





## Mechanical Hazards

### 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.

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- 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.

American National Standards Institute (ANSI). *Control of Hazardous Energy - Lockout/Tagout and Alternative Methods* (ANSI Z244.1), available from ANSI, 25 West 43<sup>rd</sup> Street, New York, NY 10036; telephone: 212-642-4900; web site: [www.ansi.org](http://www.ansi.org).

American National Standards Institute (ANSI). *Practice for Occupational and Educational Eye and Face Protection* (ANSI Z87.1), available from ANSI, 25 West 43<sup>rd</sup> Street, New York, NY 10036; telephone: 212-642-4900; web site: [www.ansi.org](http://www.ansi.org).

Occupational Safety and Health Administration (OSHA). *Code of Federal Regulations*, Title 29 Labor, Parts 1910.1 to 1910.1450, available from the U.S. Government Printing Office, 732 North Capitol Street NW, Washington, DC 20401; telephone: 800-321-6742; web site: [www.osha.gov](http://www.osha.gov).

Mine Safety and Health Administration (MSHA). *Code of Federal Regulations* Title 30 Mineral Resources, Parts 1 to 199, available from the U.S. Government Printing Office, 732 North Capitol Street NW, Washington, DC 20401; telephone: 202-693-9400; web site: [www.msha.gov](http://www.msha.gov).

American Welding Society (AWS). *Safety and Health Fact Sheets*, published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; web site: [www.aws.org](http://www.aws.org).

## INFORMATION SOURCES

American National Standards Institute (ANSI). *Safety in Welding, Cutting, and Allied Processes* (ANSI Z49.1), published by the American Welding Society, 550 NW LeJeune Rd, Miami, FL 33126; Telephone 800-443-9353; web site: [www.aws.org](http://www.aws.org).

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## **LASER WELDING AND CUTTING SAFETY**

### **INTRODUCTION**

A laser is a device which produces an intense, coherent, directional beam of light. The term LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. Lasers can be designed to deliver a large amount of energy to a very small area. In welding and cutting operations, this energy can heat metals quickly to very high temperatures. Much of the radiation that strikes the workpiece is reflected into the environment, creating hazards. Some laser light used in laser welding equipment is invisible, so the hazard may not be readily apparent.

### **HOW LASERS WORK**

Typical lasers use electricity to create the unique coherent light that is very different from ordinary non-coherent light, such as that from a light bulb. Coherent light can be tightly focused and is not diffused or scattered like ordinary light. This coherent light beam is parallel and can be focused to cut or weld metals. Laser light can be different colors of the visible light spectrum, or can be invisible when the light is ultraviolet or infrared. Lasers used for welding and cutting may be infrared, and therefore the beam may be invisible. It is very difficult to take precautions against things one cannot see. It is even more difficult to convince others to take precautions against hazards they cannot see and may not understand.

### **POTENTIAL HAZARDS**

- **RADIATION**—Both visible and invisible light radiation are produced when welding or cutting. Due to the interaction with the workpiece, high levels of hazardous blue light and ultraviolet radiation (secondary radiation) are produced. This light radiation is often reflected from the workpiece into the work area. Radiation from these processes can seriously burn eyes and skin quickly and permanently. These hazards are addressed in the American National Standards Institute Z136.1 standard.
- **FIRE**—Since the laser system produces a very small spot size with high energy, the hazard of fire is present if the beam hits flammable material. Keep flammables away from the welding or cutting area. Be sure to cover and protect anything flammable in the area, since reflected radiation could start fires in unexpected places. Protect the work area.

- **FUMES AND MISTS**—Lasers easily vaporize metals. In doing so, fumes and mists are created which can present a respiratory hazard. Often the fumes and mists cannot be seen, yet they can pose a serious health hazard. Always use adequate ventilation.
- **MECHANICAL**—The optical device on the robotic arm or other beam manipulator can malfunction and send the laser beam in unintended directions. Therefore, it is essential that the work cell be shielded in conformance with standards for the laser type and class.
- **ELECTRIC SHOCK**—Since lasers require a large amount of electrical power to accomplish specific tasks, electrical hazards are present. Conventional hazards associated with any electrical industrial power source are present. These require standard and common electrical safe practices as found in ANSI Z49.1 and in AWS Safety and Health Fact Sheet No. 5. Additionally, there are the unique electrical hazards common to lasers in general and the hazard of the individual application. Usually, the best source of safety information is provided in the instruction manual from the manufacturer of the laser system. Always read, understand, and follow the manufacturer's recommended safety procedures.
- **EYE AND SKIN DAMAGE**—Laser system eye and skin hazards are addressed in the ANSI Z136.1 standard. In many use situations, special laser eye protective devices are required. According to the ANSI Z136.1 standard, this eyewear must be labeled with both the optical density (protective factor) and wavelength(s) for which the protection is afforded. The protective eyewear must be compatible with the manufacturer's specifications for the laser system in use, to ensure that the eyewear is suitable. In addition to the primary hazard of the laser beam, there may be a considerable eye hazard from high levels of secondary radiation. The ANSI Z136.1 standard requires that the eyes be protected from this secondary radiation in addition to the primary laser beam. A precaution must be added here—standard safety glasses alone do not provide protection. Any laser eyewear, plain or prescription, must be labeled with the wavelength(s) of protection and the optical density at that wavelength(s). In some laser systems, ultraviolet light may be leaked into the workplace. Thus the eyewear should provide primary beam protection, secondary radiation protection, and also ultraviolet protection.

