The following safety fact sheets and the complete 66-page ANSI Z49.1 Safety in Welding, Cutting, and Allied Processes are available for free download at www.aws.org/safety:

1: Fumes and Gases
2: Radiation
3: Noise
4: Chromium and Nickel in Welding Fume
5: Electrical Hazards
6: Fire and Explosion Prevention
7: Burn Protection
8: Mechanical Hazards
9: Tripping and Falling
10: Falling Objects
11: Confined Spaces
12: Contact Lens Wear
13: Ergonomics in the Welding Environment
14: Graphic Symbols for Precautionary Labels
15: Style Guidelines for Safety and Health Documents
16: Pacemakers and Welding
17: Electric and Magnetic Fields (EMF)
18: Lockout/Tagout
19: Laser Welding and Cutting Safety
20: Thermal Spraying Safety
21: Resistance Spot Welding
22: Cadmium Exposure from Welding & Allied Processes
23: California Proposition 65
24: Fluxes for Arc Welding and Brazing: Safe Handling and Use
25: Metal Fume Fever
26: Arc Viewing Distance
27: Thoriated Tungsten Electrodes
28: Oxyfuel Safety: Check Valves and Flashback Arrestors
29: Grounding of Portable and Vehicle Mounted Welding Generators
30: Cylinders: Safe Storage, Handling, and Use
31: Eye and Face Protection for Welding and Cutting Operations
32: Personal Protective Equipment (PPE) for Welding & Cutting
33: Coated Steels: Welding and Cutting Safety Concerns
34: Ventilation for Welding & Cutting
35: Selecting Gloves for Welding & Cutting
36: Z49.1: Safety in Welding, Cutting, and Allied Processes

Includes the following concise and helpful fact sheets from the American Welding Society’s Committee on Safety and Health

Fact Sheet 7: Burn Protection
Fact Sheet 8: Mechanical Hazards
Fact Sheet 11: Confined Spaces
Fact Sheet 29: Grounding of Portable and Vehicle Mounted Welding Generators
Fact Sheet 30: Cylinders: Safe Storage, Handling, and Use
NATURE OF THE HAZARD

Sparks and spatter fly off from the welding arc. Hot metal and sparks blow out from the cutting flame. The workpiece and equipment get hot. The flying sparks and hot metal, slag, spatter, hot workpiece, and hot equipment can cause burns. Additionally, arc rays can cause radiation burns (see Fact Sheet No. 2).

HOW TO PREVENT BURNS

- Use approved helmets or hand shields that provide protection for the face, neck, and ears, and wear a head covering.
- Wear approved safety goggles or safety glasses with side shields, even under your helmet.
- Wear dry, hole-free insulating gloves.
- Wear flame-resistant ear plugs or ear muffs to keep sparks out of ears when welding or cutting overhead or in confined spaces.
- Wear oil-free protective garments such as leather gloves, heavy shirt, cuffless pants, high shoes, and a cap.
- Wear leather leggings and fire-resistant boots, as needed.
- Use dry, hole-free aprons, cape-sleeves, leggings, shoulder covers, and bibs approved for welding and cutting service.
- Remove any combustibles, such as a butane lighter or matches, from your person before doing any welding or cutting.
- Touching hot equipment such as electrode holders, gun tips, and nozzles can cause burns. Always wear dry, insulating gloves. Allow a cooling period before touching these and other parts of equipment that are near the actual welding or cutting operation.
- Do not wear pants with cuffs, shirts with open pockets, or any clothing that can trap molten metal or sparks.
- Keep clothing free of grease, oil, solvents, or any flammable substances.
- If combustible substances spill on protective clothing, change to clean clothing before doing any welding or cutting.
- Use sheet metal screens for extra protection when unusually heavy welding or cutting is involved.
- For highly hazardous processes or jobs, consider automation.

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• Do not attempt to repair or disconnect electrical equipment under load. Disconnecting under load produces arcing of the contacts and may cause burns or shocks.

**HOW TO PROTECT OTHERS FROM BURNS**

• Use noncombustible screens or barriers to protect nearby persons or watchers.

• Mark hot work pieces to alert others of the burn and fire hazards.

• If the job requires several persons, have all wear proper protective gear and follow all required procedures.

