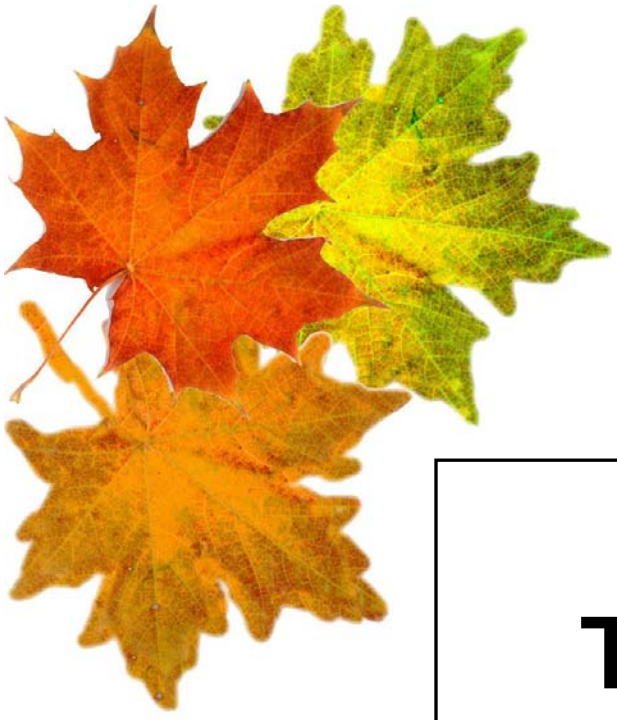

# Welding Terminology

Welders

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# Table of contents

# Introduction

To become a skilled welder, you first need to learn the technical vocabulary (language) of welding. The sections in this booklet introduce you to some of the basic terms of the welding language. Once you understand the language of welding, you will be prepared to interpret and communicate welding information accurately.

This guide mainly focuses on some of the essential terms for welding. Self-tests and answer keys have been included in this guide. A self-test is meant to be completed after you have studied the corresponding unit. After you feel you have understood the material you have read, you can then test yourself. If you are scoring below 80% on the self-tests, it is recommended that you go back and review those areas.

If you would like to study more in depth, there is a list of recommended books and Web sites at the back of this package.

# Welding Vocabulary

The following are common terms in welding.

***Abrasive -*** A material, such as sand, silicon or crushed stone, used for surface cleaning.

***Acetylene Gas -*** A chemical combination of two elements: carbon and hydrogen.

***Alloy -*** A metal that is made by mixing two or more metals, or a metal and another substance.

***Alternating Current (AC) -*** Is an electrical current in which magnitude and direction change in cycles, as opposed to direct current, in which direction is constant.

***Arc Welding (Shielded Metal Arc Welding) -*** A welding process where similar materials are joined with a heating process caused by an electric arc. In the most common use, this process includes the use of a filler metal.

***Argon -*** Is a chemical element designated by the symbol **Ar**. Argon has atomic number 18 and is the third element in group 18 of the periodic table (noble gases). Argon is present in the Earth's atmosphere at slightly less than 1%, making it the most common noble gas on Earth.

***Brazing -*** A process where metals are joined by using a filler metal that melts at a temperature above 450ºC.

***Butt Joint (Butt Weld) -*** A joint (or weld) where the two pieces being connected come directly together in the same plane.

***Buzz Box -*** Another term for a general-purpose arc welder. The name is derived from the sound made when the welder is running.

***Consumable & non-consumable electrodes -*** Consumable electrodes provide a path for the current. They also supply fuller metal to the joint. Non-consumable electrodes are only used as a conductor for the electrical current, such as in gas tungsten arc welding.

***Cutting Tip -*** The part of an oxygen torch that directs the flow of the gas.

***Cutting Torch -*** The device used in oxygen cutting to control and direct the flow of the gasses used for cutting and heating metal.

***Cylinder -*** A container to store and transport compressed gas.

***Defective Weld -*** A weld with one or more of the following defects: Porosity, undercut, slag inclusion and improper weld size.

***Direct Current (DC) -*** Or "*continuous current,*" is considered as the constant flow of electrons in the single direction from low to high potential.

***Down Hand Weld -*** A vertical weld where the welder starts at the top and works downward.

***Edge Weld -*** A weld where the edges of two pieces come together.

****Electrode (Arc Welding) -*** A rod made up of filler metal with a coating on it designed to aid and protect the bead during the welding process.

***Electrode Holder -*** The "handle" portion of the arc welder that holds the electrode in place.

***Face Shield (Helmet) -*** A safety device worn over the face to protect the eyes and face from the arc, sparks and molten metal. Arc welding without proper eye protection can lead (quickly) to permanent damage to the eyes.

***Ferrous -*** Containing or relating to iron.

***Fillet Weld -*** A weld joining two pieces of metal that are more or less perpendicular to each other.

***Filler metal -*** Is a metal added in the making of a joint through welding, brazing or soldering. Various types of filler metals exist.

***Fixture -*** A tool or device used to hold pieces in place for welding.

***Flat Weld -*** A weld where the pieces being joined come together horizontally in front of and below the welder.

***Flux -*** A substance that facilitates soldering, brazing and welding by chemically cleaning the metals to be joined.

***Forge -*** A device used to heat metal for forming and bending.
(Blacksmithing)

***Fuel Gases -*** Gases mixed with oxygen in heating and cutting operations.

***Gas Tungsten Arc Welding (GTAW) or (TIG) -*** Commonly known as **tungsten inert gas (TIG) welding;** an arc welding process that uses a non-consumable tungsten electrode to produce the weld.

***Hand Shield -*** Similar to a *Face Shield* or *Helmet,* but held in front of the face rather than worn.

***Iron -*** A base element that is the primary substance in the makeup of steel, cast iron and wrought iron.

***Inert gas/Shielding gas -*** A gas that does not normally combine chemically with materials. Their purpose is to protect the weld area from atmospheric gases, such as oxygen, nitrogen, carbon dioxide and water vapor.

***Lap Joint -*** A joint where two pieces of metal lap over each other, allowing a bead to be placed between the edge of one piece and the face of the other.

***MIG Welding (Metal Inert Gas) -** Also known as wire-feed welding, although it is possible to do wire-feed welding without the inert gas. Metals that are difficult to arc weld may be MIG welded.

***Mild Steel -** Steel with less than 0.15% carbon. (Also called low carbon steel). Most steel in common use is mild steel.

