SMAW

(Stick Welding)

SMAW Unit Topics

During this overview, we will discuss the following topics:

- Safety
- SMAW Basics
- Equipment Set-Up
- Welding Variables
- Process Advantages and Limitations
- AWS Connection
- National Academic Standards Connection

The SMAW process is great for maintenance and repair work!

Unit Objectives

- Upon successful completion of the SMAW Unit of Study, you will have learned to:
  - Properly protect yourself and others while welding
  - Set up and operate SMAW equipment
  - Strike and maintain an arc
  - Make welds in four positions using different electrodes
  - Understand a weld inspection process
  - Apply the AWS electrode classification system
  - Take the next step to becoming a certified welder

Most structural steel welders are required to be certified

SMAW Safety

- ‘SMAW Safety’ is supplemental and does not replace the information found in ‘Arc Welding Basics’
- Understand and follow all safety precautions listed in ‘Safety in Welding, Cutting, and Allied Processes’ (ANSI Z49.1) and Arc Welding Safety (E205)
- Understand and follow all warning labels found:
  - On welding equipment
  - With all consumable packaging
  - Within instruction manuals
- Read Material Safety Data Sheets (MSDS)

SMAW Safety

- **Fumes and Gases** can be dangerous
  - Keep your head out of the fumes
  - Use enough ventilation, exhaust at the arc, or both, to keep fumes and gases from your breathing zone and the general area
  - The SMAW process can withstand wind and exhaust near the arc from ventilation equipment
- **Electric Shock** can kill – to receive a shock your body must touch the electrode and work or ground at the same time
  - Do not touch the electrode or metal parts of the electrode holder with skin or wet clothing
  - Keep dry insulation between your body and the metal being welded or ground
- **Arc Rays** can injure eyes and skin - Choose correct filter shade (See chart below)

Table 1
Guide for Shade Numbers

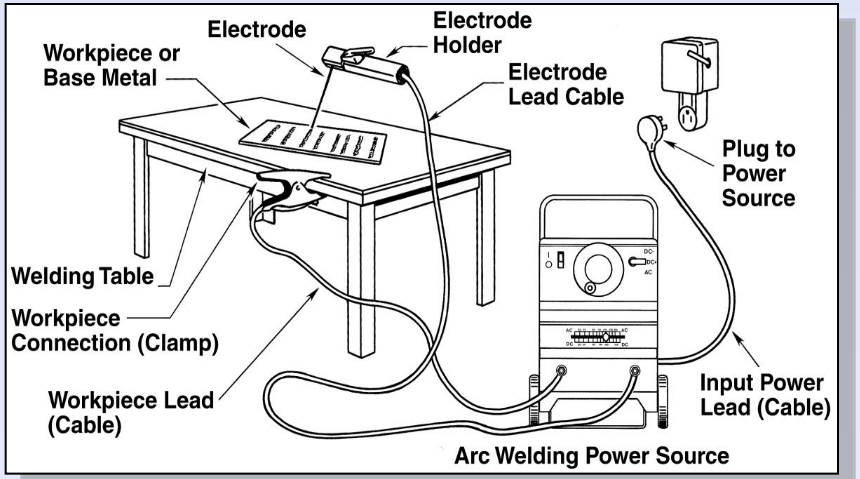
Operation	Electrode Size 1/32 in. (mm)	Arc Current (A)	Minimum Protective Shade	Suggested* Shade No. (Comfort)
Shielded metal arc welding	Less than 3 (2.5)	Less than 60	7	
	3—5 (2.5—4)	60—160	8	10
	5—8 (4—6.4)	160—250	10	12
	More than 8 (6.4)	250—550	11	14

** Information taken from ANSI Z49.1:2005**

*As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to a lighter shade which gives sufficient view of the weld zone without going below the minimum. In oxyfuel gas welding or cutting where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the (spectrum) operation.
**These values apply where the actual arc is clearly seen. Experience has shown that lighter filters may be used when the arc is hidden by the workpiece.

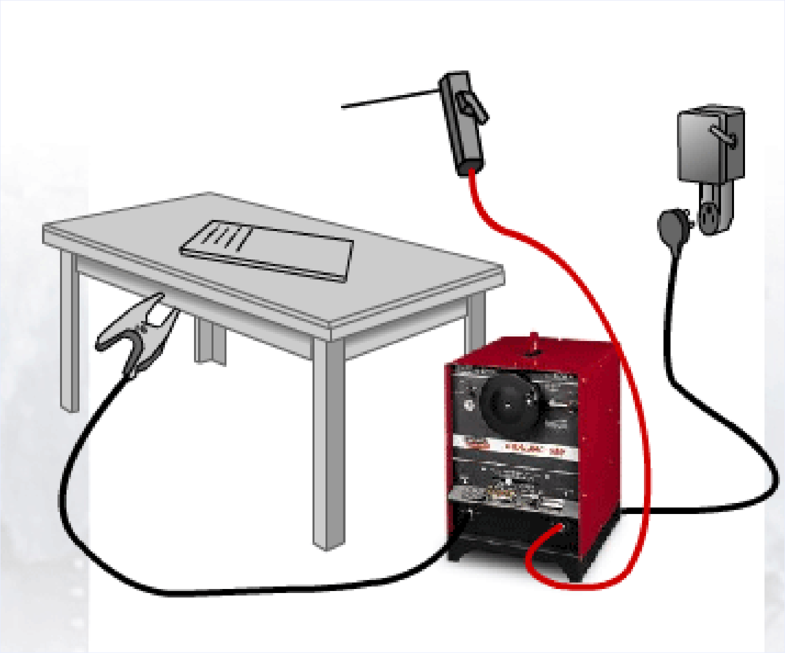
SMAW Principles

- The American Welding Society defines SMAW as Shielded Metal Arc Welding
- SMAW:
  - Is commonly known as 'Stick' welding or manual arc welding
  - Is the most widely used arc welding process in the world
  - Can be used to weld most common metals and alloys



SMAW Welding Circuit

- Current flows through the electrode cable, to the electrode holder, through the electrode, and across the arc
- On the work side of the arc, the current flows through the base material to the work clamp and back to the welding machine



Welding Polarities

WELDING POLARITIES

AC- ALTERNATING CURRENT

50% IN PLATE, 50% IN ELECTRODE HOLDER

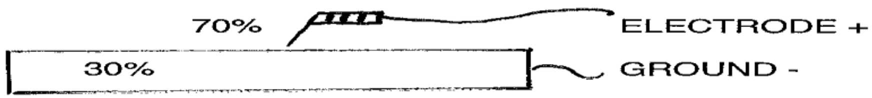
AC

DCRP- DIRECT CURRENT REVERSE POLARITY

30% IN PLATE 70% IN ELECTRODE HOLDER

RESULTS IN DEEP PENETRATION

DCRP



DCSP- DIRECT CURRENT STRAIGHT POLARITY

70% IN PLATE 30% IN ELECTRODE HOLDER

RESULTS IN LIGHT PENETRATION

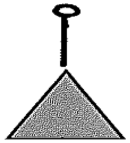
DCSP

— DCSP

AC

\+ DCRP

POLARITY SWITCH



Welding Positions and Passes

There are four positions for welding plates.

1. Flat
2. Horizontal
3. Vertical
4. Overhead

F-indicates fillet

G. Indicates groove

There are four different weld passes

1. Root-first pass
2. Hot-second pass
3. Filler-Fill joint
4. Cover-last pass

Root Pass

A lot of technical information has been written on the **root pass**. But for a beginner, it can be difficult to digest. Hopefully, we can boil it down to the basics. Most welds, whether MIG, TIG or Stick are made in multiple passes, particularly when the metal is over ¼" thick. Even on 1/8" to 3/16" metal two passes may be a good idea. The first pass is called the "root" pass. It anchors and supports all the other welds. In truth, in many cases the root weld may end up only a few thousandths thick after proper cleaning and grinding takes place, but it does serve as a foundation for the other welds.

A **root pass** is made on beveled material, or in filet welds to achieve 100% fusion without having to weld both sides. A proper root weld will actually melt through the other side, forming a bead on the backside of the weld. It should more or less resemble the front side of the weld in appearance. Typically it will not be as wide on the backside of the weld as the front, but the width of the bead on the backside should be consistent. Usually, it is performed with an ER 6010 or an ER 6011, which offer great penetration to achieve the fusion needed. However, these welding rods are somewhat difficult to manage, and create problems with cleaning up the welds. In this case a grinder may even be used to erase some of the root weld to make sure the slag is completely gone.

Hot Pass

Whenever your root (first) pass doesn't go just as it should, a **hot pass** may be in order. A person that is afraid of welding too hot with the **root pass** and blowing out the bottom of the key hole, the tendency is to run too cold and a convex weld will result. The toes will be incompletely fused or slag may be trapped in the sides of the weld.

The Hot pass is a technique which helps resurface the root pass, and make it usable without a lot of grinding and clean -up of the weld. Some welders employ the hot pass over the root pass every time, whether it needs it or not, which typically won't hurt anything if it is done correctly. A hot pass should not be blistering hot. Rather it should be just a few amps over the root pass. It should use enough amps though to melt out the top of the root pass and reshape the convex weld into a concave one, where the sides of the weld flow down toward the center of the weld, and where they weld is smooth on the surface.

Hot Pass

With the hot pass, though, too much amperage is a danger because it will create a Heat Affected Zone in the root of the weld. Carrying too much heat into the root will cause the weld to become brittle and will be a breaking point when stress is applied. A hot pass should be rapid, and just enough metal should be deposited to dish the weld sides out, making it concave.Applying to much weld metal only creates another full pass, which may be run too hot. The idea of the hot pass includes helping to push out root passes that may have some suck back, because as the weld progresses, a true hot pass makes the thin root pass become molten again, and sink down. This sinking down actually forces the bottom of the root pass out a little further.

