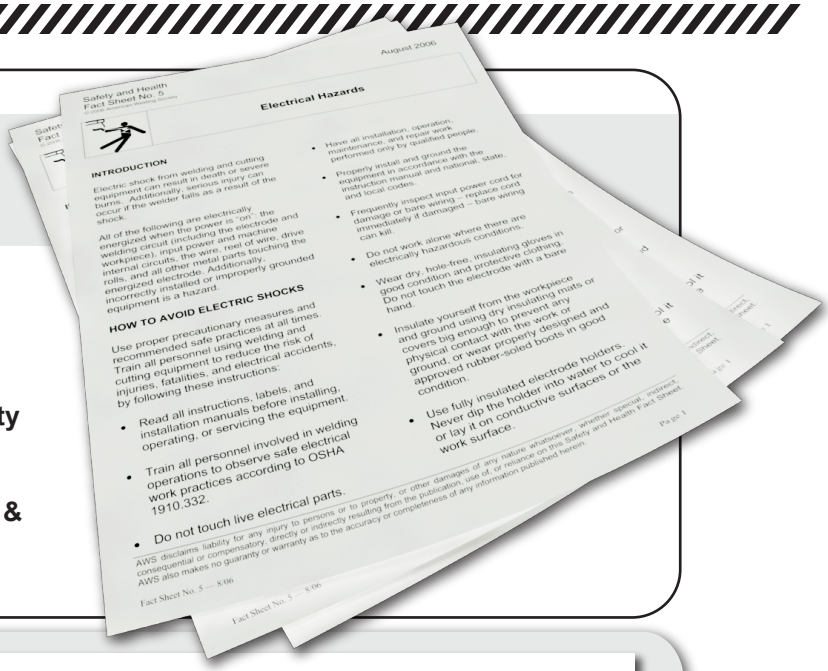
AWS SAFETY AND HEALTH FACT SHEET BUNDLE

FOR AEROSPACE WELDING

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

Fact Sheet 4: Chromium and Nickel in Welding Fume
Fact Sheet 19: Laser Welding and Cutting Safety
Fact Sheet 20: Thermal Spraying Safety
Fact Sheet 27: Thoriated Tungsten Electrodes
Fact Sheet 36: Ventilation for Welding & Cutting



Safety and Health Fact Sheet No. 5

August 2006

Electrical Hazards

INTRODUCTION

Electric shock from welding and cutting equipment can result in death or severe burns. Additionally, serious injury can occur if the welder falls as a result of the shock.

All of the following are electrically energized when the power is "on": the welding circuit (including the electrode and workpiece), input power and machine internal circuits, the wire, reel of wire, drive rolls, and all other metal parts touching the energized electrode. Additionally, incorrectly installed or improperly grounded equipment is a hazard.

HOW TO AVOID ELECTRIC SHOCKS

Use proper precautionary measures and recommended safe practices at all times. Train all personnel using welding and cutting equipment to reduce the risk of injuries, fatalities, and electrical accidents, by following these instructions:

- Read all instructions, labels, and installation manuals before installing, operating, or servicing the equipment.
- Train all personnel involved in welding operations to observe safe electrical work practices according to OSHA 1910.332.
- Do not touch live electrical parts.
- Have all installation, operation, maintenance, and repair work performed only by qualified people.
- Properly install and ground the equipment in accordance with the instruction manual and national, state, and local codes.
- Frequently inspect input power cord for damage or bare wiring – replace cord immediately if damaged – bare wiring can kill.
- Do not work alone where there are electrically hazardous conditions.
- Wear dry, hole-free, insulating gloves in good condition and protective clothing. Do not touch the electrode with a bare hand.
- Insulate yourself from the workpiece and ground using dry insulating mats or covers big enough to prevent any physical contact with the work or ground, or wear properly designed and approved rubber-soled boots in good condition.
- Use fully insulated electrode holders. Never dip the holder into water to cool it or lay it on conductive surfaces or the work surface.

Fact Sheet No. 5 — 8/06

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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

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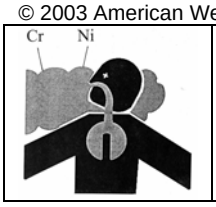


Chromium and Nickel in Welding Fume

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.
- Some persons may develop a sensitivity to chromium or nickel which can result in dermatitis or skin rash.