## **SAFETY NEEDS**

All laser welding and cutting installations are required to have a laser safety officer (LSO). The LSO is responsible for personnel protection, laser cell class conformance, and enforcement of all laser safety regulations. Be certain to follow recommendations from the laser system manufacturer. In addition, provide certified laser protective eyewear, clothing, and shields where required.

## INFORMATION SOURCES

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Kokosa, J. *Hazardous Chemicals Produced By Laser Materials Processing*, Journal of Laser Applications, 6 (1994) pp. 195–201.

Laser Institute of America (LIA). *Guide for the Selection of Laser Eye Protection*, available from Laser Institute of America, 12424 Research Parkway, Orlando, FL 32826.

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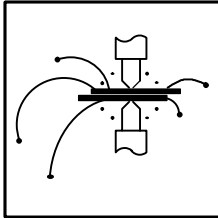
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Sliney, D. and Wolbarsht, M. *Safety with Lasers and Other Optical Sources*, Plenum Press, New York, available from Laser Institute of America, 12424 Research Parkway, Orlando, FL 32826.

Varanelli, A. *Electrical Hazards Associated with Lasers*, Journal of Laser Applications, 7 (1995) pp. 62–64.



## RESISTANCE SPOT WELDING

### INTRODUCTION

Resistance Spot Welding is one of the oldest of the electric welding processes in use by industry today. The weld is made by a combination of heat, pressure, and time. As the name implies, it is the resistance of the material to be welded to current flow that causes a localized heating in the part. The pressure is exerted by the tongs and tips. The time is how long current flows in the joint, which is determined by the material thickness and type, amount of the current, and cross-sectional area of the welding tips and contact surfaces.

### PROCESS HAZARDS OVERVIEW

Resistance Spot Welding, unlike many other welding or cutting processes, produces little fumes and only negligible arc rays. Even the fire hazard from flying sparks is modest to low compared to other processes. However, because of the tongs and linkages, there is higher risk of mechanical hazards, such as pinching and crushing the fingers and hands, than other processes. Eye or face injury from flying metal and sparks is also present, since these particles are often thrown off from the weld.

### HOW THE PROCESS WORKS

Fundamentally, Resistance Spot Welding occurs when current flows through the tips and the separate pieces of metal to be joined. The resistance of the base metal to the electrical current flow causes localized heating in the joint, and the weld is made. The weld is unique because the actual weld nugget is formed internally with relation to the surface of the base metal. A MIG or TIG spot weld, on the other hand, starts at the surface

of one piece and goes through it and into the second piece to form the weld nugget. The MIG or TIG weld is made from one side only, while the resistance spot weld is normally made with electrodes on both sides of the workpieces.

### SAFETY HAZARDS

Resistance Spot Welding is not an open-arc process. Since the weld is made inside the workpieces, there are different and unique hazards to consider. Here are the major ones to be aware of and prepare for before actually making a weld.

- Flying sparks can cause fire and explosion.
- Flying sparks and hot metal are often thrown off from the weld joint and can burn or injure eyes and skin.
- Electric shock from wiring is a possible hazard.
- Hot metal and parts can cause burns.
- Moving parts, such as tongs, tips, and linkages, can injure fingers and hands.
- Fumes from spot welding on parts coated with cleaners, paints, and platings can be hazardous.

### HOW TO AVOID THE HAZARDS

- Wear safety goggles or a face shield. Wear long sleeved shirts. Do not weld near flammables—move them away. Keep a fire extinguisher nearby, and know how to use it.
- Wear dry insulating gloves. Install and ground unit according to all codes. Disconnect input power before servicing.

