

Safety and Health Fact Sheets

Third Edition



American Welding Society



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Safety and Health Fact Sheets **Third Edition**

Prepared by
AWS Project Committee on
Labeling and Safe Practices

Under the Direction of
AWS Committee on Safety and Health

Abstract

This document brings together 25 individual Safety and Health Fact Sheets dealing with many aspects of safety and health applicable to all welding, cutting, and related processes. Subjects such as fumes and gases, radiation, noise and electrical hazards, in addition to hazards faced by welders such as mechanical hazards and falling objects, and sources of additional information for each sheet are included.



American Welding Society

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Foreword

The AWS Safety and Health Committee was established to aid the welding industry in maintaining a safe and healthful working environment. It is responsible for preparing documents, including standards and recommended practices, that address all health and safety aspects of the welder's environment. Its members represent many facets of the industrial community: safety professionals, industrial hygienists, medical doctors, and welding engineers.

The First Edition of the Safety and Health Fact Sheets, published in 1990, brought together 13 Fact Sheets, each dealing with a safety and health topic, that were developed over several years by the AWS Committee on Labeling and Safe Practices, a project committee of the AWS Safety and Health Committee. Some of the Fact Sheets were previously published in the *Welding Journal*. The Second Edition added seven new Fact Sheets and included revised, updated versions of the original 13 Fact Sheets. The Third Edition added five new Fact Sheets and includes revised versions of several Second Edition Fact Sheets. The Fact Sheets are intended for use in the preparation of standards and other documents where safety and health information is required.

Comments and suggestions for the improvement of this document are welcome. They should be sent to the Secretary, Safety and Health Committee, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

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FUMES AND GASES

INTRODUCTION

Many welding, cutting, and allied processes produce fumes and gases, which may be harmful to your health.

DEFINITION

- Fumes are solid particles which originate from welding consumables, the base metal, and any coatings present on the base metal.
- In addition to shielding gases that may be used, gases are produced during the welding process or may be produced by the effects of process radiation on the surrounding environment.
- Acquaint yourself with the effects of these fumes and gases by reading the Material Safety Data Sheets (MSDSs) for all materials used (consumables, base metals, coatings, and cleaners).
- For help, consult a recognized specialist in Industrial Hygiene or Environmental Services.
- The amount and composition of these fumes and gases depend upon the composition of the filler metal and base material, welding process, current level, arc length, and other factors.
- Fumes can cause symptoms such as nausea, headaches, dizziness, and metal fume fever.
- The possibility of more serious health effects exists when highly toxic materials are involved. For example, manganese overexposure can affect the central nervous system resulting in impaired speech and movement.
- In confined spaces the gases might displace breathing air and cause asphyxiation.

HOW TO AVOID OVEREXPOSURE

POSSIBLE EFFECTS OF OVER-EXPOSURE

- Depending on material involved ranges from irritation of eyes, skin, and respiratory system to more severe complications.
- Effects may occur immediately or at some later time.
- Keep your head out of the fumes.
- Do not breathe the fumes.
- Use enough ventilation or exhaust at the arc, or both, to keep fumes and gases from your breathing zone and general area.
- In some cases, natural air movement provides enough ventilation and fresh air.
- Where ventilation is questionable, use air sampling to determine the need for corrective measures.
- Use mechanical ventilation to improve air quality.
- If engineering controls are not feasible, use an approved respirator.
- Work in a confined space only if it is well ventilated, or while wearing an air-supplied respirator. Fumes from welding or cutting and oxygen depletion can alter air quality causing injury or death. Be sure the breathing air is safe.
- Follow OSHA guidelines for permissible exposure limits (PELs) for various fumes.

- Follow the American Conference of Governmental Industrial Hygienists recommendations for threshold limit values (TLVs) for fumes and gases.
- Have a recognized specialist in Industrial Hygiene or Environmental Services check the operation and air quality and make recommendations for the specific welding or cutting situation.

INFORMATION SOURCES

Occupational Safety and Health Administration (OSHA). *Code Of Federal Regulations*, Title 29 Labor, Chapter XVII, Parts 1901.1 to 1910.1450, Order No. 869-019-00111-5, available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

American Conference of Governmental Industrial Hygienists (ACGIH) publication, *Threshold Limit Values (TLV®) for Chemical*

Substances and Physical Agents in the Workroom Environment, available from American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240.

American Welding Society (AWS) Study. *Fumes and Gases in the Welding Environment* and other Safety and Health publications, available from American Welding Society, 550 N.W. LeJeune Road, P.O. Box 351040, Miami, FL 33135.

