

<b>Welding and Cutting</b>	S.O.P. 3F		Page 1 of 12
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STANDARD OPERATING PROCEDURE			

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### **I. SCOPE AND PURPOSE**

- A. The purpose of this policy is to protect workers from injury and illness and to protect property from damage by fire and other causes resulting from welding and cutting.
- B. These procedures shall be followed whenever personnel of the Company perform welding and cutting operations.

### **II. RELATED PROCEDURES AND RESOURCES**

- A. S.O.P. 3G, Personal Protective Equipment
- B. S.O.P. 3H, Permit-Confined Spaces
- C. S.O.P. 3I, Fire Prevention
- D. S.O.P.3O, Fall Hazard Management
- E. S.O.P. 5F, Respiratory Protection
- F. S.O.P. 5G, Hazard Communication
- G. 29 CFR 1910.253, Oxygen-fuel gas welding and cutting
- H. 29 CFR 1910.254, Arc welding and cutting
- I. 29 CFR 1926.351, Arc welding and cutting
- J. USAS Z49.1-1967, Safety in Welding and Cutting

### **III. PERSONNEL RESPONSIBILITY**

- A. Supervisor
  - 1. It is the supervisor's responsibility to read and understand this policy, which will provide him/her with the knowledge to recognize hazards and safe work practices to be followed during welding and cutting operations.
  - 2. To enforce the procedures in this policy, which will ensure compliance with this S.O.P.
  - 3. To ensure employees receive training on required topics.
  - 4. To conduct documented monthly inspection and mark all welding cables, leads, hoses and attachments associated with their use on a quarterly basis using Appendix Form 2C.2a, Quarterly Inspections Color Code Chart. The supervisor may designate an employee to conduct these inspections.
- B. Employee
  - 1. It is the employee's responsibility to follow the safe work practices outlined in this S.O.P.
  - 2. To report any recognized hazards associated with welding and cutting to his/her supervisor.
  - 3. To conduct daily visual inspections of all welding cables, leads and hoses and attachments prior to using them.
- C. Logistical Support
  - 1. It is the responsibility of Logistics Support to conduct documented inspections upon receipt and shipping of welding cables, leads, hoses and attachments.

**NOTE:** All welding cables, leads and hoses shall be marked immediately before being shipped for next field job. The Operators Manual and any grounding equipment (i.e., grounding rods, clamps, wire, etc.) shall be shipped to field jobs with the welding machine.

### **IV. PERSONAL PROTECTIVE EQUIPMENT**

- A. Minimum Safety Equipment - Welders
  - 1. When welding and cutting eye protection shall be worn as defined in Tables 3F.1a and 3F.1b.
  - 2. Minimum of a long sleeve shirt (not of polyester or rayon) or welding leathers and welder's gloves to provide hand and arm protection.
  - 3. Sturdy work shoes as per S.O.P. 3G (V).
  - 4. All Welding operations shall be performed with a hood attached to a hardhat. It is acceptable for "bill backward" if the hood is on the hardhat, unless otherwise required by our customer or facility owner. If the hood is not on the hardhat, the hard hat will be worn "bill forward". Hood shades as per Tables 3F.1a and 3F.1b shall be utilized for all welding operations.
  - 5. All Cutting operations shall be performed with cutting goggles or shields with a minimum number five (5) shade.
  - 6. Clear face shields are required when cutting overhead, if the eye protection chosen does not already include a face shield.

7. Wearing jewelry is prohibited as per S.O.P. 3G (IV)(F), e.g., watches, necklaces, and body rings of any type. Personnel needing Medical ID tags shall take necessary action against hazardous energy, i.e., electric shock.
- B. Minimum Safety Equipment - Fitters:
1. Long sleeve shirts (not of polyester or nylon) or welding leathers.
  2. Welder's gloves.
  3. Safety glasses with side shields.
  4. Sturdy work shoes as per S.O.P. 3G (V).
  5. Wearing jewelry is prohibited as per S.O.P. 3G (IV)(F), e.g., watches, necklaces, and body rings of any type. Personnel needing Medical ID tags shall take necessary action against hazardous energy, i.e., electric shock.

