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## Welding and Workers' Health

### A Primer on Welding Smoke and Fume Control

#### The Hazards of Welding Fumes

There is little doubt that welding is one of the leading causes of in-plant air pollution in industry. However, many companies are still unaware of the potential health risks inherent in welding, nor are they aware of the unnecessary expenses incurred with many common control systems.

It is difficult to generalize on the specific hazards of welding, since so little information exists on fume composition and each welder's exposure varies.

Welders, health organizations and management are all becoming increasingly concerned with the effects of welding smoke and fumes in the work place.

In addition, management is becoming increasingly conscious of the costs of absenteeism and reduced productivity resulting from illness caused by polluted air.

Few long-term health studies of chronic welding ailments are available, since both the actual duties of welders as well as their welding environments vary widely.

In fact, the composition and quantity of hazardous fumes that a worker encounters depends on many variables, including:

- The characteristics of the welding area (i.e. whether it is an open or a confined space).
- The type of welding process
- The type of alloy consumed
- The type of materials welded
- The welders position

This primer has been created to provide you an overview of the hazards involved in welding as well as the common control methods.

## Welding and Workers' Health

There is mounting evidence that welders experience more symptoms of chronic lung disease and higher mortality

rates than the general population.

A review of the more recent long-term studies in *table 1* suggests that in every instance except one, welders experienced higher incidences of chronic lung diseases than the general population. For example, a study by Barhad points out that 5 year welding veterans in shipyards who work with SMAW, FCAW or Oxygas consistently report a higher incidence of lung disease.

**Table 1:**  
Sample of cross-sectional Epidemiological Studies of Chronic Respiratory Effects in Welders

Author	Process /Electrode Type	Metal Welded	Exposure Years	Statistically Significant Excess of Chronic Lung Disease Symptoms	Statistically Significant Impairment in Lung Function Indices
NIOSH	-	-	-	Yes	-
Ross	-	-	-	Yes (in 50- 59 Yrs. Old)	No
Wilhelmens	SMAW/Basic	Mild Steel and primed Metal	Mean 17±8	Yes, In Nonsmokers	Yes, In Nonsmokers
Peters	GMAW, GTAW, GMAW	Cr, Mn, Ni alloys Mild Steel Aluminum, Stainless Steel	-	-	Yes
Fogh	SMAW	Mild Steel	5	No	No
Barhad	SMAW/ Basic FCAW, Oxygas	-	5	Yes	-
Ulrich	GMAW	-	-	Yes	No

Hatch Associates, "A Pilot Study: Health Hazards of Fume Exposure and Associated Occupations", p. 109

Two acute results of fume exposure are reported in the two case histories, which follow. These immediate reactions are, of course, the easiest to diagnose because they are immediately visible. But there are thousands of welders who may experience chronic and long-term reactions to welding that are far more difficult to diagnose.

**CASE HISTORY #1**

**Metal Fume Fever: A Frequent Condition**

After welding several sheets of galvanized metal, a welder began to experience an intense headache. An hour later, he felt feverish, weak and sick to his stomach. These symptoms subsided after 12 hours, leaving the worker weak.

This worker experienced what is widely known as “Metal Fume Fever”. It is common and acute disability of short duration, yet many workers experience this frequently.

# Welding and Workers' Health

## Case History #2

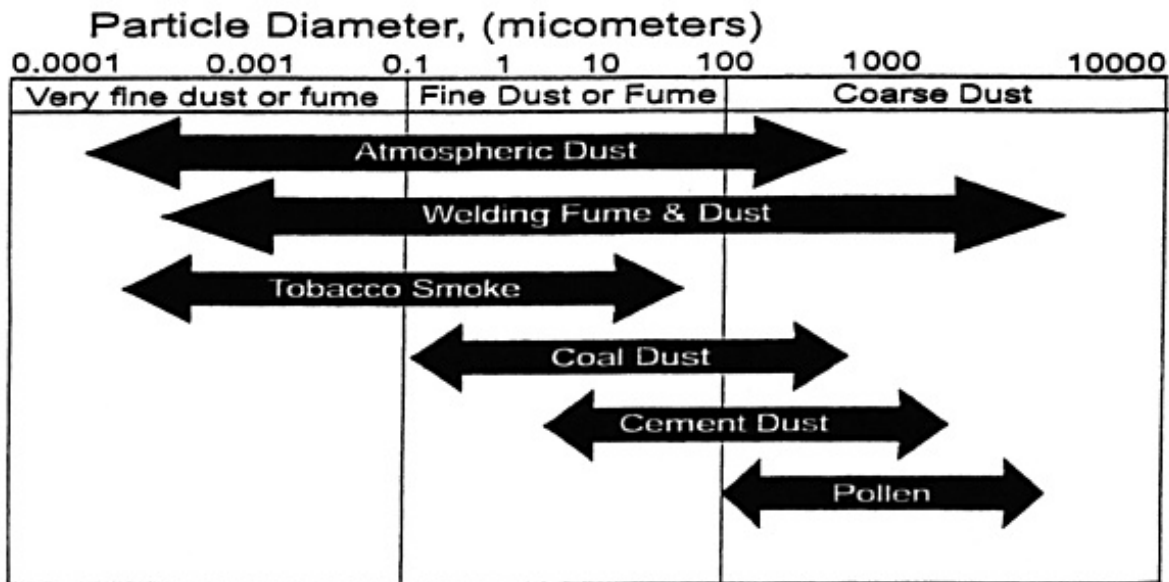
### A Cadmium Overexposure

A 34 year old welder was working for about 30 minutes with an oxyacetylene torch and silver solder. The solder contained over 20% cadmium and was not labeled as such. Within hours after the exposure, the welder had difficulty breathing and died 5 days later.

