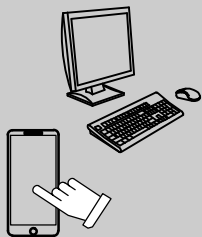


Guidelines For Pipe Welding



For product information,
Owner's Manual translations,
and more, visit

www.MillerWelds.com

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SECTION 1 – SAFETY PRECAUTIONS - READ BEFORE USING

som 2018-01

! Protect yourself and others from injury — read, follow, and save these important safety precautions and operating instructions.

1-1. Symbol Usage



DANGER! – Indicates a hazardous situation which, if not avoided, will result in death or serious injury. The possible hazards are shown in the adjoining symbols or explained in the text.



Indicates a hazardous situation which, if not avoided, could result in death or serious injury. The possible hazards are shown in the adjoining symbols or explained in the text.

NOTICE – Indicates statements not related to personal injury.

 Indicates special instructions.



This group of symbols means Warning! Watch Out! ELECTRIC SHOCK, MOVING PARTS, and HOT PARTS hazards. Consult symbols and related instructions below for necessary actions to avoid the hazards.

1-2. Arc Welding Hazards



The symbols shown below are used throughout this manual to call attention to and identify possible hazards. When you see the symbol, watch out, and follow the related instructions to avoid the hazard. The safety information given below is only a summary of the more complete safety information found in the Safety Standards listed in Section 1-5. Read and follow all Safety Standards.



Only qualified persons should install, operate, maintain, and repair this equipment. A qualified person is defined as one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated ability to solve or resolve problems relating to the subject matter, the work, or the project and has received safety training to recognize and avoid the hazards involved.



During operation, keep everybody, especially children, away.



ELECTRIC SHOCK can kill.

Touching live electrical parts can cause fatal shocks or severe burns. The electrode and work circuit is electrically live whenever the output is on. The input power circuit and machine internal circuits are also live when power is on. In semiautomatic or automatic wire welding, the wire, wire reel, drive roll housing, and all metal parts touching the welding wire are electrically live. Incorrectly installed or improperly grounded equipment is a hazard.

- Do not touch live electrical parts.

- Wear dry, hole-free insulating gloves and body protection.
- Insulate yourself from work and ground using dry insulating mats or covers big enough to prevent any physical contact with the work or ground.
- Do not use AC weld output in damp, wet, or confined spaces, or if there is a danger of falling.
- Use AC output ONLY if required for the welding process.
- If AC output is required, use remote output control if present on unit.
- Additional safety precautions are required when any of the following electrically hazardous conditions are present: 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; or when there is a high risk of unavoidable or accidental contact with the workpiece or ground. For these conditions, use the following equipment in order presented: 1) a semiautomatic DC constant voltage (wire) welder, 2) a DC manual (stick) welder, or 3) an AC welder with reduced open-circuit voltage. In most situations, use of a DC, constant voltage wire welder is recommended. And, do not work alone!
- Disconnect input power or stop engine before installing or servicing this equipment. Lockout/tagout input power according to OSHA 29 CFR 1910.147 (see Safety Standards).

- Properly install, ground, and operate this equipment according to its Owner's Manual and national, state, and local codes.
- Always verify the supply ground – check and be sure that input power cord ground wire is properly connected to ground terminal in disconnect box or that cord plug is connected to a properly grounded receptacle outlet.
- When making input connections, attach proper grounding conductor first – double-check connections.
- Keep cords dry, free of oil and grease, and protected from hot metal and sparks.
- Frequently inspect input power cord and ground conductor for damage or bare wiring – replace immediately if damaged – bare wiring can kill.
- Turn off all equipment when not in use.
- Do not use worn, damaged, undersized, or repaired cables.
- Do not drape cables over your body.
- If earth grounding of the workpiece is required, ground it directly with a separate cable.
- Do not touch electrode if you are in contact with the work, ground, or another electrode from a different machine.
- Do not touch electrode holders connected to two welding machines at the same time since double open-circuit voltage will be present.
- Use only well-maintained equipment. Repair or replace damaged parts at once. Maintain unit according to manual.
- Wear a safety harness if working above floor level.
- Keep all panels and covers securely in place.
- Clamp work cable with good metal-to-metal contact to workpiece or worktable as near the weld as practical.
- Insulate work clamp when not connected to workpiece to prevent contact with any metal object.
- Do not connect more than one electrode or work cable to any single weld output terminal. Disconnect cable for process not in use.
- Use GFCI protection when operating auxiliary equipment in damp or wet locations.

SIGNIFICANT DC VOLTAGE exists in inverter welding power sources AFTER removal of input power.

- Turn off unit, disconnect input power, and discharge input capacitors according to instructions in Manual before touching any parts.



HOT PARTS can burn.

- Do not touch hot parts bare handed.
- Allow cooling period before working on equipment.
- To handle hot parts, use proper tools and/or wear heavy, insulated welding gloves and clothing to prevent burns.



FUMES AND GASES can be hazardous.

Welding produces fumes and gases. Breathing these fumes and gases can be hazardous to your health.

- Keep your head out of the fumes. Do not breathe the fumes.
- Ventilate the work area and/or use local forced ventilation at the arc to remove welding fumes and gases. The recommended way to determine adequate ventilation is to sample for the composition and quantity of fumes and gases to which personnel are exposed.
- If ventilation is poor, wear an approved air-supplied respirator.
- Read and understand the Safety Data Sheets (SDSs) and the manufacturer's instructions for adhesives, coatings, cleaners, consumables, coolants, degreasers, fluxes, and metals.
- Work in a confined space only if it is well ventilated, or while wearing an air-supplied respirator. Always have a trained watchperson nearby. Welding fumes and gases can displace air and lower the oxygen level causing injury or death. Be sure the breathing air is safe.
- Do not weld in locations near degreasing, cleaning, or spraying operations. The heat and rays of the arc can react with vapors to form highly toxic and irritating gases.
- Do not weld on coated metals, such as galvanized, lead, or cadmium plated steel, unless the coating is removed from the weld area, the area is well ventilated, and while wearing an air-supplied respirator. The coatings and any metals containing these elements can give off toxic fumes if welded.



ARC RAYS can burn eyes and skin.

Arc rays from the welding process produce intense visible and invisible (ultraviolet and infrared) rays that can burn eyes and skin. Sparks fly off from the weld.

- Wear an approved welding helmet fitted with a proper shade of filter lenses to protect your face and eyes from arc rays and sparks when welding or watching (see ANSI Z49.1 and Z87.1 listed in Safety Standards).
- Wear approved safety glasses with side shields under your helmet.
- Use protective screens or barriers to protect others from flash, glare and sparks; warn others not to watch the arc.
- Wear body protection made from durable, flame-resistant material (leather, heavy cotton, wool). Body protection includes oil-free clothing such as leather gloves, heavy shirt, cuffless trousers, high shoes, and a cap.

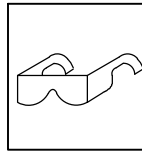


WELDING can cause fire or explosion.

Welding on closed containers, such as tanks, drums, or pipes, can cause them to blow up. Sparks can fly off from the welding arc. The flying sparks, hot workpiece, and hot equipment can cause fires and burns. Accidental contact of electrode to metal objects can cause sparks, explosion, overheating, or fire. Check and be sure the area is safe before doing any welding.

- Remove all flammables within 35 ft (10.7 m) of the welding arc. If this is not possible, tightly cover them with approved covers.
- Do not weld where flying sparks can strike flammable material.
- Protect yourself and others from flying sparks and hot metal.
- Be alert that welding sparks and hot materials from welding can easily go through small cracks and openings to adjacent areas.
- Watch for fire, and keep a fire extinguisher nearby.
- Be aware that welding on a ceiling, floor, bulkhead, or partition can cause fire on the hidden side.

- Do not cut or weld on tire rims or wheels. Tires can explode if heated. Repaired rims and wheels can fail. See OSHA 29 CFR 1910.177 listed in Safety Standards.
- Do not weld on containers that have held combustibles, or on closed containers such as tanks, drums, or pipes unless they are properly prepared according to AWS F4.1 and AWS A6.0 (see Safety Standards).
- Do not weld where the atmosphere can contain flammable dust, gas, or liquid vapors (such as gasoline).
- Connect work cable to the work as close to the welding area as practical to prevent welding current from traveling long, possibly unknown paths and causing electric shock, sparks, and fire hazards.
- Do not use welder to thaw frozen pipes.
- Remove stick electrode from holder or cut off welding wire at contact tip when not in use.
- Wear body protection made from durable, flame-resistant material (leather, heavy cotton, wool). Body protection includes oil-free clothing such as leather gloves, heavy shirt, cuffless trousers, high shoes, and a cap.
- Remove any combustibles, such as a butane lighter or matches, from your person before doing any welding.
- After completion of work, inspect area to ensure it is free of sparks, glowing embers, and flames.
- Use only correct fuses or circuit breakers. Do not oversize or bypass them.
- Follow requirements in OSHA 1910.252 (a) (2) (iv) and NFPA 51B for hot work and have a fire watcher and extinguisher nearby.
- Read and understand the Safety Data Sheets (SDSs) and the manufacturer's instructions for adhesives, coatings, cleaners, consumables, coolants, degreasers, fluxes, and metals.



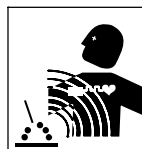
FLYING METAL or DIRT can injure eyes.

- Welding, chipping, wire brushing, and grinding cause sparks and flying metal. As welds cool, they can throw off slag.
- Wear approved safety glasses with side shields even under your welding helmet.



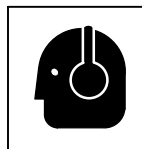
BUILDUP OF GAS can injure or kill.

- Shut off compressed gas supply when not in use.
- Always ventilate confined spaces or use approved air-supplied respirator.



ELECTRIC AND MAGNETIC FIELDS (EMF) can affect Implanted Medical Devices.

- Wearers of Pacemakers and other Implanted Medical Devices should keep away.
- Implanted Medical Device wearers should consult their doctor and the device manufacturer before going near arc welding, spot welding, gouging, plasma arc cutting, or induction heating operations.



NOISE can damage hearing.

Noise from some processes or equipment can damage hearing.

- Wear approved ear protection if noise level is high.



CYLINDERS can explode if damaged.

Compressed gas cylinders contain gas under high pressure. If damaged, a cylinder can explode. Since gas cylinders are normally part of the welding process, be sure to treat them carefully.

- Protect compressed gas cylinders from excessive heat, mechanical shocks, physical damage, slag, open flames, sparks, and arcs.
- Install cylinders in an upright position by securing to a stationary support or cylinder rack to prevent falling or tipping.
- Keep cylinders away from any welding or other electrical circuits.
- Never drape a welding torch over a gas cylinder.
- Never allow a welding electrode to touch any cylinder.

- Never weld on a pressurized cylinder – explosion will result.
- Use only correct compressed gas cylinders, regulators, hoses, and fittings designed for the specific application; maintain them and associated parts in good condition.
- Turn face away from valve outlet when opening cylinder valve. Do not stand in front of or behind the regulator when opening the valve.
- Keep protective cap in place over valve except when cylinder is in use or connected for use.
- Use the proper equipment, correct procedures, and sufficient number of persons to lift, move, and transport cylinders.
- Read and follow instructions on compressed gas cylinders, associated equipment, and Compressed Gas Association (CGA) publication P-1 listed in Safety Standards.

1-3. Additional Symbols For Installation, Operation, And Maintenance



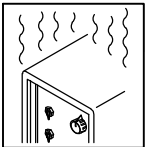
FIRE OR EXPLOSION hazard.

- Do not install or place unit on, over, or near combustible surfaces.
- Do not install unit near flammables.
- Do not overload building wiring – be sure power supply system is properly sized, rated, and protected to handle this unit.



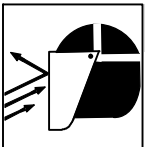
FALLING EQUIPMENT can injure.

- Use lifting eye to lift unit only, NOT running gear, gas cylinders, or any other accessories.
- Use correct procedures and equipment of adequate capacity to lift and support unit.
- If using lift forks to move unit, be sure forks are long enough to extend beyond opposite side of unit.
- Keep equipment (cables and cords) away from moving vehicles when working from an aerial location.
- Follow the guidelines in the Applications Manual for the Revised NIOSH Lifting Equation (Publication No. 94-110) when manually lifting heavy parts or equipment.