**NOTE:** Periodically check welding hoods to ensure "light-tight" since welding operations emit intense ultraviolet radiation. Additional PPE, such as Respiratory Protection, flash protection, or goggles may be required in some areas.

## **V. FIRE PREVENTION AND PROTECTION**

- A. Basic Fire Precautions
1. Flammable waste shall be removed from areas where cutting sparks and slag are generated in the course of oxygen cutting.
  2. When possible move the object to be welded or cut to a designated safe location.
  3. If the object to be welded or cut cannot be moved, remove all fire hazards from the vicinity.
  4. If the object to be welded or cut and the fire hazards cannot be moved, then guards shall be used to confine the heat, sparks and slag, and protect the immovable fire hazards. (See Special Fire Precautions)
  5. If the rules stated in the above cannot be followed then welding and cutting shall not be performed.
- B. Special Fire Precautions
1. Sweep with broom combustible floors and protect with fire blankets.
  2. Provisions shall be made to protect welders from the hazard of shock when floors are wet.
  3. Wherever there are floor openings or cracks in the flooring that cannot be closed, precautions shall be taken to limit the exposure to sparks that might drop through the floor. The same precautions shall be observed with regard to cracks or holes in walls, open doorways and open or broken windows.
  4. A Firewatcher is required when welding or cutting is performed.
  5. Suitable fire extinguishing equipment shall be maintained in a state of readiness and located near the work area for instant use.

## **VI. PROHIBITED PRACTICES**

- A. No welding, cutting, or other hot work shall be performed on used drums, barrels,

tanks or other containers until they have been cleaned so thoroughly as to make absolutely certain that there are no flammable materials present or any substance such as greases, tars, acids or other materials, which subjected to heat, might produce flammable or toxic vapors. Any pipelines or connections to the drum or vessel shall be disconnected or blanked.

**NOTE:** The owner or their representatives shall approve welding or cutting task on equipment, vessels, valves, nipples or piping that holds the potential of affecting industrial processes with in the paper/pulp, power, marine or petrochemical industry.

## **VII. VENTILATION**

- A. Ventilation for General Welding and Cutting
  - 1. Consult with a safety representative of the company to determine ventilation requirements. The following factors shall be considered:
    - a. Dimension of space in which welding and cutting is to be done (with special regard to height of ceiling).
    - b. Number of welders and cutters.
    - c. Possible evolution of hazardous fumes, gases or dust according to the metals involved.
    - d. Atmospheric conditions.
    - e. Heat generated.
    - f. Presence of volatile solvents.
  - 2. Mechanical ventilation shall be provided when welding or cutting under the following conditions:
    - a. A space of less than 10,000 cu. ft. per welder.
    - b. A room having a ceiling height of less than 16 ft.
    - c. Confined spaces or where the welding space contains partitions, balconies or other structural barriers to the extent that they significantly obstruct cross ventilation.
  - 3. Natural ventilation is considered sufficient for welding or cutting operations where restrictions in section (VII)(A)(1) are not present.
- B. Beryllium
  - 1. Welding or cutting indoors, outdoors or in confined spaces involving beryllium, containing base or filler metals, shall be done using local exhaust ventilation and air-line respirators unless atmospheric tests have established that the workers' exposure is within the acceptable concentrations defined by the United States of America Standards Institute or the American Conference of Governmental Industrial Hygienist.
  - 2. Workers in the immediate vicinity of the welding or cutting operations shall be protected as necessary by local exhaust ventilation or airline respirators.
- C. Cadmium
  - 1. Welding or cutting indoors, outdoors or in confined spaces involving cadmium-bearing or cadmium-coated base metals shall be done using local exhaust ventilation and air-line respirators unless atmospheric tests

have established that the workers' exposure is within the acceptable concentrations defined by the United States of America Standards Institute or the American Conference of Governmental Industrial Hygienist.

2. Outdoors such operations shall be done using respiratory protective equipment such as fume respirators approved by the U S Bureau of Mines.
  3. Welding involving cadmium-bearing filler metals shall be done using freely movable hoods, airline respirators or hose masks.
- D. Lead
1. Welding and cutting on suspected lead containing surfaces and/or material is prohibited. The following shall be utilized if the metal or surface preparations are unknown or if there is reasonable suspicion of containing lead.
    - a. Contact client for material verification.
    - b. Request past sample data.
    - c. Sample
  2. Lead containing material shall be abated a minimum of 18 inches from any surface preparation containing lead. Personnel are required to follow S.O.P. 7A, Abrasive Blasting and S.O.P. 8C, Lead Abatement.