Mine Safety And Health Administration (MSHA). *Code Of Federal Regulations*, Title 30 Mineral Resources, Parts 1-199, available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

For specific information, refer to the applicable Material Safety Data Sheet (MSDS) available from the manufacturer, distributor, or supplier.

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RADIATION

INTRODUCTION

Most arc welding and cutting processes, laser welding, and torch welding, cutting, and brazing, or soldering produce quantities of radiation requiring precautionary measures. Some processes, such as resistance welding and cold pressure welding, ordinarily produce negligible quantities of radiant energy.

DEFINITION

Radiation is electromagnetic energy given off by the arc or flame that can injure eyes and burn skin. An operator sees visible light radiation. However, he does not see ultraviolet or infrared radiation. Radiation is often silent and undetected, yet injury occurs. Have all users learn about the effects of radiation.

EFFECTS OF RADIATION

The effects of radiation depend on the wavelength, intensity, and length of time one is exposed to the radiant energy. Although a variety of effects is possible, the following two injuries are most common:

- Skin burns.
- Eye damage.

TYPES OF RADIATION

There are two types of radiation associated with welding operations:

- Ionizing (such as X-rays).
- Nonionizing (such as ultraviolet, visible light, or infrared).

IONIZING RADIATION

- Produced by the electron beam welding process.

- Controlled within acceptable limits by using suitable shielding around the electron beam welding area.
- Produced during grinding (pointing) of thoriated tungsten electrodes for Gas Tungsten Arc Welding (GTAW) process--the grinding dust is radioactive.
- Controlled by using local exhaust and, if necessary, an approved respirator.

NONIONIZING RADIATION

- Intensity and wavelength of energy produced depend on the process, welding parameters, electrode and base metal composition, fluxes, and any coatings or plating on the base material.
- Ultraviolet radiation increases approximately as the square of the welding current.
- Visible brightness (luminance) of the arc increases at a much lower rate.
- Processes using argon produce larger amounts of ultraviolet radiation than those using most other shielding gases.

HOW TO PROTECT AGAINST IONIZING RADIATION

- Required protection varies with time of exposure, distance from source, and shielding used.
- Follow recommended procedures in AWS F2.1.
- When grinding (pointing) thoriated tungsten electrodes, always use local exhaust and, if necessary, respiratory protection to prevent inhalation of dust.

- External radiation from thoriated tungsten electrodes during storage, welding, or disposal of residues is negligible under normal conditions.

HOW TO PROTECT AGAINST NON-IONIZING RADIATION

- Use welding helmet with correct shade of filter plate according to ANSI Z87.1.

Note: Transparent welding curtains are not intended as welding filter plates, but rather are intended to protect passersby from incidental exposure.

- Protect exposed skin with adequate gloves and clothing according to ANSI Z49.1.
- Be aware of reflections from welding arcs, and protect all persons from intense reflections.

Note: Paints using titanium dioxide or zinc oxide as major pigmentation media have a low reflectance for ultraviolet radiation.

- Locate welding operations so that other workers are not exposed to either direct or reflected radiation. Use screens, curtains, or adequate distances from other work stations, aisles, or walkways to avoid exposure.
- Wear safety glasses with UV protective side shields in addition to a proper welding helmet with filter plate. The side shields provide needed protection from reflected radiation.
- Have all persons wear safety glasses with UV protective side shields anytime near welding or cutting areas.
- Choose safety glasses according to ANSI Z87.1.

INFORMATION SOURCES ON IONIZING RADIATION

American Welding Society (AWS). *Recommended safe practices for electron beam*

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International Institute of Welding (IIW). *Statement of Commission VIII on Health Aspects in the Use of Thoriated Tungsten Electrodes*, Document VIII-1702-93, available from International Institute of Welding, ZI Paris Nord II, BP 50362, 95942 ROISSY CDG CEDEX, FRANCE.

Manufacturers' Product Information Literature.

INFORMATION SOURCES ON NON-IONIZING RADIATION

American National Standards Institute (ANSI). *Practice for occupational and educational eye and face protection*, Z87.1, available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

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National Technical Information Service. *Evaluation of the potential hazards from actinic ultraviolet radiation generated by electric welding and cutting arcs*, Nonionizing Radiation Protection Special Study No. 42-0053-77. Springfield, Virginia: National Technical Information Service.