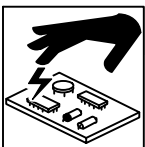
OVERUSE can cause OVERHEATING

- Allow cooling period; follow rated duty cycle.
- Reduce current or reduce duty cycle before starting to weld again.
- Do not block or filter airflow to unit.



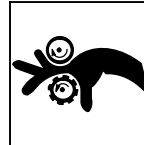
FLYING SPARKS can injure.

- Wear a face shield to protect eyes and face.
- Shape tungsten electrode only on grinder with proper guards in a safe location wearing proper face, hand, and body protection.
- Sparks can cause fires — keep flammables away.



STATIC (ESD) can damage PC boards.

- Put on grounded wrist strap BEFORE handling boards or parts.
- Use proper static-proof bags and boxes to store, move, or ship PC boards.



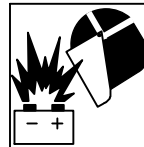
MOVING PARTS can injure.

- Keep away from moving parts.
- Keep away from pinch points such as drive rolls.



WELDING WIRE can injure.

- Do not press gun trigger until instructed to do so.
- Do not point gun toward any part of the body, other people, or any metal when threading welding wire.



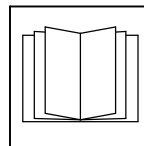
BATTERY EXPLOSION can injure.

- Do not use welder to charge batteries or jump start vehicles unless it has a battery charging feature designed for this purpose.



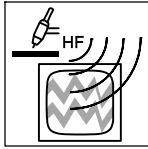
MOVING PARTS can injure.

- Keep away from moving parts such as fans.
- Keep all doors, panels, covers, and guards closed and securely in place.
- Have only qualified persons remove doors, panels, covers, or guards for maintenance and troubleshooting as necessary.
- Reinstall doors, panels, covers, or guards when maintenance is finished and before reconnecting input power.



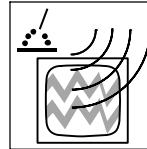
READ INSTRUCTIONS.

- Read and follow all labels and the Owner's Manual carefully before installing, operating, or servicing unit. Read the safety information at the beginning of the manual and in each section.
- Use only genuine replacement parts from the manufacturer.
- Perform installation, maintenance, and service according to the Owner's Manuals, industry standards, and national, state, and local codes.



H.F. RADIATION can cause interference.

- High-frequency (H.F.) can interfere with radio navigation, safety services, computers, and communications equipment.
- Have only qualified persons familiar with electronic equipment perform this installation.
- The user is responsible for having a qualified electrician promptly correct any interference problem resulting from the installation.
- If notified by the FCC about interference, stop using the equipment at once.
- Have the installation regularly checked and maintained.
- Keep high-frequency source doors and panels tightly shut, keep spark gaps at correct setting, and use grounding and shielding to minimize the possibility of interference.



ARC WELDING can cause interference.

- Electromagnetic energy can interfere with sensitive electronic equipment such as computers and computer-driven equipment such as robots.
- Be sure all equipment in the welding area is electromagnetically compatible.
- To reduce possible interference, keep weld cables as short as possible, close together, and down low, such as on the floor.
- Locate welding operation 100 meters from any sensitive electronic equipment.
- Be sure this welding machine is installed and grounded according to this manual.
- If interference still occurs, the user must take extra measures such as moving the welding machine, using shielded cables, using line filters, or shielding the work area.

1-4. California Proposition 65 Warnings

⚠ WARNING: This product can expose you to chemicals including lead, which are known to the state of California to cause cancer and birth defects or other reproductive harm.

For more information, go to www.P65Warnings.ca.gov

1-5. Principal Safety Standards

Safety in Welding, Cutting, and Allied Processes, ANSI Standard Z49.1, is available as a free download from the American Welding Society at <http://www.aws.org> or purchased from Global Engineering Documents (phone: 1-877-413-5184, website: www.global.ihs.com).

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).

Safe Practices for Welding and Cutting Containers that have Held Combustibles, American Welding Society Standard AWS A6.0, 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 02169 (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, 14501 George Carter Way, Suite 103, 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, Mississauga, Ontario, Canada L4W 5N5 (phone: 800-463-6727, website: www.csagroup.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 02169 (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 1910.177 Subpart N, 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).

Applications Manual for the Revised NIOSH Lifting Equation, The National Institute for Occupational Safety and Health (NIOSH), 1600 Clifton Rd, Atlanta, GA 30329-4027 (phone: 1-800-232-4636, website: www.cdc.gov/NIOSH).

1-6. EMF Information

Electric current flowing through any conductor causes localized electric and magnetic fields (EMF). The current from arc welding (and allied processes including spot welding, gouging, plasma arc cutting, and induction heating operations) creates an EMF field around the welding circuit. EMF fields can interfere with some medical implants, e.g. pacemakers. Protective measures for persons wearing medical implants have to be taken. For example, restrict access for passers-by or conduct individual risk assessment for welders. All welders should use the following procedures in order to minimize exposure to EMF fields from the welding circuit:

1. Keep cables close together by twisting or taping them, or using a cable cover.
2. Do not place your body between welding cables. Arrange cables to one side and away from the operator.
3. Do not coil or drape cables around your body.

4. Keep head and trunk as far away from the equipment in the welding circuit as possible.
5. Connect work clamp to workpiece as close to the weld as possible.
6. Do not work next to, sit or lean on the welding power source.
7. Do not weld whilst carrying the welding power source or wire feeder.

About Implanted Medical Devices:

Implanted Medical Device wearers should consult their doctor and the device manufacturer before performing or going near arc welding, spot welding, gouging, plasma arc cutting, or induction heating operations. If cleared by your doctor, then following the above procedures is recommended.

SECTION 2 – GMAW FUNDAMENTALS

2-1. Basic Information

A. Overview Of Welding Processes

The two basic types of metal transfer are short circuit and spray.

In short circuit transfer, the wire short circuits to the workpiece and weld wire is transferred with each short circuit. Short circuit transfer uses smaller wire diameters at lower arc voltages and higher slope settings. See Figure 2-1.

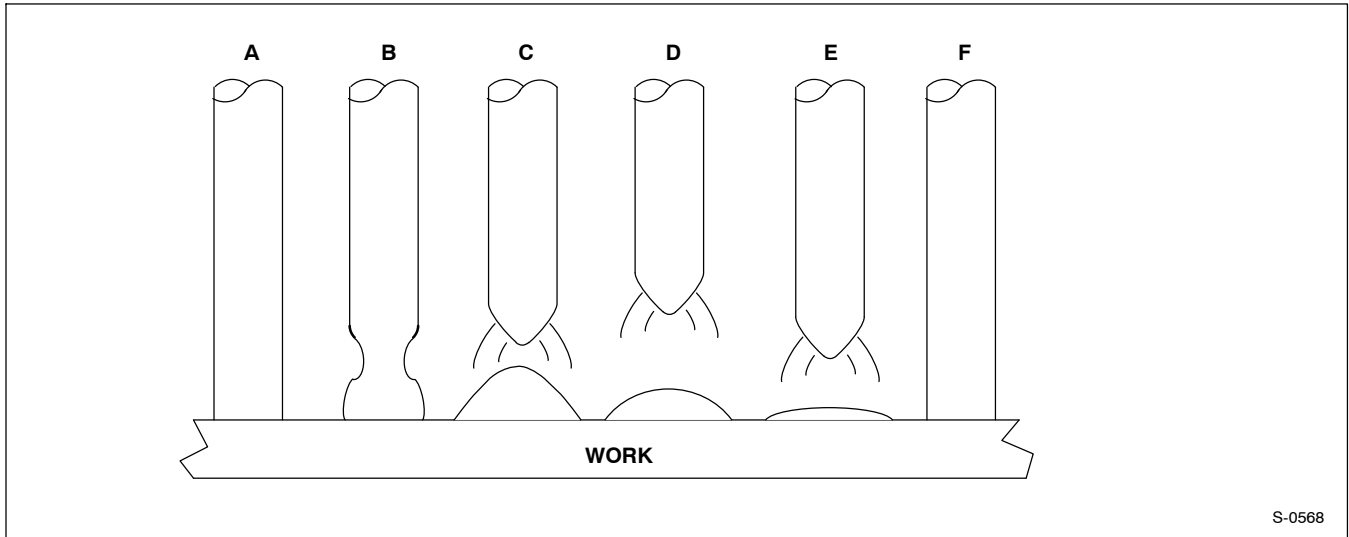


Figure 2-1. Mechanics Of Short Circuiting Transfer

In spray transfer, a steady stream of small droplets of weld wire are transferred into the weld. Spray transfer uses larger diameter wires at higher arc voltages and lower slope settings. See Figure 2-2.

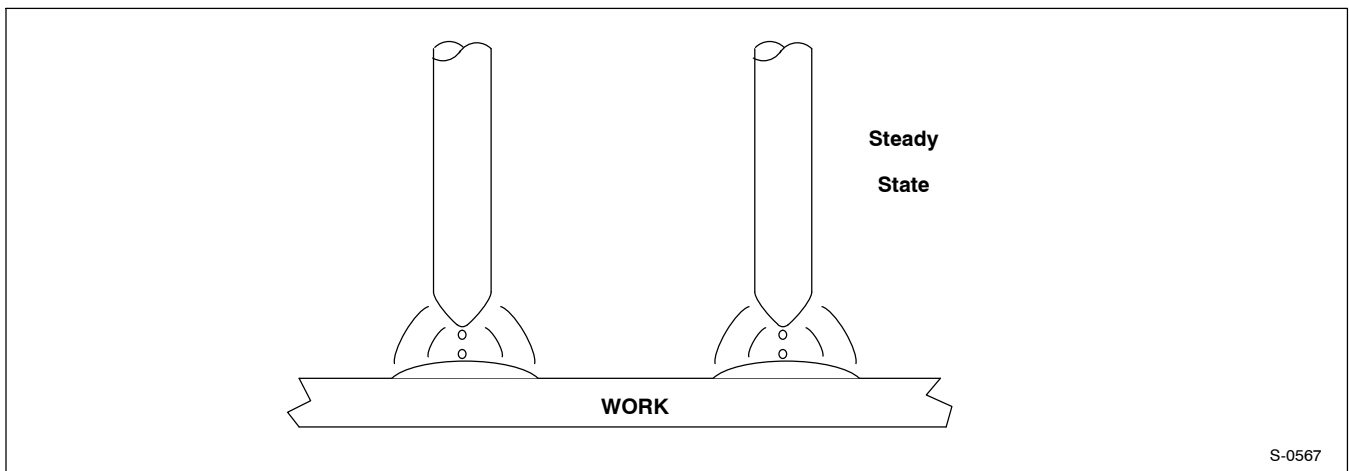


Figure 2-2. Mechanics Of Spray Transfer

For short circuit transfer, a constant voltage welding power source is required. Adjustable slope and inductance are desirable. Slope slows the response rate of the welding power source and lowers maximum short circuit current. A constant speed wire feeder is recommended for short circuit transfer.

For spray transfer, either a constant voltage or constant current welding power source can be used. A voltage sensing wire feeder is recommended for spray transfer.

The values in the following tables are a starting point for setting up a weld. Most settings can be varied while welding to fine tune the arc.

Table 2-1. Short Circuit Transfer For Mild And Low Alloy Steel*

Electrode Diameter	Amperage Range DCEP	Load Voltage	Power Source
.030 in.	70-130 A	15-21 V	CV
.035 in.	80-190 A	16-22 V	CV
.045 in.	100-225 A	17-22 V	CV

*Using CO₂ shielding gas for mild steel and Argon-CO₂ for low alloy steel.

Table 2-2. Spray Transfer For Mild And Low Alloy Steel*

Electrode Diameter	Amperage Range DCEP	Load Voltage	Power Source
.030 in.	150-265 A	24-28 V	CV or CC
.035 in.	175-290 A	24-28 V	CV or CC
.045 in.	200-315 A	24-30 V	CV or CC
1/16 in.	275-500 A	24-32 V	CV or CC
3/32 in.	350-600 A	24-33 V	CV or CC

*Using Argon - 5% Oxygen shielding gas or C10 - 90% Argon - 10% Oxygen shielding gas for mild and low alloy steel.

Table 2-3. Short Circuit Transfer For Stainless Steel 300 Series*

Electrode Diameter	Amperage Range DCEP	Load Voltage	Power Source
.030 in.	50-145 A	17-22 V	CV power source with characteristics for short circuiting transfer.
.035 in.	65-175 A	17-22 V	
.045 in.	100-210 A	17-22 V	

*Using tri-gas mixture – 90% He; 7-1/2% Ar; 2-1/2% CO₂ and flow rates of approximately 20 CFH.

