HSE JOINING

HEALTH, SAFETY AND ENVIRONMENT TRAINING FOR JOINING

# FUMES

## IO2 – EDUCATIONAL MATERIALS

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# Fumes

Welding fumes: complex mixture of metallic particles.

Formed when a metal is heated above its boiling point and its vapors condense into very fine, particles (solid particles).

Generally contain particles from the electrode and the material being welded.

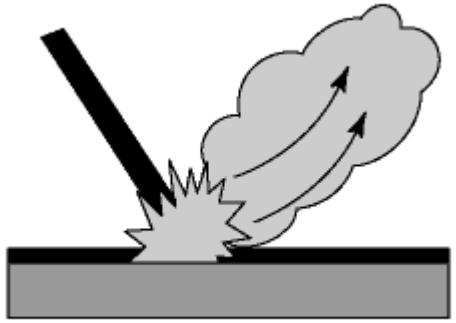

Figure 1 - Welding fumes. Source https://www.ccohs.ca/oshanswers/safety_haz/welding/fumes.html

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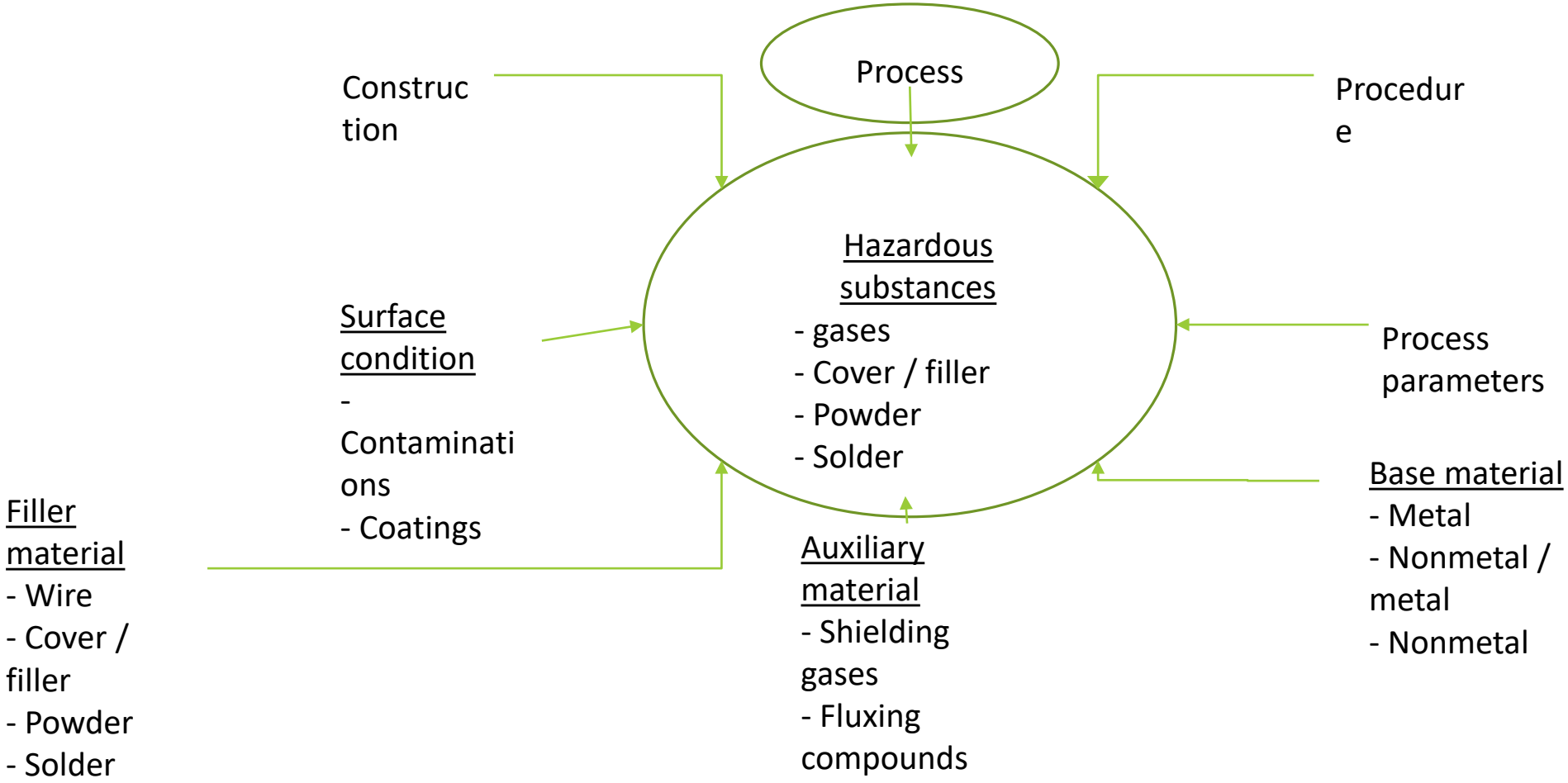
# Hazardous substances