## **VIII. CONFINED SPACES**

- A. All welding and cutting operations in confined spaces shall be adequately ventilated to prevent the accumulation of toxic materials or possible oxygen deficiency. This applies not only to the welder but also to helpers and other personnel in the immediate vicinity. Ventilation or respiratory protection is a prerequisite to work in confined spaces.
  1. Where it is impossible to provide ventilation, MSHA approved airline respirators shall be used.
  2. Replacement air shall be clean and respirable.
  3. In areas immediately dangers to life and health (IDLH), MSHA approved airline respirators or self-contained breathing apparatus (SCBA) shall be used.
- B. Gas cylinders and welding machines shall be left outside the confined space.
- C. Emergency rescue equipment shall be available for quick rescue.
- D. A confined space attendant shall be stationed outside the confined space to observe the welder at all times, and be capable of putting rescue operations into effect.
- E. After welding operations are completed, the welder shall mark the hot metal or provide some other means of warning other workers.

## **IX. HANDLING, STORAGE AND OPERATIONS OF COMPRESSED GAS CYLINDERS**

- A. Handling Cylinders
  1. When taking empty cylinders out of service, the cylinder valve shall be

closed.

2. Valve protection caps shall always be in place, hand tight, except when cylinders are in use or connected for use.
3. Cylinders shall not be placed where they may become part of an electric circuit. Avoid contact with third rails, trolley wires, etc. Cylinders shall be kept away from radiators, piping systems, layout tables, etc., that may be used for grounding electric circuits. Any practice such as the tapping of an electrode against a cylinder to strike an arc is prohibited.
4. To keep cylinders from being knocked over while in use, suitable cylinder truck, chain or steadying device shall be used.
5. Slings or electric magnets shall not be used when transporting cylinders by a crane or derrick. Valve caps, shall always be in place where cylinders are designed to accept a cap.
6. When cutting is performed above other workers, suitable protection shall be provided to prevent injury from falling sparks, slag or molten metal to those below the cutting operation, e.g., welding blankets.

B. General Storage of Cylinders

1. Cylinders shall be kept away from sources of heat.
2. Cylinders shall be stored in well protected, well ventilated, dry locations, at least 20 feet away from highly combustible materials, e.g., oil, gasoline, etc.
3. Cylinders shall be sorted and in assigned places away from elevators, stairs or gangways, with appropriate signage designating the area as cylinder storage.
4. Storage spaces shall be located where cylinders will not be knocked over or damaged by passing or falling objects, or subject to tampering with by unauthorized personnel.
5. Cylinders of oxygen and fuel-gas shall be used in rotation as received from the supplier.
6. Empty cylinders shall have their valve closed.

C. Storage of Fuel-Gas Cylinders

1. Acetylene is unstable and potentially explosive under certain conditions. Precautions when dealing with it include:
  - a. Limit regulators to a maximum of 12-psi delivery pressures. This must be accomplished thorough the use of commercially available regulators.
  - b. Always use and store in the vertical position.
  - c. At no time shall the withdrawal rate of an individual acetylene cylinder exceed 1/7<sup>th</sup> of the cylinder contents per hour. If additional flow capacity is required, as in multi-flame heating nozzle use, it may be necessary to use a different fuel gas.
  - d. Any time regulators are pressured up; the handle must be in place on the acetylene bottle.
  - e. Open cylinders a maximum of one complete turn.
2. MAPP gas is a stabilized mixture of methyl-acetylene and has