Table 2-4. Spray Transfer For Stainless Steel 300 Series*

Electrode Diameter	Amperage Range DCEP	Load Voltage	Power Source
.030 in.	160-210 A	24-28 V	CV or CC
.035 in.	180-255 A	24-29 V	CV or CC
.045 in.	200-300 A	24-30 V	CV or CC
1/16 in.	215-325 A	24-32 V	CV or CC
3/32 in.	225-375 A	24-32 V	CV or CC

*Using Argon-Oxygen shielding gas. Oxygen percentage varies from 1 - 5%.

Table 2-5. Flux Cored Arc*

Electrode Diameter	Amperage Range	Load Voltage
.045 in.	200-300 A	24-30 V
1/16 in.	200-425 A	24-29 V
5/64 in.	250-450 A	27-31 V
3/32 in.	300-500 A	29-33 V
7/64 in.	360-550 A	29-34 V
1/8 in.	425-650 A	29-34 V

*Using CO₂ as the shielding gas. Flow rates depend on nozzle diameter, surrounding air movement, and electrode extension ♦. Welding in still air generally requires flow rates from 30 to 40 CFH. Drafty conditions or longer electrode extension may require higher flow rates.

♦ Most manufacturers recommend an extension of 3/4 to 1-1/2 in. for gas shielded electrodes. Follow the electrode manufacturer's recommendations.

B. Advanced Process: RMD

RMD (Regulated Metal Deposition) is a precisely controlled short-circuit metal transfer that provides a calm, stable arc and weld puddle. This provides less chance of cold lap or lack of fusion, less spatter and a higher quality root pass on pipe. The stability of the weld process lessens the puddle manipulation required by the operator and is more tolerant to hi-lo conditions, reducing training requirements. Weld bead profiles are thicker than conventional root pass welds which can eliminate the need for a hot pass, improving weld productivity. In some stainless steel applications, it may be possible to eliminate the backing (purge) gas to further improve productivity and reduce welding costs.

- Ideally suited to root pass welding
- Consistent side wall fusion
- Less weld spatter
- Tolerant to hi-lo fit-up conditions
- More tolerant of changes in tip-to-work distance
- Less personnel training time
- Thicker root passes can eliminate hot pass
- Eliminate backing gas on some stainless steel applications

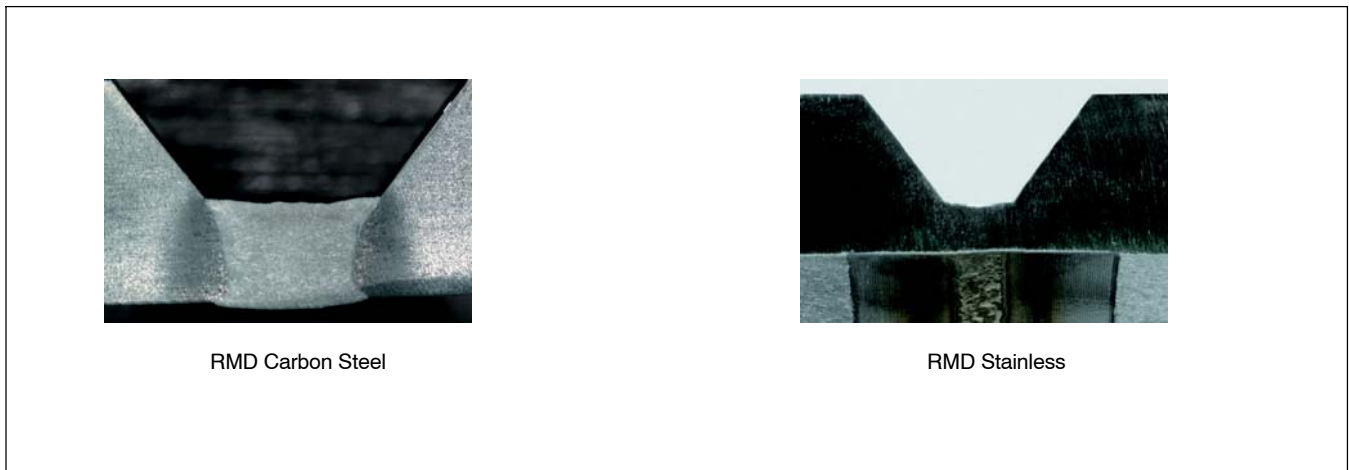


Figure 2-3. RMD Root Pass Welds

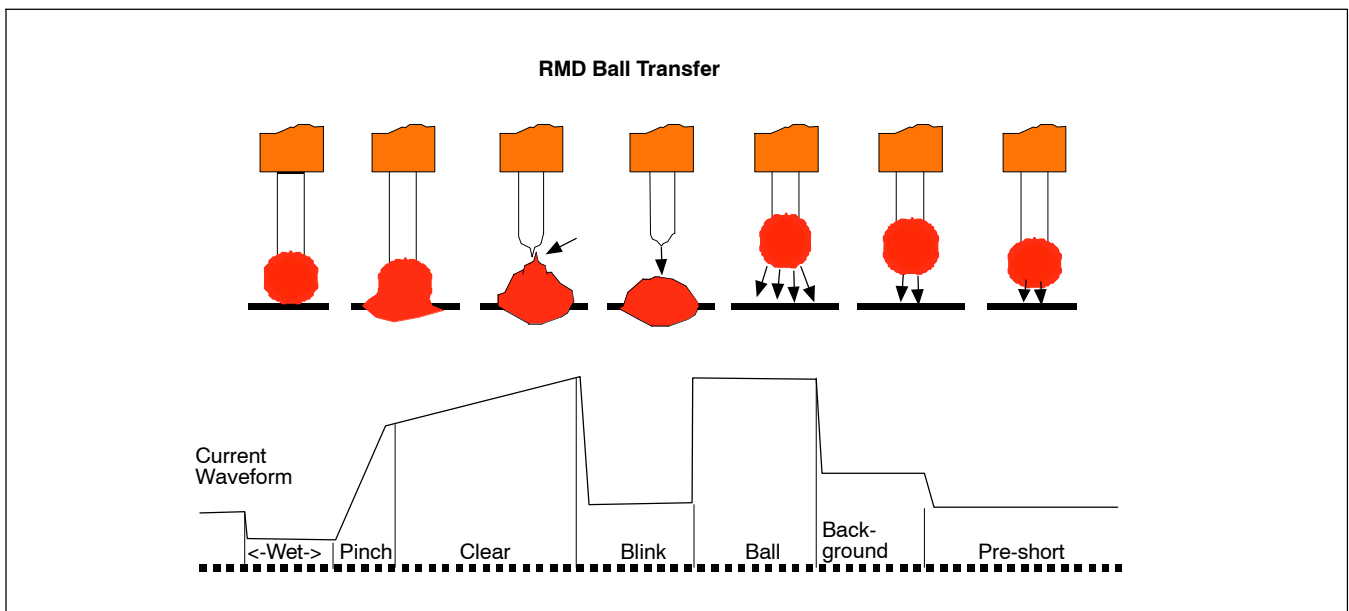


Figure 2-4. RMD Ball Transfer

C. Advanced Process: Pro-Pulse

This method of pulse welding provides a shorter arc length, narrower arc cone and less heat input than with traditional spray pulse transfer. Since the process is synergic, arc wandering and variations in tip-to-work distances are virtually eliminated. This provides easier puddle control for both in-position and out-of-position welding, reducing personnel training time. The process also improves fusion at the toe of the weld, permitting higher travel speeds and higher deposition. This process coupled with RMD Pro, for root pass welding, permits welding procedures with one wire and one gas to eliminate process switch-over time.

- Ideally suited to fill and cap pass welding
- Easier puddle control than conventional spray pulse
- Shorter arc lengths and narrow arc cone for out-of-position welding
- More tolerant of tip-to-work variation
- Improve fusion and fill at toe of weld
- Less heat input reduces interpass cooling time and improves weld cycle time
- Enables one-wire and one-gas weld procedures

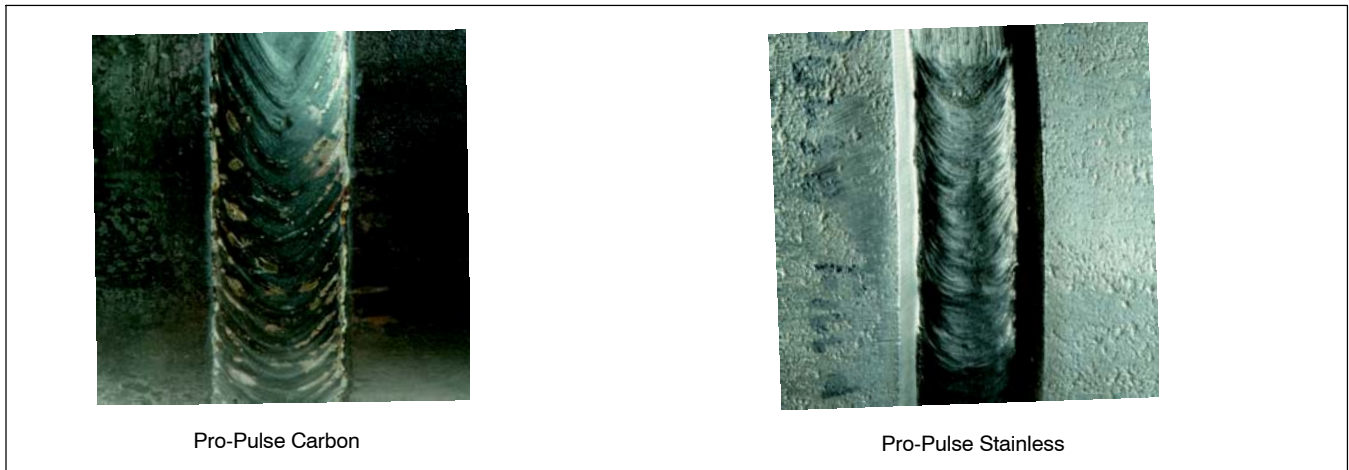


Figure 2-5. Pro-Pulse Weld Bead

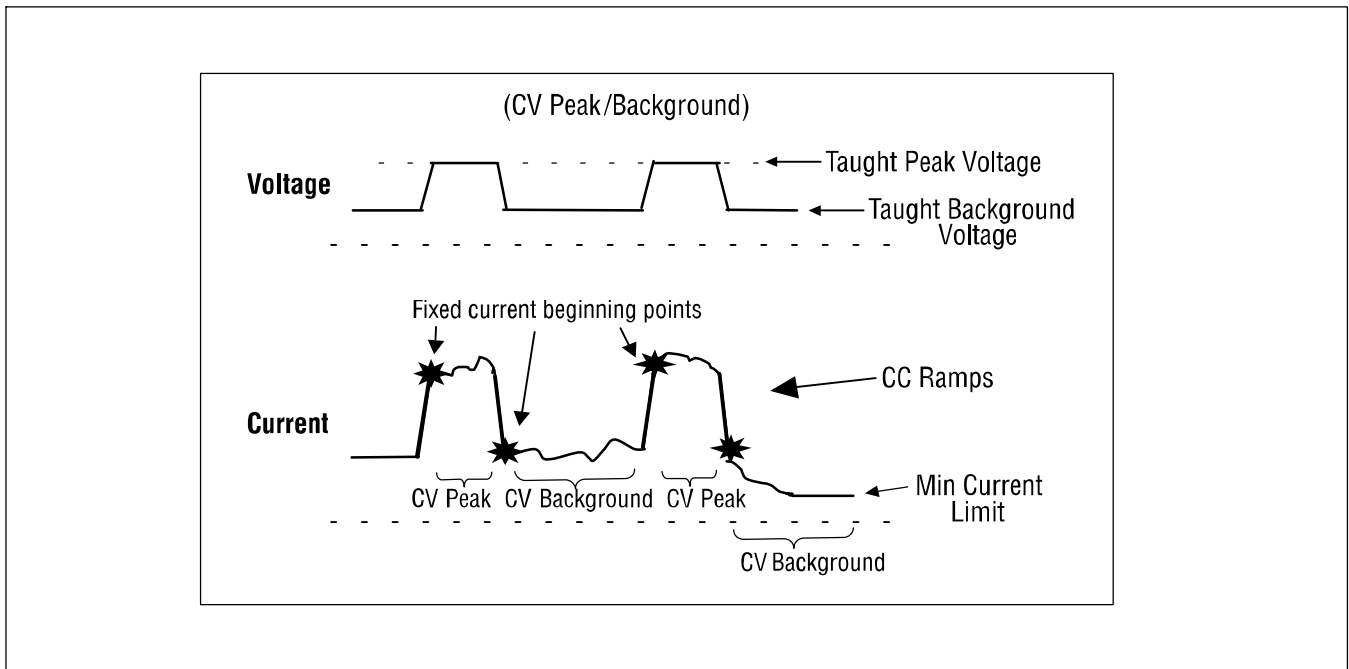


Figure 2-6. Pro-Pulse Voltage And Current Waveforms

2-2. Welding Positions

Welding position is determined by the pipe position and if the pipe is in a fixed position or rotating.