**INFORMATION SOURCES**


F2413, *Specification for Performance Requirements for Protective Footwear*, available from ASTM International, 100 Bar Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2559; telephone: 610-832-9585; web site: www.astm.org.


ASTM International Standards, F2412, *Test Methods for Foot Protection*, and AWS disclaims liability for any injury to persons or to property, or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this Safety and Health Fact Sheet. AWS also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.
NATURE OF THE HAZARD

Like other technologies that work with metals, welding and cutting seldom work in isolation. Other equipment and tools are normally used and kept nearby. The use of, or the closeness to, mechanical equipment can present hazards to the welder. Knowledge of the proper use of power tools, such as grinders, chippers, drills, and various hand tools, is important to welder safety. Know and understand the safe limits and proper use of cranes, positioners, and other material handling equipment. Use appropriate guards and personal protective equipment. Some safety recommendations follow.

PERSONAL SAFETY

• Wear proper head, eye and hand protection.

• Use face shields, safety glasses, and goggles as appropriate.

• Wear dry, hole-free insulating gloves when welding or cutting.

• Avoid wearing loose items such as earrings, rings, necklaces, bracelets, loose clothing, neckties, and scarves.

• Watch out for sharp objects, pinch points, and moving objects.

• Protect long hair and beards.

GINDING WHEEL SAFETY

• Follow grinding wheel speed limitations according to manufacturer’s instructions.

• Do not grind on the side of a wheel unless designed for such service.

• When starting a new wheel, stand to the side until it reaches speed, and correct any abnormalities noted.

• Be sure guards are in place.

TOOL SAFETY

• Use the right tool for the job. Use good quality tools. Use them for the job they were intended to perform.
  For example, it is often tempting to use a screwdriver for a chisel or a pair of pliers for a wrench. Avoid such practices. The right tool will do the job faster and safer.

• Inspect tools before use.

• Never use a tool that is in poor or faulty condition.

• Keep all tools in good condition.

• Keep a firm grip on tools to prevent them from slipping away.

• Do not overload or force a tool beyond its capabilities.
• Foresee results of unexpected occurrences such as tools getting away, binding, or coming loose from their handles.

• Check any tool that has become jammed, or otherwise overstressed, for damage before reuse.

• Anticipate the reactive force from tools.

• Anticipate what might happen to a component that is to be loosened or unbolted from its working position.

• When using tools that involve weights and spring tension, be certain that all pressures are applied and released in a safe manner.

• Follow lockout/tagout procedures for equipment and tools as required.

• Do not bypass safety interlocks on equipment. Bypassing defeats the safety device and creates a possibly serious hazard.

• Store tools in a safe place. Many accidents are caused by tools falling off ladders, shelves, or scaffolds. Each tool should have a designated place in a tool box or pouch.

• For additional information of the safe operation and guarding of mechanical equipment, refer to the manufacturers’ safe operating procedures.

INFORMATION SOURCES


NATURE OF THE HAZARD

Many different places require welding, cutting, and other hot work. Some of these places lack room and become “confined spaces.” Confined spaces have the following characteristics:

- Limited space, entry, or exit.
- Poor ventilation – lack of safe breathing air and possible buildup of hazardous gases, fumes, and particles.

EXAMPLES OF CONFINED SPACES

Small rooms  Process vessels  Tunnels
Pits  Vats  Furnaces  Silos
Storage tanks  Pipelines  Boilers  Reactor vessels  Utility vaults  Conveyers
Sewers  Degreasers  Ventilation ducts
Degreasers  Reactor vessels  Conveyers
Compartments of ships  Unventilated room areas

REASONS FOR DEATHS AND SERIOUS INJURIES FROM HOT WORK IN CONFINED SPACES

- Fire
- Electric shock
- Exposure to hazardous air contaminants
- Explosion
- Asphyxiation

ACTIONS REQUIRED BEFORE APPROVING HOT WORK IN A CONFINED SPACE

- Determine if special training or a permit is required to enter the space.
- Open all covers and secure them from closing.
- Test atmosphere for:
  1. Suitable oxygen content
  2. Combustibles or reactives
  3. Toxics

  
  Note: The testing requires special equipment and training.