***Out-Of-Position Weld -** Any weld where the work is not flat in front of the welder.

***Overhead Weld -** An inverted weld where the pieces being joined are above the welder.

***Oxyfuel -** Pure oxygen combined with gas

***Plasma -** A gas that has been heated to the point where it will conduct electricity.

***Plasma Cutting -** A cutting process where the metal is heated to the melting point by an arc through the plasma and then removed by the pressure of the gas as directed by the nozzle. CNC (computer numeric control) plasma cutters are used for precise cutting of complex patterns in metal.

***Polarity -** The polarity of a machine refers to direction of current flow. Polarity can only be obtained on a DC machine.

***Radiation -** Energy from heat or light that you cannot see.

***Shielding Gas -** *--See Inert gas.*

***Slag Inclusion -** Non-metallic material trapped in a weld.

***Soldering -** A method of joining metal parts using a filler material (solder) that has a melting temperature below 450°C (842°F).

***Spot Weld -** A weld between two overlapping pieces of material; normally used for sheet metal.

***Tack Weld -*** A small weld used to hold pieces of an assembly in place prior to the final (continuous) welding.

***TIG Welding (Tungsten Inert Gas) -*** A welding process where an inert gas protects the molten metal from the atmosphere to produce a high quality weld.

***Tungsten -*** A non-consumable material used in TIG welding to carry current to the weld puddle. (very hard, heavy, steel-grey-to-white transition metal; W in the periodic table.)

***Up Hand Weld -*** A vertical weld where the welder starts at the bottom and works upward.

***Ventilate -*** To cause fresh air to enter and move around an enclosed space

***Weave Bead -*** A welding pattern often used in butt welds where the welder moves the arc back and forth across the joint while also moving along it.

***Weld -*** To join two pieces of metal together permanently by melting the parts that touch.

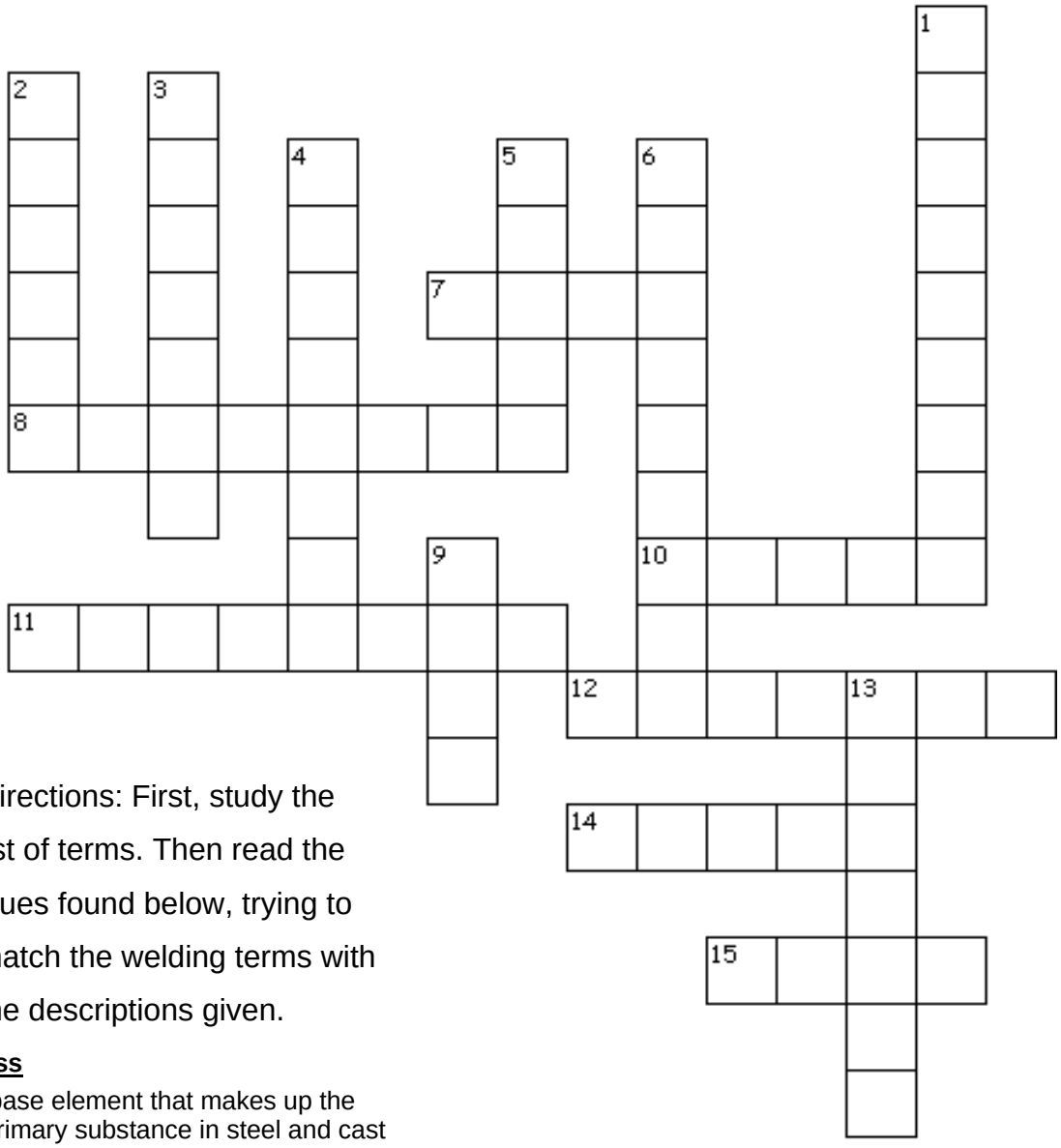
***Welder (noun) -*** A person whose job is welding.

***Welding Power Supply -*** A device that provides an electrical current to perform welding.

***Welding Rod -*** A means of delivering filler metal to the weld. In arc welding, the rod is called an electrode.

***Voltage (V) -*** Is the pressure required to move the electric current.

# Welding Vocabulary Crossword



Directions: First, study the list of terms. Then read the clues found below, trying to match the welding terms with the descriptions given.

