Helpful Hints to Basic Welding

Foreword

This pamphlet, and all the information within, is to provide you with helpful hints for basic welding. This is not a comprehensive manual, nor does it contain the scope of information needed for commercial or industrial welding purposes.

If you are not familiar with the safety practices, procedures and techniques of basic welding, you will need additional reading material and/or enrol in a basic welding course.

For any welding that involves the protection of life, limb or property, always seek the services of a competent certified professional welder.

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Everyday Welding Applications

Welding is an efficient way to cut down on maintenance or repair costs associated with metal equipment around the house or farm. Through welding, you can repair a vast number of items and equipment including:

Agriculture
- Balers
- Combines
- Farm equipment frames
- Galvanised roofing
- Grain wagons
- Tractors and trailers
- Trailer frames and sides
- Trailer hitches

Automotive
- Auto bodies and door brackets
- Bumpers
- Motorcycles
- Tailpipes
- Trailer hitches

Home Improvement
- Ductwork
- Fencing
- Garage door tracks and brackets
- Lawnmower decks and handles
- Steel patio furniture
- Wheelbarrows

Recreation
- Basketball rims
- Bicycles and tricycles
- Snowmobile skis and skags
- Swing sets
- Trampolines
- Wagons

Welding Safety

Please note welding is serious business! Make sure you take proper precaution and protect yourself. A few important safety tips can be found below:

Always wear protective clothing!

Wear a heavy cotton shirt, cuff less trousers, high shoes and a cap to protect yourself while welding or removing slag.

Always wear a welding helmet with visor shade!

Arc rays from the welding process produce intense visible and invisible (ultraviolet and infrared) rays that can burn eye and skin.
NEVER WELD WITHOUT PROPER EYE PROTECTION.

Always wear safety glasses!

Wear safety glasses with side shields to protect your eyes while welding and removing slag.
NEVER WELD WITHOUT PROPER EYE PROTECTION.

Always wear leather welding gloves!

Wear gloves to protect your hands and wrists from hot sparks and radiation burns while welding and removing slag.

Weld in a well-ventilated area, as fumes and gases can be hazardous and injurious to health!

Welding may produce fumes and gases that can make you ill. Be sure to keep your head out of the fumes - do not breathe the fumes!

Keep weld area free of flammables!

Move paint, solvent, gasoline, paper products and other flammables away from the weld area so they will not catch fire from sparks and hot slag.

Welding Safety

Protect Others!

Set up protective screens or barriers to protect other persons from flash and glare; warn others not to watch they arc.

When welding small parts, do not weld on the garage floor or driveway, use a welding table!

The heat generated by the electric arc can cause cement to explode or set asphalt on fire.

Do not weld on tanks or containers that previously held flammable materials!

Even though it may be empty, a tank or container that previously held a flammable material may still contain combustible vapours or residue that can result in an explosion.

Be familiar with your welding equipment!

Understanding how to properly operate welding equipment protects you from harm and your equipment from damage.

Stick or Wire

There are several different processes that are ideal for projects around the house or farm:

- **Stick Welding -** Also known as SMAW (Shielded Metal Arc Welding)
- **Wire Welding -** Also known as FCAW (Flux-cored Arc Welding) or GMAW (Gas Metal Arc Welding).

All these processes involve the joining of metals by means of an electric arc. This electric arc, at a temperature of about 5500ºC, melts both the metal electrode and the metal being welded (The Base Metal) together, producing a molten weld puddle that quickly solidifies upon cooling to form the weld.

Inspire of the fact that these processes depend on the use of an electric arc, they differ in technique, including the type of electrode and equipment required. Stick welding is a manual arc welding process in which stick electrode is used as the filler metal for making the weld. Wire welding is considered as a semi-automatic process, using a wire electrode that's conveniently fed through a welding gun.

Stick welding requires you to have be more skilled because you have to consistently focus on the electrodes while you are welding, keeping it in the proper welding position and manually maintaining the proper arc length as the electrode gets shorter.

Wire welding is somewhat easier than stick welding because the welding gun continuously feeds the wire while you weld, allowing you to focus on gun position for maintaining the proper arc length. Additionally, you don't have to worry about the electrode getting shorter.

Whether you prefer stick welding or wire welding, the welding process you use is most likely the one you have the most experience with or have the equipment for.

Stick welding (Also known as Shielded Metal Arc Welding or SMAW) requires use of a covered stick electrode, a metal rod that's coated with a material called flux. An electrode holder is used to hold and supply current to the stick electrode, causing it to melt and deposit molten metal. As the electrode melts, the flux coating breaks down to perform several functions:

1) Form a gas shielding to protect the weld puddle from the air.

