AWS SAFETY AND HEALTH FACT SHEET BUNDLE

FOR SHIPBUILDING

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

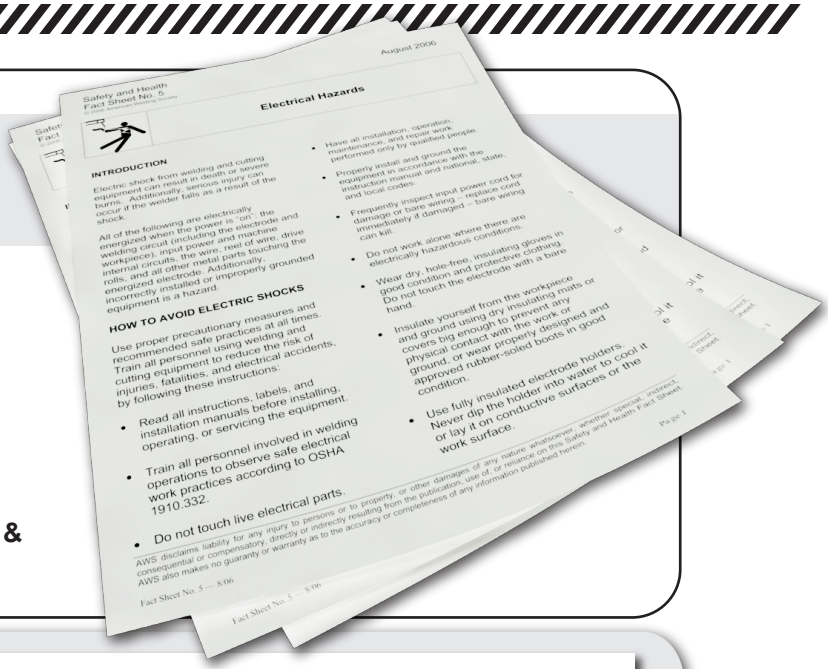
Fact Sheet 4: Chromium and Nickel in Welding Fume

Fact Sheet 6: Fire and Explosion Prevention

Fact Sheet 11: Confined Spaces

Fact Sheet 27: Thoriated Tungsten Electrodes

Fact Sheet 36: Ventilation for Welding & Cutting



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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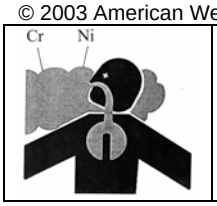


Chromium and Nickel in Welding Fume

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).

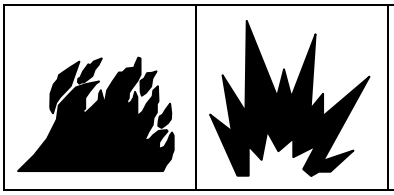
IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Chromium, Nickel, and Welding, Vol. 49 (1990), Oxford University Press, New York, NY 10016 (telephone: 212-726-6000; web site: www.oup-usa.org).

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).



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.

NATURE OF THE HAZARD

Flying sparks are the main cause of fires and explosions in welding and cutting. Sparks can travel up to 35 feet (10.7 meters) from the work area. 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, walls, or partitions.

Typical combustible materials inside buildings include: wood, paper, rags, clothing, plastics, chemicals, flammable liquids and gases, and dusts. Parts of buildings such as floors, partitions, and roofs may also be combustible.

Typical combustible materials outside buildings include dry leaves, grass, and brush.

Welding and cutting can cause explosions in spaces containing flammable gases, vapors, liquids, or dusts. Special precautions are needed for any work on containers (see AWS F4.1).

HOW TO AVOID THE HAZARD

- Develop adequate procedures, and use proper equipment to do the job safely.
- When Required obtain a Hot-Work Permit (See NFPA 51B).
- Remove combustible materials for a minimum radius of 35 feet (10.7 meters) around the work area or move the work to a location well away from combustible materials.
- If relocation is not possible, protect combustibles with covers made of fire-resistant material.
- If possible, enclose the work area with portable, fire-resistant screens.
- Cover or block all openings, such as doorways, windows, cracks, or other openings with fire resistant material.
- Do not weld on or cut material having a combustible coating or internal structure, such as in walls or ceilings, without an appropriate method for eliminating the hazard.
- When needed, have a qualified firewatcher in the work area during and for at least 30 minutes after the job is finished.

- After welding or cutting, make a thorough examination of the area for evidence of fire. Remember that easily visible smoke or flame may not be present for some time after the fire has started.

- Do not dispose of hot slag in containers holding combustible material.

- Keep appropriate fire extinguishing equipment nearby, and know how to use it.

- Make sure all electrical equipment and wiring are installed properly and have recommended circuit protection.