**Across**

7. A base element that makes up the primary substance in steel and cast iron
8. A material such as sand, silicon or crushed stone used for surface cleaning
10. The most common noble gas on Earth and represented by Ar in the periodic table
11. A container used to store and transport gas
12. Containing or relating to iron
14. A metal made by mixing two or more metals
15. A substance that facilitates soldering, brazing and welding by chemically cleaning the metals to be joined

**Down**

1. Energy from heat or light that you cannot see
2. A gas that has been heated to the point where it will conduct electricity
3. A tool or device used to hold pieces in place for welding
4. A very hard, heavy, steel-grey-to-white transition metal; W in the periodic table
5. A device used to heat metal for forming and bending
6. To cause fresh air to enter and move around an enclosed space
9. To join two pieces of metal together permanently by melting the parts that touch
13. Pure oxygen combined with gas

## Safety

Safety in the workplace is very important in Canada. If your employer sees you are not listening to the safety rules, you may be fired immediately (for example, not wearing the required safety equipment). Students are expected to buy the required safety clothing. The educational institution usually provides earplugs and safety glasses.

**Why is eye protection important?**

Eye injury can occur from the intense light and heat from a welding arc and from hot slag that can fly off from the weld during cooling, chipping or grinding.

- Protect your eyes from welding light by wearing a welder's helmet fitted with a filter shade that is suitable for the type of welding you are doing.
- ALWAYS wear safety glasses with side shields or goggles when chipping or grinding a work piece if you are not wearing a welding helmet.

**What are the various parts of eye protection for welders?**

- Eye protection is provided by a helmet, which includes the following parts:
- Helmet shell must be opaque-to-light and resistant to impact, heat and electricity.
- Outer cover plate made of polycarbonate plastic, which protects from UV radiation, impact and scratches.
- Filter lens made of glass containing a filter, which reduces the amount of light passing through to the eyes. Filters are available in different shade numbers ranging from 2 to 14. The higher the number, the darker the filter and the less light that passes through the lens.
- Clear retainer lens made of plastic prevents any broken pieces of the filter lens from reaching the eye.

- Gasket, made of heat-insulating material between the cover lens and the filter lens, protects the lens from sudden heat changes that could cause it to break. In some models the heat insulation is provided by the frame mount instead of a separate gasket.

**For gas cutting, welding and brazing,** the intensity of the light is much less than from arc welding. Lighter shade filter lenses are used with goggles in place of a helmet.

**What measures can you take to protect your skin from welding radiation?**

- Wear tightly woven work-weight fabrics to keep UV radiation from reaching your skin.
- Button up your shirt to protect the skin on your throat and neck.
- Wear long sleeves and pant legs.
- Cover your head with a fabric cap to protect the scalp from UV radiation.
- Protect the back of your head by using a hood.
- Protect your face from UV radiation by wearing a tight-fitting, opaque welder's helmet.
- Make sure that all fabric garments are resistant to spark, heat and flame. Keep the fabrics clean and free of combustible materials that could be ignited by a spark.

**What are some tips to know when using protective clothing?**

**DO**

- **Remove all ignition sources, such as matches and butane lighters, from pockets. Hot welding sparks may light the matches, ignite leaking lighter fuel or melt through the casing of a lighter and explode.**

- Wear clothing made from heavyweight, tightly woven- 100% wool or cotton fabric to protect you from UV radiation, hot metal, sparks and open flames. Flame retardant treatments become less effective with repeated laundering.
- Keep clothing clean and free of oils, greases and combustible contaminants.
- Wear long-sleeved shirts with buttoned cuffs and a collar to protect the neck. Dark colours prevent light reflection.
- Tape shirt pockets closed to avoid collecting sparks or hot metal, or keep them covered with flaps.
- Pant legs must not have cuffs and must cover the tops of the boots. Cuffs can collect sparks.
- Repair all frayed edges, tears or holes in clothing.
- Wear high-top boots fully laced to prevent sparks from entering into the boots.
- Use fire-resistant boot protectors or spats, which strap around the pant legs and boot tops, to prevent sparks from bouncing into the top of the boots.
- Wear gauntlet-type cuff leather gloves or protective sleeves of similar material to protect wrists and forearms. Leather is a good electrical insulator if kept dry.
- Direct any spark spray away from your clothing.
- Wear leather aprons to protect your chest and lap from sparks when standing or sitting.
- Wear layers of clothing. To prevent sweating, avoid overdressing in cold weather. Sweaty clothes cause rapid heat loss. Leather welding jackets are not very breathable and can make you sweat if you are overdressed.
- Wear a fire-resistant skullcap or balaclava hood under your helmet to protect your head from burns and UV radiation.

- Wear a welder's face shield to protect your face from UV radiation and flying particles.

**DO NOT**

- Do not wear rings or other jewelry.
- Do not wear clothing made from synthetic or synthetic blends. The synthetic fabric can burn vigorously, melt and produce bad skin burns. [1]

**SAFE WORK PRACTICES**

1. Stop, look and think in unfamiliar situations. Ask your instructor/supervisor for help.
2. Use personal protective equipment. Protect your entire body with fire retardant clothing, shoes and gloves. Wear eye protection at all times.
3. Be sure all safety devices are in place before operating any machine or equipment.
4. Weld only in a fire safe area. Take proper precautions to prevent fires.
5. Never weld without adequate ventilation.
6. Mark metal "HOT" with a soapstone.
7. Know all the safety rules in working with machinery, shop materials and hand tools.
8. Know how to safely work with hazardous materials in your workplace (WHMIS).
9. Keep a well-stocked first aid kit handy.

[1] Safety information taken from: www.ccohs.ca/oshanswers/safety_haz/welding/ppe.html

## Safety Quiz

**Directions: Circle the best answer for each question. Only one answer is correct.**

1. Acceptable protective clothing for a welder is made from?

    a) Heavyweight and synthetic (e.g., nylon, polyester) material

    b) Lightweight and synthetic (e.g., nylon, polyester) material

    c) Heavyweight and natural (e.g., wool, cotton) material

    d) Lightweight and natural (e.g., wool, cotton) material

2. Which of the following is acceptable when welding?

    a) Wearing a short-sleeved t-shirt when welding in the summer

    b) Wearing running shoes while welding

    c) Wearing pants with cuffs

    d) Dressing in layers

3. While welding, something starts to go wrong and you are not sure what to do.

    You should:

    a) Keep working and just do what you feel is best in the situation.

    b) Go ask your supervisor for help.

    c) Ask one of your co-workers for help.

    d) Keep working and get your co-worker to go ask the supervisor.

