An Approach to Best Welding Practice : Part – XI

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"AN APPROACH TO BEST WELDING PRACTICE, Part – XI" is the Eleventh Detail Part of **"AN APPROACH TO BEST WELDING PRACTICE"** which was written as a General and Overall approach to the subject matter.

AN APPROACH TO BEST WELDING PRACTICE Part – XI is particularly focused on the Safety Aspects regarding Electric Shock especially for Fusion Welding Processes to obtain the best possible Accident free shop floor operation.

This is a Working Guideline for Supervisors and Operators working in an Engineering Fabrication Plant using welding as the main manufacturing process to initiate awareness for observing Safety Rules and regulations.

SAFETY

Safety has been defined in many ways and in different formats.

- Safety means protection and freedom from Hazards.
- Safety means keeping away from danger
- Safety means systematically tackling dangerous and hazardous situations.

In general, dangers and hazards are caused by :

- Tools and Tackles
- Manufacturing Process
- Machineries and Plants
- Human errors.

Every manufacturing factory using machineries and equipment impose Hazards which are to be mitigated by all concerned. In order to make the working environment as much safe as possible we must understand, evaluate and mitigate dangers and hazards arising out of the process and associated tools, plant and equipment. At the same time we must formulate the safety rules to follow.

HAZARDS OF WELDING

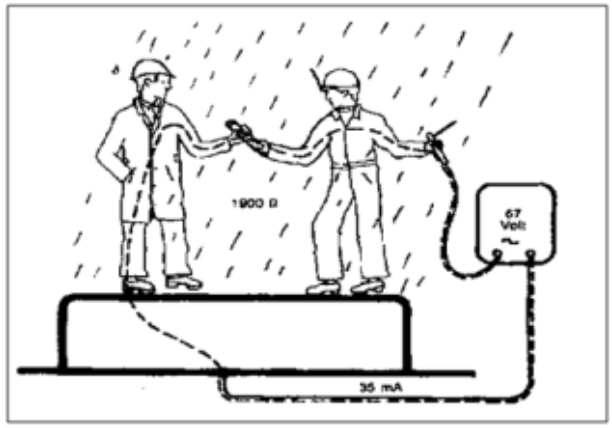
- Fire and Explosion hazards
- Electric shock.
- Radiation from Arc
- Work-Related Musculoskeletal Disorders

ELECTRIC SHOCK

Welding Circuit Shock Hazards

The welding circuit consists of all conductive material through which the welding current is intended to flow. Welding current flows through the welding machine terminals, welding cables, workpiece connection, gun, torch, electrode holder and workpiece. The welding circuit is not connected to ground within the welding machine, but is isolated from ground.

ELECTRIC SHOCK Can Kill



Assistant hands welder a metal object.

Resultant current is 35 mA

I = V/R = 67/1900 = 35 mA

Result = Assistant survived but welder died

Dangers of Electrical Shock

1. The severity of injury from electrical shock depends on the amount of electrical current and the length of time the current passes through the body. For example, 1/10 of an ampere (A) of electricity going through the body for just 2 seconds is enough to cause death.

   The amount of internal current a person can withstand and still be able to control the muscles of the arm and hand can be less than 10 milliamperes (milliamps or mA). Currents above 10 mA can paralyze or "freeze" muscles. When this "freezing" happens, a person is no longer able to release a tool, wire, or other object. In fact, the electrified object may be held even more tightly, resulting in longer exposure to the shocking current. For this reason, handheld tools that give a shock can be very dangerous. If the welder can't let go of the tool, current continues through the body for a longer time, which can lead to respiratory paralysis (the muscles that control breathing cannot move). The person will stop breathing for a period of time. People have stopped breathing when shocked with currents from voltages as low as 49 volts. Usually, it takes about 30 mA of current to cause respiratory paralysis.

   Currents greater than 75 mA cause ventricular fibrillation (very rapid, ineffective heartbeat). This condition will cause death within a few minutes unless a special device called a defibrillator is used to save the victim. Heart paralysis occurs at 4 A, which means the heart does not pump at all. Tissue is burned with currents greater than 5 A.

2. The table shows what usually happens for a range of currents (lasting one second) at typical household voltages. Longer exposure times increase the danger to the shock victim. For example, a current of 100 mA applied for 3 second is as dangerous as a current of 900 mA applied for a fraction of a second (0.03s). The muscle structure of the person also makes a difference. People with less muscle tissue are typically affected at lower current levels. Even low voltages can be extremely dangerous because the degree of injury depends not only on the amount of current but also on the length of time the body is in contact with the circuit.