- Isolate lines by capping or double blocking and bleeding. Keep vents open and valves leak-free.
- Lock out/tagout all systems not required during hot work.
- Provide means for readily turning off power, gas, and other supplies from outside the confined space.
- Protect or remove any hazardous materials or materials which may become hazardous when exposed to hot work.
REQUIRED ACTIONS DURING HOT WORK IN A CONFINED SPACE

- Continuously ventilate and monitor air to ensure fumes and gases do not exceed safe exposure limits.

- 29 CFR 1910.252(c) and 1926.353(c) require the use of local exhaust ventilation or supplied air respiratory protection when hot work is performed in a confined space where there is a potential for exposure to fluorine compounds (fluxes and rod coatings), zinc, lead, cadmium, or mercury. When beryllium is present, use both local exhaust and a supplied-air respirator.

- 29 CFR 1926.353(c) requires the use of local exhaust ventilation or supplied air respiratory protection when hot work is performed in a confined space where there is a potential for exposure to chromium or when Gas Metal Arc Welding is performed on stainless steel.

- Use NIOSH/MSHA (National Institute for Occupational Safety and Health/Mine Safety and Health Administration) approved breathing device when required by code.

- Keep unnecessary persons and equipment out of, and away from, the confined space.

- Do not allow equipment to block exit or rescue efforts.

- Place as much equipment as possible outside the confined space.

- Do not enter a confined space unless a watchperson, properly equipped and trained for rescue, is outside. Maintain continuous communications with the worker inside.

- When possible, provide means for readily turning off power, gases, and fuel from inside the confined space, even if outside turn-off means are provided.

INFORMATION SOURCES


INTRODUCTION

Proper grounding and bonding of portable and vehicle mounted welding generators that also supply 115 or 230 volts AC auxiliary power is an on-going topic among welders. This Fact Sheet will help you determine the requirements for bonding and grounding welding generators. Additionally, it will give definitions and present necessary electrical concepts to clarify the requirements for bonding and grounding.

TERMS

Sources: ANSI Z49.1, hereafter termed Z49.1, AWS A3.0, and NEC—National Electrical Code, hereafter termed NEC. See Information Sources Section at end for details.

Bonding—The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.

Ground—The electrical potential of the earth’s surface: a conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

Ground Connection—An electrical connection of the welding machine frame to the earth for safety.

Grounded—Connected to earth or to some conducting body that serves in place of the earth.

Grounded, effectively—Intentionally connected to earth through a ground connection of sufficiently low resistance and with adequate current-carrying capacity to prevent the buildup of voltage that may be hazardous to connected equipment or to persons.

Grounding—The process of bonding one or more conductive objects to the ground, so that all objects are at zero (0) electrical potential; also referred to as “earthing.”

Grounding Conductor—A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes [ground rod(s) or metal water pipe].

Ground Rod—A metal rod, typically copper, not less than eight feet in length and 1/2 inch in diameter, driven into the earth such that at least eight feet of length is in contact with the soil, to function as a suitable connection point to earth. NOTE: Since different diameters are required for different rod materials and the driven length and number of rods used depends on the special soil conditions and applications, consult the NEC for the specific data for the correct ground rod and method of use for each particular situation.
Hard Wired—Connected by separate conductors to a junction point or box—not to receptacles.

Metal Water Pipe—Typically an underground metal water pipe that supplies water to a building or premises or faucet /outlet and that is in contact with the earth for a specified distance. NOTE: Since the metal water pipe has several key requirements that must be met before it complies with regulations, consult the NEC for specific information before selecting any pipe for a ground connection.

Portable—Capable of being carried or moved about; designed for ready movement and use in field locations.

Separately Derived System--A premises wiring system whose power is derived from a battery, a solar photovoltaic system, or from a generator, transformer, or converter windings, and that has no direct electrical connection, including a solidly connected grounded circuit conductor, to supply conductors originating in another system.

Vehicle Mounted—Equipment installed in a truck, trailer, or similar wheeled vehicle.

Work—The workpiece or metal upon which the welder welds and is normally grounded independently of the welding leads to a good electrical ground unless a qualified person assures it is safe to work on an ungrounded workpiece.

Work Lead—The electric conductor between the source of arc welding current and the work. The work lead should not be referred to as the ground lead. It is preferable to connect the work lead directly to the work. Unless a separate grounding conductor is used (to connect the workpiece to an earth ground), the work lead will not be grounded.

NATURE OF THE HAZARD

Some basics:
- When the generator is running, current can pass through a wire, a ladder, a hoist, your body, or any other conductor.
- If you become part of an electrical circuit, current can pass through your body causing a shock.