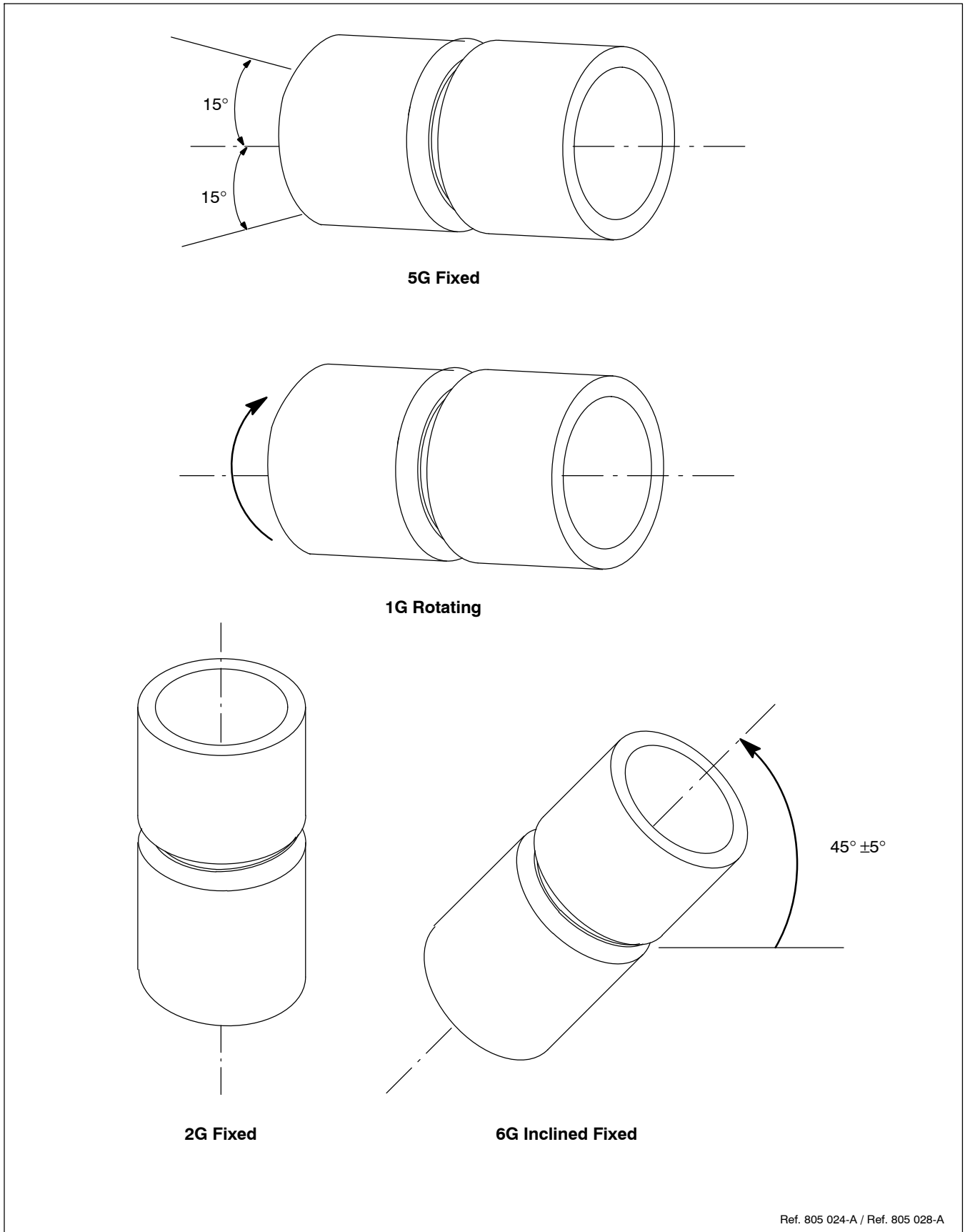
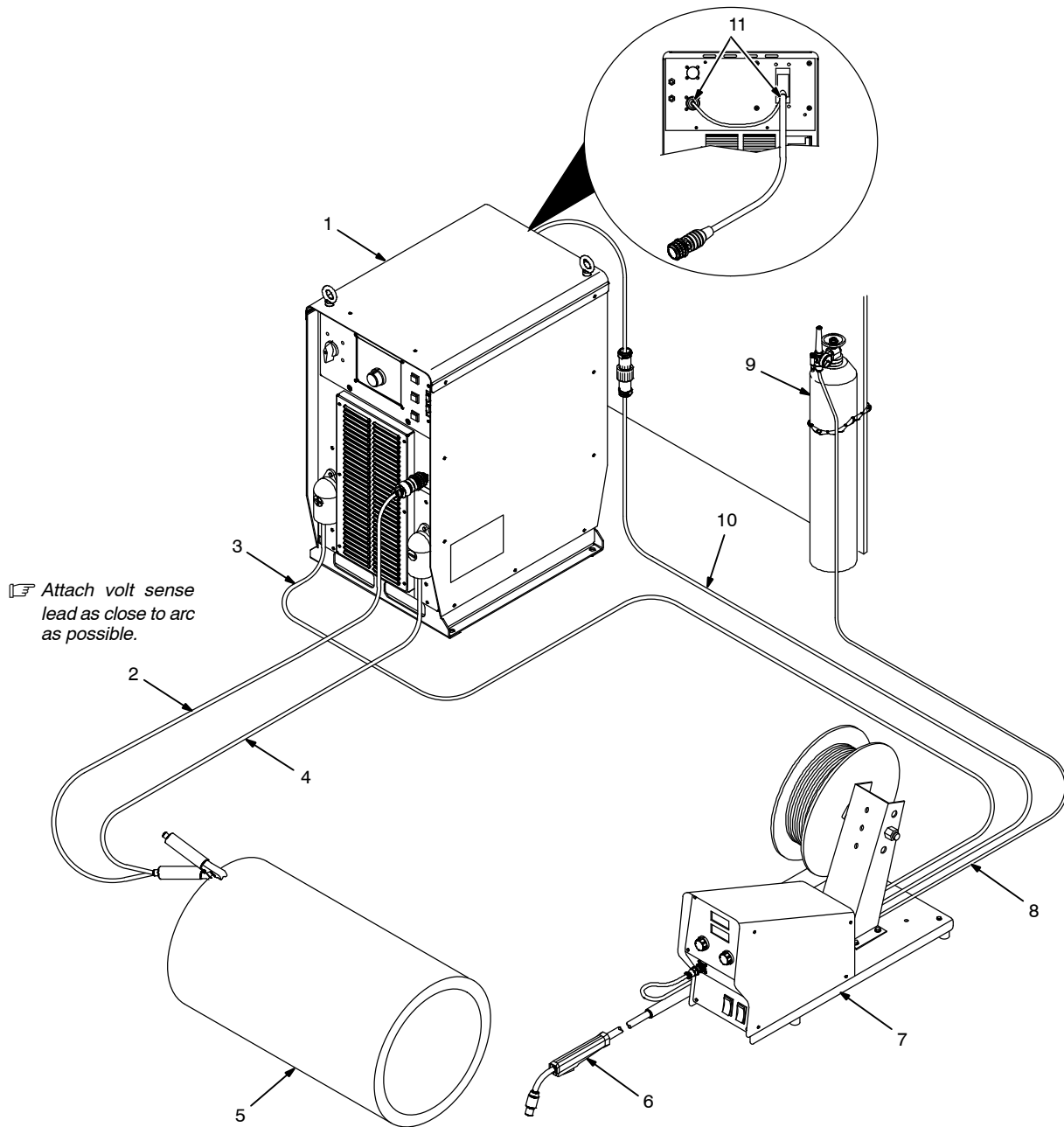


Figure 2-7. Pipe Positions

2-3. GMAW (MIG) / FCAW PipePro System



804 097-B / Ref. 804 374-C

⚠ Do not mount feeder on top of power source.

⚠ Do not put feeder where welding wire hits cylinder.

⚠ Do not move or operate equipment when it could tip.

1 Welding Power Source

☞ Attach volt sense lead as close to arc as possible.

2 Negative Volt Sense Cable

3 Positive (+) Weld Cable

4 Negative (-) Weld Cable

5 Workpiece

6 Welding Gun

7 Wire Feeder

8 Gas Hose

9 Gas Cylinder

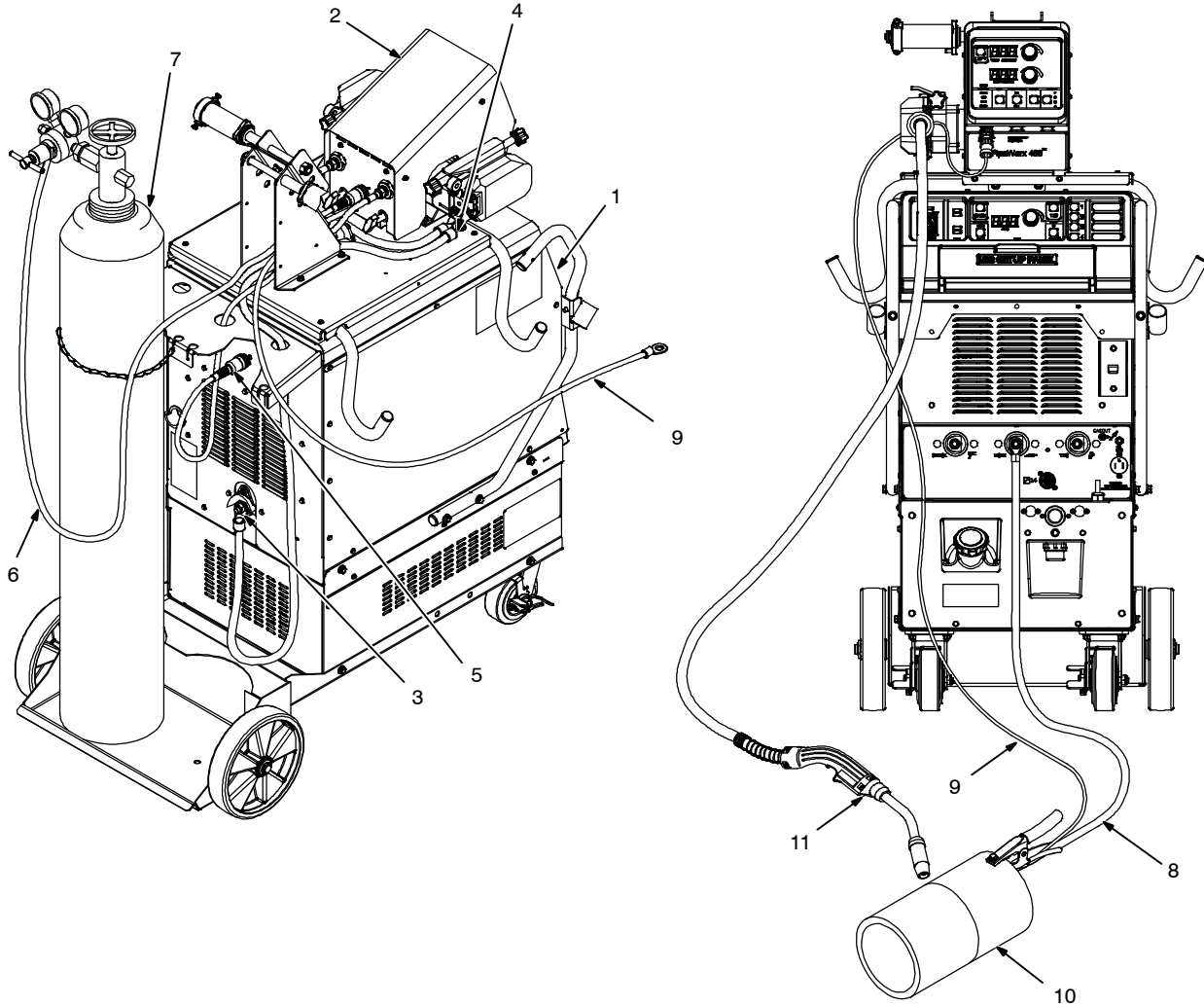
10 14-Pin Feeder Control Cable

11 Interconnect Cable

Connect 14-pin socket into wire feeder control cable or optional extension cable. Connect 72-pin connector to I/O receptacle RC72 on rear of power source. Connect 10-pin connector into receptacle RC8 on rear of power source.