A hot pass can be made with MIG TIG or Stick. With MIG, the wire speed may be left alone, and the volts bumped up. With stick a change of 10-20% amperage is all that is needed, along with using a 7018 on top of the 6010 root pass. With TIG the hot pass is likely the easiest to do, since the amount of filler metal can be controlled precisely. There is a school of thought that teaches the hot pass should only be done at a minimally higher temperature, if any change at all is done, and they refer to the hot pass as “cooking”. But true cooking is simply going over the top passes at a high rate of speed, at a high amperage just to improve weld appearance without adding much if any filler metal. When used properly the Hot pass will salvage a bad weld, and not create more harm than it does good.

Fill Pass

Also referred to as a fill, it is the amount of weld bead necessary to fill the weld joint. This pass comes after the root pass and before the cap/cover pass. In some applications, multiple fill passes are necessary.

Cover Pass

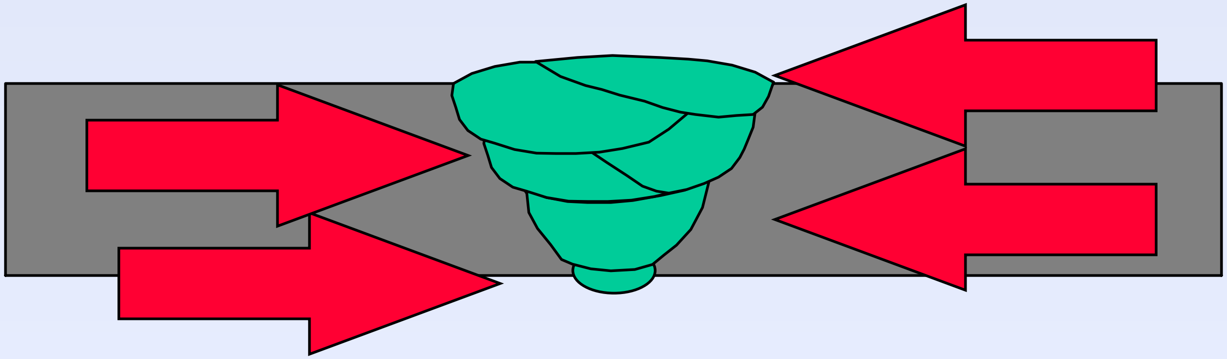
The cover pass or cap is the final pass, but it may be necessary to make more then one cover pass. The next slide shows and example of the 4 passes.

Fill Pass

Cover Pass

Root Pass

Hot Pass



Welding Definitions

- **Overlap**-The protrusion of weld metal beyond the weld toe or weld root
- **Undercut**- A groove melted into the base metal at the **weld** toe or **weld** root that is left unfilled by **weld** metal.
- **Slag inclusions**-A discontinuity resulting from the mutual dissolution of flux and nonmetallic impurities in some **welding** processes.
- **Porosity**-The appearance of tiny bubbles on a **weld** bead as a result of gas entrapment. Excessive **porosity** can weaken a **weld**.
- **Cold Shut**-the imperfection in a casting caused by the flowing of liquid metal upon partially chilled metal.
- **Gas pocket**-In a casting, a hole or void caused by the **entrapment** of air or **gas** that is produced during the solidification of the metal.

Welding Definitions

- **ARC WELDING-A** group of welding processes in which fusion is obtained by heating with an electric arc or arcs, with or without the use of filler metal.
- **BACK PASS**-A pass made to deposit a back weld
- **BRAZING**-A group of welding processes in which a groove, fillet, lap, or flange joint is bonded by using a nonferrous filler metal having a melting point above 800 °F (427 °C), but below that of the base metals. Filler metal is distributed in the joint by capillary attraction.
- **BUTT JOINT**-A joint between two work pieces in such a manner that the weld joining the parts is between the surface planes of both of the pieces joined.
- **BUTT WELD**-A weld in a butt joint
- **CORNER JOINT-**A joint between two members located approximately at right angles to each other in the form of an L.

Welding Definitions

- **CUTTING TIP**-A gas torch tip especially adapted for cutting.
- **CUTTING TORCH**-A device used in gas cutting for controlling the gases used for preheating and the oxygen used for cutting the metal.
- **CYLINDER**-A portable cylindrical container used for the storage of a compressed gas.
- EDGE JOINT-A joint between the edges of two or more parallel or nearly parallel members.
- **FACE OF WELD**-The exposed surface of a weld, made by an arc or gas welding process, on the side from which welding was done.
- **FILLER METAL-**Metal to be added in making a weld.
- **FILLET WELD-** A weld of approximately triangular cross section, as used in a lap joint, joining two surfaces at approximately right angles to each other.

Welding Definitions

- **FLASHBACK-** The burning of gases within the torch or beyond the torch in the hose, usually with a shrill, hissing sound.
- **FLUX-** A cleaning agent used to dissolve oxides, release trapped gases and slag, and to cleanse metals for welding, soldering, and brazing.
- **FULL FILLET WELD-** A fillet weld whose size is equal to the thickness of the thinner member joined.
- **GROOVE-** The opening provided between two members to be joined by a groove weld.
- **GROOVE ANGLE-** The total included angle of the groove between parts to be joined by a groove weld.
- **GROOVE FACE-** That surface of a member included in the groove.
- **GROOVE WELD-** A weld made by depositing filler metal in a groove between two members to be joined.

Welding Definitions

- **JOINT-** The portion of a structure in which separate base metal parts are joined.
- **JOINT PENETRATION-** The maximum depth a groove weld extends from its face into a joint, exclusive of reinforcement.
- **LAP JOINT-** A joint between two overlapping members.
- **MELTING POINT- The temperature at which a metal begins to liquefy.**
- **OXYACETYLENE CUTTING-** An oxygen cutting process in which the necessary cutting temperature is maintained by flames obtained from the combustion of acetylene with oxygen.
- **OXYACETYLENE WELDING-** A welding process in which the required temperature is attained by flames obtained from the combustion of acetylene with oxygen.
- **PASS-** The weld metal deposited in one general progression along the axis of the weld.

Welding Definitions

- **PITCH-** Center to center spacing of welds.
- **PLUG WELD-** A weld is made in a hole in one member of a lap joint, joining that member to that portion of the surface of the other member which is exposed through the hole. The walls of the hole may or may not be parallel, and the hole may be partially or completely filled with the weld metal.
- **PREHEATING-** The application of heat to a base metal prior to a welding or cutting operation.
- **REGULATOR-** A device used to reduce cylinder pressure to a suitable torch working pressure.
- **REINFORCED WELD-** The weld metal built up above the surface of the two abutting sheets or plates in excess of that required for the size of the weld specified.
- **REVERSE POLARITY-** The arrangement of direct current arc welding leads in which the work is the negative pole and the electrode is the positive pole of the welding arc.

Welding Definitions

- **ROOT OF JOINT-** That portion of a joint to be welded where the members approach closest to each other. In cross section, the root of a joint may be a point, a line, or an area.
- **ROOT OF WELD-** The points, as shown in cross section, at which the bottom of the weld intersects the base metal surfaces.
- **SEAL WELD- A weld used primarily to obtain tightness and to prevent leakage.**
- **SEAM WELDING-** Welding a lengthwise seam in sheet metal either by abutting or overlapping joints.
- **SHIELDED** WELDING- An arc welding process in which protection from the atmosphere is obtained through use of a flux, decomposition of the electrode covering, or an inert gas.
- **STRAIGHT POLARITY-** The arrangement of direct current arc welding leads in which the work is the positive pole and the electrode is the negative pole of the welding arc.

Welding Definitions

- **STRING BEAD WELDING-** A method of metal arc welding on pieces 3/4 in. (19 mm) thick or heavier in which the weld metal is deposited in layers composed of strings of beads applied directly to the face of the bevel.

- **STUD WELDING-** An arc welding process in which fusion is produced by heating with an electric arc drawn between a metal stud, or similar part, and the other workpiece, until the surfaces to be joined are properly heated. They are brought together under pressure.

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

- **UNDERCUT-** A groove melted into the base metal adjacent to the toe or root of a weld and left unfilled by weld metal.

Welding Definitions

- **WELD- A** localized fusion of metals produced by heating to suitable temperatures. Pressure and/or filler metal may or may not be used. The filler material has a melting point approximately the same or below that of the base metals, but always above 800 °F (427 °C).
- **WELD** METAL- That portion of a weld that has been **melted during welding.**
- **WELD SYMBOL-** A picture used to indicate the desired type of weld.
- **WELDER CERTIFICATION-** Certification in writing that a welder has produced welds meeting prescribed standards.
- **WELDING LEADS-** a. Electrode lead. The electrical conductor between the source of the arc welding current and the electrode holder.
  b. Work lead. The electrical conductor between the source of the arc welding current and the workpiece.
- **WELDING PRESSURE-** The pressure exerted during the welding operation on the parts being welded.

Welding Definitions

- **WELDING PROCEDURE-** The detailed methods and practices including all joint welding procedures involved in the production of a weldment.

  WELDING ROD- Filler metal in wire or rod form, used in gas welding and brazing processes and in those arc welding processes in which the electrode does not provide the filler metal.

- **WELDING SYMBOL-** The assembled symbol consists of the following eight elements, or such of these as are necessary: reference line, arrow, basic weld symbols, dimension and other data, supplementary symbols, finish symbols, tail, specification, process, or other references.

- **WELDING TECHNIQUE-** The details of a manual, machine, or semiautomatic welding operation which, within the limitations of the prescribed joint welding procedure, are controlled by the welder or welding operator.

Welding Definitions

- **WELDING TIP-** The tip of a gas torch especially adapted to welding.
- **WELDING TORCH-** A device used in gas welding and torch brazing for mixing and controlling the flow of g**ases.**
- **WORK LEAD-** The electric conductor (cable) between the source of arc welding current and the workpiece.

AWS Numbering System

The American Welding Society (AWS) numbering system can tell a welder quite a bit about a specific stick electrode including what application it works best in and how it should be used to maximize performance. With that in mind, let's take a look at the system and how it works.