Why Grounding is Important: Grounding the frame of electrical equipment ensures the following:
- Generators are grounded to prevent the buildup of voltages that may result in undue hazards to persons or equipment.
- When no voltage difference exists between the grounded generator frame and earth, no electric current can flow. Therefore, the shock hazard is reduced.
- Since it is the flow of electric current through the human body that is hazardous, proper grounding is one of the best ways to prevent unintended electric shock.

If we don't ground the generator and should have, the results can be hazardous—here’s why:
- If the auxiliary power circuit has a fault condition (such as a short caused by bare wires), and there is no safety ground connection to protect the user, the result can be an electric shock.
- Additionally, grounding helps prevent possible fire or explosion when fueling by reducing the chances for static electricity sparks from the fuel nozzle to the tank.
CONDITIONS WHERE GROUNDING THE GENERATOR FRAME TO A METAL WATER PIPE OR GROUND ROD IS REQUIRED BY THE NEC:

1. The welding generator is not part of a separately derived system, OR
2. It has its neutral conductor solidly interconnected to a service-supplied system neutral, OR
3. It supplies auxiliary power output (115 volts AC / 230 volts AC) by means other than cord-and-plug connection through receptacles mounted on the generator, such as connections to internal terminals on the generator—hard wired (see equipment Owner’s Manual for grounding instructions).

When ANY of these conditions are met, grounding is required.

CONDITIONS WHERE GROUNDING THE GENERATOR FRAME TO A METAL WATER PIPE OR GROUND ROD IS NOT REQUIRED BY THE NEC:

1. The welding generator has auxiliary power output (115 volts AC or 230 volts AC) and the generator receptacles have a ground pin outlet available for the equipment that plugs into the receptacle, AND
2. The generator is portable or mounted on a truck or trailer, AND
3. The auxiliary power is used by cord-and-plug-connection means through receptacles mounted on the generator, AND
4. The generator is mounted on a vehicle and the generator frame is bonded to the vehicle frame.

HOW TO AVOID THE HAZARDS

- Follow the manufacturer’s recommended procedures for grounding the welding generator.
- Watch out for bed liners in trucks—securely connect the welding generator frame to the frame of the vehicle or trailer by a ground wire or bolted metal-to-metal contact.
- Bond the generator to the vehicle frame or earth.
- When grounding a generator sitting directly on the earth, use a driven ground rod to ensure the earth connection.
- Keep the fuel nozzle in contact with the tank when fueling to prevent static sparks and fire.

SUMMARY

- Proper grounding of the welding generator frame can help prevent electric shock.
- If your generator is in a truck or trailer, and you use power directly from the receptacles via plugs, connect (bond) the generator frame to the vehicle frame—be sure there is a good metal-to-metal connection.
- If you hard wire the generator auxiliary power to a project or building electrical system, then you must connect the generator frame to a driven ground rod or metal water pipe.
- The decision is based on what you do with your auxiliary power: If you just plug equipment into the receptacles, connection to the vehicle frame is fine. If you hard wire the auxiliary power into another electrical system, then you must connect the generator frame to a driven ground rod or metal water pipe.
- Remember: The objective is to keep the frame of the generator at zero (or earth) voltage.
• In simplest terms, grounding the welding generator frame provides an electrical path to ground instead of a possible electrical shock hazard to the user.

INFORMATION SOURCES


INTRODUCTION

To use compressed gas cylinders safely, it is important that they are stored properly, handled correctly, used with the correct equipment, and that the properties of the gases they contain are fully understood.

OVERVIEW OF CYLINDER PHYSICAL HAZARDS

Physical Damage: Cylinders, with their high internal pressure (up to 2,500 pounds per square inch gauge (psig)), are very hazardous when exposed to damage from falling over or tipping, heat, electric circuits, motion, or vibration — anything that can cause a weakness or crack in the cylinder wall or shell. Such damage can cause the cylinder to rupture and explode sending sharp metal pieces, like shrapnel, blasting through the area.

