Health Hazards Of Welding

GENERAL

Welding joins pieces of metal by the use of heat, pressure, or both. Brazing, or soldering, involves a filler metal or alloy (a combination of metals) which has a lower melting point than the metal pieces to be joined.

There are many different types of welding and associated processes. Some of the most common types of welding include: arc welding, which includes "stick", or shielded metal arc welding (SMAW), the gas-shielded methods of metal inert gas (MIG) and tungsten inert gas (TIG), plasma arc welding (PAW), and submerged arc welding (SAW). Other welding processes may use oxy-acetylene gas, electrical current, lasers, electron beams, friction, ultrasonic sound, chemical reactions, heat from fuel gas, and robots.

Welding, thermal cutting, and associated processes may produce airborne contaminants, such as fumes, gases, vapors, dust, mists, and physical hazards such as radiant energy, heat, and noise.

SOURCES OF EXPOSURE

The potential hazards of welding operations include metal fumes, toxic gases, and ultraviolet and infrared radiation. Fume particles are formed from vaporization of molten metal. They are very fine in size, generally one micron or smaller, and may join together to form larger particles. The adverse health effects of overexposure to welding fumes and gases include chronic or acute systemic poisoning, metal fume fever (a short-term painful ailment with symptoms of fever and chills), pneumoconiosis (lung disease due to accumulation of mineral or metallic particles), and irritation of the respiratory tract. Generally, welding fumes and gases come from:

- The base material being welded or the filler material that is used;
- Coatings and paints on the metal being welded, or coatings covering the electrode;
- Shielding gases supplied from cylinders;
- Chemical reactions which result by the action of ultraviolet light from the arc, and heat;
- Process and consumables used; and contaminants in the air, for example vapors from cleaners and degreasers.

HEALTH HAZARDS

Chemical Hazards

The welding fumes produced at welding operations depend primarily on the composition of the metals being welded and the welding rods. When the base metal is iron or steel, with welding rods of similar composition the main component of the fume will be iron oxide. When welding on stainless steel, fumes containing nickel and chromium may be produced. Welding on plated, galvanized, or painted metals may generate fumes containing cadmium, zinc oxide, or lead. In addition, welding rods can generate fluoride in the fume as well as free silica, depending on the composition of the welding rod coating. In summary,

welding processes may generate many different metal fumes and other toxic components. It is important that the hazards of a welding operation be evaluated properly. Toxic gases that arise in welding include carbon monoxide, nitrogen dioxides, and ozone. If welding or cutting operations are conducted in the presence of chlorinated hydrocarbons (solvents) either on the metals or in the air, hazardous concentrations of phosgene and hydrogen chloride, which are highly toxic irritant gases, may be produced. The health effects of welding exposures are specific to the materials used and created during the welding process. Some common metals and other chemicals are listed on the tables at the end of this document.

PHYSICAL HAZARDS

Heat - Excessive exposure to heat can result in heat stress or heat stroke. Symptoms include fatigue, dizziness, loss of appetite, nausea, abdominal pain, and irritability. Ventilation, shielding, rest breaks, and frequent drinks will protect against heat-related hazards. For information on heat stress, see RMB #11, Preventing Heat Stress.

Ultraviolet radiation - Exposure to ultraviolet light can cause skin burns similar to sunburn, and increase the welder's risk of skin cancer.

Noise - Exposure to loud noise can permanently damage welders' hearing. Noise also causes stress and increased blood pressure, and may contribute to heart disease. Working in a noisy environment for long periods of time can make workers tired, nervous, and irritable. For information on noise, see RMB #7, Occupational Noise Exposure.

SPECIAL HAZARDS– HAZARDS OF WELDING IN CONFINED SPACES

A confined space is a small or crowded area with limited access and little or no air flow or ventilation. Adequate ventilation is essential for working in confined spaces. Dangerous concentrations of toxic fumes and gases can build up very quickly in a small space. Unconsciousness or death from suffocation can occur rapidly because welding processes can use up or displace oxygen in the air. High concentrations of some fumes and gases can also be very explosive.

All workers who may enter confined spaces either on a regular basis or in an emergency situation should be trained in appropriate confined space entry procedures, and should work within the requirements of a written confined space entry program.

WORKPLACE CONTROLS

Before beginning a welding job, it is important to identify the hazards for that particular welding operation. The hazards will depend on the type of welding, the materials (base metals, surface coatings, electrodes) to be welded, and the environmental conditions (outside or in a confined space, for instance). The material safety data sheets (MSDSs) will identify the hazardous materials used in welding and cutting products, and the fumes that may be generated. After identifying the hazard, appropriate control methods can be implemented.