- considerably fewer tendencies to backfire than acetylene.
3. Maximum allowable use pressure is 94 psig.
- D. Storage of Oxygen Cylinders
1. Pure oxygen accelerates combustion. Oil, grease, and other flammables become highly explosive in the presence of oxygen. To avoid this condition, dedicated regulators must be used for oxygen cylinders.
- E. Setting Up Equipment
1. Ensure all connections are free of dirt, dust, oil, or grease.
  2. Ensure there is no tension on the regulator adjusting screws.
  3. Ensure the use of a dedicated regulator for oxygen, as stated above.
  4. Slowly open fuel gas cylinder valve (maximum of one (1) turn for acetylene, completely open for MAPP gas).
  5. Check all connections for leaks.
- F. Lighting the Torch
1. Open the oxygen valve on the torch handle and adjust the oxygen regulator to the desired pressure.
  2. Allow gas to flow (10 seconds for every 50 feet of hose).
  3. Close oxygen valve on the torch.
  4. With the tension released on the regulator adjustment screw, open cylinder fuel valve (maximum one (1) turn for acetylene, full open for MAPP gas).
  5. Open the fuel gas valve on the torch and adjust the fuel gas regulator to the desired setting.
  6. Allow gas to flow (10 seconds for every 50 feet of hose).
  7. Close the torch fuel control valve.
  8. Holding the torch in one hand and the striker in the other; open the torch fuel valve about one-half turn and ignite the gas.
  9. Keep opening the fuel valve until the flame stops smoking and leaves the end of the tip about 1/8 inch, then slightly reduce the fuel supply to bring the flame back to the tip
  10. Open torch oxygen valve until a bright neutral flame is observed.

**NOTE:** If backfire or flashback occurs, immediately turn off the oxygen valve then the fuel valves. Repeat above steps.

- G. Shutting off the Torch
1. Shut off the torch oxygen valve then the fuel valve.
  2. Close both cylinder valves.
  3. Open the torch oxygen valve and release the pressure in the system, then close valve.
  4. Release the adjusting screw on the regulator.
  5. Repeat steps 3 and 4 for the fuel system.
- H. General Maintenance Welding and Cutting Operations
1. Cylinders, cylinder valves, couplings, and regulators shall be kept free from oily or greasy substances.
  2. Oxygen cylinders shall not be handled with oily hands or gloves.
  3. Oxygen must never be permitted to strike oily surface, greasy clothes, or

- enter a fuel oil or other storage tank.
4. No welding, cutting or other hot work shall be performed on used drums, barrels, tanks or other containers until they have been thoroughly cleaned, as to make certain that there are no flammable materials present or any substances that when subjected to heat may produce flammable or toxic vapors.

## **X. ARC WELDING REQUIREMENTS**

### **A. General Requirements**

1. When using welding power sources driven by internal combustion engines, exhaust shall be vented out doors so not to create a carbon monoxide hazard.
2. Welders shall wear welding hoods that attach directly to hard hats, so that head protection may be worn at all times. Refer to section (IV) of this S.O.P.
3. When changing electrodes, keep yourself insulated from ground or metal objects. Do not leave a rod in the electrode holder when you lay it down.
4. Goggles or safety glasses, accompanied with a face shield, shall be worn during any chipping, cleaning or grinding of metal or weldments.
5. Never weld any pipeline, tank or portable container without first obtaining positive proof that it has been properly cleaned.
6. Employees shall not weld to, or weld close to, a conduit carrying live electric wire.
7. No electrical welding machine, either AC or DC, shall be operated until the machine is properly case-grounded. Case-grounding requires one end of a stranded copper bonding cable no smaller than "0" to be fastened to the case of the welder and the other end to a driven ground rod or a ground grid system.
8. Fuel-powered welding machines shall be properly case-grounded, in addition to the work ground, anytime a power tool of any kind is powered from the welder.
9. An electrode holder of adequate rated current capacity; insulated against shock and shorting or flashing when laid on grounded materials, shall be used. The pigtail (whip/stinger) shall be at least six feet long.
10. When electrode holders are to be left unattended, the electrode shall be removed and the holder shall be placed or protected so that they cannot make electrical contact with employees or conducting objects.

### **B. Grounding**

1. The frame or case of the welding machine (except engine driven machines) shall be grounded under the conditions and according to the methods prescribed in the National Electrical Code, USA Standard CI-1965, Article 630, Electric Welders.
2. The work or metal upon which the operator welds shall be grounded to a good electrical ground. This can be done by locating the work on a grounded metal floor or platen or by connection to a grounded building

frame or other satisfactory ground. Alternatively it may be done by grounding the work lead at or near the welding machine. Care shall be taken, however, to avoid double grounding as otherwise welding current may flow through a connection intended only for safety grounding and may be of higher magnitude than the grounding conductor can safely carry.