2) Keep the weld puddle clean from contaminants.

3) Produce a protective coating, called slag, over the weld. The slag can be removed by tapping the weld with a chipping hammerer chisel and cleaned off with a wire brush.

Equipment and tools

In stick welding, the equipment and tools that are required are:

1) Power source welding machine – complete with welding cable, electrode holder and ground cable and clamp.

2) Chipping hammer or chisel, and a wire brush (for removing slag)

3) Protective clothing including helmet and gloves

Techniques

To produce a good quality weld, it is important to master the following stick welding techniques. The first thing you should do before you start welding is make sure the workpiece – the item you are welding – is as clean as possible. Use a clean cloth, wire brush or sandpaper to remove any rust, dirt, paint, grease, oil or other contaminant. Do not use cleaning solvents because you can run the risk of an explosion or fire, or illness from toxic vapours.

Setting the amperage

Select the proper amperage based on the specifications of the stick electrode. Sometimes, you may find that you have to adjust the setting so that the electrode melts properly. The best way to check this is by performing some test welds on some scrap metal. If you notice that the weld is...

1) Piling up or you see signs of burn-through (holes in the base metal), then the amperage is probably set too high;

2) Not penetrating the joint (little depth) or not fusing to the workpiece (doesn't cover joint walls) properly, then the amperage is probably set too low.

Striking an Arc

To strike an electric arc, bring the tip of the stick electrode near where you want to start the weld. Almost like striking a match, strike the stick electrode slightly across the workpiece until you have established an arc. Once you have an arc, be sure to keep the electrode slightly above the workpiece, otherwise it will stick and you will have to break the electrode free of the workpiece. If you have trouble striking an arc, you may be lifting the electrode too high off of the workpiece, causing the arc to go out.
The most important thing you want to do after you've initiated the arc is to maintain proper position of the electrode and arc. This involves three key factors, namely:

1) Arc length
2) Electrode angles
3) Travel speed

Arc Length

Maintaining the proper arc length is another key factor in producing a good quality weld. The arc length is the distance from the end of the stick electrode to the surface of the molten weld puddle. Be careful to watch the stick electrode as you weld because as it becomes shorter and shorter, you have to keep moving the electrode toward the weld joint to maintain the proper arc length. A good rule of thumb to follow is: try to keep the end of the electrode at a distance from the joint that's approximately equal to the diameter of the stick electrode.

For example, if the stick electrode you are using is 3.2mm (1/8") in diameter, then keep the end of the electrode about 3.2mm (1/8") from the molten weld puddle. Keep in mind that an arc length that is too long makes a coarse, uneven cracking sound that will often go out. You will also see an excessive amount of spatter (metal particles outside the weld) and the weld will be too wide. A short arc makes a soft buzzing noise and produces a weld that is too narrow. In some cases, the stick electrode will stick to the workpiece. If this happens, move the stick electrode side to side and pull it to free it from the workpiece.

Electrode Angles

Electrode angles are the angles at which you should hold the stick electrode in relation to the workpiece while welding. These angles differ depending on the type of weld you intend to make. For instance, when doing a lap weld (one piece of metal overlaps another) or a T-weld (joining two metals to form a 'T'), hold the electrode so that it points into the weld joint at an angle of 45°. When you start welding, angle it 10-15° toward the direction of travel until you complete the weld and terminate the arc. For butt weld (joining two pieces of metal butted together), first hold the electrode so that it is pointing into the joint of the workpiece at an angle of 90°. Then, as you start welding, angle the electrode so that it is pointing 10-15° in the direction of travel. When completing the weld, bring the electrode back to 90° and lift it to terminate the arc.

Travel Speed

Travel speed is the rate at which you weld. A good travel speed produces a uniform weld that is slightly convex in appearance. However, if you travel too slow, the weld will pile up, wasting filler metal. If you go too fast, the weld will be narrow and lack proper penetration and fusion.

7 Factors to Consider in Selecting Arc Welding Electrodes

1) **Base Metal Composition** - Know and match composition. Mild steel – any E-60XX or E-70XX electrode is satisfactory. Low alloy steel – select electrode that most closely matches base metal composition.

2) **Base Metal Strength Properties** - Know and match mechanical properties. Mild steel – generally E-60XX or E-70XX electrodes match base metal. Low alloy steel – select electrodes that match base metal properties.

3) **Joint Design and Fit-up** - Select for penetration characteristic – digging, medium, or light. No beveling or tight fit-up – use digging. Thin material or wide root opening – light, soft arc.