Valve Hazard: The CGA (in Pamphlet V-1) has established a 0.300 inch (7.62 mm) maximum valve inlet diameter as a requirement to minimize the propulsion effect in case the valve is severed. This standard has the exception of valves used in liquefied gas services and fire control systems. Special design requirements and unique applications such as fire control systems, which require a “high blow down flow”, may dictate greater diameters. The actual outcome of a broken off valve depends on the design and pressure of the valve and cylinder. If the valve is broken off and the valve inlet opening meets the Compressed Gas Association (CGA) requirements, the cylinder will rapidly release all its gas (which could be a health and/or flammability concern), cause a whistling sound, and possibly spin uncontrollably. If the valve inlet opening is different from the standard hole size used in most welding gases, such as those used for propane or butane and fire protection system cylinders, the cylinders may take off and become airborne. You can check this size matter by being sure the cylinder meets all V-1 requirements.

Tipping and Falling: The most common major hazard is having a cylinder tip over or fall on you or another nearby worker. Since cylinders are heavy and awkward to handle, they require special care and equipment in handling and securing so they don’t fall or tip over and cause injury.

Valve Leakage: Cylinder valves can leak, causing their contents to discharge. To minimize hazards from leaks, use proper ventilation and storage.

OVERVIEW OF CYLINDER CONTENTS HAZARDS

Read, understand, and follow the markings on the cylinder, the label(s) on the cylinder, and the material safety data sheet (MSDS). Each compressed gas cylinder has unique hazards based on contents. Some are filled with inert gases — especially those used in arc welding. Many gases are flammable, explosive, toxic, or a combin-
Common compressed gases include acetylene, carbon dioxide, argon, hydrogen, nitrogen, air, propane, and oxygen.

**HOW TO STORE CYLINDERS**

- Store cylinders upright and secure them with a chain, strap, or cable to a stationary building support or to a proper cylinder cart to prevent them from tipping or falling.

- Completely close the valves, and keep the valve protection devices, such as caps or guards, securely in place.

- Store cylinders in a dry, well-ventilated area at least 20 feet from combustible materials. Do not keep cylinders in lockers. If they leak, a buildup of flammable or other types of gases can occur inside the locker.

- Mark the storage area with proper precautionary signs, such as flammable, oxidizer, or toxic.

- Place them in a location where they will not be subject to mechanical or physical damage, heat, or electrical circuits to prevent possible explosion or fire. Keep cylinders away from vehicle traffic.

- Store empty cylinders separate from full ones.

- Keep oxygen cylinders 20 feet away from fuel-gas cylinders, such as acetylene, or separate them with a non-combustible barrier (such as a wall) at least 5 feet high with a fire-resistance rating of at least one-half hour.

**HOW TO TRANSPORT CYLINDERS**

- Most accidents or injuries involving cylinders happen when moving or handling the gas cylinders.

- Use the right equipment, correct procedures, and sufficient number of persons to lift and move cylinders to avoid personal injury and cylinder damage.

- Wear protective footwear, safety glasses, and heavy gloves.

- Securely install the valve protection devices, such as caps or guards.

- Secure cylinders upright to a proper hand truck or cylinder cart designed for the purpose.

- Don't drag or roll them – use a properly designed cart or hand truck.

- When using a crane, be sure to use proper cradles, nets, boats, or special platforms designed for this purpose to prevent cylinders from falling.

- Prevent damage – handle carefully – avoid dropping or banging them.

- Do not lift by the protective cap/guard or use magnets or slings to lift or move them since valves may be damaged or sheared off.

**HOW TO USE CYLINDERS**

- Follow the instructions in the Compressed Gas Association (CGA) publication P-1, “Safe Handling of Compressed Gases in Cylinders.” (The phone number and web site of the CGA are located at the end of this sheet in the Information Sources Section.) Don't tamper with safety devices.
• Keep cylinders upright and away from heat, sparks, fire, physical damage, or electrical circuits to avoid rupture.

• Use in a well-ventilated area to avoid gas accumulation.

• Do not bring cylinders into a confined space to avoid inhaling the gas and possible suffocation from the accumulation of flammable, toxic, or reactive gases.

• Read, understand, and follow all cylinder markings and labels to avoid misuse.

• Before connecting a regulator, stand to one side, and momentarily open the valve and then close it immediately. This procedure, called “cracking” the valve, is done to clear the valve of dust or dirt that could enter the regulator.

• Open valves slowly by hand to avoid gauge damage. If a specific tool is required to open the valve, leave it in position so that the flow of gas can be stopped quickly in an emergency.