## Different Welding Fumes:

### Different Welding and Health Problems

All welding processes generate fumes (particulate matter) and gases. While some of these contaminate is merely a nuisance, many are clearly hazardous. In fact, most of these fumes and gases are smaller than 1.0  $\mu\text{m}$  (micrometer). At this size, the particles penetrate deep into the respiratory tract. Table 2, below, shows particle sizes for a number of familiar pollutants.



### Definitions for hazard chart on following page

**a.** TLV Threshold Limit Value. This is the recommended exposures level to substances in the industrial environment. It is currently believed that workers can tolerate exposure below the TLV day after day at 8 hours per day for a working life without adverse health effects. The TLV's for fumes and dusts are in mg per cubic meter. This means the concentration of fumes and dust. A milligram is 1/1000 of a gram. This stands for the concentration of gaseous contaminant in the ambient air.

**b.** American Conference of Governmental Industrial Hygienists. Values are recommended except where local governments have adopted them as standards.

**c.** Occupational Safety and Health Administration. Values are maximums per 29 CFR 1910.1000.

**d.** May require special ventilation per 29 CFR 1910.252

**e.** ACGIH "substance suspect of carcinogenic potential for man."

**f.** Ceiling value

**g.** Non-carcinogenic chromium

**h.** Carcinogenic

**i.** Alkyis

**j.** Except alkyis

## Welding and Workers' Health

HAZARD CHART						
Material	Threshold limit values (TLVs) <sup>a</sup>				Potential hazard to worker	Source
	Time weighted average over 8 hours		Short-term exposure limit 15 min average			
	ACGIH <sup>b</sup>	OSHA <sup>b</sup>	ACGIH <sup>b</sup>	OSHA <sup>b</sup>		
Alundum (Al <sub>2</sub> O <sub>3</sub> )	10	-	-	-	None: Nuisance Dust	Base and filler metals, coatings on steels
Arsenic (As)	0.2	0.5	-	-	Sore Throat; infection of eyeball, eyelid, perforated wall between right and left nasal passage	Copper alloys
Berytium (Be) d,e	0.002	0.002	-	0.005	Inflammation of skin; lung disease; inflammation of air passages	Base and filler metals
Cadmium oxide (CdO) <sup>d</sup>	0.05 <sup>i</sup>	0.1	0.2	0.3	Urinary disorders; excess fluid in lungs; lung distention	Plating on steels
Chromium(Cr)	0.5 <sup>g</sup>	1.0	-	-	Respiratory irritation	Stainless steels; plating, electrode coatings
	0.05 <sup>h</sup>	-	-	-	Respiratory cancer	
Cobalt (Co)	0.1	0.1	0.1	-	Respiratory disease	Steels
Copper fume (Cu)	0.2	0.1	-	-	Irritation; metal fume fever	Wire coating; nonferrous alloys; air carbon-arc-gouging electrodes.
Flourides (as F) d	2.5	2.5	-	-	Bone degradation; irritant effects	Fluxes; coatings and flux cores of electrodes
Florine (F) <sup>d</sup>	1	0.2	2	-		
Iron fumes (FE203)	5	10	-	-	None; nuisance dust	Iron or steel base materials; electrode coatings
Lead, inorganic (Pb) <sup>d</sup>	0.15	0.2	0.45	-	Systemic poisoning; nerve damage	Electrode coatings; paints
Magnesium oxide (MgO)	10	15	-	-	None: minor dust hazard	Electrode coatings; fumes
Manganese fume (Mn)	1	-	-	5	Nervous system poisoning	Steels: welding rods

Mercury (Hg) <sup>d</sup>	0.01 <sup>i</sup>	0.04 <sup>i</sup>	0.03 <sup>i</sup>	-	Nervous system disease	Paints; coatings
	0.05 <sup>i</sup>	-	0.15 <sup>i</sup>	-	Nerve irritation; tremor, inflammation of the gums	
Molybdenum (Mo)	5 <sup>k</sup>	5 <sup>k</sup>	10 <sup>k</sup>	-	Respiratory irritation	Steels; welding rods
	10 <sup>j</sup>	15 <sup>j</sup>	20 <sup>j</sup>	-		
Nickel (Ni)	1	1	-	-	Lung and sinus cancer	Stainless and nickel-clad steel
Tin oxide (SnO <sub>2</sub> )	2	-	4	-	None: nuisance dust	Steel coatings; nonferrous alloys
Titanium dioxide (ZnO)	10	-	-	-	None: nuisance dust	Paints; electrode coatings; flux cores
Vanadium (V)	0.05	-	-	0.1	Respiratory irritation	Steels: welding rods
Zinc oxide (ZnO) <sup>d</sup>	5	5	-	-	Metal fume fever	Nonferrous alloys; galvanized or zinc-primed steels; electrode coatings
<b>Gases</b>						
Carbon dioxide (CO <sub>2</sub> )	5000	5000	15000	-	Asphyxiation: metabolic stress	Gas metal arc welding; air carbon-arc gouging; oxyfuel flames; Internal combustion engine exhaust
Carbon monoxide (CO)	50	50	400	-	Oxygen insufficiency in blood	
Hydrogen fluoride (HF)	3	3	6	-	Eyeball and eyelid irritation; respiratory irritation	Fluxes; coatings and flux cores of electrodes
Nitrogen dioxide (NO <sub>2</sub> )	3	5	5	-	Infections of breathing passages	Gas metal arc welding and flame process
Nitrogen monoxide (NO)	-	25	-	-		
Ozone (O <sub>3</sub> )	0.1	0.1	0.3	-	Excess fluid in lungs	Gas metal arc welding; air carbon-arc gouging; titanium and aluminum welding