3. Welding current preferably shall be returned to the welding machine by a single cable from the work to the welding machine. Connection of a cable from the welding machine to a common conductor or structure on which the work rests, or to which the work is connected, is a permissible procedure.
4. Conduits containing electrical conductors shall not be used for completing a work lead circuit. Pipe lines shall not be used as a permanent part of a work lead circuit, but may be used during construction, extension or repair providing current is not carried through threaded joints, flanged bolted joints or caulked joints and that special precautions are used to avoid sparking at connection of the work lead cable.
5. Chains, wire ropes, cranes, hoists and elevators shall not be used to carry welding current.
6. During construction or modification, a building or any other fabricated metal structure that is used for a welding current return circuit, shall be checked to determined whether proper electrical contact exists at all joints. Sparking or heating at any point shall cause rejection of the structure as a return circuit.
7. All ground connections shall be checked to determine that they are mechanically strong and electrically adequate for the required current.
8. When it becomes necessary to carry cables some distance from the machines, if practicable they shall be substantially supported overhead. If this cannot be done, and cables are laid on the floor or ground, they shall be protected in such a manner that they will not be damaged, entangled or interfere with safe passage.
9. For individual welding machines, the rated current-carrying capacity of the supply conductors shall not be less than the rated primary current of the welding machines.

C. Operation and Maintenance

1. Before starting operations, all connections to the machine shall be checked to make certain they are properly made. The work lead shall be firmly attached to the work. Coiled welding cable shall be spread out before use to avoid serious overheating and damage to insulation.
2. Grounding of the welding machine frame shall be checked with special attention given to safety ground connections of portable machines.
3. There shall be no leaks of cooling water, shielding gas or engine fuel.
4. Printed rules and instructions covering operation of equipment, supplied by the manufacturers, shall be strictly followed.
5. When the welder has occasion to leave his work or stop work for any appreciable time, or when the machine is to be moved, the power supply

switch in the equipment shall be open. The equipment shall be disconnected from the source of power when not in use.

6. Metal and carbon electrodes shall be removed from holders when not in use to eliminate danger of electrical contact with persons or conducting objects. Tungsten electrodes shall be removed or retracted within holders. Electrodes in wire form, in semi-automatic holders shall be retracted or cut off to remove possibility of contact. Electrode holders when not in use shall be placed so that they cannot make electrical contact with persons, conducting objects, fuel or compressed gas tanks.
7. The operator shall report any equipment defect or safety hazard to his/her supervisor.
8. Welding equipment used in the open shall be protected from inclement weather conditions. Protective cover shall not obstruct the ventilation necessary to prevent overheating of the machine.
9. Work and electrode lead cables shall be frequently inspected for wear and damage. Cables with damaged insulation or exposed bare conductors shall be replaced. Joining lengths of work and electrode cables shall be done by the use of connecting means specifically intended for the purpose. The connecting means shall have insulation adequate for the service conditions.
10. Welding cables shall be kept dry and free from grease and oil.

D. Electric Shock

1. Avoidance of electric shock is largely within the control of the welder, therefore, it is especially important that he be thoroughly instructed in detail how to avoid shock. Because most contacts required for welding voltages have not caused severe injury or electric shock, parts having these voltages are liable to be handled carelessly. These voltages are nevertheless sufficiently high that, under some circumstances, they may be dangerous to life. Even mild shocks, not dangerous in themselves from normal working voltage or from high frequency stabilizers, can cause involuntary muscular contraction, leading to injurious falls from high places. Generally the path and amount of current flowing through the body determine the severity of shock. The voltage and contact resistance of the area of skin involved determine this. Clothing damp from perspiration or wet working conditions may so reduce contact resistance as to increase an imperceptible current to a value high enough to cause such violent muscular contraction as to prevent the welder from letting go of the live part.
2. The welder shall never permit the live metal parts of an electrode holder to touch his bare skin or any wet covering on his body. Adequately dry gloves are also recommended. He shall not use electrode holders for manual shielded metal-arc welding without well-insulated jaws in good repair. Whenever changing electrodes in gas tungsten-arc electrode holders, or whenever threading coiled electrodes into gas metal-arc equipment, the welding machine supplying power to the arc, must always be turned off. Special precautions shall be taken to prevent shock-induced

falls when the welder is working above ground level (refer to S.O.P. 30, Fall Hazard Management). Cables with splices within 10 ft. of the holder shall not be used.