The prefix "E" designates an arc welding electrode. The first two digits of a 4-digit number and the first three digits of 5-digit number indicate minimum tensile strength. For example, E6010 is a 60,000 psi tensile strength electrode while E10018 designates a 100,000 psi tensile strength electrode.

E	**60**	**1**	**10**
Electrode	Tensile Strength	Position	Type of Coating and Current

AWS Numbering System

The next to last digit indicates position. The "1" designates an all position electrode, "2" is for flat and horizontal positions only; while "4" indicates an electrode that can be used for flat, horizontal, vertical down and overhead. The last 2 digits taken together indicate the type of coating and the correct polarity or current to use. See chart below:

Digit	Type of Coating	Welding Current
0	High cellulose sodium	DC+
1	High cellulose potassium	AC, DC+ or DC-
2	High titania sodium	AC, DC-
3	High titania potassium	AC, DC+
4	Iron powder, titania	AC, DC+ or DC-
5	Low hydrogen sodium	DC+
6	Low hydrogen potassium	AC, DC+
7	High iron oxide, iron powder	AC, DC+ or DC-
8	Low hydrogen potassium, iron powder	AC, DC+ or DC-

AWS Numbering System

As a welder, there are certain electrodes that you will most likely see and use time and time again as you go about your daily operations. A DC machine produces a smoother arc. DC rated electrodes will only run on a DC welding machine. Electrodes which are rated for AC welding are more forgiving and can also be used with a DC machine. Here are some of the most common electrodes and how they are typically used:

E6010
DC only and designed for putting the root bead on the inside of a piece of pipe, this is the most penetrating arc of all. It is tops to dig through rust, oil, paint or dirt. It is an all-position electrode that beginning welders usually find extremely difficult, but is loved by pipeline welders worldwide. Lincoln Fleetweld® 5P+ sets the standard in this category.

E6011
This electrode is used for all-position AC welding or for welding on rusty, dirty, less-than-new metal. It has a deep, penetrating arc and is often the first choice for repair or maintenance work when DC is unavailable. The most common Lincoln product is Fleetweld® 180 for hobby and novice users. Industrial users typically prefer Fleetweld® 35.

AWS Numbering System

E6013
This all-position, AC electrode is used for welding clean, new sheet metal. Its soft arc has minimal spatter, moderate penetration and an easy-to-clean slag. Lincoln Fleetweld® 37 is most common of this type.

E7018
A low-hydrogen, usually DC, all-position electrode used when quality is an issue or for hard-to-weld metals. It has the capability of producing more uniform weld metal, which has better impact properties at temperatures below zero.

AWS Numbering System

E7024

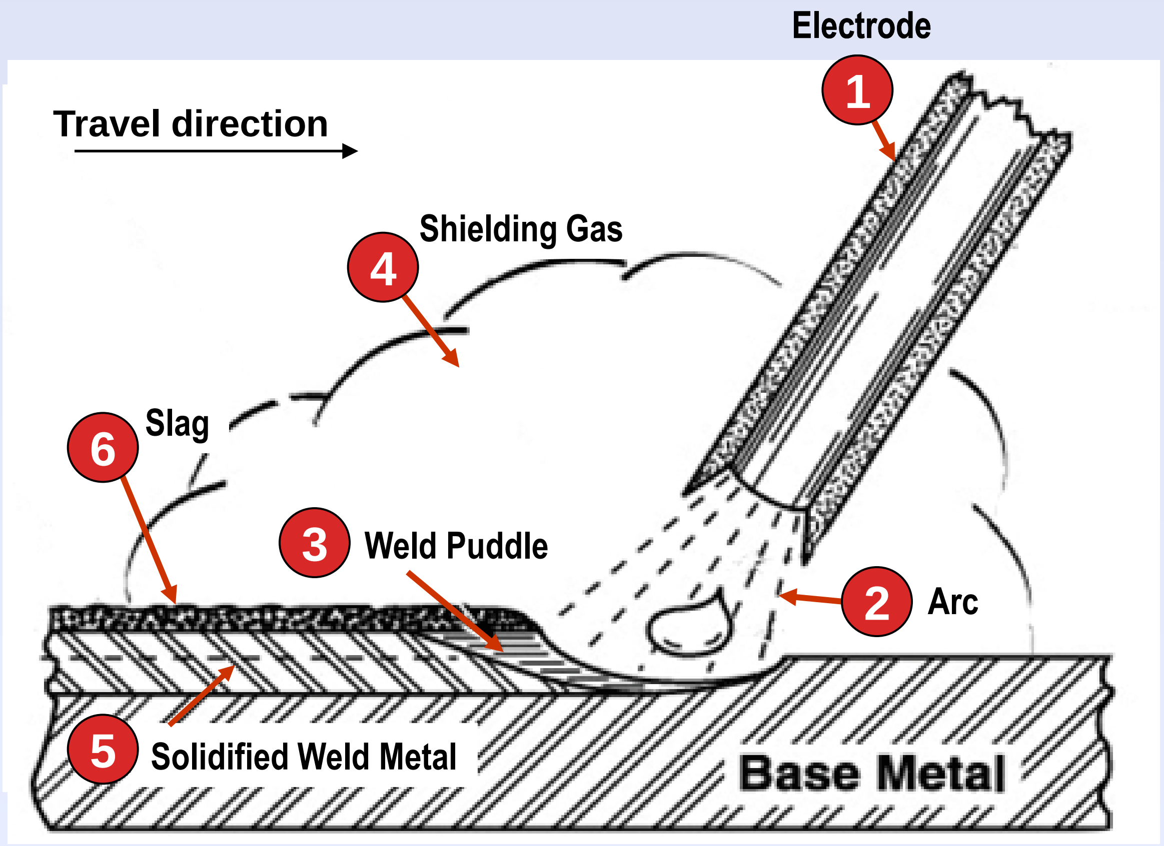
Typically used to make a large weld downhand with AC in plate that is at least ¼" thick, but more commonly used for plate that is ½" and up. Lincoln has several electrodes in this category that are called Jetweld® 1 or 2.

Other Electrodes

Although not nearly as common, an electrode may have additional numbers after it such as E8018-B2H4R. In this case, the "B2" indicates chemical composition of the weld metal deposit. The "H4" is the diffusible hydrogen designator, which indicates the maximum diffusible hydrogen level obtained with the product. And "R" stands for the moisture resistant designator to indicate the electrode's ability to meet specific low moisture pickup limits under controlled humidification tests.

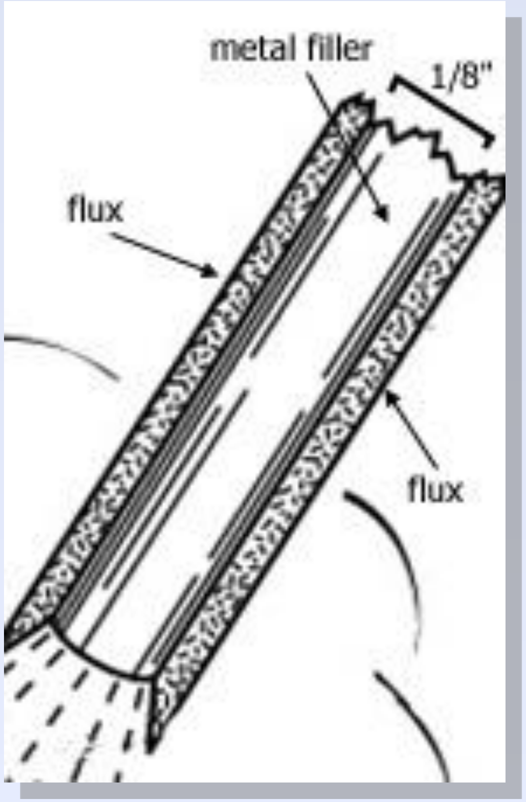
SMAW Process

Let's take a little closer look at the SMAW process…



1- The Electrode

- Is a consumable - it gets melted during the welding process
- Is composed of two parts
  - Core Rod (Metal Filler)
    - Carries welding current
    - Becomes part of the weld
  - Flux Coating
    - Produces a shielding gas
    - Can provide additional filler
    - Forms a slag



2- The Arc

Can you identify the weld joint and position being used?

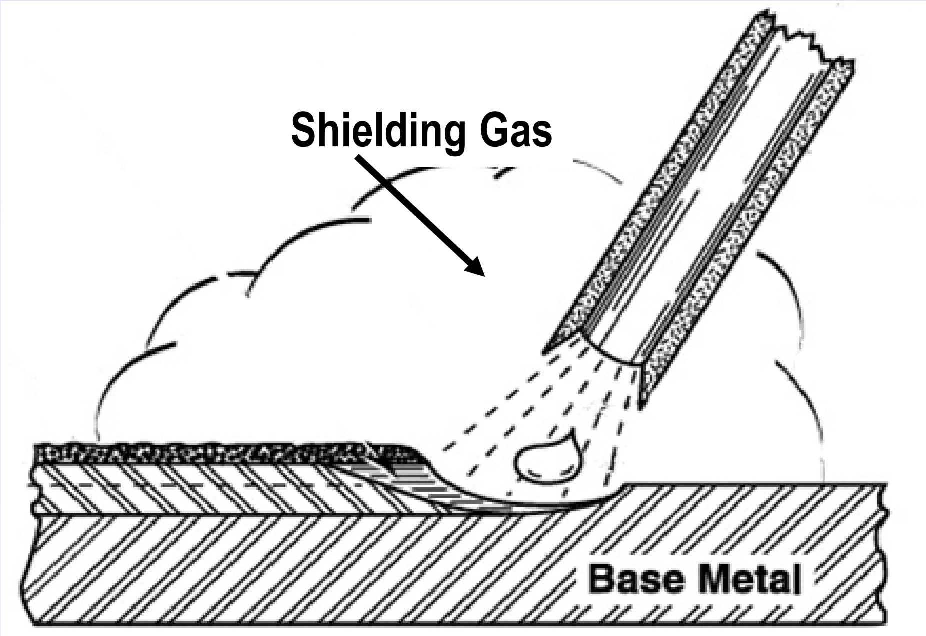
- An arc occurs when the electrode comes in contact with the work-piece and completes the circuit … like turning on a light!
- The electric arc is established in the space between the end of the electrode and the work
- The arc reaches temperatures of 10,000°F which melts the electrode and base material