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

- Definite effects are not yet determined
- Conclusions from the National Institute for Occupational Safety and Health (NIOSH): 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 below) 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): (1) there is limited evidence in humans for the carcinogenicity of welding fumes and gases, and (2) there is inadequate evidence in experimental animals for the carcinogenicity of welding fumes.

OVERALL EVALUATION

- Welding fumes are possibly carcinogenic to humans (Group 2B).
- No determination has yet been made concerning the 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 (NIOSH). *Criteria for a Recommended Standard: Occupational Exposure to Chromium (VI),* NIOSH Publication No. 76-129. Cincinnati, OH (telephone: 800-356-4674; web site: http://www.cdc.gov/niosh/homepage.html).

National Institute for Occupational Safety and Health (NIOSH). *Criteria for a Recommended Standard: Occupational Exposure to Inorganic Nickel,* NIOSH Publication No. 77-164. Cincinnati, OH (telephone: 800-356-4674; web site: http://www.cdc.gov/niosh/homepage.html).

American Welding Society (AWS). *Fumes and Gases in the Welding Environment,* published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; Web site: www.aws.org.

American Conference of Governmental Industrial Hygienists (ACGIH). *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,* available from ACGIH, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634 (telephone: 513-742-2020; web site: www.acgih.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, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954 (telephone: 800-321-6742; web site: www.osha.gov).

American Conference of Governmental Industrial Hygienists (ACGIH). *Documentation of the Threshold Limit Values and Biological Exposure Indices,* available from ACGIH, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634 (telephone: 513-742-2020; web site: www.acgih.org).

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Chromium, Nickel, and Welding, Vol. 49 (1990), Oxford University Press, New York, NY 10016 (telephone: 212-726-6000; web site: www.oup-usa.org).

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* (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.

National Institute for Occupational Safety and Health (NIOSH). *Safety and Health in Arc Welding and Gas Welding and Cutting,* NIOSH Publication No. 78-138. Cincinnati,OH (telephone: 800-356-4674; web site: http://www.cdc.gov/niosh).

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, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954 (telephone: 202-693-9400; web site: www.msha.gov).

March 1998

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 an 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, <u>must</u> 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

American National Standards Institute (ANSI). *Safe Use of Lasers*, Z136.1, available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

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.

_____. OSHA Instruction Publication 8-1.7, *Guidelines for Laser Safety and Hazard Assessment*, available from Laser Institute of America, 12424 Research Parkway, Orlando, FL 32826.

_____. *Industrial Laser Safety Reference Guide*, available from Laser Institute of America, 12424 Research Parkway, Orlando, FL 32826.

_____. *Laser Safety Guide*, available from Laser Institute of America, 12424 Research Parkway, Orlando, FL 32826.

Shannon, G., et al. *Investigation Into the Underwater Laser Welding of Steel*, Journal of Laser Applications, 6 (1994), pp 112-229.

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.

February 1997

THERMAL SPRAYING SAFETY

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.

	LVOF	HVOF	Arc	Plasma Arc	Plasma Induction (Atmosphere)
Temperature	to 5000°F	to 6000°F	4000–15,000°F	4000–15,000°F	to 30,000°F
Velocity	200–700 ft/sec (<Mach 1)	2500–4000 ft/sec (to Mach 5)	800–1100 ft/sec (<Mach 2)	800–1800 ft/sec (to Mach 2)	800–1800 ft/sec (to Mach 2)
dBA (Sound Level)	110	150	115	132	132
Spray Distance	4–10"	6–18"	2-1/2–6"	2-1/2–6"	3–8"

- 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

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.

_____. *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.

_____. *Safe Practices for Respiratory Protection*, Z88.2, available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

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

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 02402.

National Fire Protection Association (NFPA). *Standard for Fire Prevention in Use of Cutting and Welding Processes*, NFPA Standard 51B, available from National Fire Protection Association, One Batterymarch Park, Quincy, MA 02269.

_____. *National Electrical Code*, NFPA Standard 70, available from National Fire Protection Association. One Batterymarch Park, Quincy, MA 02269.

_____. *Standard for the Design of Oxygen-Fuel Gas Systems for Welding and Cutting and Allied Process*, NFPA Standard 51, available from National Fire Protection Association, One Batterymarch Park, Quincy, MA 02269.

Compressed Gas Association (CGA). *Safe Handling of Compressed Gas Cylinders*, CGA P-1, available from Compressed Gas Association, 1725 Jefferson David Highway, Suite 1004, Arlington, VA 22202.