## **XI. CAPACITOR DISCHARGE STUD WELDER**

- A. Capacitor Discharge vs. Arc Stud Welding
  - 1. The Capacitor Discharger (CD) stud welding process produces power through a rapid discharge of stored energy from a bank of capacitors. This stored energy is usually derived from a standard 110 or 120 volt AC source. CD stud welding, as a general rule, is used for studs 5/16" and less in diameter, for thin base metals and where dissimilar metals are to be jointed.
  - 2. The ARC stud welding process produces weld power through one of three standard DC welding power sources. These are Transformer-Rectifier type, Motor/Generator type, or Storage Battery type. A ceramic ferrule is required in ARC welding to maintain the proper atmosphere in the weld area. ARC stud welding is generally used for studs over 1/4" in diameter or where heavier base metals are involved.
- B. Equipment Pre-Qualification Testing
  - 1. All cords, leads and associated equipment shall be inspected as defined in this S.O.P. under Section III (A)(4), (B)(3) and (C)(1).
  - 2. Several pre-qualification test welds may be needed to adjust equipment to make a satisfactory weld.
    - a. The pre-qualification test welds set voltage on machine between 100-130. The leg on gun should be set where 1/8" of pin is sticking out past the spark shield. Touch pins to prepared area and press gun lightly until spark shield is flush with base, then pull trigger. Weld takes only milliseconds to complete.
    - b. Inspect pre-qualification weld for quality by bending pin to at least 45-degree angle. Weld should show no visible signs of cracking or separation.
    - c. Increase or decrease welding machine voltage as needed to attain proper weld, prior to proceeding to equipment qualification.
- C. Equipment Qualification
  - 1. Equipment qualification is necessary to ensure the proper function of welded connections made.
- D. Setup
  - 1. The set up of a capacitor discharge welder consist of CD Welding Machine, AC Power Cord, and Ground Cable with Clamp, Control Cable, Weld Cable, and Contact Gun.
    - a. Connect AC Cord to proper supply; 110 volts is standard with few exceptions.
    - b. Attach Gun Cables to negative outlet on CD Weld Machine.
    - c. Connect Contact Gun to Control and Weld Cables.
    - d. Connect Ground Cable to positive outlet on CD Machine;

attaching Ground Clamp to a clean area of the work piece.

E. Metal Preparation

1. Prior to welding, surface area will be thoroughly cleaned to accommodate CD weld pins.

### Filter Lenses for Protection Against Radiant Energy

Operations	Electrode Size 1/32 in.	Arc Current	Minimum(*) Protective Shade
Shielded metal arc welding	Less than 3	Less than 60	7
	3-5	60-160	8
	5-8	160-250	10
	More than 8	250-550	11
Gas metal arc welding and flux cored arc welding		less than 60	7
		60-160	10
		160-250	10
		250-500	10
Gas Tungsten arc welding		less than 50	8
		50-150	8
		150-500	10
Air carbon Arc cutting	(Light)	less than 500	10
	(Heavy)	500-1000	11
Plasma arc welding		less than 20	6
		20-100	8
		100-400	10
		400-800	11
Plasma arc cutting	(light)(**)	less than 300	8
	(medium)(**)	300-400	9
	(heavy)(**)	400-800	10
Torch brazing			3
Torch soldering			2
Carbon arc welding			14

### Filter Lenses for Protection Against Radiant Energy

Operations	Plate thickness-inches	Plate thickness-mm	Minimum(*) Protective Shade
<b>Gas Welding:</b>			
Light	Under 1/8	Under 3.2	4
Medium	1/8 to 1/2	3.2 to 12.7	5
Heavy	Over 1/2	Over 12.7	6
<b>Oxygen cutting:</b>			
Light	Under 1	Under 25	3
Medium	1 to 6	25 to 150	4
Heavy	Over 6	Over 150	5

**Footnote(\*)** 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 oxy-fuel 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.

**Footnote(\*\*)** 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 work-piece.