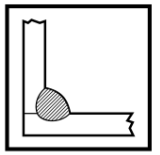
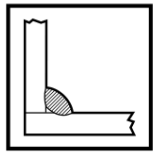
4) **Service Condition and/or Specifications** - Determine service conditions – low temperature, high temperature, shock loading – match base metal composition, ductility and impact resistance. Use low hydrogen process. Also, check welding procedure or specification for electrode type.

5) **Thickness and Shape of Base Metal** - To avoid weld cracking on thick and heavy material of complicated design, select electrode with maximum ductility. Low hydrogen processes or electrodes are recommended.

6) **Welding Current** - Match the power supply available. Some electrodes are designed for direct current (DC); others, alternating current (AC); some, either. Observe correct polarity.

7) **Welding Position** - Match electrode to welding position encountered.

Examples of good and bad stick welds

Good Weld Proper voltage and travel speed.	Bad Weld Welding current too low.	Bad Weld Welding current too high.
		
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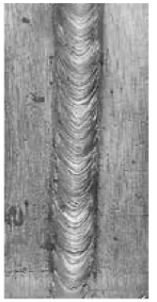
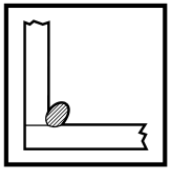
		
Weld Face	Weld Face	Weld Face
Smooth and well-informed.	**Narrow and convex.**	**Wide and flat with excessive spatter.**
Uniform contour.	**Irregular contour.**	**Very irregular contour.**
Good penetration And fusion.	**Poor penetration And fusion.**	**Undercutting along edges.**

Bad Weld travel speed too fast.



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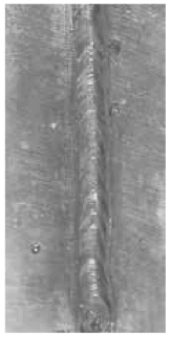


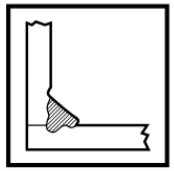
Weld Face

Narrow and convex.

Irregular contour.

Poor penetration and fusion.

Bad Weld travel speed too slow.



CROSS-SECTION

Weld Face

Wide and flat with excessive spatter.

Very irregular contour.

Undercutting along edges.

A Quick Review

Wire welding is a semi-automatic process in which a continuous wire electrode is automatically fed through a welding gun. By simply positioning the gun near the workpiece and depressing the trigger, you can initiate an arc and maintain the automatic feeding of the wire electrode while you weld until you release the trigger.

Among the many types of wire electrodes available on the market, the two best suited for home and farm welding are solid wire electrodes and flux-cored wire electrodes. If you use a solid wire electrode, then you are doing what is known as MIG welding (also known as gas metal arc welding or GMAW).

If you use a flux-cored wire electrode, then you are doing flux-cored welding (also called flux-cored arc welding or FCAW).

Wire Electrodes

A solid wire electrode, like blume® ER70S-6, requires use of a shielding gas to protect the molten weld puddle from impurities in the atmosphere, namely oxygen and nitrogen. As a result, no slag is produced. Common shielding gases for solid wire applications include 100% CO_2, (carbon dioxide) and 75% Ar/25% CO_2 (75% argon and 25% carbon dioxide).

Any impurities in the weld are brought to the weld surface in the form of a thin covering called slag which can be removed with either a chipping hammer or chisel and cleaned off with a
wire brush.

**Flux-cored wires that do not require shielding gas are called self-shielded wires; however, there are flux-cored wires that do not require use of a shielding gas, but these are primarily used for industrial applications in which the shielding gas helps the weld metal attain certain characteristics.*

Equipment and tools

In wire welding the tools that are required are:

1) Power source welding machine – complete with welding gun and gun cable assembly; automatic wire feeder and control system; and ground cable and clamp

2) Shielding gas system* that consists of a gas cylinder, regulator, flowmeter and gas hose.

3) Wire cutters, chipping hammer or chisel, and wire brush

4) Proper clothing including helmet and gloves

Techniques

To produce a good quality weld, it is important to master the following wire welding techniques. However, before starting any welding project, make sure the workpiece – the item you are welding – is as clean as possible. Use a clean cloth, wire brush or sandpaper to remove rust, dirt, paint, grease, oil or any other contaminant. Do not use cleaning solvents because you run the risk of an explosion or fire, or illness from toxic vapours.

Wire Polarity

Be sure to check the wire manufacturer's instructions for wire polarity and set the power source accordingly. If the power source is not set for the proper polarity, you may end up with a poor quality weld.