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Mine Safety And Health Administration (MSHA). *Code Of Federal Regulations*, Title 30 Mineral Resources, Parts 1-199, available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

American Welding Society (AWS). *Ultraviolet Reflectance of Paint*, URL, available from American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.



NOISE

INTRODUCTION

In welding, cutting, and allied operations, noise may result from the process, the power source, or other equipment. Air carbon arc cutting and plasma arc cutting are examples of processes which are frequently noisy. Engine-driven generators may also be quite noisy. Excessive noise is a known health hazard.

DEFINITION

Scientifically, noise is composed of several frequencies and involves random changes in frequency or amplitude. Sound waves are produced when the air is mechanically disturbed. Sound is measured by its frequency (pitch-high or low) and intensity (loudness). Practically, noise is unwanted or unpleasant sound. It can get in the way of the sounds we would rather hear and often need to hear for safety reasons.

EFFECTS OF OVEREXPOSURE TO NOISE

- Loss of hearing that may be either full or partial and either temporary or permanent.
- Hearing loss may be a temporary threshold shift from which the ears may recover if removed from the noise source.
- Creates stress that can affect your physical and mental well-being.
- Causes accidents when you cannot hear instructions or warning signals.
- If a person is exposed to this same noise level for a longer time, the loss of hearing may become permanent.

- The time required to develop permanent hearing loss depends on individual susceptibility, noise level, and exposure duration.
- There is evidence that excessive noise affects other bodily functions and behavior as well.

HOW TO PROTECT AGAINST NOISE

- Reduce the intensity of the source.
- Shield the source where practical.
- Use engineering control methods, such as room acoustics, to control noise.
- If engineering methods fail to reduce noise to acceptable levels, wear approved personal protective devices such as ear muffs or ear plugs appropriate for the situation.
- Follow OSHA regulations which require a Hearing Conservation Program if noise levels reach 85 dB on an 8-hour, Time Weighted Average (TWA) basis.
- If noise level is questionable, have a certified safety specialist or Industrial Hygienist take measurements and make recommendations.

INFORMATION SOURCES

Occupational Safety and Health Administration (OSHA). *Code Of Federal Regulations*, Title 29 Labor, Chapter XVII, Part 1901.1 to 1910.1450, Order No. 869-019-00111-5, available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

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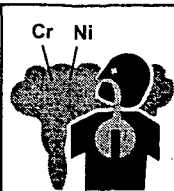
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CHROMIUM AND NICKEL IN WELDING FUME

INTRODUCTION

The fume from welding processes may contain compounds of chromium, including hexavalent chromium, and of nickel. The composition of the base metals, the welding materials used, and the welding processes affect the specific compounds and concentrations found in the welding fume.

IMMEDIATE EFFECTS OF OVER-EXPOSURE TO FUMES CONTAINING CHROMIUM AND NICKEL

- Similar to the effects produced by fumes from other metals.
- Cause symptoms such as nausea, headaches, dizziness, and respiratory irritation.
- Although some persons may develop a sensitivity to chromium or nickel, which can result in dermatitis or skin rash, there is no evidence in the literature of such sensitivity when exposed to welding fume.

CHRONIC (LONG TERM) EFFECTS OF EXPOSURE TO FUMES CONTAINING CHROMIUM AND NICKEL

- Definite effects are not yet determined
- The National Institute for Occupational Safety and Health (NIOSH) concluded that some forms of hexavalent chromium and nickel and their inorganic compounds should be considered occupational carcinogens (cancer-causing agents).
- NIOSH Criteria Documents 76-129 and 77-164 (listed in Information Sources) contain these conclusions based on data

from the chromate producing industry and from nickel ore-refining processes.

- Conclusions from the International Agency for Research on Cancer (IARC Group 2B): (1) there is limited evidence in humans for the carcinogenicity of welding fumes, and (2) there is inadequate evidence in experimental animals for the carcinogenicity of welding fumes. (The IARC classification 2B means that the agent is possibly carcinogenic to humans. By contrast, a 2A designation would mean that the agent is probably carcinogenic to humans.)

OVERALL EVALUATION

- Welding fumes containing chromium and nickel are possibly carcinogenic to humans (IARC, NIOSH).
- No determination has yet been made concerning the chronic health effects on welders or users of chromium- or nickel-containing alloys.
- Nevertheless, give consideration to the NIOSH and IARC conclusions.

HOW TO PROTECT AGAINST OVER-EXPOSURE

- Do not breathe fumes and gases.
- Keep your head out of the fumes.
- Use enough ventilation or exhaust at the arc or both to keep fumes and gases from your breathing zone and general area.
- If ventilation is questionable, use air sampling to determine the need for corrective measures.
- Keep exposure as low as possible.