4. Which of the following items can be worn while welding?

   a) Insulated gloves

   b) Jewelry

   c) A long-sleeve polyester shirt

   d) Pants with cuffs

**True or False: Write a "T" next to the true statements, "F" next to the false statements.**

5. The intensity of the light from arc welding is less than that from gas welding, cutting or brazing. ____

6. A welder's helmet is always essential when doing arc welding. ____

7. When dressing for work, it doesn't matter if a welder's clothes are clean as long as they have been approved for safety. _____

8. The best pants to wear when welding are long pants with cuffs. ____

9. Both insulated gloves and a heat resistant jacket are part of a welder's work clothing. ____

10. It's okay to weld in a small room with no windows. ____

11. You should always make sure to mark metal "HOT" with a soapstone. ____

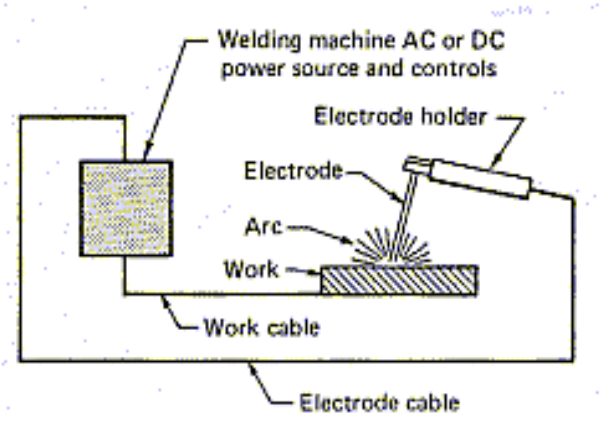
# Arc Welding

**Arc welding** refers to a group of welding processes that use a welding power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point. They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes. The welding region is sometimes protected by some type of inert or semi-inert gas, known as a shielding gas, and/or an evaporating filler material.

The following are arc welding processes that will be described in more detail later on in this package:

- Shielded Metal Arc Welding (SMAW)
- Gas Metal Arc Welding (GMAW)
- Gas Tungsten Arc Welding (GTAW)

**Basic Welding Circuit**[2]




[2] American Welding Society, Jefferson's Welding Encyclopedia, 18th Ed. Miami: American Welding Society, 1997.

**Shielding gases** are inert or semi-inert gases that are commonly used in several welding processes, such as gas metal arc welding (GMAW) and gas tungsten arc welding (GTAW). Their purpose is to protect the weld area from atmospheric gases, such as oxygen, nitrogen, carbon dioxide and water vapor. Depending on the materials being welded, these atmospheric gases can reduce the quality of the weld or make the welding process more difficult to use. Other arc welding processes use other methods of protecting the weld from the atmosphere as well. For example, shielded metal arc welding uses an electrode covered in a flux that produces carbon dioxide when consumed. (Carbon dioxide is a semi-inert gas that is an acceptable shielding gas for welding steel.)

## Welding Power Supply

A **welding power supply** is a device that provides an electrical current to perform welding. Welding usually requires high current (above 80 amps) and it can need above 12,000 amps in spot welding. Low current can also be used; welding two razor blades together at 5 amps with gas tungsten arc welding is a good example. A welding power supply can be as simple as a car battery and as sophisticated as a modern machine based on silicon controlled rectifier technology with additional logic to assist in the welding process.

## Arc Welding Equipment

### Electricity in welding machines

In welding, the relationship between voltage (the pressure) and amperage (the amount of electricity flowing) is most important. In arc welding, there are two voltages to be considered: (1) open circuit voltage (OCV) and (2) arc voltage (AV). OCV is the voltage that exists between the terminals of the welding machine when there is no welding being performed. It is approximately 70V to 80V. AV is the voltage between the electrode and the base metal during the actual welding operation (15V to 40V).

"CC" means constant current. These were the first welding machines. They are still used for SMAW and GTAW because a steady current (amperage) is very important in these processes. Another machine with constant voltage is called a constant voltage or constant potential (CV or CP) machine, which has a constant much lower OCV. With GMAW, constant voltage is essential.

**Here are the types of power sources that should be used in each process:**

| For These Processes | Use This Type of Power Source |
|---|---|
| SMAW (Shielded Metal Arc Welding) | CC AC/DC |
| GMAW (Gas Metal Arc Welding) | CV DC |
| GTAW (Gas Tungsten Arc Welding) | CC AC/DC |

## Electrode Identification

Because there are so many different types of electrodes, the American Welding Society (AWS) has established a numbering system that is used by the welding industry. The American Welding Society A-5.1 specification for mild and low alloy steel uses codes such as E6014, E10014 and E6011.

**The Canadian Standards Association** standard for mild and low alloy steel electrodes is W48-1M, which is almost the same as the American Welding Association A5.1 standard. The difference lies in the fact that the CSA uses SI metric and the AWS still uses the inch-pound system to indicate tensile strength of an electrode. The CSA uses megapascals (MPa). In the case of the E7024 electrode, 70,000 pounds per square inch translates into 480 000 MPa. Under the CSA specification, E7024 becomes E48024 but the requirements the electrode must meet are the same in both cases. [3]

[3] Welding 3rd edition, page 144.

This is how the numbers read:

1) The letter “E” indicates that the rod is for arc welding.

2) The next two numbers (if four numbers are used) or three numbers (if five digits are used) multiplied by 1000 indicate the tensile strength of the weld metal in psi. The next-to-last number indicates the position in which the electrode can be used. The position may be flat, horizontal, vertical or overhead.

3) A number 1 here would indicate that the electrode could be used in all of the positions. A number 2 would indicate that the electrode can only be used in the flat position

4) The last number indicates the electrical characteristics of the electrode, that is, AC, DC, and DC straight or reverse. This last number has become somewhat unreliable because of the type of electrodes used today.