- Do not put hands between tips. Keep away from linkages and pinch points. Keep all guards and panels in place.
- Do not breathe the fumes. Use proper ventilation. Read Material Safety Data Sheets (MSDSs) for metals, coatings, and cleaners.
- Do not touch hot workpiece, tips, or tongs with bare hands. Allow tongs and tips to cool before touching. Wear proper insulating gloves if handling hot work or parts is necessary.

### INFORMATION SOURCES

Occupational Safety and Health Administration (OSHA). *Code of Federal Regulations*, Title 29 Labor, Chapter XVII, Parts 1900 to 1910, Order No. 869-019-00111-5, available from Superintendent of Documents, U.S. Government Printing Office, Washington DC 20402.

American National Standards Institute (ANSI). *Safety in Welding, Cutting, and Allied*

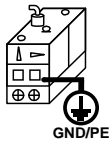
*Processes*, Z49.1, available from American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

National Fire Protection Association (ANSI/NFPA 70). *National Electrical Code*, available from National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

Canadian Standards Association (CSA) (Standard W117.2). *Code for Safety in Welding and Cutting*, available from Canadian Standards Association, Standards Sales, 178 Rexdale Boulevard, Rexdale, Ontario, Canada M9W 1R3.

\_\_\_\_\_. *Safety Practices For Occupational and Educational Eye and Face Protection*, Z87.1, available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

National Fire Protection Association. *Cutting and Welding Processes*, NFPA Standard 51B, available from National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.



## Grounding of Portable and Vehicle Mounted Welding Generators

### 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.

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**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.

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## **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.

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- 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

American National Standards Institute (ANSI). *Safety in Welding, Cutting, and Allied Processes*, Z49.1, published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; Web site: [www.aws.org](http://www.aws.org).

Occupational Safety and Health Administration (OSHA). *Code of Federal Regulations*, Title 29 Labor, Parts 1926.400, 1926.403, 1926.404, 1926.449, and 1910.302 available from U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954 (phone: 800-321-6742, website: [www.osha.gov](http://www.osha.gov)).

National Fire Protection Association (NFPA). *National Electrical Code* (NFPA 70), available from National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101 (phone: 800-344-3555, website: [www.nfpa.org](http://www.nfpa.org)).

Institute of Electrical and Electronic Engineers (IEEE), *IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems*—Green Book, ISBN 1-5593-7141-2, Product Number SH14498-TBR Standard 142-1991, available from IEEE Publications Office, 10662 Los Vaqueros Circle, P.O. Box 3014, Los Alamitos, CA 90720-1264 (phone: 800-272-6657, website: [www.ieee.org](http://www.ieee.org)).

American Welding Society (AWS). *Welding Terms and Definitions*, A3.0, published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; Web site: [www.aws.org](http://www.aws.org).



## Coated Steels: Welding and Cutting Safety Concerns

### INTRODUCTION

Steels are coated to provide a protective covering or a decorative finish. Protective coatings are designed to prevent rusting or to shield the steel from chemical attack.

Coatings found on steels can become airborne or give off fumes, smoke, or dust, during joining and cutting. Some of the coating's dusts, fumes or gases can harm you and their exposure limits should not be exceeded. Exposure limits include:

- Permissible Exposure Limit (PEL): The PEL is set by the Occupational Safety and Health Administration (OSHA) and is a legal employee exposure limit in the U.S.
- Threshold Limit Value (TLV<sup>®</sup>): The TLV<sup>®</sup> is published by the American Conference of Governmental Industrial Hygienists (ACGIH) and is a guideline for employers to consider in controlling employee exposures.

### OVERVIEW OF HEALTH HAZARDS

Employers need to know which chemical may be released into the air that may injure welders. Welders must be trained in how to do each process the correct way, and they shall cut or weld only after proper safety precautions have been taken.

Coatings may give off fumes and gases when welding or cutting is performed. A health hazard may be created when its dusts, fumes or gases get into the air in large enough amounts that safe levels are exceeded.

Protective coatings on steels can contain chromium, lead, tin, zinc or other materials. It is always good for the welder to understand the coating types for the materials he works with. If not, the welder should get this information from his supervisor or employer.

Paints are made up of compounds that may release hazardous materials into the air when heated. Paints are usually used on a "phosphated" and passivated (often with chromium) metal surface. The heat from the arc can cause paints to give off unsafe amounts of gases like carbon monoxide and carbon dioxide. These also increase the risk of suffocation in confined work areas, or those with poor air movement.