☞ Maximum cable length not to exceed 150 feet.

2-4. Typical PipeWorx Connection Diagram For MIG (GMAW) Equipment With Feeder On Welding Power Source



805 144-B

- ⚠ Do not put feeder where welding wire hits cylinder.**
- ⚠ Do not move or operate equipment when it could tip.**

- 1 Welding Power Source
- 2 Wire Feeder
- 3 MIG Connection
- 4 Positive (+) Weld Cable
- 5 Feeder Control Cable Connection

- 6 Gas Hose
- 7 Gas Cylinder

Connect 14-pin plug to rear of power source, and connect 14-socket plug to rear of wire feeder. Connect one end of weld cable to weld terminal on rear of power source. Connect remaining end of weld cable to wire feeder drive housing. Connect one end of gas hose to regulator/flowmeter on gas cylinder and connect remaining end

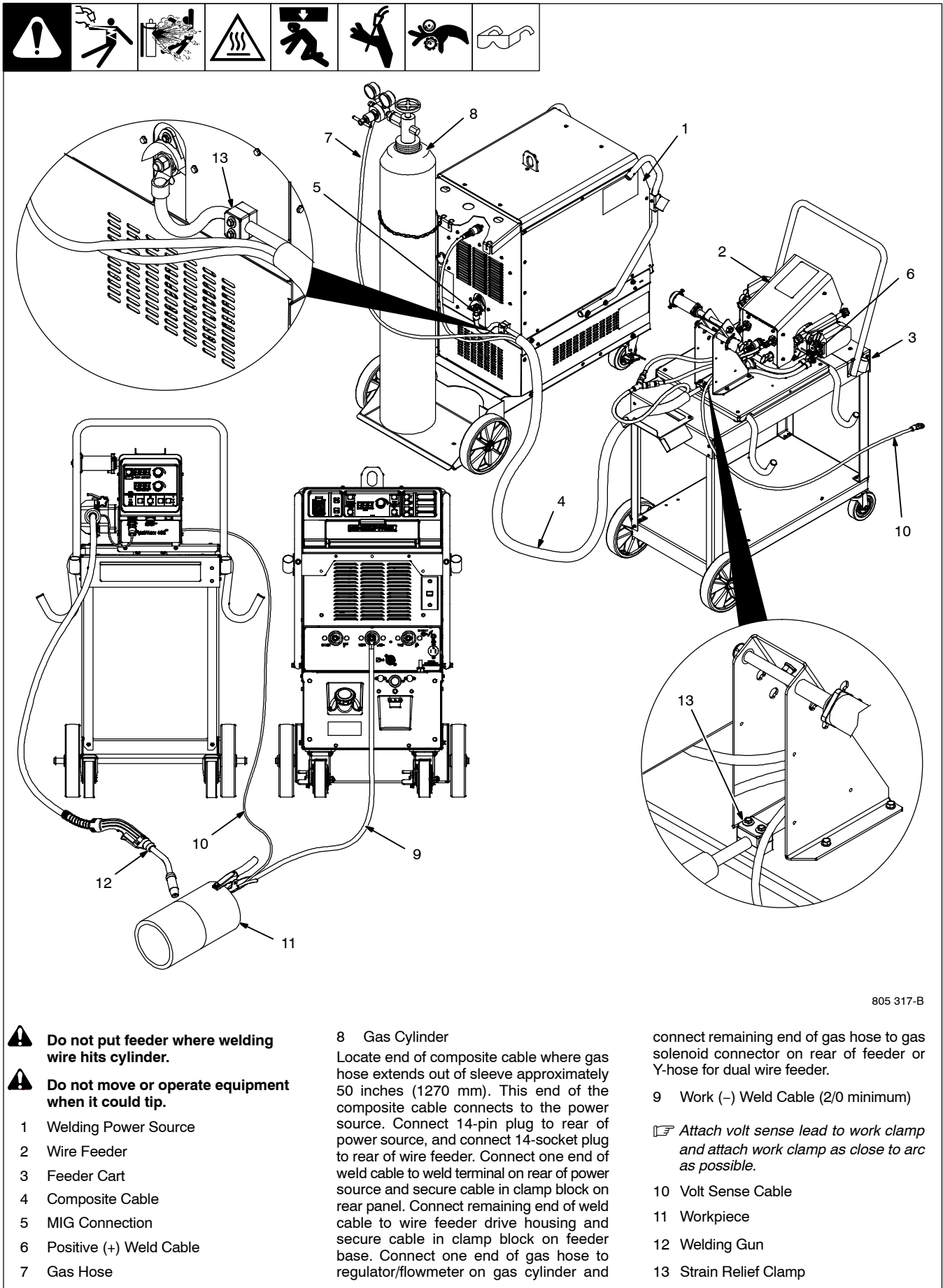
of gas hose to gas solenoid connector on rear of feeder or Y-hose for dual wire feeder.

- 8 Work (-) Weld Cable

Attach volt sense lead to work clamp and attach work clamp as close to arc as possible.

- 9 Volt Sense Cable
- 10 Workpiece
- 11 Welding Gun

2-5. Typical PipeWorx Connection Diagram For MIG (GMAW) Equipment With Feeder On Cart



805 317-B

- ⚠ Do not put feeder where welding wire hits cylinder.**
- ⚠ Do not move or operate equipment when it could tip.**


- 1 Welding Power Source
- 2 Wire Feeder
- 3 Feeder Cart
- 4 Composite Cable
- 5 MIG Connection
- 6 Positive (+) Weld Cable
- 7 Gas Hose

8 Gas Cylinder

Locate end of composite cable where gas hose extends out of sleeve approximately 50 inches (1270 mm). This end of the composite cable connects to the power source. Connect 14-pin plug to rear of power source, and connect 14-socket plug to rear of wire feeder. Connect one end of weld cable to weld terminal on rear of power source and secure cable in clamp block on rear panel. Connect remaining end of weld cable to wire feeder drive housing and secure cable in clamp block on feeder base. Connect one end of gas hose to regulator/flowmeter on gas cylinder and

connect remaining end of gas hose to gas solenoid connector on rear of feeder or Y-hose for dual wire feeder.

9 Work (-) Weld Cable (2/0 minimum)

 Attach volt sense lead to work clamp and attach work clamp as close to arc as possible.

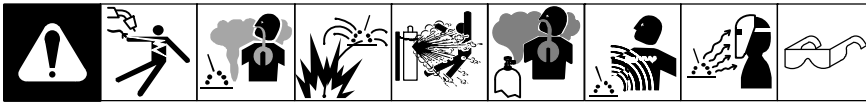
10 Volt Sense Cable

11 Workpiece

12 Welding Gun

13 Strain Relief Clamp

2-7. Joint Preparation And Typical Recommendations For 1G, 5G, 6G, And 6GR



A. Establish Good Technique

As with any welding process, success with the RMD process requires establishing and maintaining good preparation and welding techniques. The following guidelines, which are extremely easy to follow, lead to proven success and increased productivity for welding stainless steel pipe.

Start with pipe joint sections that have the standard 37.5 degree bevels, for a total included angle of 75 degrees. The lands can range from a knife edge to 3/32 in. Use a minimum 1/8 in. root opening to ensure proper root reinforcement on the weld's backside. An easy way to space the gap is with a filler rod that matches the desired gap size.

B. Tack Welding System

Tack the pipe with the RMD process, making tacks (in this order) at the 12-, 6-, 3-, and 9-o'clock positions. Remove the filler metal spacer after making the first tack, then check the gap with a tool designed for that purpose. Tacks on smaller diameter pipe can be 1/4- to 1/2-in. long. Tack on larger pipe may be 1 in. or longer. Note that tack welds will shrink during cooling, causing the gap to close up. In areas with less than a 1/8-in. gap, grind the joint using a 3/32-in. cutting wheel to open the root. Finish preparing the pass by grinding each tack weld to a feather edge to ensure that the root pass consumes the tack weld.

C. Welding In The 1G Rolled Position

Start the arc in the center of a tack around the 1:30- to 2-o'clock position. Hold the gun perpendicular to the pipe with a 5- to 10-degree drag angle. Use a 3/8- to 5/8-in. electrode stick-out. In some cases, this may require a recessed contact tip to help maintain correct stick-out.

Establish the weld puddle and position the electrode in the center of the weld puddle as the pipe rolls away from the operator (essentially, the operator is dragging the weld puddle). Watch the puddle closely to ensure that it ties into the sidewalls. Normally, do not use a weave technique. However, if the gap is greater than 3/16-in., the operator may need to weave the electrode slightly across the gap and up the sidewall to bridge it.

When the electrode is properly positioned in the weld puddle, the RMD process creates a muted buzzing sound that is much softer than the "crackling bacon" sound of traditional short circuit GMAW.

Although the RMD process appears colder than typical GMAW, the weld puddle fuses into the sidewall and penetrates the joint due to the calm metal transfer and stable arc. The face of a good root weld appears flat (neither concave or convex) and, as noted, it is thicker than a traditional GMAW root.

With traditional GMAW, operators position the arc on the leading edge of the puddle. Do not do this with RMD, as the arc will stutter and create spatter and greater penetration on the inside of the pipe (note that an optimum root has about a 1/16-in. reinforcement). If travel speeds become too slow and the electrode becomes unstable (listen for a sound more like traditional GMAW. Also, the weld face will be convex. If this happens, grind out the high spots to prevent areas of lack of fusion on the next pass).

If the joint is misaligned, continue to concentrate the arc in the center of the joint. Do not favor the high side of the joint; the new technology will automatically compensate. Let the arc do the work.

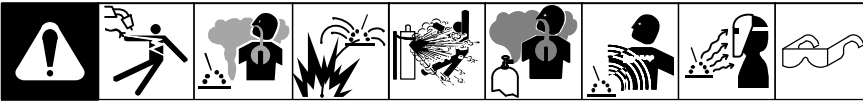
D. Welding In The 5G Fixed Position

Begin welding in the 12-o'clock position. As with the 1G position, start the arc in the center of a tack weld using a 5- to 10-degree drag angle and a 3/8- to 5/8-in. stick-out. At the start of the weld, keep the arc in the center of the puddle, but move the electrode back and forth across the gap using a half moon motion (with the face of the moon pointing down).

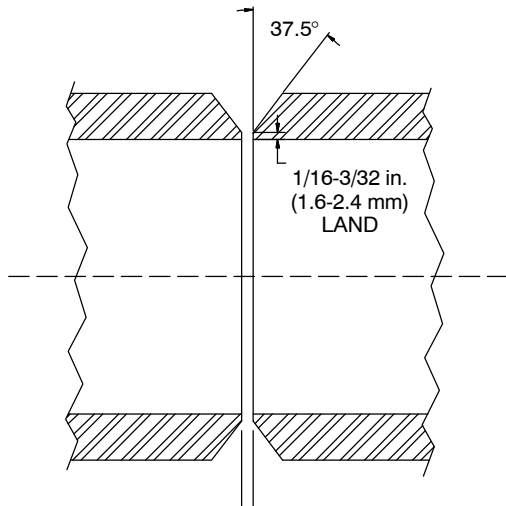
At about the 1-o'clock position, gravity starts to push the puddle down the joint. Once gravity takes over, stop weaving and concentrate on directing the electrode into the center of the weld puddle. At about the 5-o'clock position, use a slight side-to-side motion until reaching 6-o'clock, ending the bead on the feathered tack weld. The side-to-side motion flattens the weld bead and minimizes grinding.

If the weld does not end on a tack weld (e.g., the operator breaks the arc for whatever reason), this may lead to a pin-hole at the end of the weld. Grind out the end of the weld before resuming. After completing the root pass, also grind out starts, stops and high points before making the first fill pass (remember that the root pass with the modified process can eliminate the hot pass).