3- Weld Puddle

- As the core rod, flux coating, and work pieces heat up and melt, they form a pool of molten material called a weld puddle
- The weld puddle is what a welder watches and manipulates while welding

1/8” E6013 at 125 Amps AC

4- Shielding Gas



The shielding gas protects the molten puddle from the atmosphere while stabilizing the arc

- A shielding gas is formed when the flux coating melts.
- This protects the weld puddle from the atmosphere preventing contamination during the molten state

5- Solidified Weld Metal

- As the molten weld puddle solidifies, it forms a joint or connection between two pieces of base material
- When done properly on steel, it results in a weld stronger than the surrounding base metal

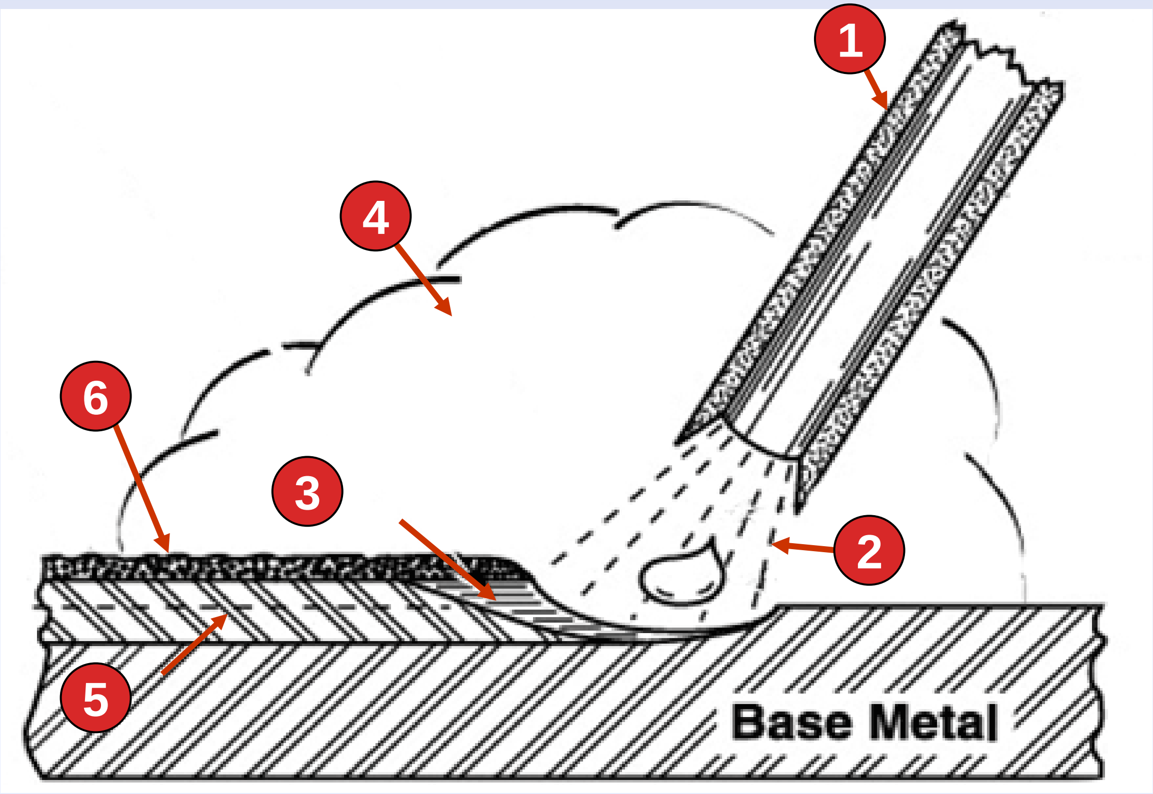
6- Slag

- Slag is a combination of the flux coating and impurities from the base metal that float to the surface of the weld.
- Slag quickly solidifies to form a solid coating
- The slag also slows the cooling rate of the weld
- The slag can be chipped away and cleaned with a wire brush when hard

This welder chips the slag off of a weld during the repair of railroad tracks

Application Activity

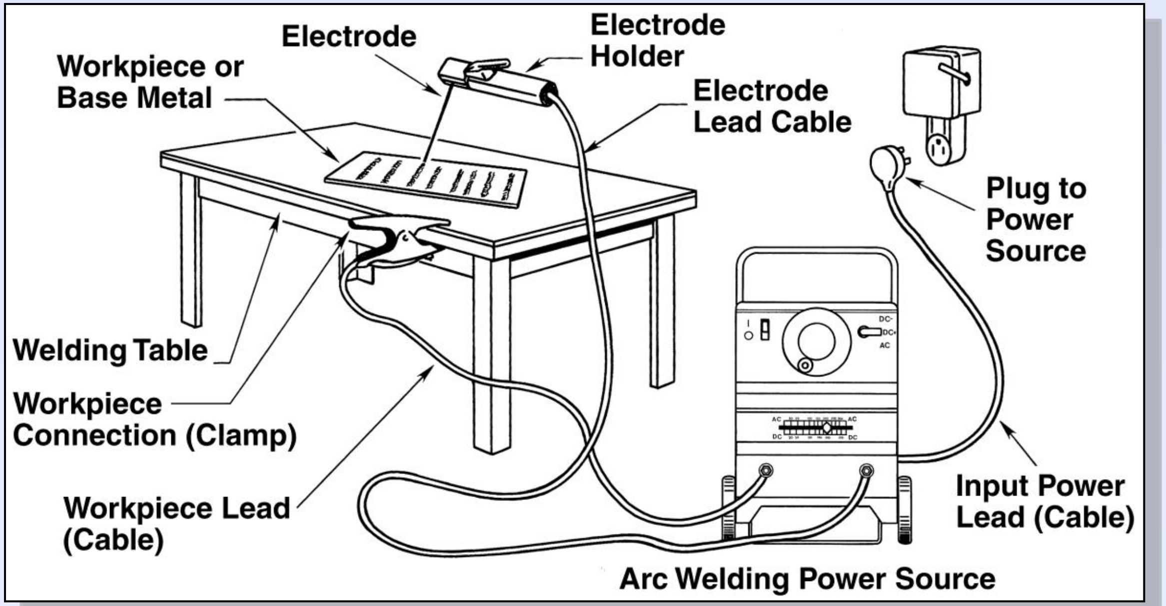
Let's review the SMW process …



- 1: The Electrode
- 2: The Arc
- 3: The wet puddle
- 4: Shielded Gas
- 5: Solidified weld metal
- 6: Slag

SMAW Equipment Set Up

1. Turn power supply on
2. Connect work clamp
3. Select electrode
   a. Type
   b. Diameter
4. Adjust output
   a. *Polarity*
   b. Amperage
6. Insert electrode into electrode holder



SMAW Process Variables

- Settings on the machine
  - Polarity : AC, DC+, DC-
  - Amperage Output
- Operator Controlled Variables
  - Work Angle
  - Travel Angle
  - Arc Length
  - Travel Speed

A straight AC machine will not have a polarity switch like this AC/DC machine

Striking an Arc

- To begin the SMAW Process, you must first strike an arc. This can be done using one of the following techniques:
  - Scratch start – scratch the electrode on the base metal like a match
  - Tap Start – tap the rod against the base metal

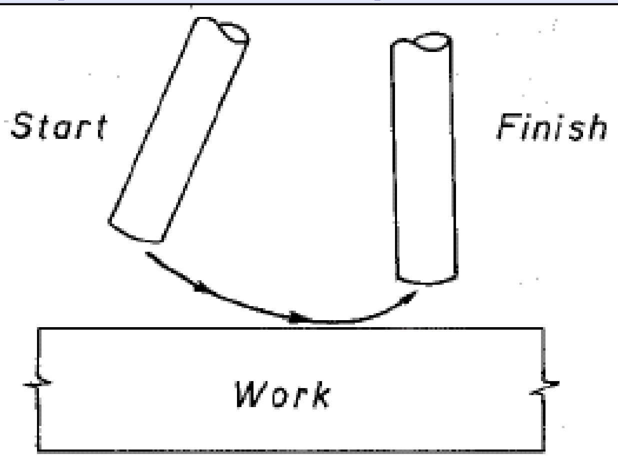


Figure 1. "Scratch" method of arc starting.