Steels coated with plastic materials should not be cut or welded unless proper precautions are taken. It is best to remove coating to a distance away from the weld or cut where the temperature won't go above the point where the material starts to break down.

For additional information, see AWS Fact Sheet 1, *Fumes and Gases*.

## HOW TO AVOID HEALTH HAZARDS FROM OVEREXPOSURE

The welder should make sure he or she knows what a coating might give off when heated or burned:

- Obtain the Material Safety Data Sheets (MSDSs) for all materials used.
- Read and understand the specification for coating type and coating weights.
- Find out what hazardous materials are present or might be given off by the coating when it is exposed to the arc or high temperatures.
- Use adequate ventilation whenever an airborne fume gas or dust must be controlled. Use enough ventilation, exhaust, or both to keep the air the welder breathes below recommended safe levels such as the PEL and TLV®.
- Have air monitoring done as necessary to test for exposure levels in the breathing zone of the welder and other persons working nearby.
- Use a respirator when required.
- Orient the work so the welder's head is kept out of the fume plume.
- See AWS Fact Sheet 1, *Fumes and Gases*.
- See AWS Fact Sheet 25, *Metal Fume Fever*.
- See AWS Fact Sheet 11, *Hot Work in Confined Spaces*.

## SUMMARY

Coatings on steels may be a source of exposure to fumes and gases during welding, brazing and cutting. Steel coatings and paints contain materials that can cause harmful overexposure when breathed. This is why coatings must also be looked at in order to remove hazards from welding and cutting. The joining of some coated steels require special types of ventilation. In some cases, the welder must wear a respirator to keep safe.

## INFORMATION SOURCES

American National Standards Institute (ANSI). *Safety in Welding, Cutting, and Allied Processes* (ANSI Z49.1), published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; web site: [www.aws.org](http://www.aws.org).

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**AWS D8.1M:2007**  
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# **Specification for Automotive Weld Quality— Resistance Spot Welding of Steel**

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**American Welding Society**



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**Approved by the**  
**American National Standards Institute**  
**January 12, 2007**

**Specification for**  
**Automotive Weld Quality—**  
**Resistance Spot Welding of Steel**

**1st Edition**

Prepared by the  
American Welding Society (AWS) D8 Committee on Automotive Welding

Under the Direction of the  
AWS Technical Activities Committee

Approved by the  
AWS Board of Directors

**Abstract**

This document contains both visual and measurable acceptance criteria for resistance spot welds in steels. The information contained herein may be used as an aid by designers, resistance welding equipment manufacturers, welded product producers, and others involved in the automotive industry and resistance spot welding of steels.



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# Specification for Automotive Weld Quality— Resistance Spot Welding of Steel

## 1. Scope

This specification expresses an industry consensus of quality characteristics and metrics pertinent to resistance spot welds on automotive steels. The evaluation methods and inspection criteria specified herein can be used to evaluate the effectiveness of particular welding equipment and procedures used to weld a particular base material combination. The subject matter is considered to be realistic and tempered with the knowledge of what a resistance spot welding process is capable of accomplishing in a high volume production environment. The criteria and metrics are the same for all welds regardless of the service load and are intended to be applied in conditions typically encountered during manufacturing. Welds at variance from the stated weld quality criteria in this document can still have mechanical properties that satisfy product and design requirements. Any attempted application of this document, or the evaluation criteria contained herein, to other uses, such as post-crash weld quality assessment, may lead to an erroneous result.

This standard makes sole use of the International System of Units (SI).

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, 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.

American Welding Society (AWS) standards:<sup>1</sup>

(1) AWS A3.0, Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying and

(2) AWS D8.9M, Recommended Practices for Test Methods for Evaluating the Resistance Spot Welding Behavior of Automotive Sheet Steel Materials

## 3. Terms and Definitions

The terms listed in AWS A3.0, Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying, shall apply to this document, except for those listed below. The terms listed below as used in various sections of this document require definition for correct interpretation. Most of these terms are not contained in AWS A3.0, or if they are listed, their definitions have been enhanced to clarify their use in this document.

For the purposes of this document, the following definitions apply:

aspect ratio. The ratio of the maximum dimension to the minimum dimension of the fused area.

button. The part of a spot weld which tears out during destructive testing of welded steel. It may include all or part of the nugget, the heat-affected zone (HAZ) and base metal. A hole is left in the mating sheet(s).

button pull. A fracture mode of a spot weld where separation occurs through the heat-affected zone (HAZ) of the weld, resulting in a button (see example in Figure 10).

button size. The average of the maximum and minimum dimensions of the button.

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