INFORMATION SOURCES

National Institute for Occupational Safety and Health. *Criteria for a Recommended Standard – Occupational Exposure to Chromium (VI)*, NIOSH Publication No. 76-129. Cincinnati, Ohio: National Institute for Occupational Safety and Health.

National Institute for Occupational Safety and Health. *Criteria for a Recommended Standard – Occupational Exposure to Inorganic Nickel (VI)*, NIOSH Publication No. 77-165. Cincinnati, Ohio: National Institute for Occupational Safety and Health.

American Welding Society (AWS) Study. *Fumes and Gases in the Welding Environment*, available from American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33136.

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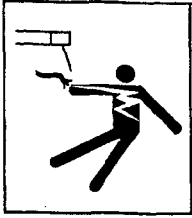
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International Agency for Research on Cancer (IARC). *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans—Chromium, Nickel, and Welding*, Vol. 49 (1990), Oxford University Press, New York, NY 10016.

The following references include the specific precautionary methods used to protect against exposure to fumes and gases:

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 33136.

Mine Safety and Health Administration (MSHA). *Code Of Federal Regulations*, Title 30 Mineral Resources, Parts 1-199, available from Superintendent of Documents, U.S. Government Printing Office, P.O. Box 371954, Pittsburgh, PA 15250.



ELECTRICAL HAZARDS

INTRODUCTION

Electric shock from welding and cutting equipment can kill, cause severe burns, and cause serious injury if falling happens because of the shock. The electrode and work circuit are electrically energized when the output is on. The input power circuit and machine internal circuits are also electrically energized when the power is on. When wire welding, the wire, wire reel, drive rolls, and all other metal parts touching the wire are electrically energized.

HOW TO AVOID ELECTRIC SHOCKS

Use proper precautionary measures, recommended safe practices, and train personnel using welding and cutting equipment to avoid injuries, fatalities, and electrical accidents as follows:

- Read the instruction manual before installing, operating, or servicing the equipment.
- Have all installation, operation, maintenance, and repair work performed only by qualified people.
- Properly install and ground the equipment according to the instruction manual and national, state, and local codes.
- Do not touch live electrical parts.
- Wear dry, insulating gloves in good condition and protective clothing.
- Insulate yourself from the workpiece and ground by wearing rubber soled shoes or standing on a dry insulated mat or platform.
- Use fully insulated electrode holders. Never dip the holder in water to cool it or lay it on conductive surfaces or the work surface. Do not touch holders connected to two welding machines at the same time or touch other people with the holder or electrode.
- Do not use worn, damaged, undersized, or poorly spliced cables, welding gun cables, and torch cables. Make sure all connections are tight, clean, and dry.
- Do not wrap cables carrying welding current around your body.
- Ground workpiece if required by codes.
- If required, ground the workpiece to a good electrical earth ground. The work lead is not a ground lead. Use a separate connection to ground the workpiece to earth.
- Do not touch an energized electrode while you are in contact with the work circuit.
- In confined spaces or in electrically hazardous locations due to water or perspiration, do not use a welder with AC output unless it is equipped with a voltage reducer and remote output control. Use equipment with DC output.
- Wear a safety harness to prevent falling if working above floor level where there are no other protective measures such as railings, walls, guard fences, or the like.
- Turn off all equipment when not in use. Disconnect the power to equipment if it will be left unattended or out of service.
- Disconnect the input power or stop the engine before installing or servicing the equipment. Lock the input disconnect switch open, or remove line fuses so power cannot be turned on accidentally.

- Use only well maintained equipment. Repair or replace damaged parts before further use.
- Keep all covers and panels securely in place.
- Follow lockout procedures as required by OSHA.

WEARERS OF PACEMAKERS

The technology of heart pacemakers and the extent to which these devices are affected by other electrical devices changes frequently. Have wearers of pacemakers or other electronic equipment vital to life check with the device manufacturer or their doctor to determine if any hazard exists when near welding or cutting operations. See Fact Sheet No. 16 for additional information about pacemakers and welding.

TREATMENT FOR ELECTRIC SHOCK

- Turn off the power.
- Use nonconducting material, such as wood, to pull the victim away from contact with live parts or wires.
- If the victim is not breathing, administer cardiopulmonary resuscitation (CPR) after breaking contact with the electrical source.
- Call a physician and continue CPR until breathing starts or until a physician arrives.
- Treat an electrical burn as a thermal burn by applying clean, cold (iced) compresses.