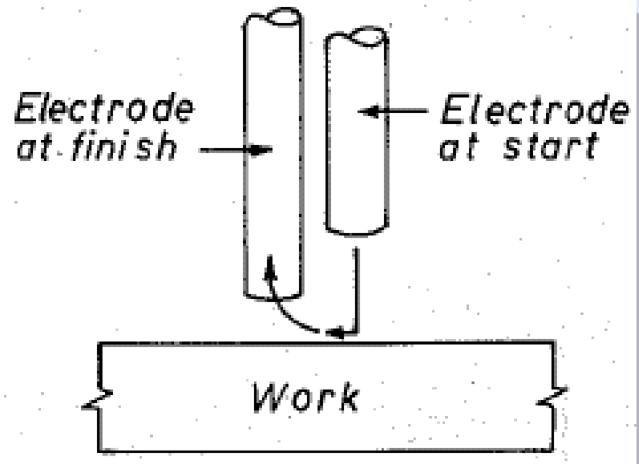
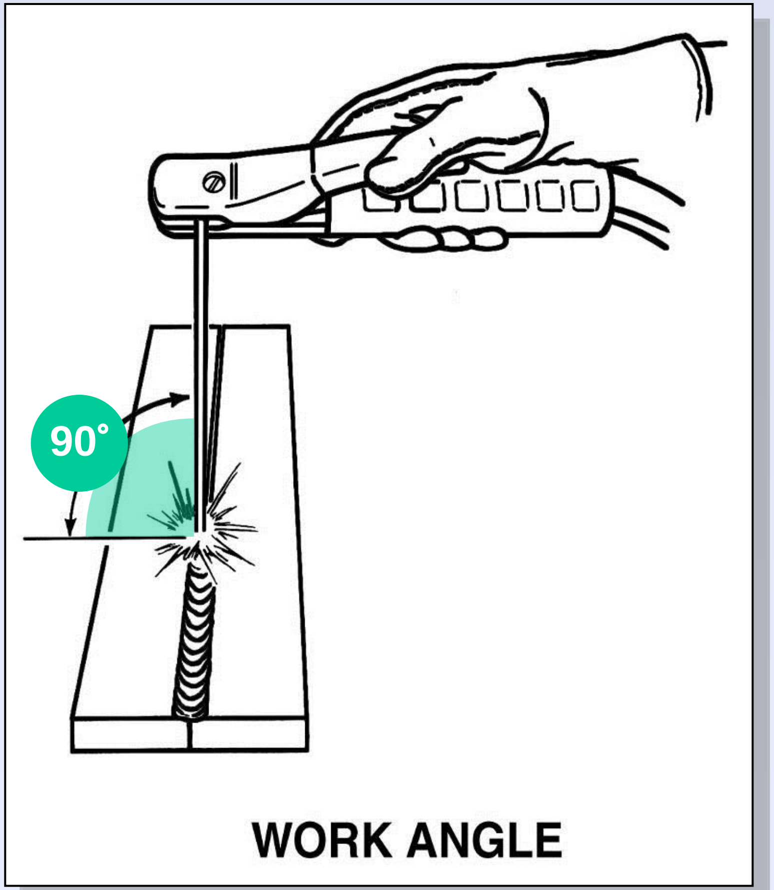


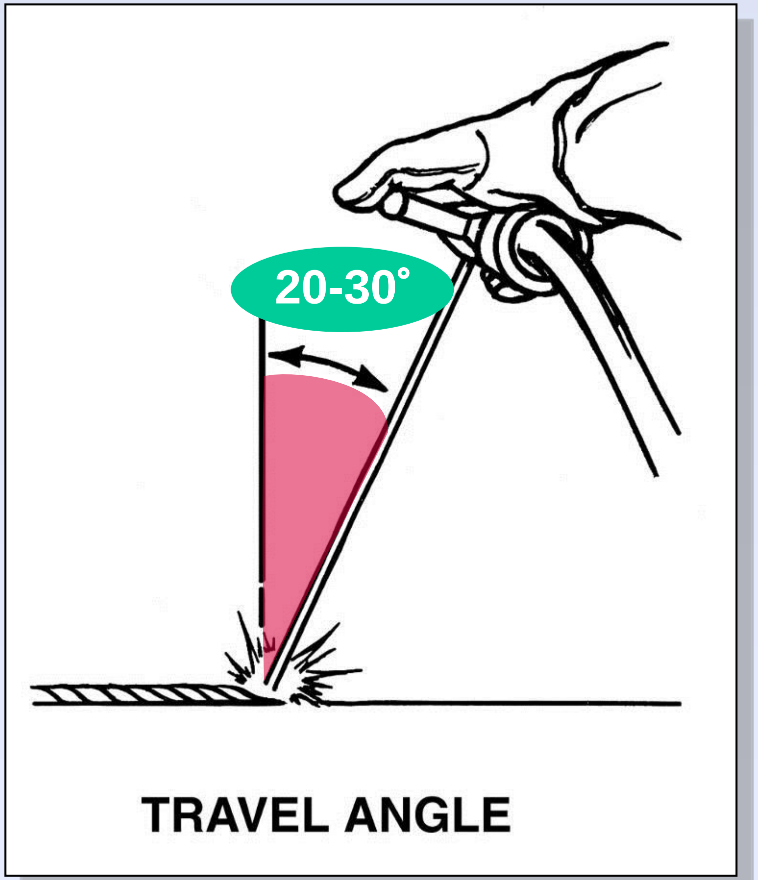
Figure 2. "Tapping" method of arc starting.

Work Angle



- The work angle is the angle between the electrode and the work as depicted on the left
- Work angles can vary depending on the position the weld is being made in

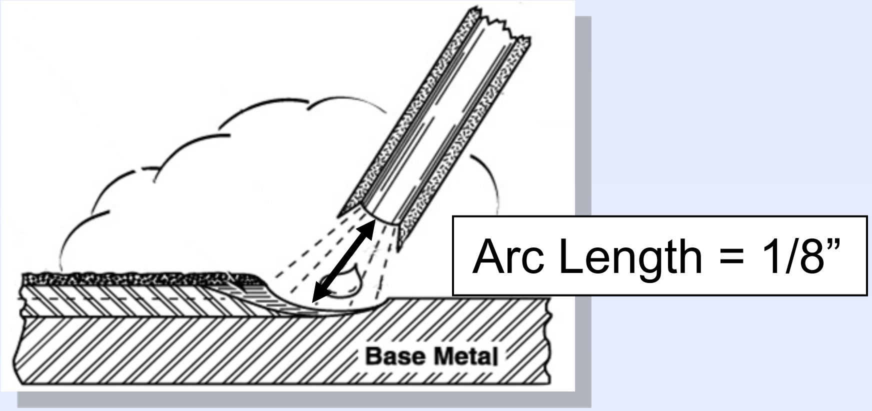
Travel Angle



- Also commonly called Lead Angle
- The travel (lead) angle is the angle between the electrode and the plane perpendicular to the weld axis

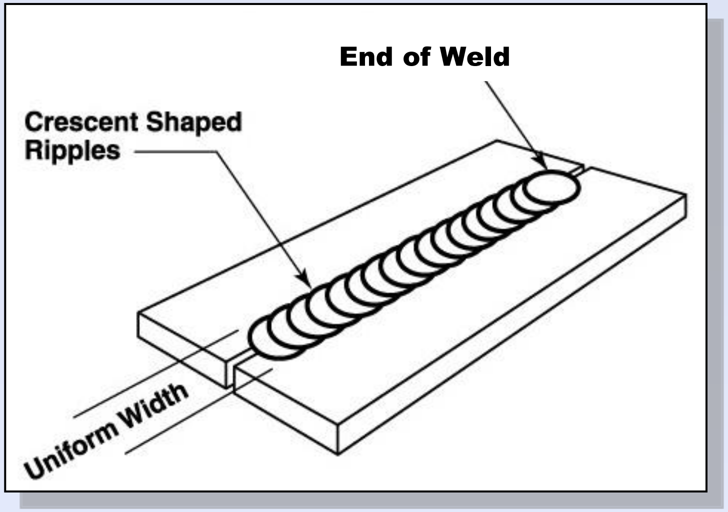
Arc Length

- After striking the arc, maintain a 1/8” distance between the electrode and the workpiece
  - If the arc length becomes too short, the electrode will get stuck to the workpiece or ‘short out’
  - If the arc length becomes too long; spatter, undercut, and porosity can occur



Travel Speed

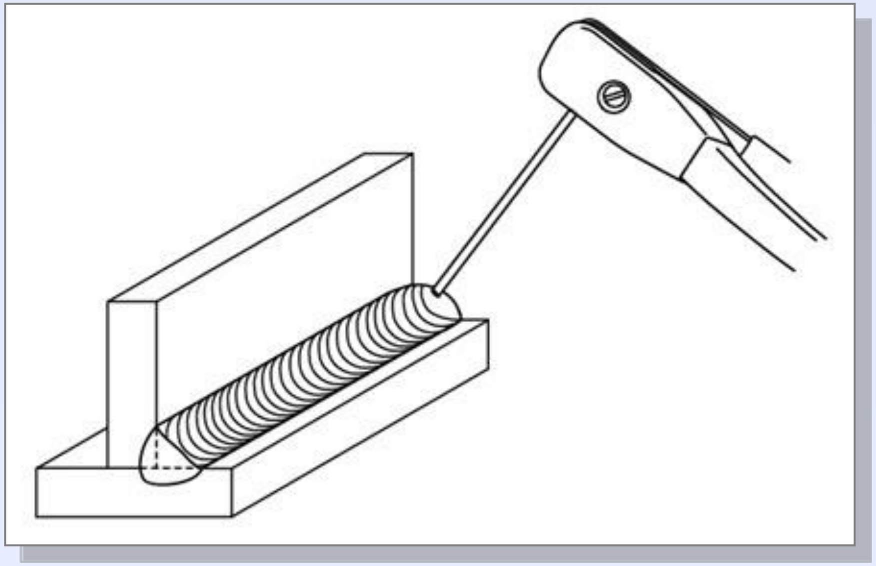
- The travel speed is the speed at which the electrode moves along the base material while welding
  - Too fast of a travel speed results in a ropey or convex weld
  - Too slow of a travel speed results in a wide weld with an excessive metal deposit



The travel speed impacts the shape of the bead.