Robotic Industries Association (RIA). *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.

American Welding Society (AWS). *Thermal Spraying: Practice, Theory, and Application*, available from American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

Thoriated Tungsten Electrodes

INTRODUCTION

Thoriated tungsten electrodes contain thorium, a radioactive material that can pose health and environmental risks at elevated exposure levels. Thorium is a low-level radioactive material that primarily emits alpha particles as well as some beta and gamma radiation. These electrodes are normally sharpened by grinding as part of the standard procedure while preparing to perform gas tungsten arc welding (GTAW). Dust particles from this grinding process can cause internal radiation exposure if the dust is accidentally ingested or inhaled, so caution is necessary. Concern regarding radiation exposure to the external body from these electrodes is minimal.

Thoriated tungsten electrodes are widely used because they make good welds and are long lasting and quite easy to use. A thoriated tungsten electrode operates at a temperature well below its melting temperature compared to a pure tungsten electrode. This results in a much lower rate of consumption of the electrode during welding, which eliminates much of the “arc wander” associated with balled pure tungsten. Other reasons for their use include easier arc initiation, reduced weld metal contamination, higher current-carrying capacity, the ability to sharpen the electrode, and long life.

IS THERE A CONCERN TO THE USER?

The risk of internal exposure during welding is negligible in most circumstances since the thoriated electrode is consumed at a very slow rate.

During the grinding of the thoriated tungsten electrodes, radioactive dust is created, posing the potential hazard of internal radiation exposure by inhalation or ingestion unless care is taken to control the dust.

HOW TO REDUCE EXPOSURE

- Choose thorium-free tungsten electrodes such as those containing cerium, lanthanum, yttrium, or zirconium whenever possible.
- Read, understand, and follow all information in the Material Safety Data Sheet (MSDS) for the selected tungsten electrode.
- Use a high-efficiency dust collection system to capture particles created during the grinding of electrodes or disturbed during housekeeping.
- Evaluate the ventilation system before acceptance and periodically thereafter to minimize personnel and environmental contamination.

- Develop and implement standard operating procedures for the use of thoriated tungsten electrodes, including proper procedures for storage, grinding, use, housekeeping and disposal.

- Provide training in the operation of the welding and grinding equipment, personal hygiene, and safety.

WHAT TO DO WITH THE COLLECTED DUST PARTICLES

- Regularly remove the dust generated by grinding.

- Properly dispose of the dust and spent electrodes in accordance with federal, state, and local regulations.

SUMMARY

Several of the information sources listed indicate that the risk of occupational exposure to radiation during storage, handling, and welding with thoriated tungsten electrodes is negligible where simple precautions are taken. Special care should be taken to control and collect dust from grinding these electrodes in order to prevent a potential ingestion and inhalation exposure to radioactive dust particles resulting from this operation.

INFORMATION SOURCES

International Institute of Welding (IIW). Statement from Commission VIII, Health and Safety 2000. *Welding with Non-Consumable Thoriated Tungsten Electrodes.* Document IIW-VIII-1901-00. np: np.

Jankovic, J. T., W. S. Underwood, and G. M. Goodwin. 1999. Exposures from Thorium Contained in Thoriated Tungsten Electrodes. *American Industrial Hygiene Journal* 60: 384 – 389.

Nuclear Regulatory Commission (NRC). *Code of Federal Regulations, Title 10 Energy, Part 40.13 (c) (1) (iii)* (Available from the U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954; tel: 800-321-6742; Web site: www.nrc.gov).

Oak Ridge National Laboratory (ORNL): Estimated Radiation Doses from Thorium and Daughters Contained in Thoriated Welding Electrodes, by L. M. McDowell-Boyer (ORNL/NUREG/TM-344). Oak Ridge, TN: ORNL, 1979.

Sinclair, M. L., and K. S. Thind: "Assessment of Thorium Exposure Due to Grinding of Thoriated Tungsten Electrodes." Paper presented at the American Industrial Hygiene Conference, Boston, MA., May 1992,

Breslin, A. J., and W. B. Harris: Use of thoriated tungsten electrodes in inert gas shielded arc welding. *Ind. Hyg. Q. 13*:191-195 (1952).