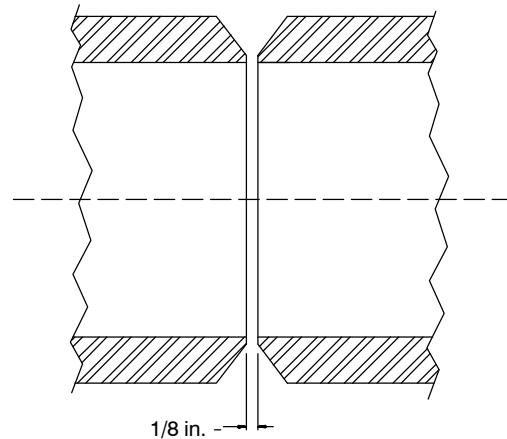
2-8. RMD Open Root Joint Preparation



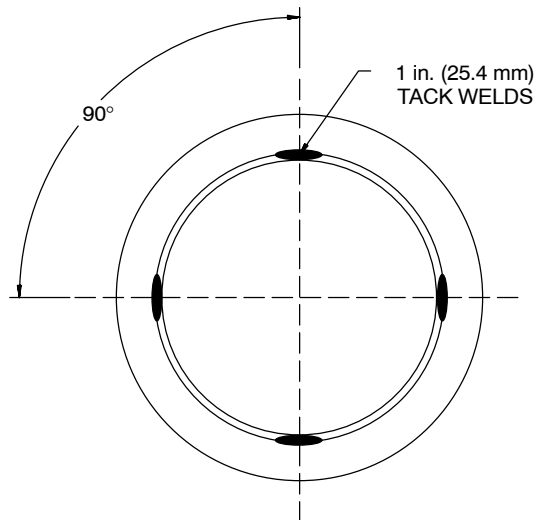
1. Bevel pipe end to 37.5° (standard pipe bevel) leaving a $1/16$ to $3/32$ in. (1.6 to 2.4 mm) land.



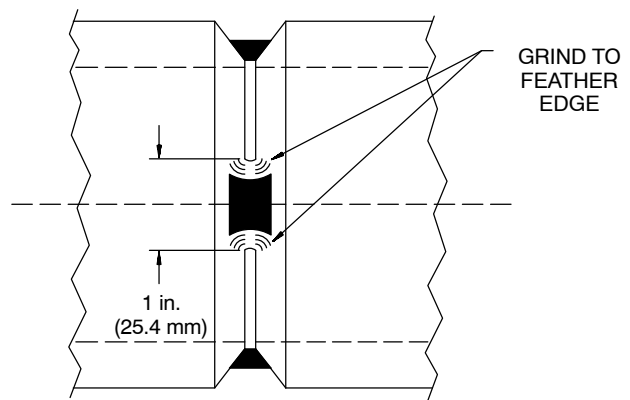
2. Align pipe ends together leaving a minimum of $1/8$ in. (3.2 mm) gap.



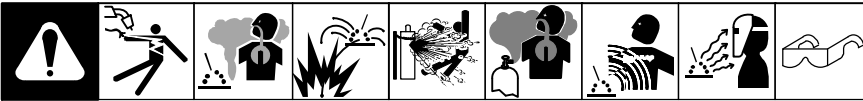
3. Tack pipe ends together in four locations approximately 90° apart and 1 in. (25.4 mm) long on pipe that is 6 in. (152.4 mm) or larger diameter. Use appropriate sized tack welds on smaller pipe.



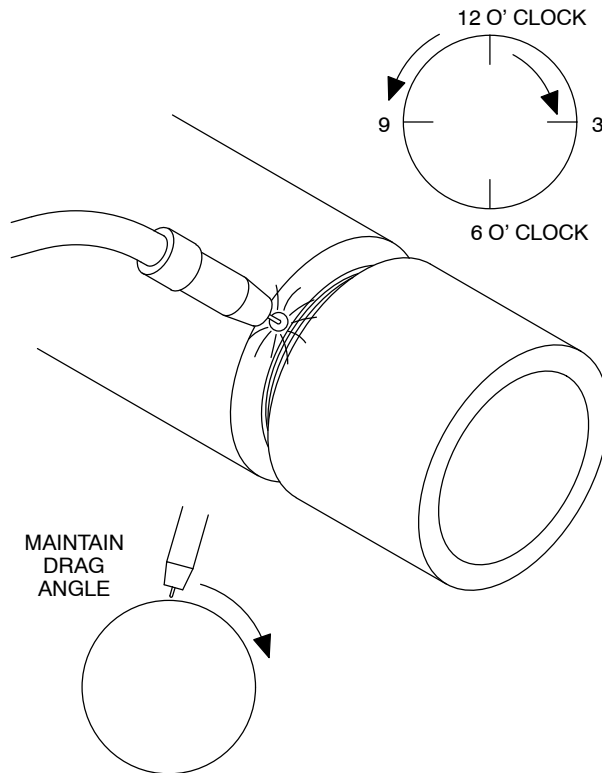
4. Grind each end of the tack weld to a feather edge (knife edge).



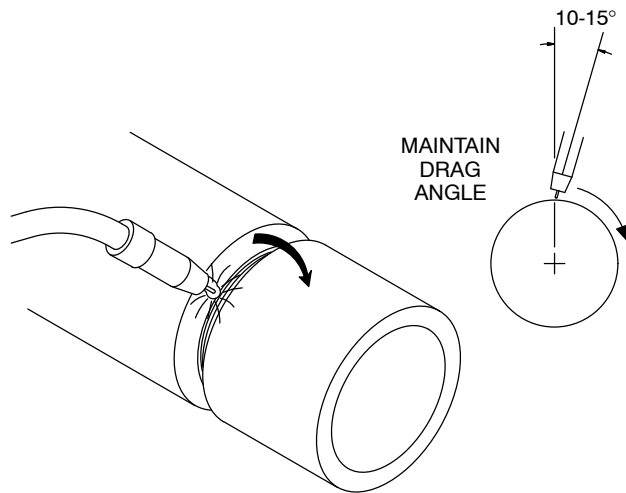
2-9. 5G Welding Technique Recommendations



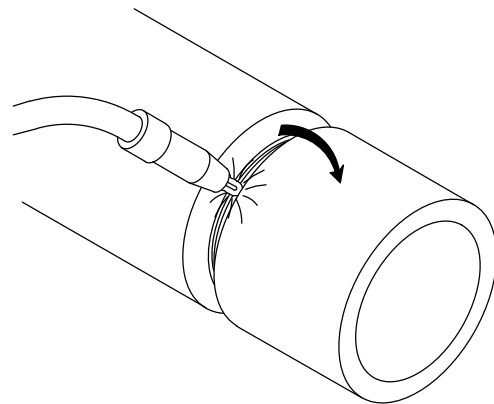
1. Start arc on sidewall or in center of tack weld, not in the gap.



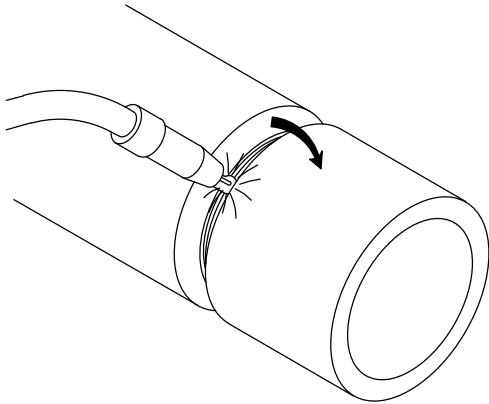
2. After puddle is established, maintain the arc on the center of the puddle with a 1/2 to 5/8 in. (12.7 to 15.9 mm) tip to work distance.



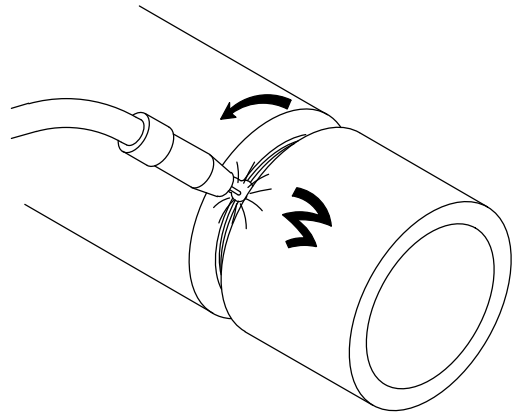
3. Move across the gap.



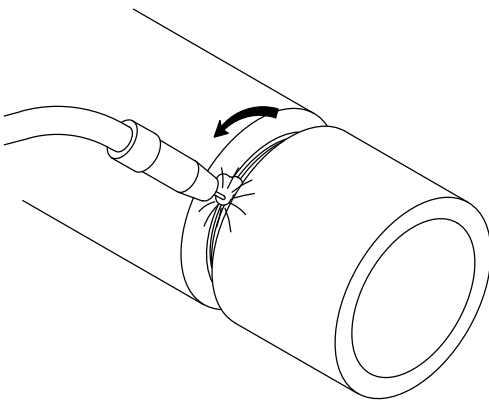
4. Move slightly up the sidewall.



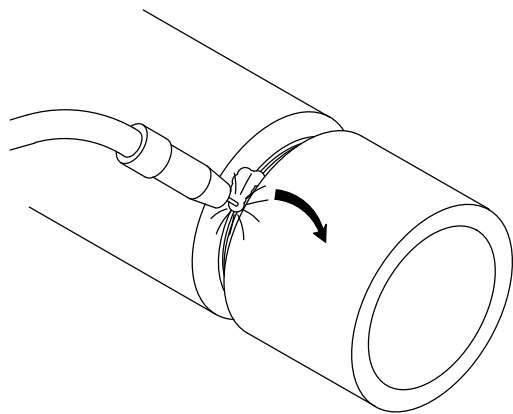
5. Stay in the puddle and move the electrode back across the gap. Move the electrode down the joint in a half-moon motion.



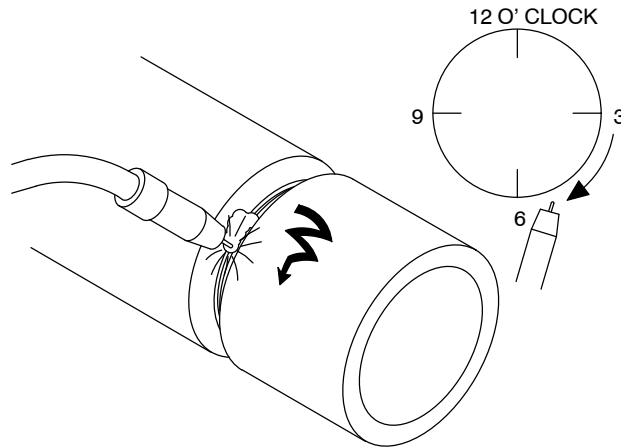
6. Continue moving back and forth (weaving) across the gap until reaching the 1 o'clock position.



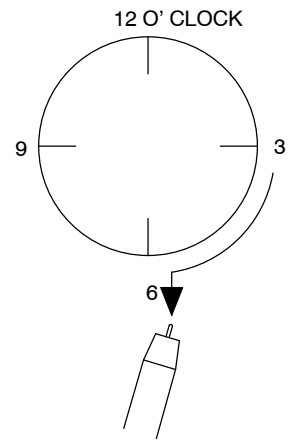
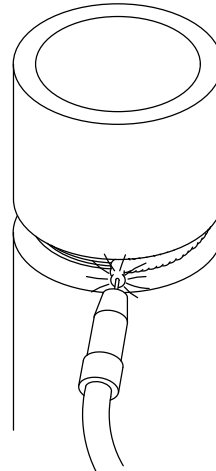
7. At the 1 o'clock position, stop weaving. Concentrate the arc on the center of the weld puddle and move down the pipe joint until the 5 o'clock position.



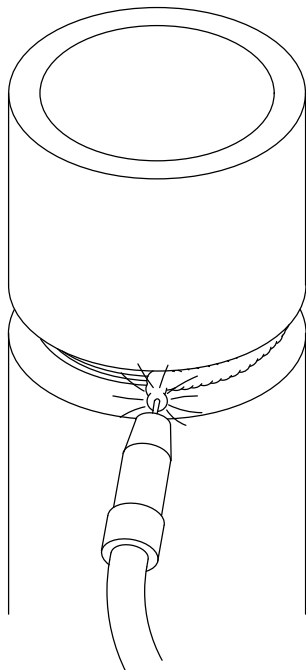
8. At the 5 o'clock position, repeat steps 3 – 6. However, at Step 6 the instruction should read "until reaching the 6 o'clock position" instead of the 1 o'clock position.



9. End the weld at the 6 o'clock position by moving the electrode onto the feathered tack weld.

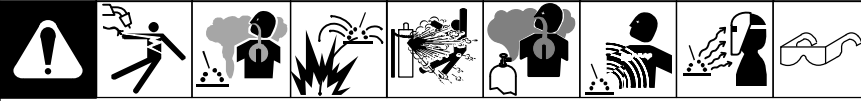


10. DO NOT stop welding in the root. This may cause pinholes. Be sure to grind the weld at the stop position to ensure pinhole is removed and weld is feathered.

