and Safety for Welding

Health and safety issues associated with welding related activities:

- Grinding and material removal
- Safe disposal of waste
- Workshop layout such as:

1. Obstacles in the workshop
2. Noise or heavy noise areas (muffling or distancing?)
3. Hot Metal fragments or work pieces & safe places to put them
4. Positioning of cables including welding torch leads & electrical and gas cables/hoses

1.4 Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) and the reasons for need:

- Protection of others from Hazards
- Hot Materials
- Sparks
- Falling Objects
- Heat
- Burns
- Safe Start-up and shutdown procedures

1.5 Types of Hazards from Fumes during Welding

- Particulate - Particulate fume is made up of, discrete, solid particles, As the particles are tiny and most of the fume falls into the 'respirable' size range. Respirable particulate fume can be breathed in, reach the lungs, and stay there.
- The fume is made up mainly of oxides and silicates from the metals present in the consumable and, to some extent, the parent material being used.
- Whether the fume is likely to cause damage depends largely on the material, or the concentration of it and the length of exposure to it.
- Gaseous - consists of either one or more pollutant gases, mixed around the welding area. In its gaseous state it can easily enter the lungs. Whether the fume causes damage, depends on what the gas is, and the concentration consumed and the length of time you are exposed to it.
- Fumes may be formed by welding, or the radiation from it, or the air surrounding the arc, something within the flux or coatings or contaminants on the component. Gaseous fumes are not emitted by the metal or the consumable.
- Fume Gases - The fume given off by welding and hot cutting processes is a varying mixture of airborne gases and very fine particles which if inhaled can cause ill health. Gases that may be present in welding and cutting fume are:
- nitrous oxide (NOx),
- carbon dioxide (CO_2),
- carbon monoxide (CO)
- shielding gas (eg Argon, helium)
- ozone (O_3)

The visible part of the fume cloud is mainly particles of metal, metal oxide and flux (if used). The exact level of risk from the fume will depend on 3 factors:

- How toxic the fume is
- How concentrated the fume is

How long you are breathing the fume

1.6 Health Effects of Welding Fumes

How toxic is the fume?

For arc welding, the visible fume comes mostly from the filler wire when it's exposed to the electric arc. The amount of hazardous substances in the filler wire should be included in the product information that is printed on the original packaging. Many of the common metals used in filler wires are harmful and several have Workplace Exposure Limits (WEL).

Cadmium and Beryllium are rarely found, but are particularly toxic. Chromium, Nickel, Vanadium, Manganese and Iron all have WEL's. Generally the smaller the number for the WEL the more toxic the substance is. The toxic constituents of fume can be affected by the choice of welding process.

A full list can be found at: http://www.hse.gov.uk/pubns/priced/eh40.pdf

Methods of Fume/Gas Control

Methods of Fume/Gas Control

- Extraction
- Local Extraction
- Air Fed Heat Shield (Yellow)
- Respirator (Red)
- Breathing Apparatus

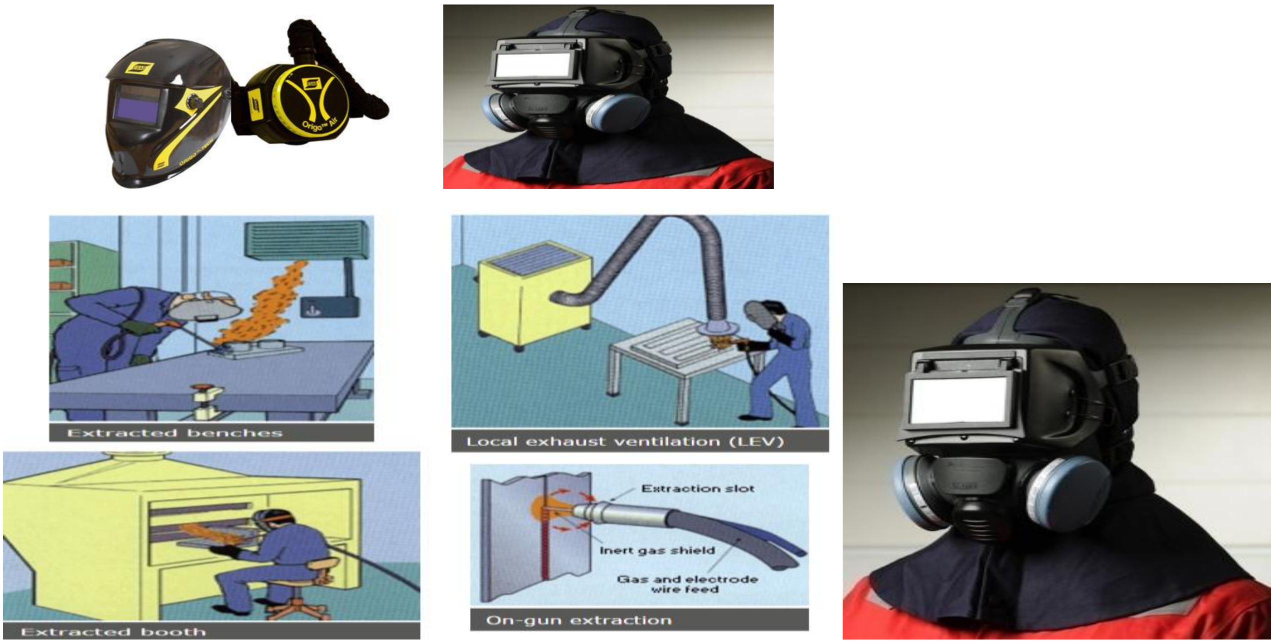


Figure 1.6 safety equipment

Self-Check -4	Written Test

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

Part I multiple choose

1. **Methods of Fume/Gas Control in TIG welding**. (**3 points**)

   A. Extraction B. Local Extraction

   C. Respirator (Red) **D.All**

2. Personal Protective Equipment (PPE) and the reasons for need: (**3 points**)

   A. Protection of others from Hazards B. Hot Materials

   C.Sparks **D.All**

3. Health and safety issues associated with welding related activities: (**3 points**)

   A.Grinding and material removal B. Safe disposal of waste

   C.Workshop layout **D.All**

Note: **Satisfactory rating – 9 points** **Unsatisfactory - below 9 points**

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

Answer Sheet

Score = ____________
Rating: ______________

Name: ___________________________ Date: ________________

Short Answer Questions

List of Reference Materials

1. *en.wikipedia.org/wiki/GTAW*
2. www.weldwell.co.nz/site/weldwell
3. http://www.azom.com/article.aspx?ArticleID=1446
4. Karunakaran, N. (2012). Effect of Pulsed Current on Temperature Distribution, Weld Bead Profiles and Characteristics of GTA Welded Stainless Steel Joints.
5. http://www.ijser.org
6. www.PDHcenter.com
7. *FordAluminumGMA(MIG)WeldingQualificationTestBOOK*
8. **www.weldability.com |**
9. **support@weldability.com**
10. http://www.ijser.org

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