

# FUME MINIMISATION GUIDELINES

## Welding, Cutting, Brazing and Soldering

### GUIDELINE 3:

#### **MATERIALS**

##### **1. INTRODUCTION**

The potential hazards associated with base materials and consumables are detailed in material safety data sheets (MSDS) which are available from the supplier. This guideline gives a general indication of the effect of the material on fume hazard and may be helpful in situations where MSDS are not available for example in the case of coatings.

##### **2. TYPES OF FUME**

The materials found in fume consist of:

###### *Particulates*

- metal and metal oxides, lead from paint
- inorganic fluxes yielding halide salts

###### *Gases and liquids*

- added and photo-oxidant gases
- from coatings, paints and solvents, which can generate gases such as phosgene
- fluxes from colophony or rosin which can give rise to hydrocarbons, formaldehyde, hydrochloric acid, benzene, styrene, acetone and other chemicals
- inorganic fluxes yielding halide acids

##### **3. SOURCES OF FUME**

Materials present in fumes may come from the following sources:

- Consumable – most of the metal fume comes from the consumable
- Surface coatings or surface preparations
- Gases which are added - such as carbon dioxide, argon, helium
- Gases formed by electric arcs - such as ozone and oxides of nitrogen
- Parent metal

It is necessary to consider all these sources to determine the materials in your fume.

##### **4. EXPOSURE STANDARDS**

The ratio of substances in fume is not equal to the ratio of the input sources. Some elements, which are more volatile than iron, can appear in greater quantity in the fume.

The exposure standard for welding fume is  $5\text{mg}/\text{m}^3$ , although some individual component metals (e.g. chromium VI in stainless steel) have lower limits which should be observed. In non-ventilated laboratory tests, most welding processes result in a breathing zone concentration greater than the exposure standard. The exposure standard for ozone is 0.1 ppm and in similar non-ventilated trials, this level was commonly exceeded. The exposure standard for solder flux (pyrolised rosin as formaldehyde) is  $0.1\text{mg}/\text{m}^3$ . It is usual for this concentration to be exceeded in poorly or non-ventilated workshops.

##### **5. CONSUMABLES**

- Consumables generally contain metals and also various elements, which assist the process and protect the weld from the atmosphere.
- Brazing fluxes contain mixtures of potassium bifluorides and borates. Fluorosilicates, boron, sodium aluminium fluoride and sodium fluoride may be present in specific formulations. Aggressive soldering fluxes contain inorganic salts often with hydrochloric acid as well as fluorides and fluoroborates, orthophosphoric acid and glycerin. Less aggressive solder fluxes contain organic compounds which decompose at soldering temperatures. They may contain hydrazine monohydrobromide, lactic acid, glutamic acid, hydrochloric acid and wetting agents. Non corrosive fluxes, typically used in electronic applications, are based on rosin in water or solvent and may contain halide or organic acid activator additions. Colophony is rosin.
- Submerged arc welding gives off minimal fume, but care needs to be taken to avoid dust when handling the flux.

Remember to refer to the MSDS, which is available from your consumable supplier.

## 6. COATINGS

Metals can be coated with plastics, polyurethane, epoxy materials, paint or other metals. Common examples include primers with rust preventatives, galvanised steel and chrome plating. Particular care must be taken for cadmium coatings, which are highly toxic. If it is not possible to identify the coating, fume control must be employed.

For welding, a 20-25mm band should be removed prior to welding. For flame cutting, this band should be 50-100mm.

1. *Metallic coatings*: galvanising (zinc), sprayed coatings (aluminium, zinc and others), electroplating (chromium with copper and nickel underlays, cadmium, zinc or tin) are common.
2. *Paints*: give off a complex mixture. Lead, zinc, chromium, cadmium and other metals may arise from pigments and resins.
3. *Plastics*: give off a complex mixture. Ammonia, hydrochloric acid, carbon dioxide, cyanides can arise. These can be irritant, corrosive, asphyxiating and toxic.

## 7. SURFACE PREPARATIONS

Chlorinated hydrocarbons like trichloroethylene, perchloroethylene, trichloroethane, acetone and freons are used as degreasing agents. Do not breathe vapours of these agents.

Chlorinated hydrocarbons and freons, under certain conditions, can decompose to form phosgene, which is highly toxic. Care must be taken to dry the surface before welding.