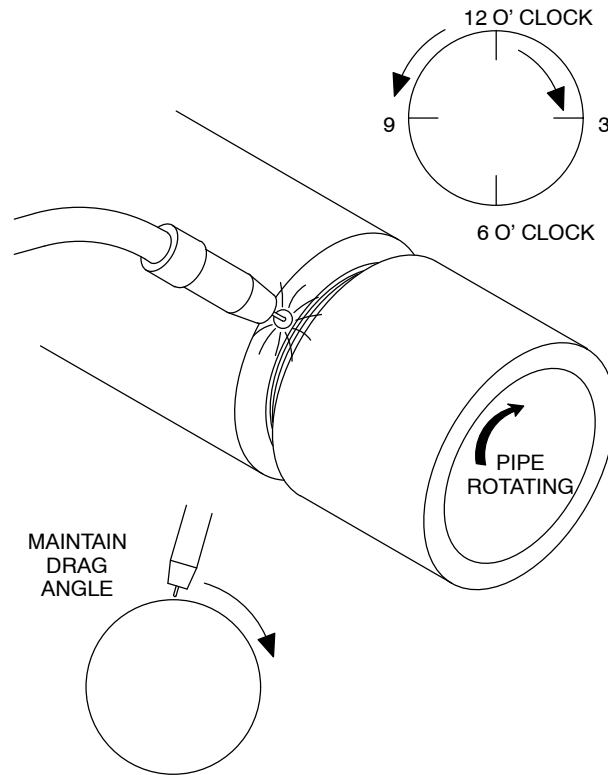


11. When root weld is complete, remove excess silicon with a wire wheel or with light grinding. Also, grind any high spots on root pass to make it uniform in height.

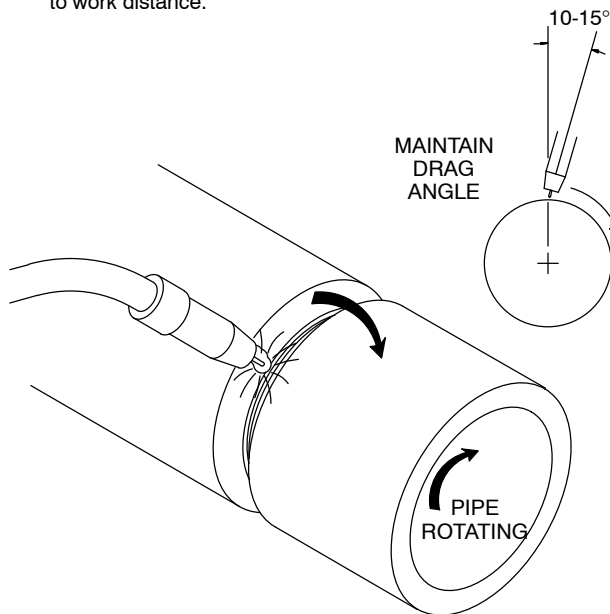
2-10. 1G Welding Technique Recommendations



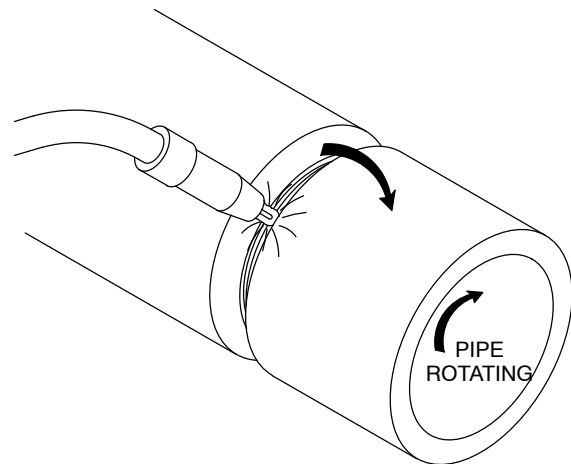
1. Start arc on sidewall or in center of tack weld, not in the gap.



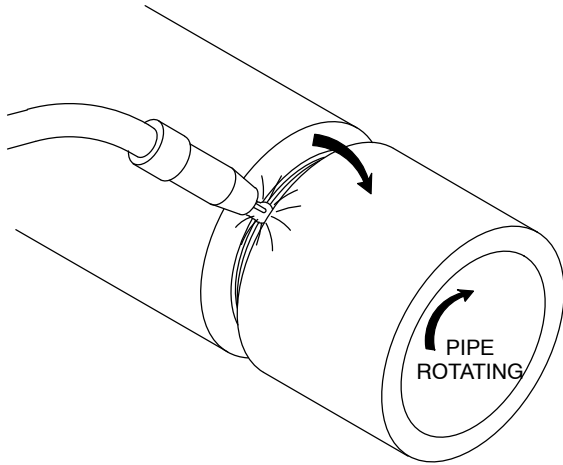
2. After puddle is established, maintain the arc on the leading edge of the puddle with a 1/4 to 1/2 in. (6.4 to 12.7 mm) tip to work distance.



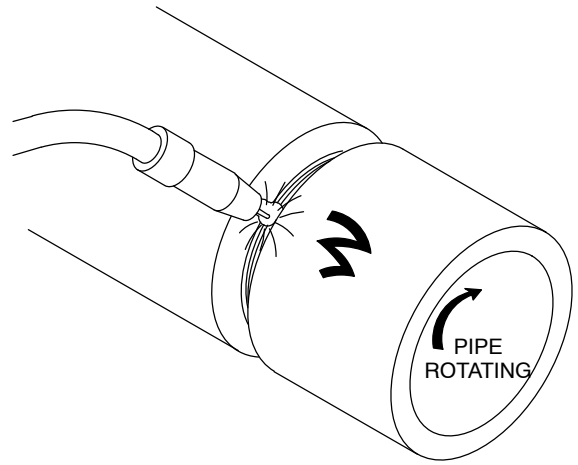
3. Move across the gap. Watch the puddle, not the arc.



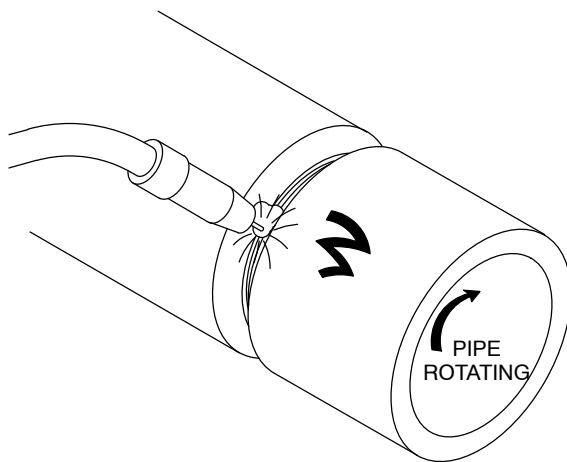
4. Move slightly up the sidewall. Keep the electrode near the top of the pipe joint.



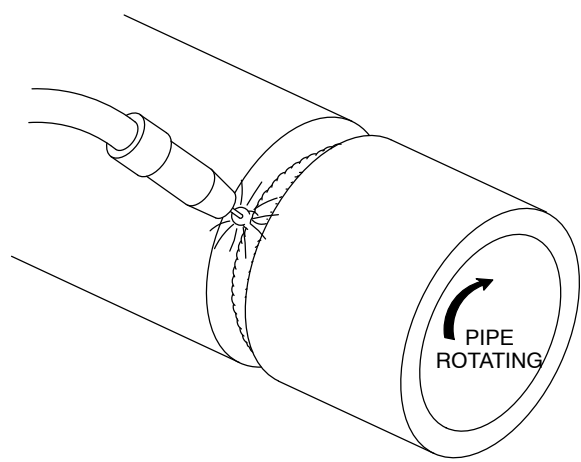
5. Stay on the leading edge of the puddle and move the electrode back across the gap. Move the electrode in a half-moon motion.



6. Continue moving back and forth (weaving) across the gap. Be sure pipe rotates at a constant speed. Maintain a steady arc length.



7. DO NOT stop welding in the root. This may cause pinholes. Fill the crater by welding into the previous weld start. Use a short arc length to control heat. Be sure to grind the weld at the stop position to ensure any pinhole is removed and weld is feathered.



8. When root weld is complete, remove excess silicon with a wire wheel or with light grinding. Also, grind any high spots on root pass to make it uniform in height.

2-11. Welding Passes And Appropriate Process With Parameter Ranges

A. Welding Process Data

Table 2-6. PipePro 450 RFC Welding Programs

Steel					
Process	Wire Size in (mm)	Wire Feed Speed IPM (mpm)	Arc Adjust/Trim	Arc Control	Shielding Gas
RMD Steel	.035 (0.9)	100-300 w/200 Nominal (2.5-7.7 w/5.1 Nominal)	47-53 w/50 Nominal	25	90/10
	.035 (0.9)	100-300 w/200 Nominal (2.5-7.7 w/5.1 Nominal)	47-53 w/50 Nominal	25	85/15
	.035 (0.9)	100-300 w/200 Nominal (2.5-7.7 w/5.1 Nominal)	47-53 w/50 Nominal	25	75/25
	.035 (0.9)	100-300 w/200 Nominal (2.5-7.7 w/5.1 Nominal)	47-53 w/50 Nominal	25	CO ₂
	.040 (1.0)	100-275 w/175 Nominal (2.5-7.0 w/4.4 Nominal)	50-55 w/53 Nominal	25	90/10
	.040 (1.0)	100-275 w/175 Nominal (2.5-7.0 w/4.4 Nominal)	47-53 w/50 Nominal	25	85/15
	.040 (1.0)	100-275 w/175 Nominal (2.5-7.0 w/4.4 Nominal)	50-55 w/53 Nominal	25	75/25
	.040 (1.0)	100-275 w/175 Nominal (2.5-7.0 w/4.4 Nominal)	50-55 w/53 Nominal	25	CO ₂
	.045 (1.1)	100-200 w/150 Nominal (2.5-5.1 w/3.8 Nominal)	47-53 w/50 Nominal	25	90/10
	.045 (1.1)	100-200 w/150 Nominal (2.5-5.1 w/3.8 Nominal)	47-53 w/50 Nominal	25	85/15
	.045 (1.1)	100-200 w/150 Nominal (2.5-5.1 w/3.8 Nominal)	47-53 w/50 Nominal	25	75/25
	.045 (1.1)	100-200 w/150 Nominal (2.5-5.1 w/3.8 Nominal)	47-53 w/50 Nominal	25	CO ₂
ProPulse Steel Using A Positioner (Rolling The Pipe)	.035 (0.9)	225-600 w/250 Nominal (5.7-15.2 w/6.4 Nominal)	52-57 w/56 Nominal	25	90/10
	.035 (0.9)	120-780 w/250 Nominal 3.0-19.8 w/6.4 Nominal	52-57 w/56 Nominal	30-35	85/15
	.040 (1.0)	120-600 w/250 Nominal 3.0-15.2 w/6.4 Nominal	52-56 w/56 Nominal	25	90/10
	.040 (1.0)	120-600 w/250 Nominal 3.0-15.2 w/6.4 Nominal	52-56 w/56 Nominal	25	85/15
	.045 (1.1)	140-500 w/250 Nominal (3.6-12.7 w/6.4 Nominal)	52-57 w/56 Nominal	25	90/10
	.045 (1.1)	140-500 w/250 Nominal (3.6-12.7 w/6.4 Nominal)	52-57 w/56 Nominal	25	85/15
ProPulse Steel Welding In Position	.035 (0.9)	120-780 w/200 Nominal (3.0-19.8 w/5.1 Nominal)	52-57 w/54 Nominal	25	90/10
	.035 (0.9)	120-780 w/200 Nominal (3.0-19.8 w/5.1 Nominal)	52-57 w/54 Nominal	30-35	85/15
	.040 (1.0)	120-600 w/175 Nominal (3.0-15.2 w/4.4 Nominal)	52-56 w/54 Nominal	25	90/10
	.040 (1.0)	120-600 w/175 Nominal (3.0-15.2 w/4.4 Nominal)	52-56 w/54 Nominal	25	85/15
	.045 (1.1)	140-500 w/175 Nominal (3.6-12.7 w/4.4 Nominal)	50-55 w/53 Nominal	25	90/10
	.045 (1.1)	140-500 w/175 Nominal (3.6-12.7 w/4.4 Nominal)	50-55 w/53 Nominal	25	85/15