Current.	Current Reaction on Body
1 mA	Just a faint tingle
5 mA	Slight shock felt. Disturbing, but not painful. Most people can "let go."However, strong involuntary movements can cause injuries.
6 - 25 A (women)	Painful shock. Muscular control is lost. This is the range where "freezing currents" start. It may not be possible to let go.
9 - 30 mA (men)	Painful shock. Muscular control is lost. This is the range where "freezing currents" start. It may not be possible to let go.
50 -150 mA	Extremely painful shock, respiratory arrest (breathing stops), severe muscle contractions. Flexor muscles may cause holding on; extensor muscles may cause intense pushing away. Death is possible
1,000 - 4,300 mA	Ventricular fibrillation (heart pumping action not rhythmic) occurs. Muscles (1-4.3 A) contract; nerve damage occurs. Death is likely.
10,000 mA	Cardiac arrest and severe burns occur. Death is probable. (10 A)
15,000 mA	Lowest overcurrent at which a typical fuse or circuit breaker opens a circuit! (15A)

The electrode and work (or ground) circuits are electrically "hot" when the welding power source is on. In semiautomatic or automatic MIG/MAG welding, the electrode, electrode spool, welding head, nozzle or semiautomatic welding gun are also electrically "hot".

The hazard of electric shock is one of the most serious and immediate risks facing a welder. Contact with metal parts which are "electrically hot" can cause injury or death because of the effect of the shock upon the body or a fall which may result from the reaction to the shock.

The electric shock hazard associated with arc welding may be divided into two categories which are quite different:

- Primary Voltage Shock (i.e., 230, 460 V); and
- Secondary Voltage Shock (i.e., 20-100 V).

The primary voltage shock is more hazardous because it is much greater voltage than the secondary voltage of the Power Source. The Welder can receive a shock from the primary (input) voltage if he touches a lead inside the welding power source with the power to the welder "on" while the Welder has his body or hand on the welding power source case or other grounded metal. The Welder must remember that turning the welding power source's power switch "off" does not turn the power off inside the welding power source. To turn the power inside the welder "off", the input power cord must be unplugged or the power disconnect switch turned off. The fixed panels from the welder should never be removed; in fact, it is better to have a qualified technician repair the welder if it isn't working properly. Also, the welding power source should be installed by a qualified electrician so it will be correctly wired for the primary voltage which supplies it power and so the case will be connected to an earth ground.

Utilizing proper grounding in the welding environment must be done, though it does not remove all possibility of electrical shock. The welding circuit is energized by welding voltage. A person will receive a shock if he becomes a part of the electrical path across the welding circuit. Precautions must be taken to insulate the Welder from the welding circuit by using Personal Protecting Equipment and definitely dry insulating gloves and other insulating means and maintaining insulation on weld cables, electrode holders, guns and torches to provide protection.

Similarly, electric shock originating from the electrical supply system must be prevented. Proper maintenance of electrical equipment and extension cords will insulate the welder from electrical sources. These "hot" parts in touch with bare skin or wet clothing of a welder cause shock.

Grounding and Arc Welding Safety

What does Grounding have to do with Arc Welding Safety?

Grounding of electrical circuits is a safety practice that is documented in various codes and standards (see Additional Safety Information). A typical arc welding setup may consist of several electrical circuits. Applying and maintaining proper grounding methods within the welding area is important to promote electrical safety in the workplace. Associated processes such as plasma cutting will also benefit from proper grounding.

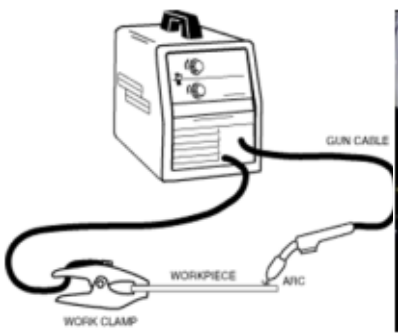
Welding Machine Ground

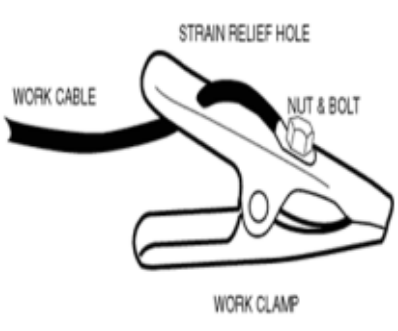
Welding machines that utilize a flexible cord and plug arrangement or those that are permanently wired into an electrical supply system contain a grounding conductor. The grounding conductor connects the metal enclosure of the welding machine to ground. If we could trace the grounding wire back through the electrical power distribution system we would find that it is connected to earth, and usually through a met