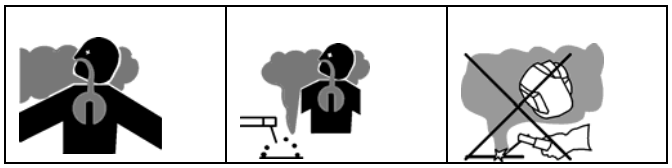
United States Nuclear Regulatory Commission. (February 1995). *Airborne Thorium from Welding Rods.* HPPOS-255 PDR-9308020142. U.S. NRC, Washington, DC. (Web site: www.nrc.gov).

Ventilation for Welding and Cutting

INTRODUCTION

Ventilation is used to control overexposures to the fumes and gases during welding and cutting. Adequate ventilation will keep the fumes and gases from the welder's breathing zone.

NOTE: This safety and health fact sheet does not address ventilation in confined spaces. Also, the term "welding" includes "cutting."



NATURE OF THE HAZARD— THE FUME PLUME

The heat of the arc or flame creates fumes and gases (fume plume). Fumes contain respirable particles. Gases include the shielding gas, and combustion products. The heat from the arc or flame causes the fume plume to rise.

Fumes contain hazardous substances. Overexposure to them may cause acute (short term) or chronic (long term) health effects. Fumes and gases may be produced at toxic levels and they can displace oxygen in the air causing asphyxiation. Overexposure to welding fumes and gases can cause dizziness, illness, and even unconsciousness and death.

HOW TO AVOID THE HAZARD — VENTILATION

Keep your head out of the fumes. Reposition the work, your head, or both to keep from breathing the fumes.

Use ventilation to control the fumes and gases produced from cutting and welding. Adequate ventilation keeps exposures to airborne contaminants below allowable limits. Have a technically qualified person evaluate the exposure to determine if the ventilation is adequate. Wear an approved respirator when ventilation is not adequate or practical.

Adequate ventilation depends on:

- Size and shape of the workplace
- Number and type of operations
- Contents of the fume plume
- Position of the worker's and welder's head
- Type and effectiveness of the ventilation

Adequate ventilation can be obtained through natural or mechanical means or both.

Natural Ventilation – is the movement of air through a workplace by natural forces. Roof vents, open doors and windows provide natural ventilation. The size and layout of the area/building can affect the amount of airflow in the welding area. Natural ventilation can be acceptable for welding operations if the contaminants are kept below the allowable limits.

	**<u>Natural Ventilation</u>: Using airflow from open windows, doors, and roof vents may be adequate.**

Mechanical Ventilation – is the movement of air through a workplace by a mechanical device such as a fan. Mechanical Ventilation is reliable. It can be more effective than natural ventilation. Local exhaust, local forced air, and general ventilation are examples of mechanical ventilation.

<u>Local exhaust ventilation</u> systems include a capture device, ducting and a fan. The capture devices remove fumes and gases at their source. Fixed or moveable capture devices are placed near or around the work. They can keep contaminants below allowable limits.

One or more of the following capture devices are recommended:

- Vacuum nozzle at the arc
- Fume Hoods
- Gun mounted fume extractor

Some systems filter the airflow before exhausting it. Properly filtered airflow may be recirculated.

	**<u>Local Exhaust Ventilation</u>: Use enough local exhaust at the arc to remove the fumes and gases from your breathing area.**

<u>Local forced air ventilation</u> is a local air moving system. A fan moves fresh air horizontally across the welder's face. A wall fan is an example of Local Forced Air Ventilation.

When using localized ventilation, remember:

- Locate the hood as close as possible to the work.
- Position the hood to draw the plume away from the breathing zone.
- Curtains may be used to direct airflow.
- Some toxic materials or chemicals may require increased airflows.
- Velocities above 100 feet per minute at the arc or flame may disturb the process or shielding gas.
- The capture device can depend on the type of job.

SUMMARY

Adequate ventilation removes the fumes and gases from the welder's breathing zone and general area. It prevents overexposure to contaminants. Approved respirators may be required when ventilation is not adequate.

To minimize worker overexposure to fumes and gases:

- Keep your head out of the fumes, and do not breathe the fumes.
- Reposition the work and your head to avoid the fumes.
- Choose the correct ventilation method(s) for the specific operation.
- Use enough ventilation, exhaust at the arc, or both, to keep fumes and gases from your breathing zone and the general area.
- Understand what is in the fumes.
- Have a technically qualified person sample your breathing air and make recommendations.
- Keep hazardous air contaminants below allowable limits.
- Wear the proper respirator when necessary.