Wire Feed Speed and Voltage

Select the proper wire feed speed (amperage) and voltage based on the specifications of your wire electrode. Sometimes, you may need to adjust the settings. The best way to check wire feed speed and voltage settings is by performing some test welds on scrap metal.

Be sure that you...

do not use wire feed speed that is set too fast as it will cause too much metal to be deposited, wasting filler metal or resulting in possible burn-through;

do not use wire feed speed that is set too low because it will produce a weld that doesn't penetrate or fill the joint properly and may cause the wire to "burn back" or melt at the tip;

do not use voltage that is too high because it will create a flatter, wider weld bead that is porous, plus excessive spatter. In addition, high voltage can cause undercutting, a groove melted into the workpiece that doesn't get properly filled with weld metal;

do not use voltage that is set too low or the weld bead will be narrow and lack proper penetration and fusion.

Initiating an Arc

To initiate an arc, simply position the gun close to the weld joint and depress the trigger.

Once the arc is initiated, pay close attention to the following key factors in achieving a good quality weld:

- electrode angles
- electrode stick-out
- travel speed
- welding gun manipulation

Electrode Angles

In wire welding, you want to be sure that you properly position the wire electrode over the weld joint for maximum coverage. This involves paying special attention to the work angle and the travel angle.

The *work angle* is the angle at which the wire is pointing at the weld joint. For lap and T-welds, the work angle is 45°, for butt welds, it is 90°.

The *travel angle* is the angle of the wire as it travels along the weld path. For most wire welding applications, this angle is 15-30°. For home and farm welding applications, the travel angle most commonly used is called a *drag angle*, when the electrode is pointing in a direction that's opposite the arc travel.

Electrode Stick-Out

Electrode stick-out is the length of unmelted wire coming out of the contact tip of the welding gun. It affects the amount of amperage drawn by the wire and is important because it can affect the outcome of your weld. Determining how much stick-out to use depends on the diameter size of your wire. For instance, a good guideline to follow is: for 0.6mm (.024") and 0.8mm (.030") wire, use 9.5mm - 12.5mm (3/8"-1/2") stick-out; for 0.9mm (.035") and 1.2mm (.045") wire, use 12.5mm - 16mm (1/2"-5/8").

You can make slight adjustments to the stick-out to "fine-tune" the amperage for the result you want. For instance, by lengthening the stick-out, you slightly decrease the amperage; by shortening the stick-out, you slightly increase the amperage.

Travel Speed

Travel speed is the rate at which you weld. As you weld, watch the molten weld puddle and listen to the arc for evidence of traveling too fast or too slow. Moving at a high travel speed or too fast causes insufficient penetration, plus you'll hear popping sounds as the wire comes into contact with the cold metal just ahead of the puddle. Welding at low travel speeds, or moving too slow, will cause the weld metal to pile up, resulting in poor fusion.

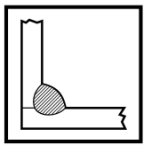
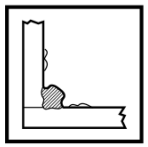
Welding Gun Manipulation

How you manipulate the welding gun, therefore the electrode, is another key factor in producing a good quality weld.

For lap and T-welds, manipulating the gun to create a series of small ovals provides good welding coverage. Be careful not to move too far back into the weld puddle or else fusion problems may occur.

For butt joints, manipulate the gun so that the electrode moves in a 'Z' pattern while traveling along the workpiece. This pattern is most effective because it produces a flatter weld, spreading the molten weld puddle evenly across the joint.

Examples of good and bad wire welds

Good weld proper wire feed speed, voltage and travel speed.	Bad weld wire feed speed too low.	Bad weld wire feed speed too high.
		
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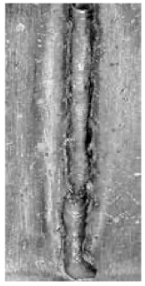
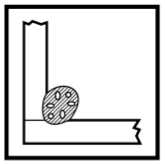
		
Weld Face	Weld Face	Weld Face
Smooth and well-informed.	**Wide and flat with excessive spatter.**	**Narrow and convex**
Uniform contour.	**Very irregular contour.**	**Irregular contour**
Good penetration and fusion.	**Undercutting along edges.**	**Slag may be difficult to remove**

Bad Weld travel speed too fast.	Bad Weld travel speed too slow.
	
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	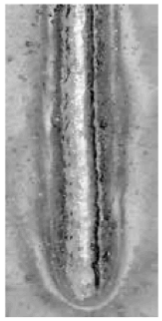
Weld Face	Weld Face
Narrow and convex.	**Excessively wide and flat with spatter.**
Irregular contour.	**Irregular contour.**
Extremely porous.	**Poor penetration Along edges.**

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