An E7024 electrode, for instance, will have the following characteristics:

| | |
|---|---|
| E | - electrode (arc welding) |
| 70 | - multiplied by 1000 means 70,000 psi (pounds per square inch) tensile strength. |
| 2 | - flat position |
| 4 | - AC and DC (straight and reverse) |
| E7024 | |

## AWS/CSA CLASSIFICATION FOR SMAW ELECTRODES

| CSA W48-1 1984 | AWS A5.1 | Current/ Polarity | Coating Type | Application characteristics | Welding Position |
|---|---|---|---|---|---|
| E41010 | E6010 | DCRP | cellulose | For X-ray quality welds. Deep penetration, light slag | all |
| E41011 | E6011 | DCRP/DCSP AC | cellulose | Same as for E41010/E6010 but can also be used with AC | all |
| E41012 | E6012 | AC or DCSP | rutile | For general purpose work with poor fit up. Medium penetration and slag. | all |
| E41013 | E6013 | DCRP/DCSP AC | rutile | For good-quality general purpose work. Heavy slag, mild penetration. | all |
| E41014 | E6014 | DCRP/DCSP AC | rutile, iron powder | Similar to E41013/E6013. Mild penetration, heavy slag, smooth weld appearance. Can be dragged. | all |
| E41015 | E6015 | DCRP | low hydrogen | For low alloy and mild steels. Medium penetration. Glassy slag. | all |
| E41016 | E6016 | DCRP/DCSP AC | low hydrogen | As above for E41015/E6015 but can be used on AC. | all |
| E41018 | E6018 | DCRP or AC | low hydrogen | Excellent for low alloy and mild steel. Medium glassy slag, excellent penetration. | all |
| E41024 | E6024 | DCRP/DCSP AC | rutile, 50% iron powder | For extra weld metal deposition. Mild penetration, smooth weld appearance. Can be dragged. | flat welds, horizontal fillets |
| E41028 | E6028 | DCRP or AC | low hydrogen, 50% iron powder | Combination of low hydrogen and iron powder. Extra weld metal deposit. Can be dragged. Very smooth appearance in weld, heavy glassy slag. | horizontal fillets, flat welds |

The above table is only a sample. Check with your local electrode manufacturer or distributor who will supply complete information on all welding rods, usually in a pocket booklet.

# Arc Welding Quiz

**Directions: Fill in the Blanks with the appropriate words from the word bank.**

## Word Bank

| | | |
|---|---|---|
| Arc welding | Inch-pound | Weld position |
| Amperage | Open circuit voltage (OCV) | Protect |
| Alternating Voltage (AV) | Shielding | Voltage |
| Current | SI metric | |
| Electrical characteristics | Welding power supply | |

1.) _____ is a group of welding processes that use a welding power supply to create an electric arc.

2.) Gases used in GMAW and GTAW are called _____ gases.

3.) A _____ is a device that provides an electrical current to perform welding.

4.) In welding, the relationship between _____ (the pressure) and _____(the amount of electricity flowing) is most important.

5.) _____ is the voltage that exists between the terminals of the welding machine when there is no welding being performed.

6.) _____ is the voltage between the electrode and the base metal during the actual welding operation (15V to 40V).

7.) One of the causes of a poor welding arc may be low _____.

8.) The difference between the American Welding Societies classification and the Canadian Standard Associations is that _____ is used in the Canadian Association, and the American system uses the _____ system.

9.) Under the CSA specification, E48024 is an example of a classification. “E” stands for the arc welding rod, “480” stands for the tensile strength of the weld, the “2” stands for _____ , and the last number “4” stands for the _____.

10.) 10.) The purpose of shielding gases is to _____ the weld area from atmospheric gases, such as oxygen, nitrogen, carbon dioxide, and water vapor.

# Gas Tungsten Arc Welding

**Gas tungsten arc welding** (**GTAW**), commonly 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 by a shielding gas (usually an inert gas like argon) to keep its strength, and a filler metal is normally used. A constant-current welding power supply produces energy, which is conducted across the arc through a column of highly ionized gas and metal vapors known as plasma.

GTAW is most commonly used to weld thin sections of stainless steel and light metals, such as aluminum, magnesium and copper alloys. The process gives the welder 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 it is significantly slower than most other welding techniques.

**Filler Metals**

A filler metal is a metal added in the making of a joint through welding, brazing or soldering. Four types of filler metals exist. They are covered electrodes, bare electrode wire or rod, tubular electrode wire and welding fluxes. Sometimes, non-consumable electrodes are included as well, but since these metals are not consumed by the welding process, they are normally excluded.

Covered electrodes are used extensively in shielded metal arc welding and are a major factor in that method's popularity. Bare electrode wires are used in gas metal arc welding, and bare electrode rods are used in gas tungsten arc welding. Tubular electrode wire is used in flux-cored arc welding. Welding fluxes are used in submerged arc welding.

# Gas Tungsten Arc Welding Comprehension Questions

Directions: Study the section first, and then test yourself.

1) Are GTAW and TIG welding the same thing?

_____

2) A tungsten electrode is used to weld. Describe its characteristics.

_____

_____

3) What is GTAW most commonly used to weld?

_____

_____

4) What are two advantages of GTAW?

_____

_____

_____

5) What are the disadvantages?

_____

_____

_____

6) What is a filler metal?

_____

7) Name the four types of filler metals:

_____

_____

_____

_____

## Shielded Metal Arc Welding

**Shielded metal arc welding (SMAW)**, *also known as stick welding***,** is a manual arc welding process that uses a consumable electrode coated in flux to lay the weld. An electric current, in the form of either alternating current or direct current from a welding power supply, is used to form an electric arc between the electrode and the metals to be joined. As the weld is laid, the flux coating of the electrode disintegrates, giving off vapors that serve as a shielding gas and providing a layer of slag, both of which protect the weld area from atmospheric contamination.

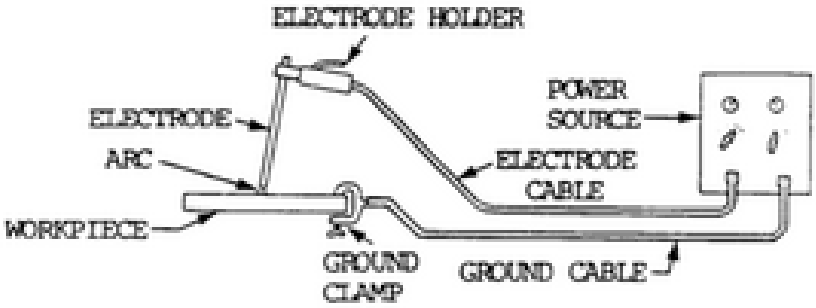
Because of the versatility of the process and the simplicity of its equipment and operation, shielded metal arc welding is one of the world's most popular welding processes. It dominates other welding processes in the maintenance and repair industry, and although flux-cored arc welding is growing in popularity, SMAW continues to be used extensively in the construction of steel structures and in industrial fabrication. The process is used primarily to weld iron and steels (including stainless steel), but aluminum, nickel and copper alloys can also be welded with this method.[4]

**Shielded Metal Arc Welding (SMAW)** is performed by striking an arc between a coated-metal electrode and the base metal. Once the arc has been established, the molten metal from the tip of the electrode flows together with the molten metal from the edges of the base metal to form a sound joint. This process is known as **fusion.** The coating from the electrode forms a covering over the weld deposit, shielding it from contamination. Therefore, the process is called **shielded metal arc welding.** The main advantage of shielded metal arc welding is that high-quality welds are made rapidly at a low cost.

