AWS SAFETY AND HEALTH
FACT SHEET BUNDLE
FOR RAILROAD WELDING

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

Fact Sheet 18: Lockout/Tagout
Fact Sheet 20: Thermal Spraying Safety
Fact Sheet 29: Grounding of Portable and Vehicle Mounted Welding Generators
Fact Sheet 30: Cylinders: Safe Storage, Handling, and Use
Fact Sheet 34: Coated Steels: Welding and Cutting Safety Concerns

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
33: Personal Protective Equipment (PPE) for Welding & Cutting
34: Coated Steels: Welding and Cutting Safety Concerns
36: Ventilation for Welding & Cutting
37: Selecting Gloves for Welding & Cutting

Z49.1: Safety in Welding, Cutting, and Allied Processes
INTRODUCTION

Sometimes work must be performed on equipment, pipelines, and machinery that may contain moving parts, pressurized gases or liquids, electrical energy, or other hazards. Contact with any of these may result in injury or death.

DEFINITIONS

“Lockout” means to install a locking device that keeps the switch, valve, or other mechanism from being turned on or opened. “Tagout” means to put a tag on the locking device. The tag indicates DANGER or WARNING, along with a brief message. It has a place to put the date and person’s name who lockedout the equipment so that he or she may be easily found or notified.

STEPS TO FOLLOW

• Train employees in the purpose and methods of lockout/tagout.

• Inform the job supervisor about the proposed work, and obtain permission to lockout and tagout the equipment.

• Shut down the equipment.

• Place locks and tags on the switches and valves to prevent their use.

Note: If more than one person is performing work on the equipment, it is recommended that they have their own locks and tags on the lockout point.

• Have the operator try to start the equipment or open the valves. If the equipment and valves are not operable, proceed to the next step. If they are operable, check where the locks should be placed or, if needed, place additional locks to ensure that equipment or valves are not operable. Check the equipment or valves for operation again.
• Start the work. If the employees’ shift ends before the work is completed, they must remove their locks and the next shift’s employees must install their locks before continuing the work and before the previous shift’s locks are removed.

• When the work is completed, ensure that all employees are clear before removing the locks and tags, energizing equipment, or opening valves.

INFORMATION SOURCES


For specific information on recommended lockout points for equipment, machinery, and valves, contact the manufacturer.
INTRODUCTION

Thermal spraying processes use modifications of arc, plasma, and oxyfuel energy sources to produce the resulting heat, atmosphere, and particle velocity needed to properly coat an object (a substrate) with the desired thickness and properties of a surfacing material. The high temperatures, velocity, and projectile distance of the spraying processes create a unique set of safety hazards for the operator and those nearby.

DEFINITIONS/PROCESS DESCRIPTIONS

According to ANSI/AWS A3.0, Standard Welding Terms and Definitions, Thermal Spraying (THSP) is a group of processes that deposit molten metallic or non-metallic surfacing materials onto a prepared substrate. All thermal spraying processes introduce a feedstock (usually a powder or wire) into a heating device (combustion or electrical). There the material is heated, blended into the heat plume, and sprayed onto a prepared substrate. The molten particles strike the surface, flatten, and form thin platelets that conform and adhere to the substrate and to one another. As they cool, they build up a lamellar structure to form the desired coating.

Combustion processes include Low-Velocity Oxyfuel (LVOF) and High-Velocity Oxyfuel (HVOF) systems. Electrical processes are Arc (two-wire), Plasma Arc (powder), and Plasma Induction (powder) systems. Typical operating conditions for the various processes are shown in the table below.

POTENTIAL HAZARDS AND HAZARDOUS EFFECTS

- Dust—Finely divided airborne solid particulate should be treated as an explosive and inhalation hazard. Adequate ventilation and wet collection of the overspray should be provided to minimize these hazards.

- Fumes, Vapors, and Gases—Ventilate and use safe practices according to ANSI Z49.1, the MSDSs, and AWS Safety and Health Fact Sheet No. 1. In addition, most spray and abrasive blasting operations require the use of an approved respirator that complies with requirements of ANSI Z88.2. Also, precautions should be exercised to avoid the presence of chlorinated hydrocarbon solvent vapor in the area of the arc or plasma spraying. Hazardous phosgene gas can be produced when hydrocarbon vapors are exposed to ultra-violet radiation from these processes.
• Noise—The loud noise (high dBA ranges) of these processes must be addressed. Ear muffs and noise control procedures should be provided to conform to the standard limits of OSHA 29 CFR 1910.95.

• Radiation—Intense ultraviolet (UV) and infrared (IR) radiation occurs with these processes. They require total protection of the eyes and all exposed skin to avoid eye damage and burns. Eye shades of No. 3–6 for combustion and 9–12 for electrical processes are recommended (see AWS Safety and Health Fact Sheet No. 2).

• Electric Shock—The higher process voltages used in Arc, Plasma Arc, and Plasma Induction Spraying increase the risk of electric shock. Take precautionary measures according to ANSI Z49.1 and AWS Safety and Health Fact Sheet No. 5.

• Fire—Use care when handling spray guns during operation to avoid injury to personnel or causing fire (see AWS Safety and Health Fact Sheet No. 6).