Filling the Crater

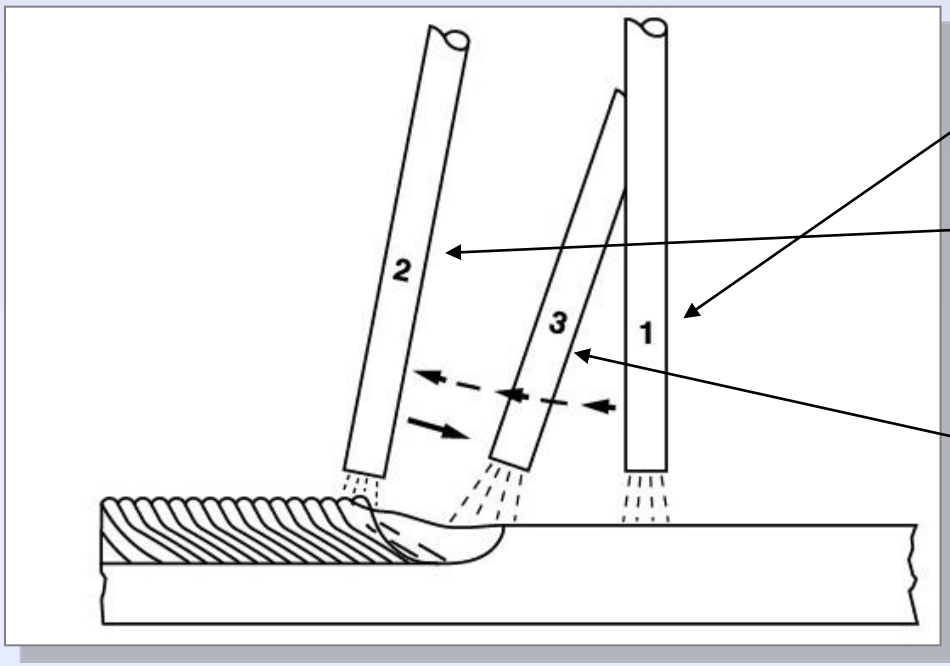
- At the end of the weld, the operator breaks the arc which creates a ‘crater’
- Use a short pause or slight back step at the end of the weld to fill the crater
- Large craters can cause weld cracking



Back stepping is a short move in the opposite direction of weld travel

Restarting a Bead

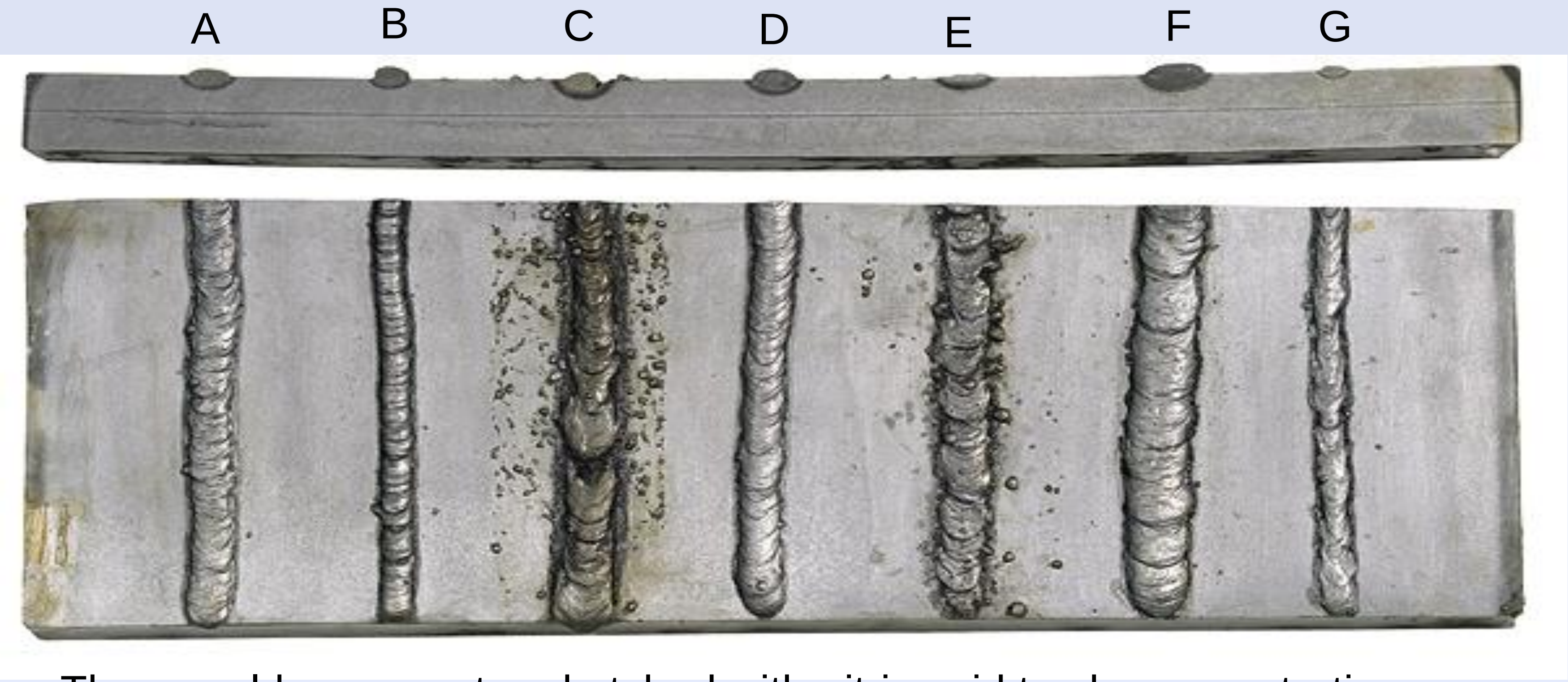
- Here is the proper technique for restarting a weld:



1. Strike Arc Here
2. Move Electrode to Crown of Crater
3. Resume Forward Travel

Troubleshooting Welds

Troubleshooting Welds



These welds were cut and etched with nitric acid to show penetration

- A – Good Weld: Proper Current, Travel Speed and Arc Length
- B – Current too low: Ropey, convex bead appearance
- C – Current too High: Excess spatter and possible burn-through of base materials
- D – Arc Length too short: Poor wet-in at toes, electrode can 'short' to base material
- E – Arc Length too Long: Excess spatter, undercut and porosity
- F – Travel Speed too slow: Wide weld with excess metal deposit
- G – Travel Speed too high: Ropey and convex bead

Advantages of SMAW

- Low initial cost
- Portable
- Easy to use outdoors
- All position capabilities
- Easy to change between many base materials

Limitations of SMAW

- Lower consumable efficiency
- Difficult to weld very thin materials
- Frequent restarts
- Lower operating factor
- Higher operator skill required for SMAW than some other processes

Building a barge in a large shipyard

AWS Classification of SMAW Electrodes

E70XX

Electrode

Tensile in Ksi

Welding Position:

1 = All Position, 2 = Flat & Horizontal

Type of Current and Coating

FPR (Field Performance Requirement)

The following 16 lesson's will need to be completed under supervision of a qualified employee (Foreman)

There is no written test on this section, so after the 16 are completed, this will complete this module.

SMAW Lesson #1

- Objective: Strike and establish an arc
- Equipment:
  - Single Process – Constant Current Power Source
  - Use equipment made available by Pike Electric
- Material:
  - Mild Steel Plate 1/8” or thicker
  - 1/8” Fleetweld 5P+ (E6010) for DC or Fleetweld 180 (E6011) for AC

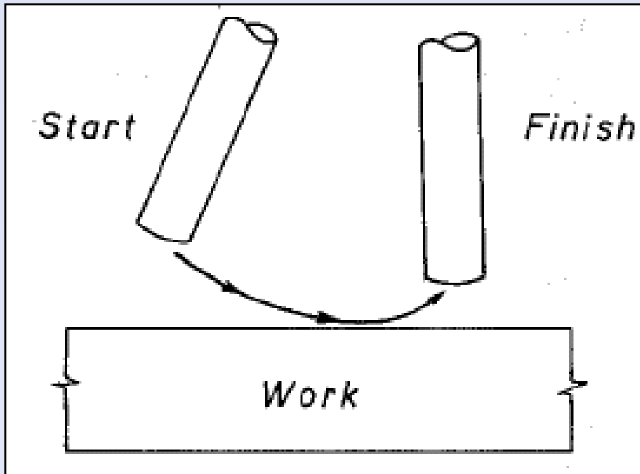


Figure 1. “Scratch” method of arc starting.

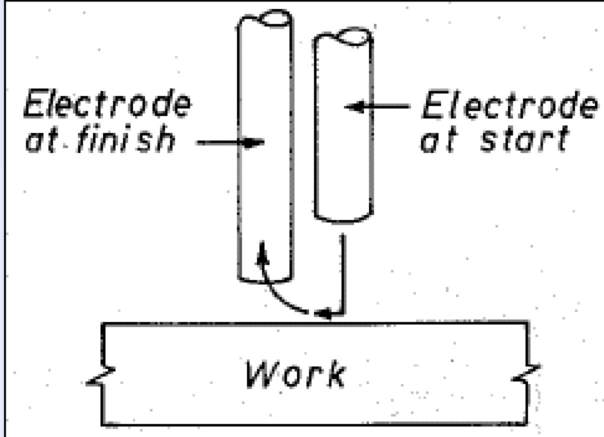


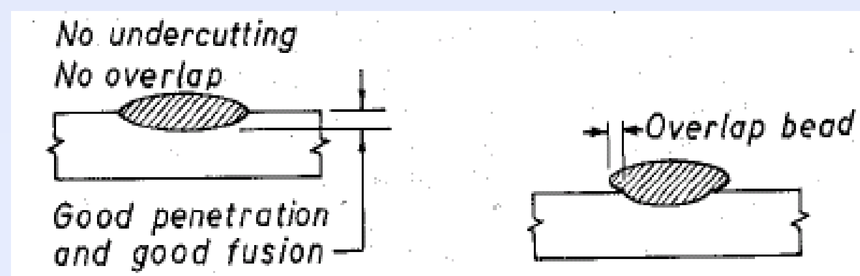
Figure 2. “Tapping” method of arc starting.