ENGINEERING CONTROLS

Ventilation should be used to remove harmful fumes and gases. Local exhaust ventilation, which removes the fumes and gases at their source, is the most effective method. This can be provided by a partial enclosure, such as a ventilated work bench, or by hoods positioned as close to the point of welding as possible. Mobile ventilation units are useful for welding jobs which are not at a fixed location. General ventilation, which uses roof vents, open doors and windows, roof fans, or floor fans to move air through the entire work area is not as effective as local exhaust ventilation, and may simply spread chemicals around the workplace. General ventilation is often helpful, however, when used to supplement local ventilation. Substitution of hazardous materials for less hazardous materials, e.g., use of cadmium-free silver solders is also an effective control method.

WORK PRACTICES

Modification of the work process and following safe work practices can eliminate or reduce health hazards.

For example:

- Avoid welding on painted or coated parts by removing all surface coatings before welding.
- Take a position while welding or cutting so that the head is not in the fumes.
- Minimize the production of welding fumes by using the lowest acceptable amperage and holding the electrode perpendicular and as close to the work surface and possible.
- Avoid arc welding within 200 feet of degreasing equipment or solvents.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal protective equipment should always be used along with, but never instead of, engineering controls and safe work practices. PPE commonly used in welding operations include:

- Welding helmets, goggles, or other eye protectors must contain special filter plates or lenses for workers exposed to arc welding or cutting processes, oxyfuel gas welding, brazing, or cutting.
- Hearing protectors (ear plugs or ear muffs) should be used during noisy operations such as air arcing and grinding.

Respiratory protection should be used when engineering and work practice controls are not enough to reduce exposure. To be effective, a respiratory protection program should be in place and followed. For information on respiratory protection, see RMB #110, Establishing A Respirator Program.

WORKPLACE EXPOSURE LIMITS

There are no exposure limits for total welding fume, but limits for the individual components of the fume and for associated gases are available. Local exhaust or general ventilation must be provided to keep exposure to toxic fumes, gases, or dusts less than the established exposure limits.

Exposure limits specified by OSHA are regulatory, but other non-regulatory exposure limits are set by other organizations, such as the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) and the National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL). Although the non-regulatory limits are not required by law, they are generally accepted as reflective of current research on levels necessary to prevent illness.

The National Institute for Occupational Safety and Health (NIOSH) has concluded that welders may be harmed by welding fume even when the concentrations of the individual components are less than workplace exposure limits.

NIOSH recommends that welding emissions be reduced to the lowest feasible concentrations using state-of-the-art engineering controls and work practices. Air monitoring can be conducted to determine whether levels of any materials present a health hazard.

For further information or assistance, contact your Zenith Safety & Health Consultant.

Material	Where Found	Health Hazards
Metals		
Aluminum	Aluminum component of some alloys, e.g., Inconels, copper, zinc, steel, magnesium, brass	Respiratory irritant
Beryllium	Hardening agent found in copper, magnesium, aluminum alloys and electrical contacts	Damage to respiratory tract; a carcinogen
Cadmium	Silver solders, rust preventive coatings, alloying element	Severe lung irritation, pulmonary edema; potential carcinogen
Chromium	Most stainless steel and high-alloy materials, welding rods, plating material	Irritation of eyes and respiratory system; perforation of nasal septum; skin irritation or ulceration; increased risk of lung cancer.
Copper	Alloys such as Monel, brass, bronze; welding rods	Irritation of eyes and upper respiratory system; metal fume fever
Iron	Main component in all steel	Siderosis, a benign lung disease. Acute effects include irritation of nasal passages and lungs, clears up when exposure stops.
Lead	Solder, brass and bronze alloys, coatings on steel	Chronic effects to central nervous system, circulatory system, reproductive system, kidneys, and muscles
Manganese	Alloying element in steel, especially high tensile steels	Central nervous system effects (Parkinson's-like symptoms); metal fume fever
Nickel	Stainless steel, Inconel, Monel and other high-alloy materials, welding rods and plated steel	Irritation of eyes, nose, throat, allergic asthma, pneumonitis, sensitization dermatitis; potential carcinogen.
Zinc	Galvanized steel, brass, painted metals	Metal fume fever

Material	Where Found	Health Hazards
Gases		
Carbon monoxide	Created during incomplete combustion of fuels, such as acetylene gas, or breakdown of carbon dioxide shielding gas	Absorbed into bloodstream, causing pounding of heart, headache, dizziness. High concentrations may result in unconsciousness or death
Chlorinated hydrocarbon solvents	Degreasing or cleaning operations. Decomposition by ultraviolet radiation forms phosgene	See phosgene
Fluorine compounds	Component of some fluxes or rod coatings	Irritation of eyes, nose and throat; bone damage
Nitrogen oxides	Created by decomposition of air from ultraviolet radiation and nitrogen shielding gas	Irritation of eyes, nose and throat, pulmonary edema
Ozone	Created by decomposition of air from ultraviolet radiation	Irritation of mucous membranes, pulmonary edema
Phosgene	Created by decomposition of chlorinated solvents (nearby degreasing operations) by ultraviolet radiation	Severe irritant to eyes, nose and respiratory system