Prevent contamination, and cover with a clean, dry dressing.

INFORMATION SOURCES

American National Standards Institute (ANSI). *Safety in Welding, Cutting, and Allied Processes*, Z49.1, available from American Welding Society, 550 N.W. LeJeune Road, P.O. Box 351040, Miami, FL 33135.

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FIRE AND EXPLOSION PREVENTION

INTRODUCTION

Welding, cutting, and allied processes produce molten metal, sparks, slag, and hot work surfaces. These can cause fire or explosion if precautionary measures are not followed.

MAIN CAUSES OF FIRES IN WELDING AND CUTTING - FLYING SPARKS

- Sparks can travel up to 35 feet (10 meters) on a horizontal direction from the work area.

Note: Sparks and molten metal can travel greater distances when falling.

- Sparks can pass through or become lodged in cracks, clothing, pipe holes, and other small openings in floors or partitions.

TYPICAL COMBUSTIBLE MATERIALS AND CONDITIONS

- Parts of buildings such as floors, partitions, and roofs.
- Contents of buildings such as wood, paper, clothing, plastics, chemicals, and flammable liquids and gases.
- Outdoor combustible materials include dry leaves, grass, and brush.
- Welding and cutting have caused explosions when performed in spaces containing flammable gases, vapors, liquids, or dusts.

HOW TO PREVENT FIRES

- Remove any combustible material from the work area.

- Where possible, move the work to a location well away from combustible materials.
- If relocation is not possible, protect combustibles with a cover made of fire-resistant material.
- Remove or make safe all combustible materials for a radius of 35 feet (10 meters) around the work area.
- Using fire-resistant material, cover or block all open doorways, windows, cracks, and other openings.
- If possible, enclose the work area with portable fire-resistant screens.
- Protect combustible walls, ceilings, floors, etc., from sparks and heat with fire-resistant covers.
- If working on a metal wall, ceiling, etc., prevent ignition of combustibles on the other side by moving the combustibles to a safe location.
- If relocation of combustibles cannot be done, designate someone to serve as a fire watch, equipped with a fire extinguisher, during the welding operation and for at least one half-hour after welding is completed.
- Do not weld or cut on material having a combustible coating or combustible internal structure, as in walls or ceilings, without an approved method for eliminating the hazard.
- Do not dispose of hot slag in containers holding combustible material.
- Keep a charged fire extinguisher nearby, and know how to use it.

- After welding or cutting, make a thorough examination for evidence of fire. Remember that easily visible smoke or flame may not be present for some time after the fire has started.
- Be aware that overloading and improper sizing can cause overheating of electrical equipment and possible fire hazard.
- Be sure all electrical equipment and wiring are installed properly and have recommended circuit protection.
- Be sure the work cable is connected to the work as close to the welding area as practical. Work cables connected to the building framework or other locations some distance from the welding area increase the possibility of the welding current passing through lifting chains, crane cables, or other alternate circuits. This can create fire and shock hazards or overheat lifting chains or cables until they fail.
- Do not weld or cut in atmospheres containing dangerously reactive or flammable gases, vapors, liquids, or dust.
- Do not apply heat to a container that has held an unknown substance or a combustible material whose contents, when heated, can produce flammable or explosive vapors.
- Do not apply heat to a workpiece covered by an unknown substance or whose coating can produce flammable, toxic, or reactive vapors when heated.
- Develop adequate procedures, and use proper equipment to do the job safely.
- Provide adequate ventilation in work areas to prevent accumulation of flammable gases, vapors, or dusts.
- Clean and purge containers before applying heat.

- Vent closed containers, including castings, before preheating, welding, or cutting. Venting prevents the buildup of pressure and possible explosion due to the heating and expansion of gases.

INFORMATION SOURCES

American National Standards Institute (ANSI). *Safety in Welding And Cutting*, Z49.1, available from American Welding Society, 550 N.W. LeJeune Road, P.O. Box 351040, Miami, FL 33135.

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

American Welding Society (AWS). *Recommended Safe Practices For The Preparation For Welding And Cutting Containers That Have Held Hazardous Substances*, AWS F4.1, available from American Welding Society, 550 N.W. LeJeune Road, P.O. Box 351040, Miami, FL 33135.

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Mine Safety And Health Administration (MSHA). *Code Of Federal Regulations*, Title 30 Mineral Resources, Parts 1-199, available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.