

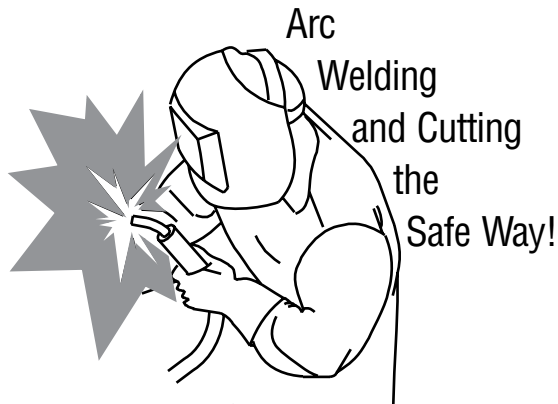


Topic 6.

Welding Process Training Series

Shielded Metal Arc Welding

SAFETY



As in all occupations, safety is paramount. Because there are numerous safety codes and regulations in place, we recommend that you always read all labels and the Owner's Manual carefully before installing, operating, or servicing the unit. Read the safety information at the beginning of the manual and in each section. Also read and follow all applicable safety standards, especially ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes.

ANSI Z49.1: Safety in Welding, Cutting, and Allied Processes is available as a free download from the American Welding Society at: <http://www.aws.org>

Here is a list of additional safety standards and where to get them.

Safe Practices for the Preparation of Containers and Piping for Welding and Cutting, American Welding Society Standard AWS F4.1, from Global Engineering Documents (Phone: 1-877-413-5184, website: www.global.ihs.com).

National Electrical Code, NFPA Standard 70, from National Fire Protection Association, Quincy, MA 02269 (Phone: 1-800-344-3555, website: www.nfpa.org and www.sparky.org).

Safe Handling of Compressed Gases in Cylinders, CGA Pamphlet P-1, from Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, VA 20151 (Phone: 703-788-2700, website: www.cganet.com).

Safety in Welding, Cutting, and Allied Processes, CSA Standard W117.2, from Canadian Standards Association, Standards Sales, 5060 Spectrum Way, Suite 100, Ontario, Canada L4W 5NS (Phone: 800-463-6727, website: www.csa-international.org).

Safe Practice For Occupational And Educational Eye And Face Protection, ANSI Standard Z87.1, from American National Standards Institute, 25 West 43rd Street, New York, NY 10036 (Phone: 212-642-4900, website: www.ansi.org).

Standard for Fire Prevention During Welding, Cutting, and Other Hot Work, NFPA Standard 51B, from National Fire Protection Association, Quincy, MA 02269 (Phone: 1-800-344-3555, website: www.nfpa.org).

OSHA, Occupational Safety and Health Standards for General Industry, Title 29, Code of Federal Regulations (CFR), Part 1910, Subpart Q, and Part 1926, Subpart J, from U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954 (Phone: 1-866-512-1800) (There are 10 OSHA Regional Offices—phone for Region 5, Chicago, is 312-353-2220, website: www.osha.gov).

Booklet, *TLVs, Threshold Limit Values*, from American Conference of Governmental Industrial Hygienists (ACGIH), 1330 Kemper Meadow Drive, Cincinnati, OH 45240 (Phone: 513-742-3355, website: www.acgih.org).

Towing a Trailer – Being Equipped for Safety, Publication from U.S. Department of Transportation, National Highway Traffic Safety Administration, 400 Seventh Street, SW, Washington, D.C. 20590

U.S. Consumer Product Safety Commission (CPSC), 4330 East West Highway, Bethesda, MD 20814 (Phone: 301-504-7923, website: www.cpsc.gov).

Applications Manual for the Revised NIOSH Lifting Equation, The National Institute for Occupational Safety and Health (NIOSH), 1600 Clifton Rd, Atlanta, GA 30333 (Phone: 1-800-232-4636, website: www.cdc.gov/NIOSH).

Prepared by the Miller Electric Mfg. Co. Training Department.

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WARNING

This document contains general information about the topics discussed herein. This document is not an application manual and does not contain a complete statement of all factors pertaining to those topics.