- Do not overload or improperly size input conductors and/or weld output conductors to avoid equipment and building fire hazards.

- Connect the work cable to the work as close to the welding area as practical.

- Do not weld or cut in atmospheres containing reactive, toxic, or flammable gases, vapors, liquids, or dust.

- Do not apply heat to a workpiece covered by an unknown substance or coating that can produce flammable, toxic, or reactive vapors when heated.

- Do not apply heat to a container that has held an unknown substance or a combustible material unless container is made or declared safe. (see AWS F4.1).

- Provide adequate ventilation in work areas to prevent accumulation of flammable gases, vapors, or dusts.

SUMMARY

Remember that sparks can travel up to a radius of 35 feet (10.7 meters) from the work and pass through or become lodged in all kinds of openings and cause fires where least expected. Recognize that sparks can travel well beyond the 35 foot (10.7 meters) radius when falling or during plasma arc cutting and air carbon arc cutting or gouging. Remove combustible materials and prevent flammable gases, vapors, and dusts from accumulating in the work area to reduce the possibility of a fire or explosion. Always have appropriate fire extinguishing equipment nearby, and know how to use it.

Fires and explosions can be prevented by being aware of your surroundings, minimizing the combustibles in them, and taking the appropriate protective precautions.

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. Phone 800-443-9353; Web site: www.aws.org.

National Fire Protection Association (NFPA), *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, NFPA 51B, available from the National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, Massachusetts USA 02269-9101. Phone: 617-770-3000; Web site: www.nfpa.org.

Occupational Safety and Health Administration (OSHA). *Code of Federal*

Regulations,Title 29 Labor, Chapter XVII, Parts 1901.1 to 1910.1450, available from Superintendent of Documents, U.S. Government Printing Office, P.O. Box 371954, Pittsburgh, PA 15250-7954. Phone: 866-512-1800; Web site: www.osha.gov.

American Welding Society (AWS). *Safe Practices for the Preparation for Welding and Cutting of Containers or Piping*, AWS F4.1, available from the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126. Phone: 800-443-9353; Web site: www.aws.org.

American Welding Society (AWS). *Fire Safety in Welding and Cutting*, Pamphlet, available from the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126. Phone: 800-443-9353; Web site: www.aws.org.

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 15250-7954. Phone: 866-512-1800; Web site: www.msha.gov.

Safety and Health
Fact Sheet No. 11 September 2009

Hot Work in Confined Spaces

NATURE OF THE HAZARD

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

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

EXAMPLES OF CONFINED SPACES

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

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

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

ACTIONS REQUIRED BEFORE APPROVING HOT WORK IN A CONFINED SPACE

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

  Note: The testing requires special equipment and training.
- Isolate lines by capping or double blocking and bleeding. Keep vents open and valves leak-free.
- Lock out/tagout all systems not required during hot work.
- Provide means for readily turning off power, gas, and other supplies from outside the confined space.
- Protect or remove any hazardous materials or materials which may become hazardous when exposed to hot work.

REQUIRED ACTIONS DURING HOT WORK IN A CONFINED SPACE

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

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

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

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

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

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

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

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

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

INFORMATION SOURCES

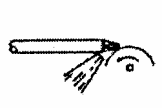
American National Standards Institute (ANSI). *Safety in Welding, Cutting, and Allied Processes* (ANSI Z49.1), published by the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126; telephone 800-443-9353; web site: www.aws.org.

Occupational Safety and Health Administration (OSHA). *Code of Federal Regulations,* Title 29 Labor, Parts 1910 and 1926, 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.

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

American National Standards Institute (ANSI). *Safety Requirements for Confined Spaces* (ANSI Z117.1), available from ANSI, 25 West 43rd Street, New York, NY 10036; telephone: 212-642-4900; web site: www.ansi.org.

National Institute for Occupational Safety and Health (NIOSH) Respirator Rule. *Code of Federal Regulations,* Title 42 Public Health, Part 84, available from the U.S. Government Printing Office, 732 North Capitol Street NW, Washington, DC 20401; telephone: 800-356-4674; web site: www.cdc.gov/niosh.



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.

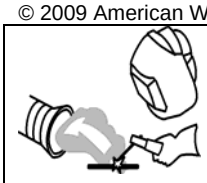
Nuclear Regulatory Commission (NRC). *Code of Federal Regulations, Title 10 Energy, Part 40.13 (c) (1) (iii)* (Available from the U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954; tel: 800-321-6742; Web site: www.nrc.gov).

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).