Figure 2 – Hazardous substances. Source: Doc. IIW VIII 2085-2009, excerpt from BGI 593



# Two Types of Health Effects

- Acute: Short-Term effects on body (shortly after exposure);
- Chronic: Long-Term effects on body (repeated low level exposures);

  Symptoms develop over a period of time.

Examples:

- Drunkenness = acute effect from overindulgence in alcohol;
- Liver & brain damage = chronic effect;
- Smoking: Acute = Wheezing, Shortness of Breath;

  Chronic = Lung Cancer, Emphysema;

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# Exposure Limits

Two main types:

- PEL: Permissible Exposure Limits (exposed up to 8 hours a day, 40 hours/week, without experiencing adverse health effects);

- TLV: Threshold Limit Values. Recommended Exposure Limits. PELs take precedent over TLVs;

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# Toxic Effects

✖**Corrosive**: Liquid or solid that causes visible destruction or irreversible alterations in human tissue.

- *Examples: Acids, Flux, Caustics, Hydroxides, Ammonia*

✖**Irritant**: Inflammatory response of eye, skin or respiratory system

- *Examples: Smoke, Dusts, Almost all Chemical Vapors*

✖**Neurotoxin**: Causes neurological damage to the central nervous system,

(after long-term over exposures).

- *Examples: Solvents*

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# Classification of particulate hazardous substances in welding and allied processes according to particle size