[4] http://en.wikipedia.org/wiki/Shielded_metal_arc_welding

Shielded metal arc welding equipment typically consists of a constant current welding power supply and an electrode, with an electrode holder, a work clamp and welding cables (also known as welding leads) connecting the two.

**SMAW system setup**




**Various welding electrodes and an electrode holder**

**Basic Rules for SMAW**

*1)* Arc **L**ength: The distance between the tip of the electrode and the base metal being welded. *The correct distance must be kept.*

*2)* **A**ngle of electrode: During welding, *the electrode must be held at the correct angle.*

*3)* **S**peed of travel: If a good weld is to be made, *the correct speed must be kept.*

*4)* Amperage: *Incorrect amperage (**h**eat) will result in a poor weld.*

Some welders use the word “L-A-S-H” to remember these four points.

**Length – Angle – Speed – Heat (amperage)**

# Shielded Metal Arc Welding Quiz

1.) What are the advantages of SMAW?

_____

_____

2.) What is fusion?

_____

_____

3.) Why is SMAW the world's most popular welding process?

_____

_____

4.) What are the five pieces of equipment typically used in SMAW?

_____

_____

_____

_____

_____

5.) What do the letters "L-A-S-H" stand for?

L-_____

A-_____

S-_____

H-_____

# Metal Inert Gas / Gas Metal Arc Welding

**Gas metal arc welding (GMAW)**, also known as **metal inert gas (MIG) welding**, is a semi-automatic or automatic arc welding process in which a continuous and consumable wire electrode and a shielding gas are fed through a welding gun. A constant voltage, direct current power source is most commonly used with GMAW, but constant current systems, as well as alternating current, can be used. There are four primary methods of metal transfer in GMAW, each of which has distinct properties and corresponding advantages and limitations.

The four primary methods of metal transfer in GMAW are:

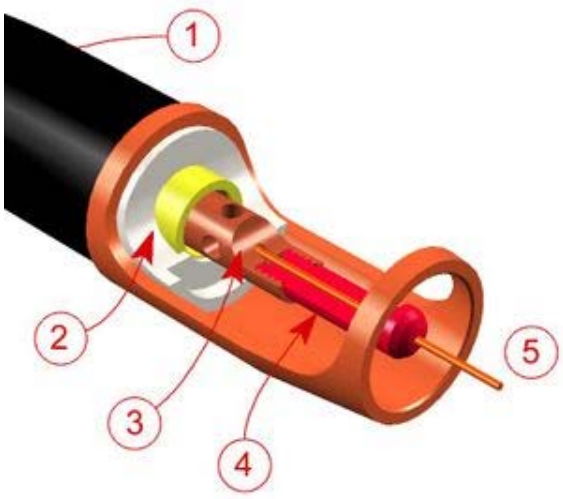
- Globular,
- short-circuiting,
- spray, and
- pulsed-spray

GMAW was applied to steels because it allowed for lower welding time as compared to other welding processes. Today, GMAW is commonly used in industries, such as the automobile industry, where it is preferred because it can be used in many different ways and it is quick.

## Gas Metal Arc Welding Equipment

### Welding gun and wire feed unit

(GMAW torch nozzle cutaway image)




**(1)** Torch handle,

**(2)** Moulded phenolic dielectric (shown in white) and threaded metal nut insert (yellow)

**(3)** Shielded gas nozzle

**(4)** Contact tip

**(5)** Nozzle output face

### A GMAW wire feed unit

# MIG/GMAW Quiz

1.) Explain the differences between SMAW and MIG welding.

_____

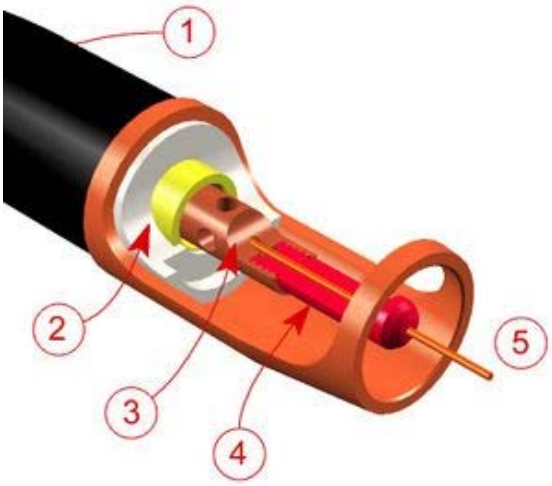
_____

_____

_____

_____

2.) Name the parts of the welding gun:




(1)_____

(2)_____

(3)_____

(4)_____

(5)_____

3.) Why is GMAW preferred in the automobile industry?

