

Welding Fume And Smoke – Hazards And Controls

There is little doubt that welding is one of the leading causes of in-plant air pollution. Welding trades, health organizations and governmental authorities are all becoming increasingly concerned with the effects of welding fume and smoke in the work place. In addition, company management is becoming increasingly conscious of the costs of absenteeism and reduced productivity resulting from illnesses caused by polluted air.

While it is difficult to generalize the specific health hazards presented by welding, several long-term studies point to increased incidence of chronic lung disease, respiratory tract cancer, and higher mortality rates for welders than for the general population. Acute illnesses, such as metal fume fever, also result from exposure to welding operations.

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

- The characteristics of the welding area (open or confined space).
- The type of welding process.
- The type of alloy consumed.
- The type of materials welded.
- The position of the welder.

While the health risks presented to workers by welding should be evaluated by a qualified professional, some preliminary steps can be taken to determine the extent of risk:

- Identify hazardous materials used in welding operations.
- Determine toxicity of materials and set maximum permissible concentrations in the breathing zone (ACGIH TLV's and OSHA PEL's).
- Evaluate welders' work practices and procedures to assist with understanding the manner in which toxic materials present health hazards.
- Assess the risk based on the above.

Once the health risks have been evaluated, the next step is to assure their control. Three basic welding fume and smoke control methods are:

- Change the welding process to reduce/change the quantity and type of welding fumes and smoke that are generated.
- Remove welding fume and smoke at the source by local exhaust ventilation.
- Isolate welders from the fume and smoke through the use of respirators and other personal protective equipment.

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To assist in the assessment of health hazards presented by welding operations, the following guide lists some of the common welding pollutants, their sources and their effects on welders' health.

Welding Hazards Guide

THRESHOLD LIMIT VALUES (TLV's)^a

Material (Fumes, Dusts)	Time-Weighted Average Over 8 Hours		Short-term Exposure Limit (15 Minute Average)		Potential Health Hazard	Source
	ACGHI ^b	OSHA ^b	ACGHI ^b	OSHA ^b		
Alundum (Al ₂ O ₃)	10	-	-	-	None - Nuisance Dust	Base and Filler Metals Coatings on Steel
Arsenic (As)	0.2	0.5	-	-	Sore Throat, Eye Infections, Perforated Wall Between Nasal Passages	Copper Alloys
Beryllium (Be) ^{d,a}	0.002	0.002	-	0.005	Skin Inflammations, Lung Diseases, Air Passage Inflammations	Base and Filler Metals
Cadmium Oxide (CdO) ^d	0.05i	0.1	0.2	0.3	Urinary Disorders, Fluid in Lungs	Platings on Steel
Chromium (Cr)	0.5 ^g 0.05 ^h	1.0 ^g -	- -	- -	Respiratory Irritation Respiratory Cancer	Stainless Steel Platings
Cobalt (Co)	0.1	0.1	0.1	-	Respiratory Disease	Steels
Copper Fume (Cu)	0.2	0.1	-	-	Irritation, Metal Fume Fever	Wire Coatings, Non-Ferrous Alloys
Fluorides (F) ^d	2.5	2.5	-	-	Bone Degradation, Irritant Effects	Fluxes, Coatings and Flux
Fluorine (F) ^d	1.0	0.2	2	-	Bone Degradation, Irritant Effects	Cores of Electrodes
Iron Fumes (Fe ₂ O ₃)	5	10	-	-	None - Nuisance Dust	Iron and Steel Base Metals
Lead (Pb) ^d	0.15	0.2	0.45	-	Systemic Poisoning, Nerve Damage	Electrode Coatings, Paints
Magnesium Oxide (MgO)	10	15	-	-	None - Minor Dust Hazard	Electrode Coatings
Manganese Fume (Mn)	1	-	-	5	Nervous System Poisoning	Steels, Welding Rod
Mercury (Hg) ^d	0.01i 0.05i	0.04i -	0.03i 0.151	- -	Nervous System Disease Nerve Irritation, Tremor, Gum Irritation	Paints, Coatings
Molybdenum (Mo)	5k 10l	5k 15l	10k 20l	- -	Respiratory Irritation	Steels, Welding Rod
Nickel (Ni)	1	1	-	-	Lung and Sinus Cancer	Stainless and Nickel-Clad Steel

Welding Hazards Guide (Cont.)

THRESHOLD LIMIT VALUES (TLV's)^a

Material (Fumes, Dusts)	Time-Weighted Average Over 8 Hours		Short-term Exposure Limit (15 Minute Average)		Potential Health Hazard	Source
	ACGIH ^b	OSHA ^b	ACGIH ^b	OSHA ^b		
Tin Oxide (SnO ₂)	2	-	4	-	None - Nuisance Dust	Steel Coatings, Non-Ferrous Alloys
Titanium Dioxide (TiO ₂)	10	-	-	-	None - Nuisance Dust	Paints, Electrode Coatings, Flux Cores
Vanadium (V)	0.05	-	-	0.1	Respiratory Irritation	Steels, Welding Rod
Zinc Oxide (ZnO) ^d	5	5	-	-	Metal Fume Fever	Non-Ferrous Alloys, Galvanized Steel, Electrode Coatings
Gases						
Carbon Dioxide (CO ₂)	5,000	5,000	15,000	-	Asphyxiation, Metabolic Stress	Gas Metal Arc Welding, Oxy-Fuel Flames, Internal Combustion Engine Exhaust
Carbon Monoxide (CO)	50	50	400	-	Oxygen Insufficiency in Blood	Gas Metal Arc Welding, Oxy-Fuel Flames, Internal Combustion Engine Exhaust
Hydrogen Fluoride (HF)	3	3	6	-	Eye Irritation, Respiratory Irritation	Fluxes, Coatings on Electrodes
Nitrogen Dioxide (NO ₂)	3	5	5	-	Breathing Passages Infections and Flame Processes	Gas Metal Arc Welding
Nitrogen Monoxide (NO)	-	25	-	-	Breathing Passages Infections and Flame Processes	Gas Metal Arc Welding
Ozone (O ₃)	0.1	0.1	0.3	-	Excess Fluid in Lungs	Gas Metal Arc Welding, Titanium & Aluminum Welding

^a TLV Threshold Limit Value. This is the recommended exposure 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. TLV's for fumes and dusts are in mg/m³ (milligrams per cubic meter), for gases in ppm (parts per million).

mg/m³ - milligram per cubic meter – This means the concentration of fumes and dust. A milligram is 1/1000 (10⁻³) of a gram. (The higher the number, the denser the concentration).

ppm - parts per million (by weight) – This stands for the concentration of a gaseous contaminant in the ambient air. (Again, the higher the number, the denser the concentration).

^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 Noncarcinogenic chromium

^h Carcinogenic chromium

ⁱ Alkylis

^j Except alkylis

^k Soluble molybdenum

^l Insoluble molybdenum

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