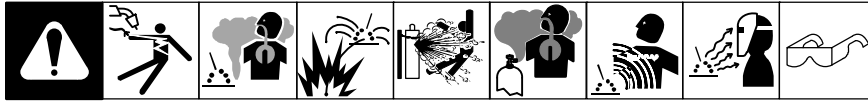
Stainless Steel					
Process	Wire Size in (mm)	Wire Feed Speed IPM (mpm)	Arc Adjust/Trim	Arc Control	Shielding Gas
RMD Stainless Steel	.035 (0.9)	120-290 w/200 Nominal (3.0-7.4 w/5.1 Nominal)	47-51 w/50 Nominal	25	Tri-H
	.040 (1.0)	120-275 w/200 Nominal (3.0-7.4 w/5.1 Nominal)	48-52 w/50 Nominal	30	Tri-H
	.040 (1.0)	120-275 w/200 Nominal (3.0-7.4 w/5.1 Nominal)	48-52 w/50 Nominal	25	98/2 CO ₂
	.040 (1.0)	120-275 w/200 Nominal (3.0-7.4 w/5.1 Nominal)	48-52 w/50 Nominal	25	98/2 Ox
	.045 (1.1)	120-160 w/150 Nominal (3.0-4.1 w/3.8 Nominal)	48-52 w/50 Nominal	25	Tri-H
ProPulse Stainless Steel Using A Positioner (Rolling The Pipe)	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	53-57 w/55 Nominal	25	Tri-H
	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	52-57 w/56 Nominal	16	Tri-A
	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	48-54 w/53 Nominal	18	98/2 CO ₂
	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	48-52 w/51 Nominal	18	98/2 Ox
	.045 (1.1)	140-450 w/200 Nominal (3.6-11.4 w/5.1 Nominal)	52-55 w/55 Nominal	25	Tri-H
	.045 (1.1)	120-525 w/200 Nominal (3.0-13.3 w/5.1 Nominal)	53-57 w/55 Nominal	16	98/2 CO ₂
	.045 (1.1)	120-525 w/200 Nominal (3.0-13.3 w/5.1 Nominal)	53-57 w/55 Nominal	25	98/2 Ox
ProPulse Stainless Steel Welding In Position	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	53-57 w/55 Nominal	25	Tri-H
	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	52-56 w/54 Nominal	16	Tri-A
	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	48-52 w/50 Nominal	18	98/2 CO ₂
	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	46-50 w/48 Nominal	18	98/2 Ox
	.045 (1.1)	120-525 w/140 Nominal (3.0-13.3 w/3.6 Nominal)	53-57 w/55 Nominal	25	Tri-H
	.045 (1.1)	120-525 w/140 Nominal (3.0-13.3 w/3.6 Nominal)	50-55 w/53 Nominal	16	98/2 CO ₂
	.045 (1.1)	120-525 w/140 Nominal (3.0-13.3 w/3.6 Nominal)	50-55 w/53 Nominal	25	98/2 Ox
	.045 Inconel 625	150-500 w/300 Nominal (3.8-12.7 w/7.6 Nominal)	50-55 w/53 Nominal	25-30	Argon
Flux Core					
Process	Wire Size in (mm)	Rolling Pipe/In Position Wire Feed Speed IPM (mpm)	Voltage	— —	Shielding Gas
Flux Core/GMAW	.045 (1.1)	175-780 w/200 Nominal (4.4-19.8 w/5.1 Nominal)*	24.5-32 w/24.5 Nominal	— —	75/25*
Note: Arc Control is arc width and Arc Adjust/Trim is arc length. Wire feed speed and voltage are synergic for the RMD and ProPulse processes. Therefore, when adjusting wire feed speed, the voltage is automatically adjusted so it is not necessary to adjust Arc Adjust/Trim. These are only starting parameters, the operator must make final adjustments depending on material and conditions.					
*See wire manufacturer for recommended wire feed speed and gas mixture.					

Table 2-7. PipeWorx 400 Welding Parameters

Steel				
Process	Wire Size in. (mm)	Wire Feed Speed IPM (mpm)	Arc Length	Shielding Gas
RMD Steel	.035 (0.9)	100-350 w/200 Nominal (2.5-8.9 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	C8 – C15
	.035 (0.9)	100-350 w/200 Nominal (2.5-8.9 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	C20 – C25
	.035 (0.9)	100-250 w/200 Nominal (2.5-6.4 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	CO ₂
	.045 (1.1)	100-250 w/150 Nominal (2.5-6.4 w/3.8 Nominal)	+3.0 to -3.0 w/zero Nominal	C8 – C15
	.045 (1.1)	100-250 w/150 Nominal (2.5-6.4 w/3.8 Nominal)	+3.0 to -3.0 w/zero Nominal	C20 – C25
	.045 (1.1)	100-200 w/150 Nominal (2.5-5.1 w/3.8 Nominal)	+3.0 to -3.0 w/zero Nominal	CO ₂
ProPulse Steel Using A Positioner 1G (Rolling The Pipe)	.035 (0.9)	120-780 w/250 Nominal (3.0-19.8 w/6.4 Nominal)	+3.0 to -3.0 w/zero Nominal	C8 – C15
	.045 (1.1)	140-500 w/250 Nominal (3.6-12.7 w/6.4 Nominal)	+3.0 to -3.0 w/zero Nominal	C8 – C15
ProPulse Steel Welding In Position 5G	.035 (0.9)	120-780 w/200 Nominal (3.0-19.8 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	C8 – C15
	.045 (1.1)	140-500 w/175 Nominal (3.6-12.7 w/4.4 Nominal)	+3.0 to -3.0 w/zero Nominal	C8 – C15
Stainless Steel				
Process	Wire Size in. (mm)	Wire Feed Speed IPM (mpm)	Arc Length	Shielding Gas
RMD Stainless Steel	.035 (0.9)	120-350 w/200 Nominal (3.0-8.9 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	C2
	.035 (0.9)	120-350 w/200 Nominal (3.0-8.9 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	98/2 Ox
	.035 (0.9)	120-350 w/200 Nominal (3.0-8.9 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-H
	.035 (0.9)	120-350 w/200 Nominal (3.0-8.9 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-A
	.045 (1.1)	120-250 w/150 Nominal (3.0-6.4 w/3.8 Nominal)	+3.0 to -3.0 w/zero Nominal	C2
	.045 (1.1)	120-250 w/150 Nominal (3.0-6.4 w/3.8 Nominal)	+3.0 to -3.0 w/zero Nominal	98/2 Ox
	.045 (1.1)	120-250 w/150 Nominal (3.0-6.4 w/3.8 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-H
	.045 (1.1)	120-250 w/150 Nominal (3.0-6.4 w/3.8 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-A

Stainless Steel				
Process	Wire Size in. (mm)	Wire Feed Speed IPM (mpm)	Arc Length	Shielding Gas
ProPulse Stainless Steel Using A Positioner 1G (Rolling The Pipe)	.035 (0.9)	150-780 w/250 Nominal (3.8-19.8 w/6.4 Nominal)	+3.0 to -3.0 w/zero Nominal	C2
	.035 (0.9)	150-780 w/250 Nominal (3.8-19.8 w/6.4 Nominal)	+3.0 to -3.0 w/zero Nominal	98/2 Ox
	.035 (0.9)	225-600 w/250 Nominal (5.7-15.2 w/6.4 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-H
	.035 (0.9)	150-780 w/250 Nominal (3.8-19.8 w/6.4 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-A
	.045 (1.1)	120-780 w/200 Nominal (3.0-19.8 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	C2
	.045 (1.1)	120-780 w/200 Nominal (3.0-19.8 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	98/2 Ox
	.045 (1.1)	140-780 w/200 Nominal (3.6-19.8 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-H
	.045 (1.1)	120-780 w/200 Nominal (3.0-19.8 w/5.1 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-A
ProPulse Stainless Steel Welding In Position 5G	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	+3.0 to -3.0 w/zero Nominal	C2
	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	+3.0 to -3.0 w/zero Nominal	98/2 Ox
	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-H
	.035 (0.9)	150-780 w/175 Nominal (3.8-19.8 w/4.4 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-A
	.045 (1.1)	120-525 w/140 Nominal (3.0-13.3 w/3.6 Nominal)	+3.0 to -3.0 w/zero Nominal	C2
	.045 (1.1)	120-525 w/140 Nominal (3.0-13.3 w/3.6 Nominal)	+3.0 to -3.0 w/zero Nominal	98/2 Ox
	.045 (1.1)	120-525 w/140 Nominal (3.0-13.3 w/3.6 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-H
	.045 (1.1)	120-525 w/140 Nominal (3.0-13.3 w/3.6 Nominal)	+3.0 to -3.0 w/zero Nominal	Tri-A
Flux Core				
Process	Wire Size in. (mm)	Rolling Pipe/In Position Wire Feed Speed IPM (mpm)	Voltage	Shielding Gas
Flux Core/GMAW	Not Dependent	175-780 w/200 Nominal (4.4-19.8 w/5.1 Nominal)*	24.5-32 w/24.5 Nominal	Not Dependent
Note: Arc Length – Length of arc from end of wire to weld puddle. Wire feed speed and voltage are synergic for the RMD and ProPulse processes. This means when adjusting wire feed speed, the voltage is automatically adjusted so it is not necessary to adjust the Arc Length.				
*See wire manufacturer for recommended wire feed speed and gas mixture.				

2-12. Troubleshooting Guide



A. Process Issues

Trouble	Possible Causes	Remedy
Undercutting	Travel speed too high	Slow down travel speed
	Welding voltage too high	Decrease arc length, trim, or voltage
	Dwell time not long enough	Pause longer while weaving
	Gun angle	Maintain 10 to 15 degree drag angle in RMD and 5 to 10 degree angle in pulse
Porosity	Inadequate shielding gas coverage	Check flowmeter for 35 to 50 SCFH
	Gas in contaminated/leaky connections	Check fittings, hoses, and shielding gas connections
	Electrode contamination	Replace electrode
	Workpiece contamination	Remove paint, mill scale, rust, oil, and oxide
	Arc Voltage too high	Decrease arc length, trim, or voltage
	Excessive contact tube to work distance	3/8 to 5/8 in. (10 to 16 mm) stick-out for RMD or pulse 3/4 to 1 in. (19 to 25 mm) stick-out for FCAW
Incomplete fusion	Weld zone surfaces not free of film or excessive oxide	Grind or sand to clean off surface
	Insufficient heat input	Increase wire feed speed
	Too large of a weld puddle	Increase travel speed or decrease wire feed speed
	Improper welding technique	Re-evaluate welding method for proper technique
	Improper joint preparation	Increase joint angle
	Excessive travel speed	Decrease travel speed or increase wire feed speed
Humping and crowning	Excessive travel speed	Slow down travel speed or weave electrode
Unmelted electrode on root side ("whiskers")	Improper welding technique	Focus electrode back further on weld puddle
Spatter	Long arc length	Shorten arc length or decrease voltage
	Bad shielding gas	Replace shielding gas
	Welding in globular transfer range (Argon gas)	Decrease voltage
Excessive melt through	Excessive heat input	Reduce wire feed speed
	Improper joint penetration	Shorten root opening
Other issues	Unable to resolve problem	Contact factory pipe welding products service (920-735-4001)

B. Parameter Issues

Change Required	Arc Voltage	Welding Current	Travel Speed
Deeper penetration		Increase	
Shallower penetration		Decrease	
Larger bead		Increase	Decrease
Smaller bead		Decrease	Increase
Higher, narrower bead	Decrease		
Flatter, wider bead	Increase		
Faster deposition		Increase	
Slower deposition		Decrease	



Owner's Record

Please complete and retain with your personal records.

Model Name

Serial/Style Number

Purchase Date

(Date which equipment was delivered to original customer.)

Distributor

Address

City

State

Zip



For Service

Contact a DISTRIBUTOR or SERVICE AGENCY near you.

Always provide Model Name and Serial/Style Number.

Contact your Distributor for:

Welding Supplies and Consumables

Options and Accessories

Personal Safety Equipment

Service and Repair

Replacement Parts

Training (Schools, Videos, Books)

Technical Manuals (Servicing Information and Parts)

Circuit Diagrams

Welding Process Handbooks

To locate a Distributor or Service Agency visit www.millerwelds.com or call 1-800-4-A-Miller

Contact the Delivering Carrier to:

File a claim for loss or damage during shipment.

For assistance in filing or settling claims, contact your distributor and/or equipment manufacturer's Transportation Department.

Miller Electric Mfg. LLC

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