The purpose of connecting the equipment enclosure to ground is to ensure that the metal enclosure of the welding machine and ground is at the same potential. When they are at the same potential, a person will not experience an electrical shock when touching the two points. Grounding the enclosure also limits the voltage on the enclosure in the event that insulation should fail within the equipment.

The current carrying capability of the grounding conductor is coordinated with the over current device of the electrical supply system. The coordination of ampacity allows the grounding conductor to remain intact even if there is an electrical fault within the welding machine.

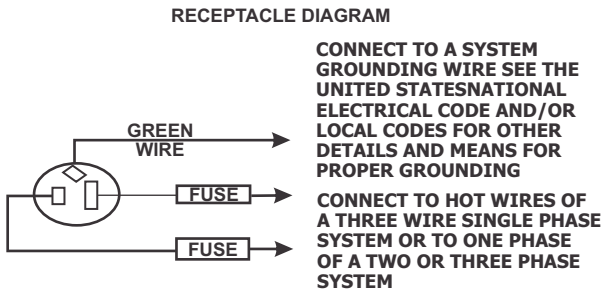
Some welding machines may have a double insulated design. In this case, a grounding conductor connection is not required. This type of welding machine relies on extra insulation to protect the user from shock. When double insulation is present it is identified by a "box within a box" symbol on the rating plate.





For small welding machines that utilize a plug on the end of a power cord, the grounding conductor connection is made automatically when the welding machine is plugged into the receptacle. The grounding pin of the plug makes a connection within the receptacle. The use of adapters that effectively remove the grounding pin connection at the plug is not recommended.

Receptacle circuit testers will easily check the continuity of the grounding conductor. Receptacle circuit testers for 120 V circuits are available at electrical supply or hardware stores; these inexpensive test devices plug into an electrical outlet. Indicator lights show whether the grounding circuit is available at the outlet, as well as other circuit tests. If the test device shows the absence of a ground connection or other circuit problem, call a qualified electrician for assistance. This is a simple test and should be done periodically. Consult with a qualified electrician to test circuits greater than 120 V.



Workpiece Ground

The welding circuit consists of all conductive material through which the welding current is intended to flow. Welding current flows through the welding machine terminals, welding cables, workpiece connection, gun, torch, electrode holder and workpiece. The welding circuit is not connected to ground within the welding machine, but is isolated from ground. How do we ground the welding circuit?

According to ANSI Z49.1, "Safety in Welding, Cutting and Allied Processes," the workpiece or the metal table that the workpiece rests upon must be grounded. We must connect the workpiece or work table to a suitable ground, such as a metal building frame. The ground connection should be independent or separate from the welding circuit connection.

Grounding the workpiece has similar benefit to grounding the welding machine enclosure. When the workpiece is grounded, it is at the same potential as other grounded objects in the area. In the event of insulation failure in the arc welding machine or other equipment, the voltage between the workpiece and ground will be limited. Note that it is possible to have an ungrounded workpiece, but this requires the approval of a qualified person.

The Workpiece Connection is not a Ground Clamp

"Ground clamp" and "ground lead" are common terms used by many welders. The workpiece is connected to a welding cable typically by means of a spring loaded clamp or screw clamp. Unfortunately, a workpiece connection is often incorrectly called a "ground clamp" by many welders and the workpiece lead is incorrectly called "ground lead." The welding cable does not bring a ground connection to the workpiece. The ground connection is separate from the workpiece connection.

High Frequency Ground

Some welding machines utilize starting and stabilizing circuits that contain a high frequency voltage. This is common on Tungsten Inert Gas (TIG) welding machines. The high frequency voltage may have frequency components that extend into the megahertz region. In contrast, the welding voltage may be as low as 60 Hz.

One method to minimize the radiation of high frequency signals is to ground the welding circuit.