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.

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.

National Fire Protection Association (NFPA). *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work* (NFPA 51B), available from National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269–9101, telephone: 800–344–3555, web site: www.nfpa.org.

American Conference of Governmental Industrial Hygienists (ACGIH), *Industrial Ventilation – A Manual of Recommended Practice* 21st edition, published by the ACGIH, 6500 Glenway Avenue, Building D-7, Cincinnati, OH 45211-4438; telephone , 513-742-2020; web site: www.acgih.org.

American Welding Society (AWS). *Ventilation Guide for Weld Fume* (AWS F3.2), published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; web site: www.aws.org.

Edison Welding Institute (EWI). *Reduction of Worker Exposure and Environmental Release of Welding Emissions* (NSRP report No. 43149GTH, November 30, 2003), available from the Edison Welding Institute, 1250 Arthur E. Adams Drive, Columbus, OH 43221; telephone: 614-688-5000; web site: www.ewi.org.

Occupational Safety and Health Administration (OSHA). *OSHA Technical Manual* (OTM), Section III Health Hazards, Chapter 3 Ventilation Investigation, available from OSHA, Room N3655, 200 Constitution Ave., N.W., Washington, DC 20210; telephone: 202-693-2095; web site: http://www.osha.gov.

AWS D17.2/D17.2M:2007
An American National Standard

Specification for Resistance Welding for Aerospace Applications

American Welding Society

Approved American National Standard
ANSI

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Approved by the
American National Standards Institute
January 4, 2007

Specification for Resistance Welding for Aerospace Applications

1st Edition

Prepared by the
American Welding Society (AWS) D17 Committee on Welding in the Aircraft and Aerospace Industry

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

This specification provides the general resistance welding requirements for aerospace hardware. It includes, but is not limited to, resistance spot and resistance seam welding of aluminum, magnesium, iron, nickel, cobalt, and titanium-based alloys. There are requirements for machine and procedure qualification, production witness samples, and inspection and acceptance criteria for aerospace hardware.

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Table of Contents

Page No.

List of Tables

Table **Page No.**

List of Figures

Figure **Page No.**

Guide for Strengthening and Repairing Existing Structures

1. General Provisions

1.1 Scope. This document contains basic information pertinent to the welded strengthening and repair of existing steel structures. The information contained in this guide is intended for both Engineers and Contractors with the purpose of providing direction and guidance to perform weld repairs, weld strengthening, and other weld procedures to correct problematic issues with existing structures. This guide contains background information that will be useful to the Engineer who is obligated under AWS D1.1/D1.1M:2008 Clause 8 to provide a comprehensive plan to address projects that involve strengthening and repairing of steel structures. The approach to the strengthening and repairing of these materials is to be developed using the information provided herein.

This guide is intended to apply to the strengthening and repair of existing structures made of the following materials:

(1) Steel with a minimum specified yield strength of 100 ksi [690 MPa] or less

(2) Cast iron

(3) Wrought iron

Strengthening or repairing an existing structure includes modifications to meet new serviceability or load requirements as well as corrections made to repair conditions unsuitable for future use specified by the Engineer. The Engineer should prepare a contract for the work including, but not limited to, design, workmanship, inspection, acceptance criteria, and documentation. Except as modified in this clause, provisions of this guide should apply to the strengthening and repair of existing structures, including heat straightening of distorted members.

1.2 Limitations. This guide is intended to assist in the evaluation of existing structural elements and the development of appropriate procedures for repairing those elements. It does not provide exhaustive coverage of any specific topic.

This guide is intended to apply to the strengthening and repair of existing buildings and other structural systems. It is not intended to apply to:

(1) Structures made of steels less than 1/8 in [3 mm] thick

(2) Pressure vessels and pressure piping

(3) Structures made of materials other than those listed under the scope

(4) Seismic upgrades

(5) New construction

Whereas this guide is not intended to apply the application outside the scope, the principles contained in this guide may be applied to other materials and applications. The Engineer is advised to use caution and engineering judgment for application outside the scope of this guide.

More importantly, it is critical to state here that this document does not provide detailed specific procedures and direction to correct any specific strengthening or repair operation regardless of how common or standard the procedure may be. Instead, information supplied herein as well as that material referenced in Annex A is intended to provide users with an overall approach to weld modifications as they pertain to: strengthening and repair; technical resources to develop