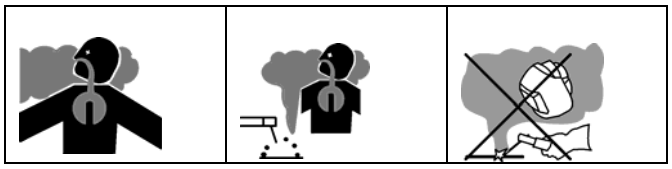


Ventilation for Welding and Cutting

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 D3.7:2004
An American National Standard

Guide for Aluminum Hull Welding

American Welding Society

Approved American National Standard
ANSI

Key Words—Aluminum hull welding, ship welding, hull welding, aluminum hulls, boats, crafts, ships

AWS D3.7:2004
An American National Standard

Approved by
American National Standards Institute
December 17, 2003

Guide for

Aluminum Hull Welding

Supersedes ANSI/AWS D3.7-90

Prepared by
AWS D3 Committee on Welding in Marine Construction

Under the Direction of
AWS Technical Activities Committee

Approved by
AWS Board of Directors

Abstract

This guide provides information on the welding of sea going aluminum hulls and other structures in marine construction. Included are sections on hull materials, construction preparation, welding equipment and processes, qualification requirements, welding techniques, and safety precautions.

American Welding Society
550 N.W. LeJeune Road, Miami, Florida 33126

Table of Contents

Page No.

List of Tables

List of Figures

Guide for Aluminum Hull Welding

1. General

1.1 Scope. This standard makes sole use of U.S. Customary Units. Approximate mathematical equivalents in the International System of Units (SI) are provided for comparison in parentheses or in appropriate columns in tables and figures.

This guide provides information on proven processes, techniques, and procedures for welding aluminum hulls and related ship structures. The information presented applies chiefly to the welding of aluminum hulls that are over 30 ft (9 m) in length and made of sheet and plate 1/8 in. (3.2 mm) thick and greater. Thin-gage aluminum welding usually requires specific procedures in the area of fixturing, welding sequence, and other techniques for distortion control that are not necessarily applicable to thick plates. Similarly, the choice of welding process or applicable process conditions, or both, also differs according to thickness.

1.2 Welding Processes. The inert gas shielded welding processes have been employed as the principal joining method for the majority of aluminum naval and merchant ship structures built since the early 1950s. In their basic forms, these processes employ two distinct types of electrodes, although both use a protective shield of inert gas to prevent oxidation of the hot metal in the weld zone.

1.2.1 Gas Tungsten Arc Welding (GTAW).[1] The first inert gas welding process to be developed was gas tungsten arc welding which is sometimes referred to as TIG welding. Introduced in 1941, this process uses a nonconsumable tungsten electrode. Inert gas is fed through the welding torch while filler metal, when required, is added into the weld pool separately by hand or machine.

1.2.2 Gas Metal Arc Welding (GMAW).[2] The second process, gas metal arc welding, which is sometimes referred to as MIG welding, is employed for over 90% of the joining in a welded aluminum hull because it is much faster than GTAW. This process also uses an inert gas shield, but employs a continuous aluminum wire electrode that provides filler metal as it is fed mechanically through a welding gun. Introduced in 1948, GMAW is suitable for production welding of aluminum of 1/16 in. (1.6 mm) thickness and greater.

1.3 Comparison of Welding Processes. The gas shielded arc welding processes GMAW and GTAW offer speed, good weld strength, and ease of operation in all positions on a wide range of aluminum thicknesses and joint types.

Inert gas shielded arc welded joints in aluminum alloys, generally recommended for marine use, retain a high percentage of the original base metal strength. Similarly, properly made welded joints, produced with the correct filler metals have virtually the same corrosion resistance as the base metal.

Oxyfuel gas and shielded metal arc welding are not suitable for aluminum ship structures because weld quality is inadequate, and the residual chlorides from the flux must be removed.

1.4 Serviceability of Welded Aluminum Hulls. Service records of welded aluminum craft and other marine structures are excellent. Maintenance and repair cost records of hulls, which have been in service for 20 years or more, are impressive.

In many respects, preparation of aluminum hull plate for welding is simpler and more flexible than preparation of steel plate. Portable routers and radial saws, operating at relatively high speeds, and plasma arc cutting are widely used to advantage in cutting aluminum.

Machining operations to provide the required joint geometry for sound welds usually can be done with the same equipment employed for steel, but the cutting tools should be designed for aluminum. Shipyards already equipped with plate milling and planing machines, for example, employ the equipment for aluminum edge preparation using tools properly shaped for cutting aluminum.

1. Refer to AWS C5.5/C5.5M, *Recommended Practices for Gas Tungsten Arc Welding*, and the *Welding Handbook*, Vol. 2, 8th Ed. 73–108.
2. Refer to AWS C5.6, *Recommended Practices for Gas Metal Arc Welding*, and the *Welding Handbook*, Vol. 2, 8th Ed. 109–156.