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Don't let your health go up in smoke
Learn about and prevent the effects of welding fumes

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Although the health effects of welding exposures often are difficult to predict, components of welding fumes have a range of toxicities that, under the right conditions, can affect many parts of the body adversely. Knowing what situations and welding process components can negatively impact your health is the first step toward learning how to protect yourself from those health hazards.

Increasing knowledge about the health hazards associated with breathing welding fumes and gases above certain concentrations and the serious illnesses that can result emphasizes the need to educate, train, and provide welders with appropriate protection.

Welding fumes are very fine, solid particles of metal oxides that form during the welding process. The specific substances and amount a welder inhales depend on the welding method, conditions under which the welding takes place, and the types of metals being welded. Many types of metals may be found in welding fumes, including arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, silicates, selenium, vanadium, and zinc.

Gases commonly associated with welding are carbon dioxide, carbon monoxide, nitrogen oxides, ozone, fluorine compounds, and phosgene. These gases may be present as the result of:

- Combustion of flux shielding.
- Ultraviolet radiation interaction with shielding gases, oxygen, carbon dioxide, and solvents.
- Burning metal coatings.

The health effects of welding fume exposures often are difficult to predict because the fumes contain a variety of substances in many concentrations. Components of welding fumes have a range of toxicities that, under the correct conditions, can affect many parts of the body adversely, including lungs, heart, kidneys, and central nervous system.

Acute Short-term Health Effects: Metal Fume Fever

According to the American Welding Society (AWS) Fact Sheet #25, January 2002, exposure to excessive concentrations of welding fumes containing zinc, magnesium, copper, and cadmium may cause metal fume fever. Symptoms usually occur within four hours of exposure and include chills, fever, thirst, muscle ache, chest soreness, coughing, fatigue, nausea, and a metallic taste in the mouth. These flulike symptoms may last six to 24 hours, and complete recovery without intervention occurs within 24 to 48 hours.

Welding fumes also can irritate the eyes, nose, chest, and respiratory tract, causing coughing, shortness of breath, bronchitis, fluid in the lungs (pulmonary edema), and increased risk of pneumonia.

Long-term Exposure: Chronic Health Effects

Studies indicate that welders may have up to a 30 percent to 40 percent increased risk of lung cancer as compared with other occupations.[1] However, the specific cause of this increased risk remains elusive. Confounding factors include high rates of smoking among welders and frequent exposure to asbestos and silica. The most likely cancer-causing components of welding fumes are hexavalent chromium and nickel. Another possible contributor is inhaling thorium particles while grinding thoriated tungsten electrodes.

Documented chronic respiratory ailments associated with overexposure to welding fumes include bronchitis, asthma, pneumonia, emphysema, and siderosis (caused by iron oxide dust in the lungs). In addition, evidence may link welding fumes to heart disease, skin diseases, ulcers, kidney damage, hearing loss, and reproductive problems. Welders also may have an increased risk of silicosis resulting from exposure to crystalline silica during secondary operations such as grinding and sanding.

Exposure to Welding Fumes With Manganese

One of the more recent ailments identified by the National Institutes of Health that can afflict welders is manganism, also known as welder's disease. Manganese is added to most steel to promote hardness. Inhaling manganese has been linked to weakness/lethargy, speech and psychological disturbances, paralysis, and tremors.

Hexavalent Chromium

Another area receiving attention today is exposure to hexavalent chromium from welding stainless steel. Fluxes used in shielded metal arc welding (SMAW) and flux-cored arc welding (FCAW) tend to increase the amount of hexavalent chromium relative to the total chromium fume produced. Studies of workers in chromate production, plating, and pigment industries consistently show increased rates of lung cancer. The compound also has been linked to permanent eye damage, skin rashes, and ulcers.

The Occupational Safety and Health Administration (OSHA) proposed a standard in October 2004 that would reduce the exposure limit for hexavalent chromium to 1 microgram per cubic meter of air (µg/m3), down from the current limit of 52 µg/m3. The final standard is expected early in 2006.

Controlling Fume Hazards

Before beginning any welding job, it's critical to identify potential respiratory hazards particular to that operation. Fume exposure will depend on the following factors:

- The type of welding: More than 80 different types of welding and associated processes exist. Variables such as welding amperage, shielding gases, and pulsing within each method can influence fume generation rates significantly.
- The materials being welded: base metals, electrodes, and surface coatings.
- The position of the welder relative to the rising smoke plume.
- The ability to remove welding fumes at the point of generation using ventilation. Material Safety Data Sheets (MSDSs) should be reviewed to identify any hazards that might be associated with the welding job.

Good engineering controls and work practices are imperative. For example, it's important, when feasible, to use local and source-exhaust ventilation to remove harmful fumes and gases. Where possible, less hazardous materials should be substituted.

Personal Protective Equipment

In many cases, engineering controls alone can't reduce exposure levels adequately. In such cases, it may be appropriate to use respirators. For any particular welding application, an array of respirator types that provide an appropriate level of protection are available. The unit cost of these respirators may be from around $1 for a basic negative-pressure, disposable, filtering facepiece to $1,000 or more for a positive-pressure system.

But the initial price is only one part of the equation. It's also important to consider that:

- Reusable respirators may last longer, but they require daily cleaning and maintenance?an added labor cost that's often overlooked. Depending on the type of unit, maintenance may include washing, filter changing, battery charging, inspection, and component replacement.
- Depending on job conditions, disposable respirators?also known as dust masks?can become clogged or damaged after one work shift. In these cases, the long-term cost of frequent replacement may offset a lower unit cost.
- Training requirements and respirator maintenance costs vary, depending on the respirator selected. For example, consider if users will be trained to maintain their personal units or if designated maintenance personnel will be responsible.

Respirators With Air Conditioning

Heat stress is a common problem in welding and other metal fabrication operations. Heat stress may result in reduced productivity, reduced quality, increased risk of accidents, and higher employee turnover.

When heat stress is an issue, positive-pressure respirator systems employing vortex-cooling technology may be appropriate. To be used properly, these small, lightweight, belt-mounted devices require that breathing-quality air be supplied to the respirator from a remote compressor through an air hose. Air entering the headpiece can be lowered by up to 50 degrees F. Some systems provide heating when cold stress is an issue.

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Note: 1. James M. Antonini, "Health Effects of Welding," Critical Reviews in Toxicology, Vol. 33, No. 1 (2003), pp. 61-103.

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