SMAW Lesson #2

- Objective: To run a straight bead on flat plate and to fill the crater
- Equipment:
  - Single Process -
    Constant Current Power Source
  - Use equipment made available by Pike Electric

Material:

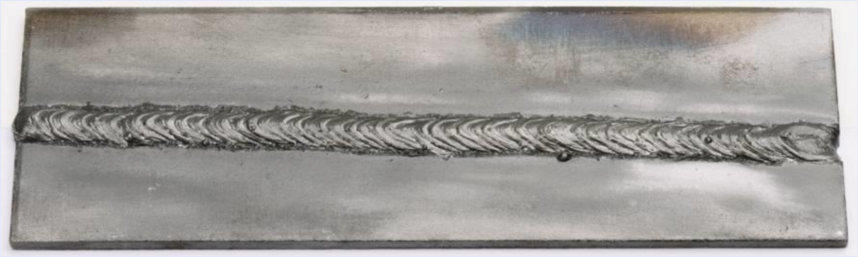
- Mild Steel Plate 3/16” or thicker
- 1/8” Fleetweld 37 (E6013)



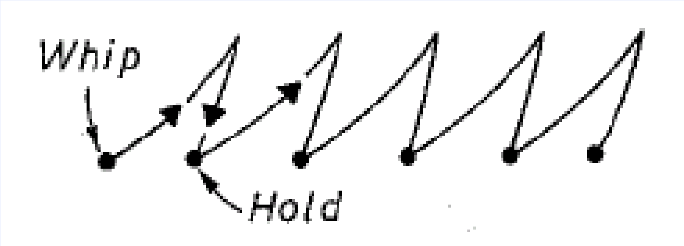
Good Poor

SMAW Lesson #3

- Objective: To run a bead with the whip technique
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric

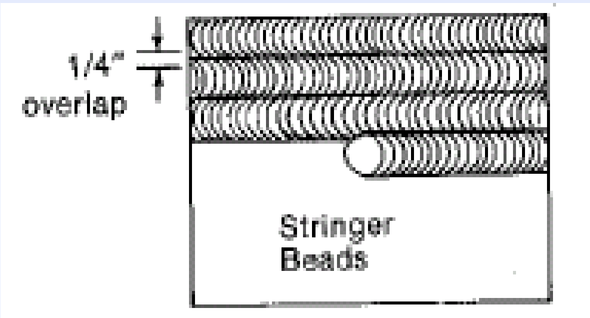


- Material:
  - Mild Steel Plate 3/16” or thicker
  - 1/8” Fleetweld 5P+ (E6010) for DC or Fleetweld 180 (E6011) for AC



SMAW Lesson #4

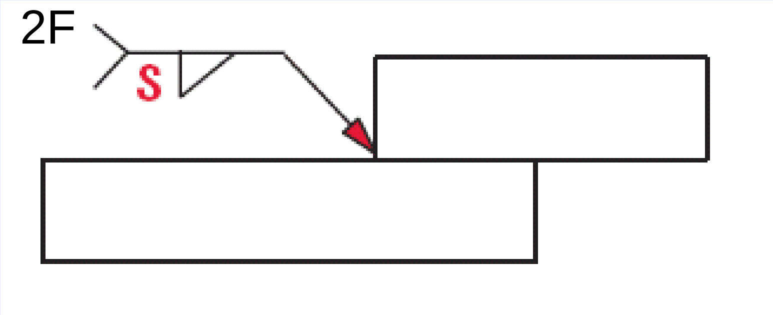
- Objective: To build a pad
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric
- Material:
  - Mild Steel Plate 3/16” or thicker
  - 1/8” Fleetweld 37 (E6013)

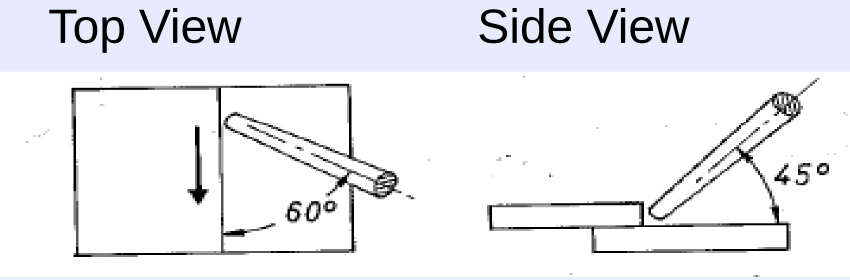


SMAW Lesson #5

- Objective: To make a fillet weld on a lap joint in the horizontal position (AWS Position 2F)
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric

  Material:
  - Mild Steel Plate - 10 gauge
  - 1/8” Fleetweld 5P+ (E6010) for DC or Fleetweld 180 (E6011) for AC

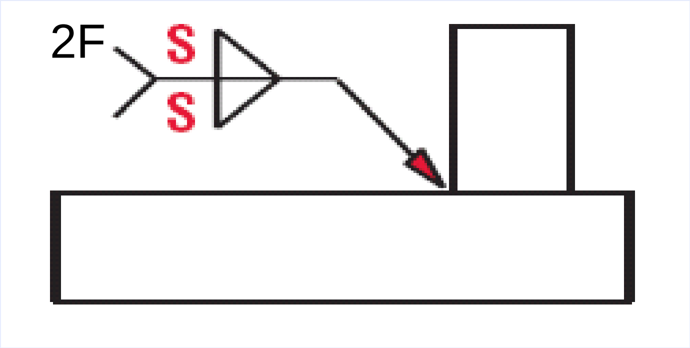


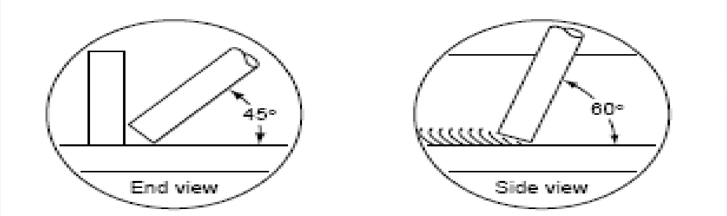


SMAW Lesson #6

- Objective: To make a fillet weld on a tee joint in the horizontal position (AWS Position 2F)
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric

- Material:
  - Mild Steel Plate - 10 gauge
  - 1/8” Fleetweld 5P+ (E6010) for DC or Fleetweld 180 (E6011) for AC



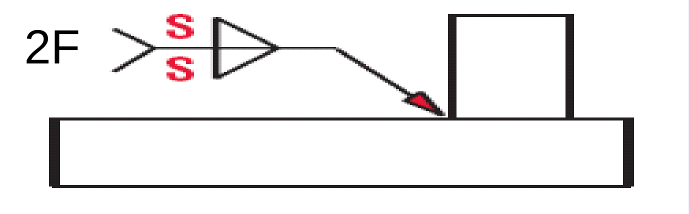


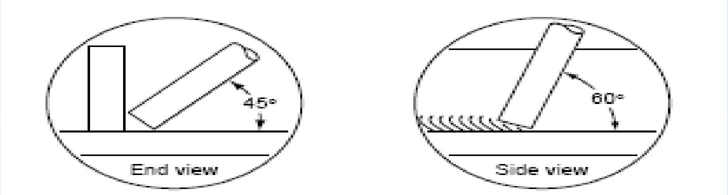
SMAW Lesson #7

- Objective: To make a fillet weld on a tee joint in the horizontal position (AWS Position 2F)
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric

- Material:
  - Mild Steel Plate - 10 gauge
  - 1/8" Excalibur 7018 (E7018) for DC

    or Lincoln 7018AC (E7018) for AC

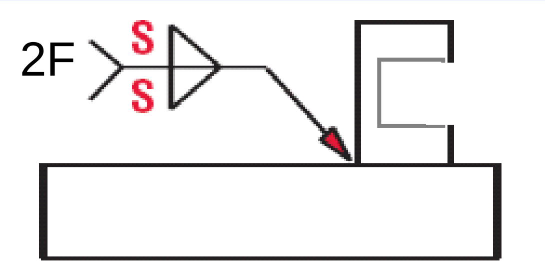


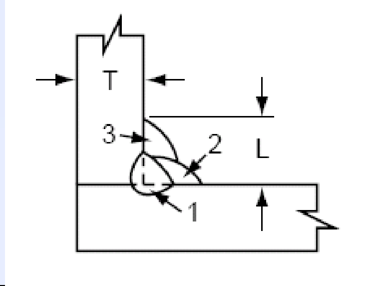


SMAW Lesson #8

- Objective: To make a three pass fillet weld on a tee joint in the horizontal position (AWS Position 2F)
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric
- Material:
  - Mild Steel Plate – ¼”
  - 1/8” Excalibur 7018 (E7018) for DC or

    Lincoln 7018AC (E7018) for AC



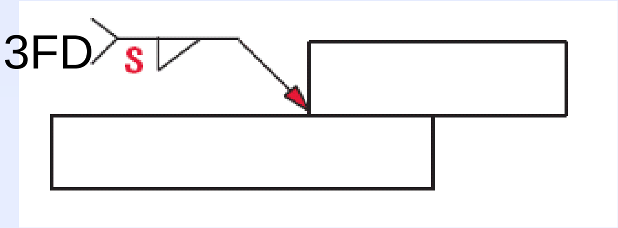


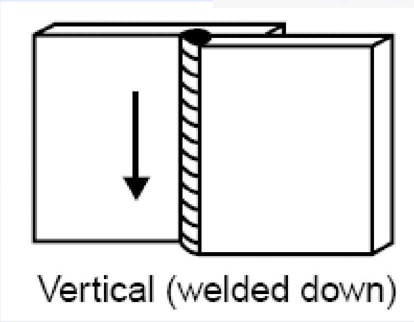
SMAW Lesson #9

- Objective: To make a fillet weld on a lap joint in the vertical position welding down.
  (AWS Position 3FD)

- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric

- Material:
  - Mild Steel Plate - 10 gauge
  - 1/8” Fleetweld 37 (E6013)