The installation, operation, and maintenance of arc welding equipment and the employment of procedures described in this document should be conducted only by qualified persons in accordance with applicable codes, safe practices, and manufacturer's instructions.

Always be certain that work areas are clean and safe and that proper ventilation is used. Misuse of equipment and failure to observe applicable codes and safe practices can result in serious personal injury and property damage.

Shielded Metal Arc Welding

Welding Process and Filler Metals Training Series:

Welcome to the Welding Process and Filler Metals Training Series. This training series was developed for the purpose of providing a basic set of educational materials that can be used individually or in a classroom setting.

The topics covered in the series are:

Welding Processes

- Topic 1. [Introduction To Welding](#)
- Topic 2. [Welding Safety](#)
- Topic 3. [Basic Electricity For Welding](#)
- Topic 4. [Welding Power Source Design](#)
- Topic 5. [Engine Driven Power Sources](#)
- Topic 6. [Shielded Metal Arc Welding](#)
- Topic 7. [Gas Tungsten Arc Welding](#)
- Topic 8. [Gas Metal Arc Welding](#)
- Topic 9. [Flux Cored Arc Welding](#)
- Topic 10. [Metal Cutting](#)
- Topic 11. [Troubleshooting Welding Processes](#)
- Topic 12. [Submerged Arc Welding](#)

Filler Metals

- Topic A. [Introduction To Metals](#)
- Topic B. [Tubular Wires](#)
- Topic C. [Low Alloy Steel](#)
- Topic D. [Stainless Steel](#)
- Topic E. [Aluminum](#)
- Topic F. [Hard Surfacing](#)

Please note, this series was not developed to teach the skill of welding or cutting, but rather to provide a foundation of general knowledge about the various processes and related topics.

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Definition And General Description

Shielded Metal Arc Welding (SMAW) is defined by the American Welding Society (AWS) as an arc welding process with an arc between a covered electrode and the weld pool. The process uses a disposable electrode with a flux coating. As the weld is made the flux burns off to provide shielding for the weld while the electrode provides the filler metal.

Shielded Metal Arc Welding, also called Stick Welding, is one of the most widely used processes, particularly for short welds in production, maintenance and repair work, and for field construction. The process has many advantages:

- The equipment is relatively simple, inexpensive, and portable.
- The filler metal, and the means of protecting it and the weld metal from harmful oxidation during welding, are provided by the covered electrode.
- Auxiliary gas shielding or granular flux is not required.
- The process is less sensitive to wind and draft than gas shielded arc welding processes.
- It can be used in areas of limited access.
- The process is suitable for most of the commonly used metals and alloys.



Principles of Operation

Shielded Metal Arc Welding occurs when a constant current, high amperage, low voltage welding power supply generates an electric arc between an electrode and the workpiece. Using a welding power supply that generates a constant current high amperage low voltage welding arc. Figure 1 shows the basic components needed for the welding process:

- Constant current welding power source
- Welding and work cables (electrode and work leads)
- Work clamp
- Electrode holder
- Covered welding electrodes

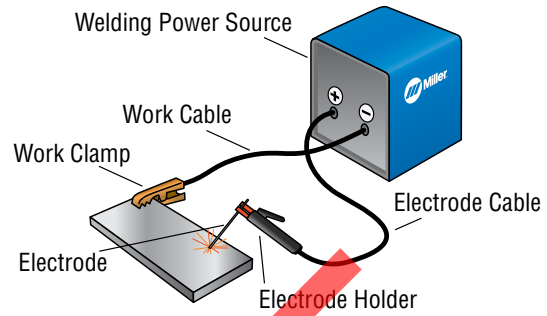


Figure 1 – SMAW System

As illustrated in Figure 2, the arc is generated between the base metal and the core wire that makes up the electrode. This electric arc produces enough heat, about 9000° F (5000° C), to melt both the base metal and electrode forming a weld pool. Small droplets of the core wire melt and transfer to the weld pool providing additional metal to the weld pool. As the electrode covering is heated and melted, it produces gasses that protect the molten puddle from atmospheric contamination. The electrode covering also contains elements that help to stabilize the welding arc, clean the base metal, and provide a protective slag coating that helps form the weld bead as well as protect it from the atmosphere.