• Mechanical Hazards—The substrate surface preparation, spraying, finishing, and post-treatment operations involved with thermal spraying processes present a variety of mechanical hazards specific to Thermal Spraying. Consult the equipment manufacturers’ manuals and material suppliers’ MSDSs for their recommended safe practices.

• Compressed Gases—Compressed gases require safe handling and use as specified in ANSI Z49.1.

INFORMATION SOURCES


Safety Requirements for Industrial Head Protection, Z89.1, available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.


Safety Requirements for Industrial Robots and Robot Systems. RIA R15.06, available from the Robotic Industries Association (RIA), P.O. Box 3724, 900 Victors Way, Ann Arbor, MI 48106.

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 (O) 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, blasted 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.

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• 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


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®): The TLV® 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*.  

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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


Abstract

This specification establishes minimum standards for the manufacture and maintenance of railroad equipment. Clauses 4 through 17 cover the general requirements for welding in the railroad industry. Clauses 18 through 24 cover specific requirements for the welding of base metals thinner than 1/8 in [3 mm].
Foreword

This foreword is not part of AWS D15.1/D15.1M:2007, Railroad Welding Specification for Cars and Locomotives, but is included for informational purposes only.

This specification establishes minimum standards for the manufacture and maintenance of railroad equipment. It was developed and is maintained by the D15 Committee on Railroad Welding of the American Welding Society.

Welding of railroad components is vital to the industry. An investigating committee was formed in 1982 which recommended a Railroad Welding Committee be formed to establish minimum welding standards for the industry. This recommendation was made because of confusion and incompleteness of the existing welding specifications and guides as applied to the railroad industry needs. The committee is made up of individuals from all segments of the railroad industry: both users and suppliers, the general public, and representatives of the Association of American Railroads.

The purpose of this specification is to provide a single comprehensive document of welding data that will be used throughout the railroad industry. Also, it should contribute to improvements in welding quality and performance. This document includes data from AWS D1.1, Structural Welding Code—Steel; AWS D1.2, Structural Welding Code—Aluminum; AWS D1.3, Structural Welding Code—Sheet Steel; and AWS D1.6, Structural Welding Code—Stainless Steel.

AWS D15.1-86 was titled simply Railroad Welding Specification. For the 1993 revision, the suffix Cars and Locomotives was added because the locomotive section had been introduced. A later revision was published in 2001, AWS D15.1:2001. The welding of rail is addressed in AWS D15.2, Recommended Practice for the Welding of Rails and Related Rail Components for Use by Rail Vehicles.

Several significant modifications have been made in AWS D15.1/D15.1M:2007. A vertical line in the margin indicates a revision from the 2001 edition. The document has incorporated SI Units within the text as well as all figures and tables in order to create a dual dimension standard. The overall format of AWS D15.1/D15.1M:2007 has changed; thus, all clauses as well as figure and table notations throughout the document have been altered to comply with the new style. Also important to note, Annex A—Base Metal Groupings, Annex E—Glossary, Annex F—Safety Considerations, and finally Annex H—Metric Tables and Figures from AWS D15.1:2001 have all been removed in this edition. Additions in AWS D15.1/D15.1M:2007 include a new Annex A—Alternate Base Material Specifications (Steel) and a Figure 7.2K—Prequalified Partial Joint Penetration (PJP) Groove Weld Joint Details. The section on Inspection—General Requirements, Clauses 14 through 17, has been updated along with Figure 8.1—Weld Pass in Which Depth and Width Exceed the Width of the Weld Face, Table 8.1—Prequalified Base Metal–Filler Metal Combinations for Matching Strength, Table 8.2—Prequalified Minimum Preheat and Interpass Temperature (Steel), and Table 10.1—Procedure Qualification—Number and Type of Specimens and Range of Thickness Qualified—Complete Joint Penetration (CJP) Groove Weld.
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Railroad Welding Specification for Cars and Locomotives

1. Scope

1.1 This specification covers the minimum welding requirements applicable to welded structures used in the railroad industry. It is not intended to apply to tank car tanks nor to the welding of rails. Recommended practices for welding railroad rails and related components are included in D15.2, Recommended Practice for the Welding of Rails and Related Rail Components for Use by Rail Vehicles. Specifications for welding tank car tanks and components welded directly thereto are outlined in the AAR Manual of Standards and Specifications for Welding, Section C—Part III, Specification M-1002 (AAR M-1002 C-III).

1.2 Welding symbols shall be those shown in the latest edition of AWS A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.

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

1.4 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, state, and local regulations.

1.5 This specification may involve hazardous materials, operations, and equipment. The specification does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to establish safety and health practices. The user should determine the applicability of any regulatory limitations prior to use.

2. Normative References

The standards listed below 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:1

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

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

AWS A5.01/A5.01M, Filler Metal Procurement Guidelines

AWS A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding

AWS A5.5/A5.5M, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding

AWS A5.9/A5.9M, Specification for Bare Stainless Steel Welding Electrodes and Rods

AWS A5.10/A5.10M, Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods

AWS A5.17A5.17M, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding

AWS A5.18/A5.18M, Specification for Carbon Steel Filler Metals for Gas Shielded Arc Welding

AWS A5.20/A5.20M, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding

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