## 8. MAJOR CLASSES OF METALS

*Mild steel may contain*

- iron, carbon, manganese, silicon, aluminium
- Occasionally nickel, chromium, molybdenum, niobium, vanadium, boron

*Stainless steels may contain*

- iron, chromium and nickel
- Occasionally molybdenum, manganese, titanium and other elements

*Aluminium may contain:*

- aluminium, silicon, iron, copper, manganese, chromium, zinc, titanium
- Occasionally gallium, vanadium and/or boron in wrought alloys
- Occasionally tin and/or lead in cast alloys

*Copper, bronze and brass alloys may contain*

- copper, zinc, nickel, aluminium, tin, lead, silicon, iron
- Occasionally manganese, tellurium, sulphur, chromium, cadmium, beryllium, silver, cobalt

The specific quantities of additions will vary with the grade of material selected. The relevant industry associations listed in the introduction to these guidelines should be contacted for further information if required.

## List of Atmospheric Contaminants, Worksafe Australia's Exposure Standards, and the medical effects.

Substance	Type		TWA		STEL mg/m <sup>3</sup>	Carcinogen Category	Medical Effects
			ppm	mg/m <sup>3</sup>			
Aluminium	Fume	Al	5				Respiratory irritant
Barium	Sol. compounds	Ba	0.5				Respiratory tract and skin irritant, benign pneumoconiosis with heavy exposure
Beryllium	& compounds	Be	0.002			2	Very toxic, damages respiratory tract, quick acting, carcinogenic
Boron oxide			10				Eye and respiratory irritant
Cadmium	& compounds	Cd	0.01			2	Very toxic, lung and kidney damage. Quick acting, may be fatal
Calcium Oxide	Fume	CaO	2				Irritant of eyes, mucous membranes and skin
Chromium	Compounds	Cr(II)&(III) Cr(VI)	0.5 0.05			1	Toxic, damages respiratory tract, corrosive to skin Carcinogenic
Cobalt	Metal dust & fume	Co	0.05				Irritant, fibrosis of the lung, sensitizer
Copper	Fume	Cu	0.2				Metal fume fever
Fluorides		F	2.5				Irritant of eyes, mucous membranes, skin and lungs
Iron Oxide	Fume	Fe <sub>2</sub> O <sub>3</sub>	5				Siderosis (no long term effects)
Lead	Fume	Pb	0.15				Affects the nervous system, digestive system, and mental capacity
Magnesium Oxide	Fume	MgO	10				Irritant, metal fume fever
Manganese	Fume	Mn	1		3		Toxic, tiredness, pneumonia, psychotic behaviour
Molybdenum	Sol. Compounds Insol. Compounds	Mo	5 10				Irritant
Nickel	Metal Sol. compounds	Ni	1 0.1				Metal fume fever, possible carcinogen
Nitrogen Dioxide		NO <sub>2</sub>	3	5.6	9.4		Irritant
Ozone		O <sub>3</sub>	0.1	0.2	Peak	Limitation	Irritant of the respiratory tract and lungs.
Phosphoric acid		H <sub>3</sub> PO <sub>4</sub>	1		3		Mild irritant of the eyes, upper respiratory tract and skin.
Potassium Hydroxide		KOH	2		Peak	Limitation	Severe irritant of eyes, mucous membrane, and skin
Selenium	Compounds	Se	0.2				Irritant of eyes, mucous membranes and skin. Central nervous system effects with chronic exposure.
Silica	Respirable dust	SiO <sub>2</sub>	2				Fever, similar to metal fume fever
Sodium Hydroxide		NaOH	2		Peak	Limitation	Severe irritant of eyes, mucous membrane, and skin
Tin	Oxide & inorganic compounds	Sn	2		Peak	Limitation	Stannosis, a rare benign pneumoconiosis
Titanium Dioxide		TiO <sub>2</sub>	10				Mild respiratory irritant
Vanadium Pentoxide	Respirable dust & fume	V <sub>2</sub> O <sub>5</sub>	0.05				May cause tremor and depression of central nervous system
Zinc Oxide	Fume	ZnO	5		10		Metal fume fever, bronchitis
General Fume			5				

**Metal fume fever** - The fumes of several metals and their oxides can give rise to metal fume fever. Fever, nausea, cough, shivering, headache, muscle ache, shortness of breath and general malaise may occur. The condition may start a few hours after the end of the working day, and last a day or so. The fever subsides spontaneously and no chronic effects result.

**Other health effects** - Certain alloying elements may result in further health complication