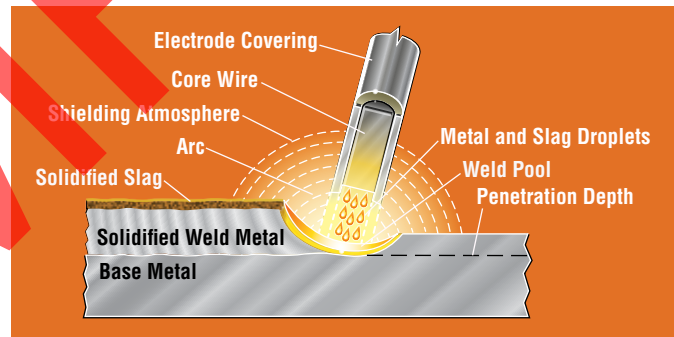


Figure 2 – SMAW Arc

SMAW Equipment

Power Source

There are two types of welding power sources used for the electric arc welding processes: constant current and constant voltage. The Shielded Metal Arc Welding process requires a constant current welding power source. This type of welding power source requires the operator to set welding amperage. The source may be any of the types: transformer, transformer-rectifier, inverter, or engine-driven.

Shielded Metal Arc Welding

With the many types of power sources available, some criteria are necessary in selecting the right one for the job. One consideration is current type - AC or DC. The light duty power sources found in many small repair shops, on the farm, and around the home, are usually AC machines. They are inexpensive to purchase, very simple to operate, and can usually be operated from residential type electrical service. They provide the necessary power for use with electrodes designed for alternating current.



Figure 3 – An Inverter Welding Power Source

AC power sources are generally used to eliminate arc blow. Arc blow occurs with direct current because of magnetic fields set up by a steady current flow in one direction. Arc blow is most severe when welding in tight fillet corners or box sections. The arc will wander from its intended path and molten metal droplets are expelled as spatter. Arc blow can cause welding defects in the form of undercut and unfilled weld craters, plus excessive spatter. Arc blow is most severe when using large electrodes at high amperages.



Figure 4 – An AC/DC Transformer-Rectifier Welding Power Source

Direct current machines are selected when the application calls for an electrode that operates from direct current. DC is normally preferred for out-of-position work and for use with stainless steel or non-ferrous electrodes. DC is usually preferred for pressure vessels, pipelines, and other critical weldments because of the arc characteristics it provides with the low alloy electrodes frequently used for these applications. Direct current welding power sources offer extra versatility because of polarity selection. Nearly all electrodes can be used with direct current.

In some shops it is desirable to have available both AC and DC power sources. Transformer rectifier-type welding power sources can provide both AC and DC power. The operator can easily select alternating current or direct current from this type of power source.

The duty cycle of the welding power source is another consideration. Analyzing the amperage needs and selecting a power source which will provide the required output within the duty cycle rating is important. A welding power source can be overloaded for a short period of time, but continuous overloading will cause damage to the unit.



Figure 5 – An AC/DC Transformer-Rectifier Engine-Driven Welding Power Source

Physical size can be another issue when selecting a welding power source. Inverter power sources offer exceptional arc characteristics in all processes and are considerably smaller in size than conventional power sources. Inverter power sources are also more electrically efficient than conventional welding power sources.

The primary power available must be considered when selecting a welding power source. Primary power is normally available at 208 volts, 230 volts, 460 volts, or 575 volts. Some welding power sources may operate from only one primary voltage while others can be connected for several primary voltages. AC and AC/DC power sources require single-phase power while DC power sources normally require three-phase primary power. In rural and residential areas, single-phase power is common and three-phase power would require special wiring. Most industrial locations have three-phase power available since it is required by many electric motors and other electrical equipment.

Engine-driven power sources are used on construction sites, mines, cross country pipelines and in remote areas where mobility is a factor and welding utility power is not readily available. Air and liquid-cooled engines are available in gasoline or diesel versions for this type of power source.

Regardless of the type of input voltage, whether they are AC or DC, static equipment or engine-driven, a welding power source has one function: to provide electrical energy at the arc. Amperage demands for welding may vary from a few amperes to over 1000 amperes. Welding power sources are available in many sizes and types to fill the needs of the application.