_____

_____

# Answer Key

**Welding Vocabulary Crossword** (page 10)

Across: 7. Iron 8. Abrasive 10. Argon 11. Cylinder 12. Ferrous 14. Alloy 15. Flux

Down: 1. Radiation 2. Plasma 3. Fixture 4. Tungsten 5. Forge 6. Ventilate 9. Weld 13. Oxyfuel

**Safety Quiz**: (page 15)

1. C, 2. D, 3.B 4.A 5. F 6.T 7.F 8.F 9.T 10.F 11.T

**Arc Welding Quiz (**page 23)

1. Arc welding
2. Shielding
3. Welding power supply
4. Voltage, amperage
5. Open circuit voltage
6. Alternating voltage
7. Current
8. SI metric, inch-pound (Standard)
9. Welding position, electrical characteristics
10. Protect

**Gas Tungsten Arc Welding Comprehension Questions** (page 26)

1. Yes
2. A very hard, heavy steel gray metal rod is used to weld.

3. A thin stainless steel and light metals
4. The process gives the welder greater control over the weld and it is also a stronger, higher quality weld.
5. It is more complex and difficult to master, and it is significantly slower.
6. A metal added in the making of a joint through welding, brazing or soldering
7. Name the four types of filler metals: covered electrodes, bare electrode wire or rod, tubular electrode wire and welding fluxes

**Shielded Metal Arc Welding Quiz** (page 29)

1. High-quality welds are made rapidly at a low cost.
2. Fusion is the molten metal from the tip of the electrode flowing together with the molten metal from the edges of the base metal to form a sound joint.
3. Because of the versatility of the process and the simplicity of its equipment and operation
4. A constant current welding power supply, an electrode, an electrode holder, a work clamp, and welding cables (also known as welding leads)
5. Length – Angle – Speed – Heat (amperage)

**MIG/GMAW Quiz** (page 32)

1. In GMAW, an inert gas is used to shield the weld; in SMAW, the weld is shielded by a flux coating. In GMAW, a wire is fed through a welding gun. A constant voltage (DC power source) is used.
2. **(1)** Torch handle **(2)** Moulded phenolic dielectric (shown in white) and threaded metal nut insert (yellow) **(3)** Shielding gas nozzle **(4)** Contact tip and the **(5)** Nozzle output face
3. Because it can be used in many different ways and it is quick

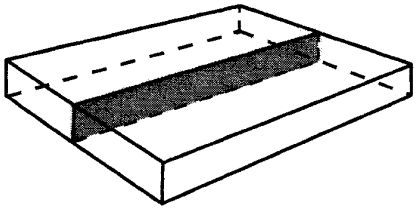
# References

Wikipedia: Welding, Retrieved Oct. 12, 2006 from www.en.wikipedia.org/wiki/Welding

American Welding Society. Jefferson's Welding Encyclopedia, 18th Ed. Miami: American Welding Society, 1997.

# Appendix 1[5]

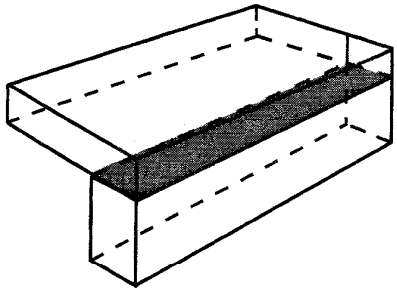
## Types of Weld Joints



(A) BUTT JOINT

APPLICABLE WELDS

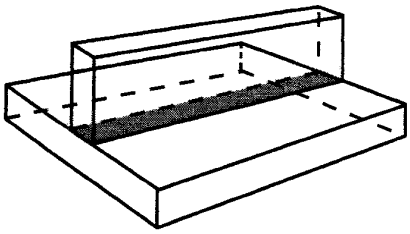
| | |
|---|---|
| BEVEL-GROOVE | U-GROOVE |
| FLARE-BEVEL-GROOVE | V-GROOVE |
| FLARE-V-GROOVE | EDGE-FLANGE |
| J-GROOVE | BRAZE |
| SQUARE-GROOVE | |



(B) CORNER JOINT

APPLICABLE WELDS

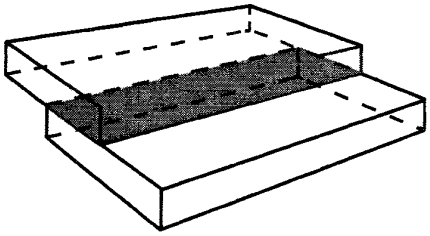
| | |
|---|---|
| FILLET | V-GROOVE |
| BEVEL-GROOVE | PLUG |
| FLARE-BEVEL-GROOVE | SLOT |
| FLARE-V-GROOVE | SPOT |
| J-GROOVE | SEAM |
| SQUARE-GROOVE | PROJECTION |
| U-GROOVE | BRAZE |



(C) T-JOINT

APPLICABLE WELDS

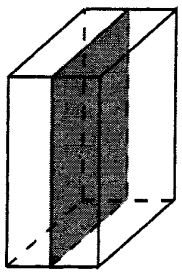
| | |
|---|---|
| FILLET | SLOT |
| BEVEL-GROOVE | SPOT |
| FLARE-BEVEL-GROOVE | SEAM |
| J-GROOVE | PROJECTION |
| SQUARE-GROOVE | BRAZE |
| PLUG | |



(D) LAP JOINT

APPLICABLE WELDS

| | |
|---|---|
| FILLET | SLOT |
| BEVEL-GROOVE | SPOT |
| FLARE-BEVEL-GROOVE | SEAM |
| J-GROOVE | PROJECTION |
| PLUG | BRAZE |