Portable and Vehicle Mounted Welding Generator Grounding

Portable and vehicle mounted arc welding generators often have the capability to supply 120 and 240 V auxiliary power. These generators are used in remote locations away from an electrical power distribution system. A convenient earth ground is not usually available for connection. Should the generator frame be grounded?

The rules for grounding depend on the specific use and design of the auxiliary power generator. Most applications fall into one of the two categories summarized below:

1. If all of these requirements are met, then it is not required to ground the generator frame:
   - ❖ The generator is mounted to truck or trailer
   - ❖ The auxiliary power is taken from receptacles on the generator using a cord and plug arrangement
   - ❖ The receptacles have a grounding pin
   - ❖ The frame of the generator is bonded, or electrically connected, to the truck or trailer frame
2. If neither of these conditions are met, then the generator frame must be grounded:
   - ❖ The generator is connected to a premises wiring system. For example, to supply power to a house during a blackout.
   - ❖ The auxiliary power is hard wired into the generator without the use of cords and plugs.

Extension Chord Grounds

Extension chords should be periodically tested for ground continuity. Extension cords lead a rough life while lying on the ground; they are under foot and prone to damage. The use of a receptacle circuit tester will confirm that all of the connections are intact within the cord, plug and receptacle.

INSPECTION AND MAINTENANCE OF EQUIPMENT AND WORK

- ❍ Before starting any arc welding operation, you should make a complete inspection of your equipment.
  - ❖ Have you read the instruction manual and do you understand the instructions?
  - ❖ Have you read the warnings and instructions on the equipment nameplates and decals as well as the consumables labels and material safety data sheets?
- ❍ For the welding power source:
  - ❖ Are all the connections tight, including the earth ground?
  - ❖ OSHA regulations require output terminals to be insulated. Rubber boots are available for that purpose.
  - ❖ Are the electrode holder and welding cable well insulated and in good condition?
  - ❖ Are the settings correct for the job you're about to begin?
- ❍ For an engine-driven welder:
  - ❖ Is it running OK?
  - ❖ Are the cables the right size for your job? Be sure any damaged cable insulation is repaired.
  - ❖ Are they spread out and run neatly to prevent overheating?
  - ❖ Is the Work Lead connected securely?
  - ❖ Is there enough dry insulation between your body and the work piece?
  - ❖ Is there adequate ventilation in your work area?

TEN COMMANDMENDS

- ❍ BE SURE you are insulated from live electrical parts.
- ❍ BE SURE equipment is adequate for the job.
- ❍ BE SURE equipment is installed according to prevailing codes.
- ❍ BE SURE damaged parts are repaired or replaced.
- ❍ BE SURE welding machine is properly grounded.
- ❍ BE SURE gloves have no holes.
- ❍ BE SURE to stay dry; do not weld when you are wet.
- ❍ BE SURE equipment is turned OFF when not in use.
- ❍ DO NOT use cables that are too small, damaged, or poorly spliced.
- ❍ DO NOT wrap cables around your body.

Electric and Magnetic Fields

Electric current flowing through any conductor causes

localized Electric and Magnetic Fields (EMF). Welding current create EMF fields around welding cables and welding machines. EMF fields may interfere with some pacemakers, and welders having a pacemaker should consult their physician before welding.

All welders should use the following procedures in order to minimize exposure to EMF fields from the welding circuit:

- Route the electrode and work cables together – Secure them with tape when possible.
- Never coil the electrode lead around your body.
- Do not place your body between the electrode and work cables. If the electrode cable is on your right side, the work cable should also be on your right side.
- Connect the work cable to the workpiece as close as possible to the area being welded.
- Do not work next to welding power source.

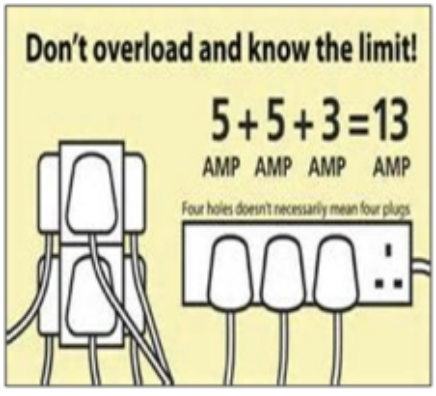
HIGH VOLTAGE can kill.