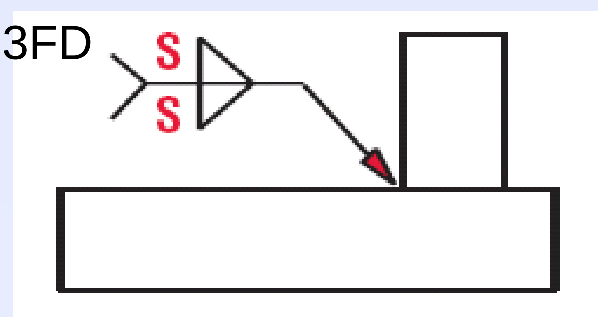


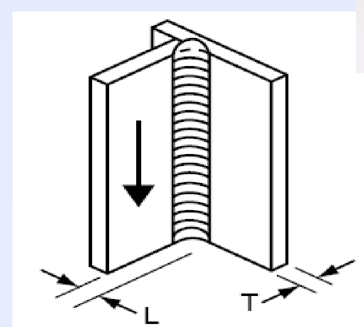


SMAW Lesson #10

- Objective: To make a fillet weld on a tee joint in the vertical position welding down (AWS Position 3FD)
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric
- Material:
  - Mild Steel Plate - 10 gauge
  - 1/8” Fleetweld 5P+ (E6010) for DC or Fleetweld 180 (E6011) for AC

3FD

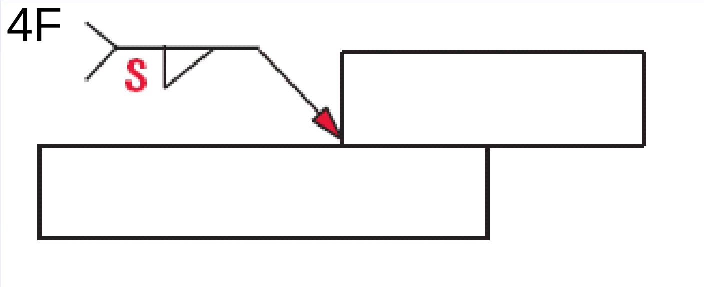


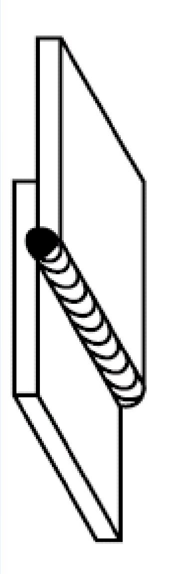


SMAW Lesson #11

- Objective: To make a fillet weld on a lap joint in the overhead position (AWS Position 4F)
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric

- Material:
  - Mild Steel Plate - 10 gauge
  - 1/8” Fleetweld 5P+ (E6010) for DC or Fleetweld 180 (E6011) for AC

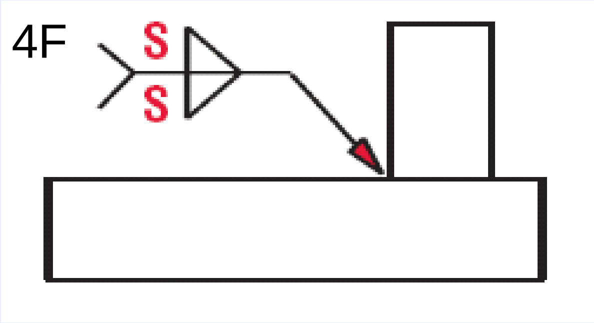


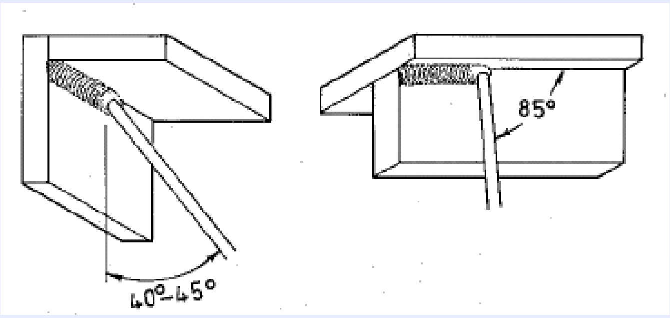


SMAW Lesson #12

- Objective: To make a fillet weld on a tee joint in the overhead position (AWS Position 4F)
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric

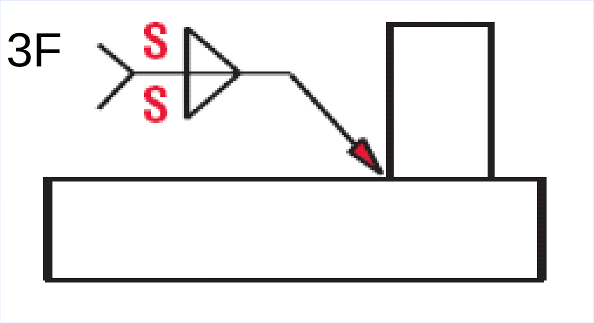
- Material:
  - Mild Steel Plate - 10 gauge
  - 1/8” Fleetweld 5P+ (E6010) for DC or Fleetweld 180 (E6011) for AC

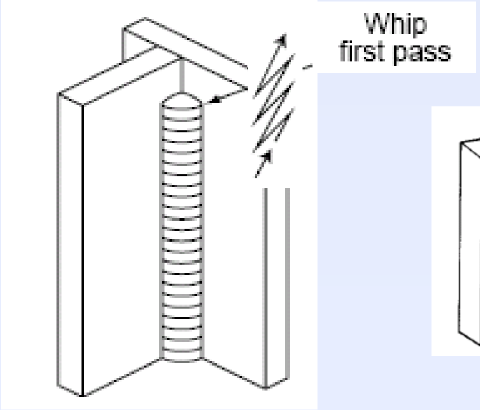


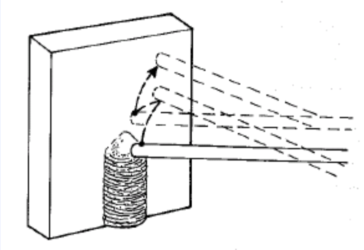


SMAW Lesson #13

- Objective: To make a single pass fillet weld on a tee joint in the vertical position welding up (AWS Position 3F)
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric
- Material:
  - Mild Steel Plate – 1/4”
  - 1/8” Fleetweld 5P+ (E6010) for DC or Fleetweld 180 (E6011) for AC







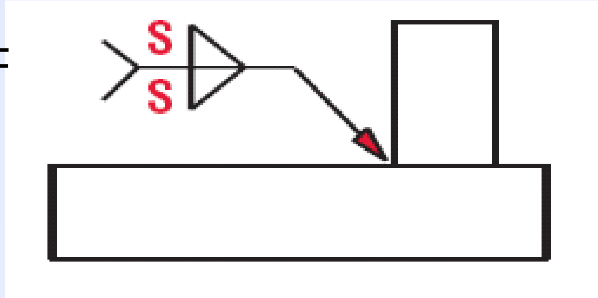
SMAW Lesson #14

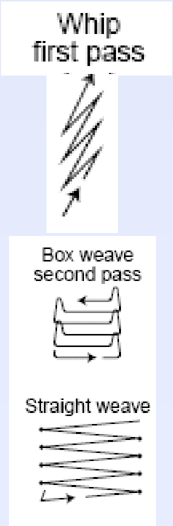
- Objective: To make a three pass fillet weld on a tee joint in the vertical position welding up (AWS Position 3F)

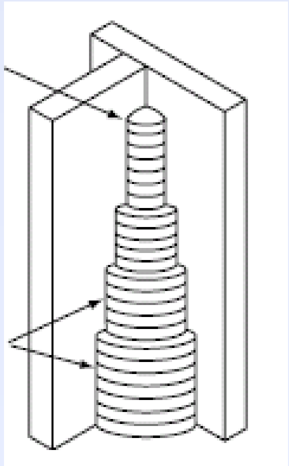
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric

- Material:
  - Mild Steel Plate – 1/4”
  - 1/8” Fleetweld 5P+ (E6010) for DC or Fleetweld 180 (E6011) for AC

3F

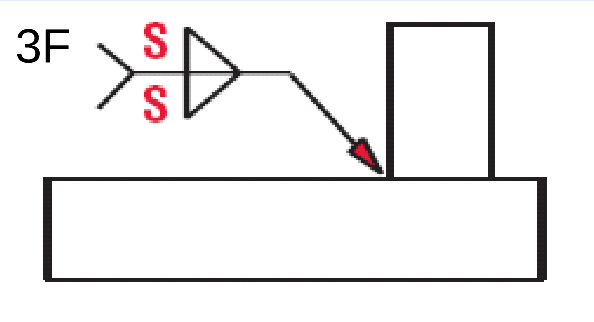


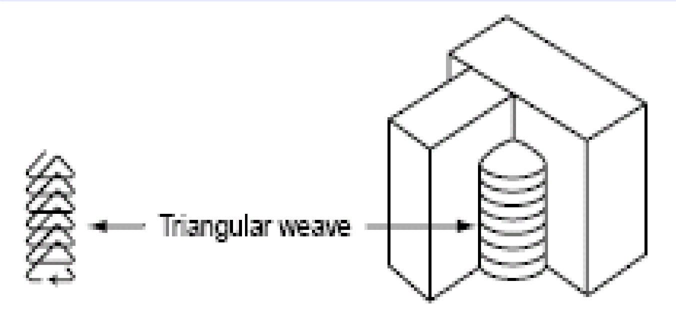




SMAW Lesson #15

- Objective: To make a single pass fillet weld on a tee joint in the vertical position welding up (AWS Position 3F)
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric
- Material:
  - Mild Steel Plate – 1/4”
  - 1/8” Excalibur 7018 (E7018) for DC or Lincoln 7018AC (E7018) for AC





SMAW Lesson #16

- Objective: To make a three pass fillet weld on a tee joint in the vertical position welding up (AWS Position 3F)
- Equipment:
  - Single Process - Constant Current Power Source
  - Use equipment made available by Pike Electric
- Material:
  - Mild Steel Plate – 1/4”
  - 1/8” Excalibur 7018 (E7018) for DC or

    Lincoln 7018AC (E7018) for AC