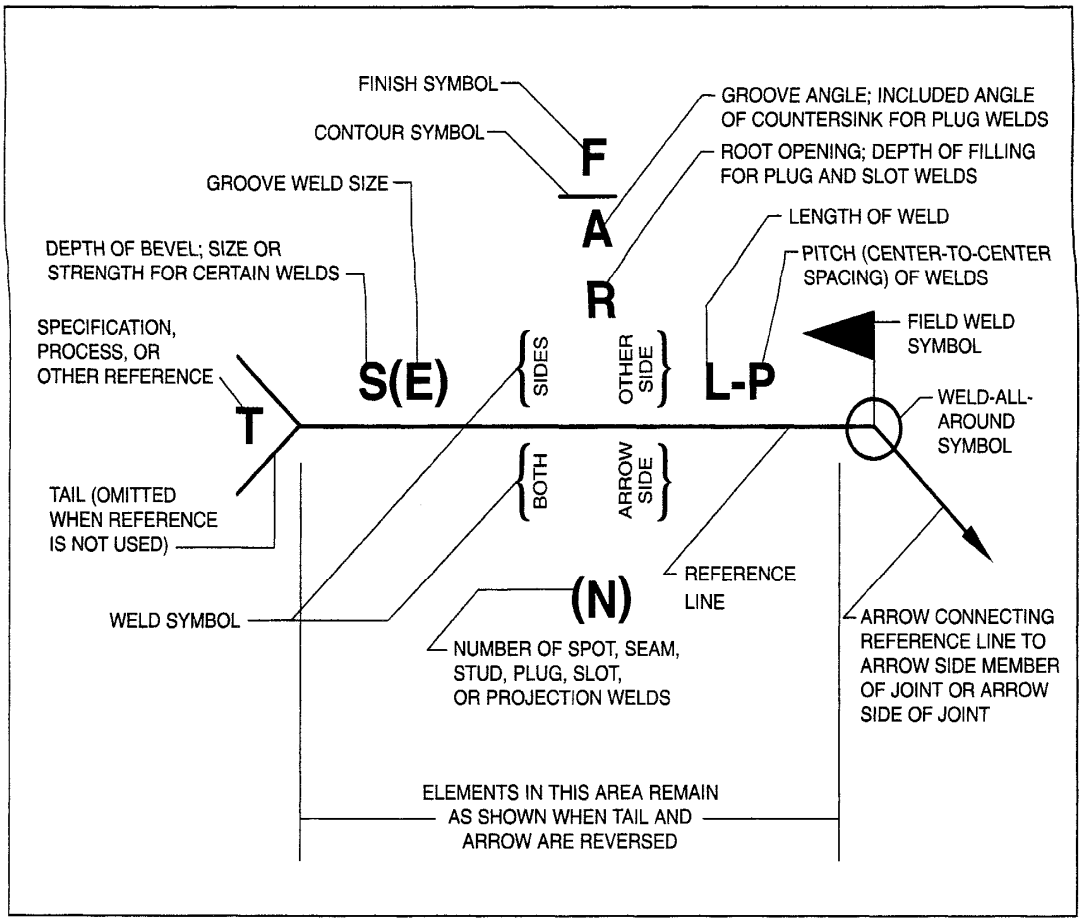
(E) EDGE JOINT

APPLICABLE WELDS

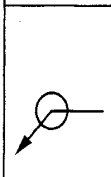
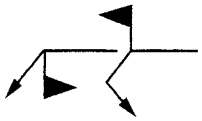
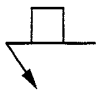
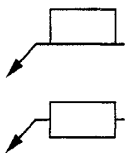
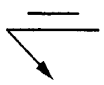
| | |
|---|---|
| BEVEL-GROOVE | U-GROOVE |
| FLARE-BEVEL-GROOVE | V-GROOVE |
| FLARE-V-GROOVE | EDGE |
| J-GROOVE | SEAM |
| SQUARE-GROOVE | |

[5] Ibid.

# Appendix 2[6]




**Standard Location of Elements of a Welding Symbol**

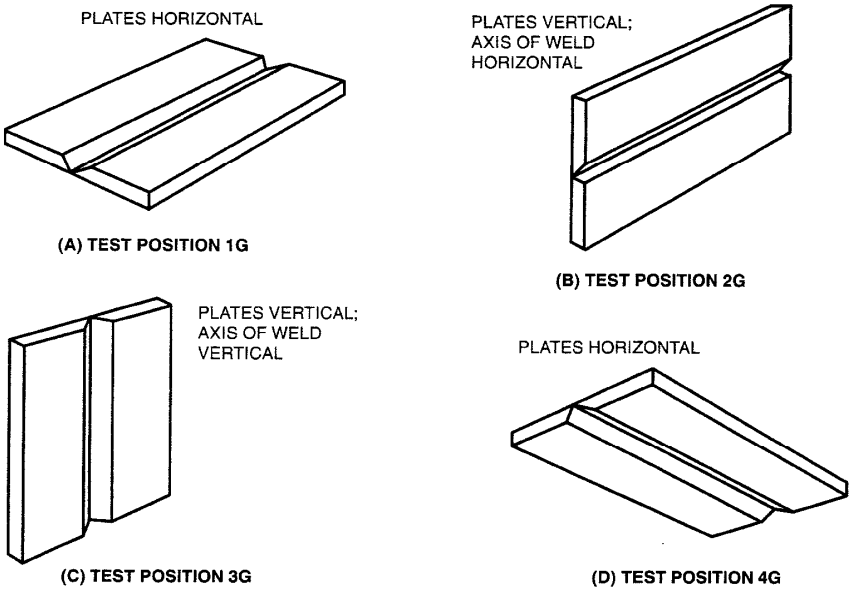
| WELD ALL AROUND | FIELD WELD | MELT THROUGH | CONSUMABLE INSERT (SQUARE) | BACKING OR SPACER (RECTANGLE) | CONTOUR | | |
|---|---|---|---|---|---|---|---|
| | | | | | FLUSH OR FLAT | CONVEX | CONCAVE |
|  |  |  |  |  |  |  |  |

**Supplementary Symbols**

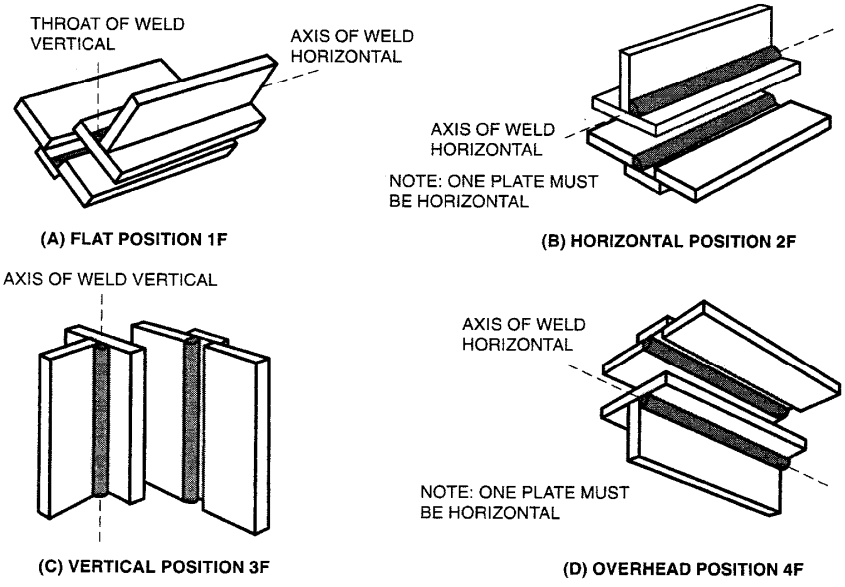
[6] Ibid.

# Appendix 3[7]

## Welding Test Positions




**Positions for Test Plates for Groove Welds**




**Positions of Test Plates for Fillet Welds**

Updated: August 2008

[7] Ibid.