- Do not operate with covers removed.
- Disconnect input power before servicing.
- Do not touch electrically live parts.
- When electrical supply lines are connected to a welder, check the welder capacity nameplate and connection instructions to be sure the input is the correct phase (single phase or three phase) and voltage. Many welders may be set up for single phase or three phase and for multiple input voltages.
- Be certain the welder is set up for the electrical supply to which it is connected. Only a qualified electrician should connect input power. The case must be grounded so that if a problem develops inside the welder a fuse will blow, disconnecting the power and letting you know that repair is required. Never ignore a blown fuse because it is a warning that something is wrong.
- If welding must be performed under electrically hazardous conditions (in damp locations or while wearing wet clothing; on metal structures such as floors, gratings or scaffolds; when in cramped positions such as sitting, kneeling or lying, if there is a high risk of unavoidable or accidental contact with the work piece or ground) use the following equipment:
  - Semiautomatic DC Constant Voltage Welder
  - DC Manual (Stick) Welder
  - AC Welder with Reduced Voltage Control
- A secondary voltage shock occurs when you touch a part of the electrode circuit — perhaps a bare spot on the electrode cable — at the same time another part of your body is touching the metal upon which you're welding (work). To receive a shock your body must touch both sides of the welding circuit — electrode and work (or welding ground) — at the same time. To prevent secondary voltage shock, you must develop and use safe work habits.
- Remember the voltage at the electrode is highest when you are not welding (open circuit voltage).
  - Wear dry gloves in good condition when welding.
  - Do not touch the electrode or metal parts of the electrode holder with skin or wet clothing.
  - Keep dry insulation between your body (including arms and legs) and the metal being welded or ground (i.e., metal floor, wet ground).
  - Keep your welding cable and electrode holder in good condition. Repair or replace any damaged insulation.

PRE-OPERATIONAL SAFETY CHECKS

- Locate and ensure you are familiar with all machine operations and controls.
- Check workspaces and walkways to ensure no slip/trip hazards are present.
- Ensure the work area is clean and clear of grease, oil and any flammable materials.
- Keep the welding equipment, work area and your gloves dry to avoid electric shocks.
- Ensure electrode holder and work leads are in good condition.
- Ensure other people are protected from flashes by closing the curtain to the welding bay or by erecting screens.

Use Miniature Circuit Breakers in all the Incoming Power Terminals for each Power source



OPERATIONAL SAFETY CHECKS

- Keep welding leads as short as possible and coil them to minimise inductance.
- Ensure work return earth cables make firm contact to provide a good electrical connection.
- Ensure the electrode holder has no electrode in it before turning on the welding machine.
- Ensure current is correctly set according to electrode selection.

ENDING OPERATIONS AND CLEANING UP

- Switch off the machine and fume extraction unit when work is completed.
- Remove electrode stub from holder and switch off power source.

Hang up electrode holder and welding cables. Leave the work area in a safe, clean and tidy state.

ADDITIONAL SAFETY INFORMATION

"Precautions and Safe Practices for Arc Welding, Cutting and Gouging", Form 52-529.

The following publications, which are available from the American Welding Society are recommended :

1. ANSI/ASC Z49.1 - "Safety in Welding and Cutting"
2. AWS C5.1 - "Recommended Practices for Plasma Arc Welding"
3. AWS C5.2 - "Recommended Practices for Plasma ArcCutting"
4. AWS C5.3 - "Recommended Practices for Air Carbon Arc Gouging and Cutting"
5. AWS C5.5 - "Recommended Practices for Gas Tungsten Arc Welding"
6. AWS C5.6 - "Recommended Practices for Gas Metal Arc Welding""
7. AWS SP - "Safe Practices" - Reprint, Welding Handbook.
8. ANSI/AWS F4.1, "Recommended Safe Practices for Welding and Cutting of Containers That Have Held Hazardous Substances
9. American Welding Society, ANSI Z49.1:2005 "Safety in Welding, Cutting, and Allied Processes."
10. National Fire Protection Association, NFPA 70, "National Electrical Code", 2005.
11. American Welding Society, Safety and Health Fact Sheet No. 29, "Grounding of Portable and Vehicle Mounted Welding Generators", July 2004.
12. American Welding Society, AWS A3.0-2001, "Standard Welding Terms and Definitions."
13. ANSI/NFPA 70, "National Electrical Code" for the specifics.