• Lift and move cylinders properly.

• Close the gas cylinder valves when not in use such as during breaks, lunch, or end-of-shift to avoid leaks.

• Avoid getting any oil or grease on the cylinders or regulators/gauges, particularly those containing oxygen, to avoid fire or explosion.

• Storage is not required for single cylinders of fuel gas and oxygen ready for use with regulators attached secured to a proper cart.

HOW TO MAINTAIN THEM

• Protect the markings on cylinders that identify the contents, and mark the full/empty status on cylinders (do not use color to identify contents). Mark all empty cylinders (some companies use "MT").

• Don’t use the recessed top of the cylinder as a storage area for tools or material.

• If cylinders are leaking, isolate them outdoors and away from sparks or heat. Call your gas supplier to send qualified people to take care of the problem – don’t try any repairs yourself. Tag leaking cylinders.

• Never mix gases in a cylinder or try to refill a cylinder – always contact your gas supplier.

SUMMARY

Even though high-pressure, compressed gas cylinders are near or part of most welding and cutting operations, they are used safely everyday by many people throughout the world. To prevent injury, always store, handle, use, and maintain them properly. Treat them with the respect they deserve.

INFORMATION SOURCES


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Fact Sheet No.30 — 3/05


Guide for Multipass Orbital Machine Pipe Groove Welding

1st Edition

Prepared by the
American Welding Society (AWS) D10 Committee on Piping and Tubing
Under the Direction of the
AWS Technical Activities Committee
Approved by the
AWS Board of Directors

Abstract

Foreword

This foreword is not part of AWS D10.14M/D10.14:2010, Guide for Multipass Orbital Machine Pipe Groove Welding, but is included for informational purposes only.

This document was created as a result of the recognized need to bring together a description of the various technologies combined in orbital multipass machine pipe groove welding. This document should be of benefit to readers wishing to familiarize themselves with the mechanized orbital pipe welding option to manual or semiautomatic pipe groove welding.
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1. Scope

The scope of this document is multipass, orbital machine pipe groove welding of pipe by arc fusion processes with filler metal addition. The orbital machines described in this document are typically used to weld pipe in plants, such as power generation plants or chemical processing plants, and to weld transmission pipelines, both cross-country and offshore. Offshore pipeline construction includes “S-lay,” “J-lay,” and “Reel-lay.” Each of these will be described in further detail. This guide is organized into sections describing welding processes, pipe beveling, pipe line-up, weld heads, nondestructive examination, plant pipe welding, cross-country welding, “S-lay” welding, “J-lay” welding, and finally reel lay welding. The guide concludes with a brief description of methods used to estimate consumable usage, engineering critical assessments, methods to calculate maximum repair lengths, and safety.

This document excludes orbital tube welding, which is addressed by AWS D18.1, Specification for Welding of Austenitic Stainless Steel Tube and Pipe Systems in Sanitary (Hygienic) Applications.

This document presents an overview of multipass orbital machine pipe groove welding including the welding processes, pipe beveling equipment, pipe line-up equipment, welding equipment, and nondestructive examination equipment. This document includes the steps required to prepare for and use multipass, orbital machine pipe groove welding equipment.

The alternative to multipass orbital machine pipe groove welding is manual welding, which includes welding with a torch, gun, or electrode held and manipulated by hand. Orbital machine welding is a form of mechanized welding which offers an alternative to manual welding when the investment in mobilization and equipment costs can be offset by productivity gains. The goal of this guide is to familiarize the reader with the orbital machine alternative to manual welding.

This standard makes use of both the International System of Units and U.S. Customary Units. The latter are shown within brackets ([ ]) or in appropriate columns in tables and figures. The measurements may not be exact equivalents; therefore, each system must be used independently.

Safety and health issues and concerns are beyond the scope of this standard and therefore are not fully addressed herein. Safety and health information is available from other sources, including, but not limited to, ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes, AWS Safety and Health Fact Sheets (see Annex B) and applicable federal and state regulations.

2. Normative References

The following standards contain provisions which, through reference in this text, constitute mandatory provisions of this AWS standard. For undated references, the latest edition of the referenced standard shall apply. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply.

AWS documents:

AWS A2.4, Standard Symbols for Welding, Brazing and Nondestructive Examination

1 AWS standards are published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.