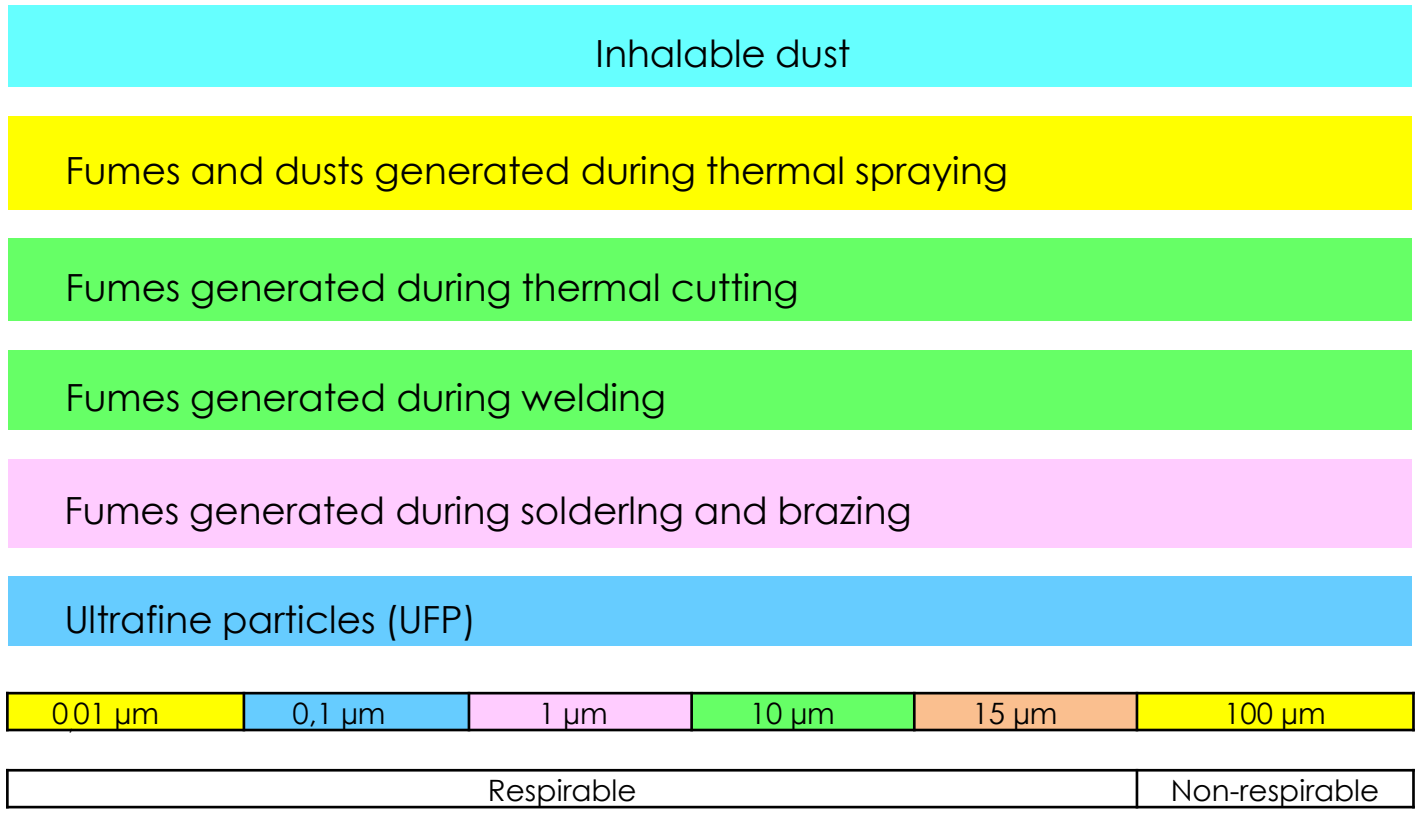


Table 1 – Fume classification acc. to particle size acc. Source: EN481

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# Ventilation

1st option.

Hazards in the confined space?

Air volume intake in a safe location?

Continuous ventilation?

Retest confined space before entry.

Figure 3 – Improper welding conditions. Source: https://www.lincolnelectric.com/en-us/support/welding-solutions/Pages/Five-potential-welding-safety-

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# Fumes

- Fume = Small solid particles
- Particles have been volatilized to their gaseous state
  - VERY small particles (90% less than 1 micron in size)

- Small particles: HIGHLY respirable (they can get deep in lungs)
- Vary considerably in toxicity
- Sources:
  - **Consumable or filler metal;**
  - Base metal;
  - **Coatings or surface treatments;**

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# Factors Affecting Fume Formation & Exposure

- Type of consumable (composition, coating/flux type);
- Amperage (current);
- Polarity;
- Wire feed rate;
- Amount of arc time;
- Welding position;
- Ventilation;

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# Metal Fumes- Chromium

Routes of exposure

- Skin contact;
- Inhalation;
- Ingestion;

Trivalent form

- Irritant;

Hexavalent form

- Cancer:
  - Evidence is primarily from chrome plating; less compelling for welding;
- Soluble forms:
  - Perforation of nasal septum;
  - Nasal irritation;
  - Nasal ulcerations;
  - Asthma;
  - Bronchitis;
  - Allergic skin reactions;
  - Skin ulcers;
  - Irritant contact dermatitis;

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# Welding and $Cr^{+6}$

Exposures can vary greatly:

- Generated during welding or cutting of stainless steel or metal structures coated with chromate paint;
- Electroplating (chrome plating);

Affected industries:

- Food processing;
- Chemical processing;
- Foundries;
- Metal fabricators;
- Contractors installing SS;
- Equipment/repair operations;
- Tank/truck manufacturers;
- Shipbuilding;
- Electric utilities;
- Maintenance work on SS equipment;
- Demolition & repair;

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# Respiratory Protection

Required when exposures exceed the PEL and:

- - Where controls not feasible (i.e. maintenance, repair activities )
- - Controls cannot get <PEL
- - The exposures take place <30 days/year
- - During emergencies.

Figure 4 –Proper use of respirators. Retrieved from https://www.allsafetyproducts.com/msa-pressure-demand-supplied-air-respirators-p-22150.html

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# Exposure Determination

If samples show < Action Level

- May discontinue monitoring

If samples show ≥ Action Level

- Periodic monitoring every six months

If samples show ≥ Permissible Exposure Level

- Periodic monitoring every three months

Additional monitoring if changing process.

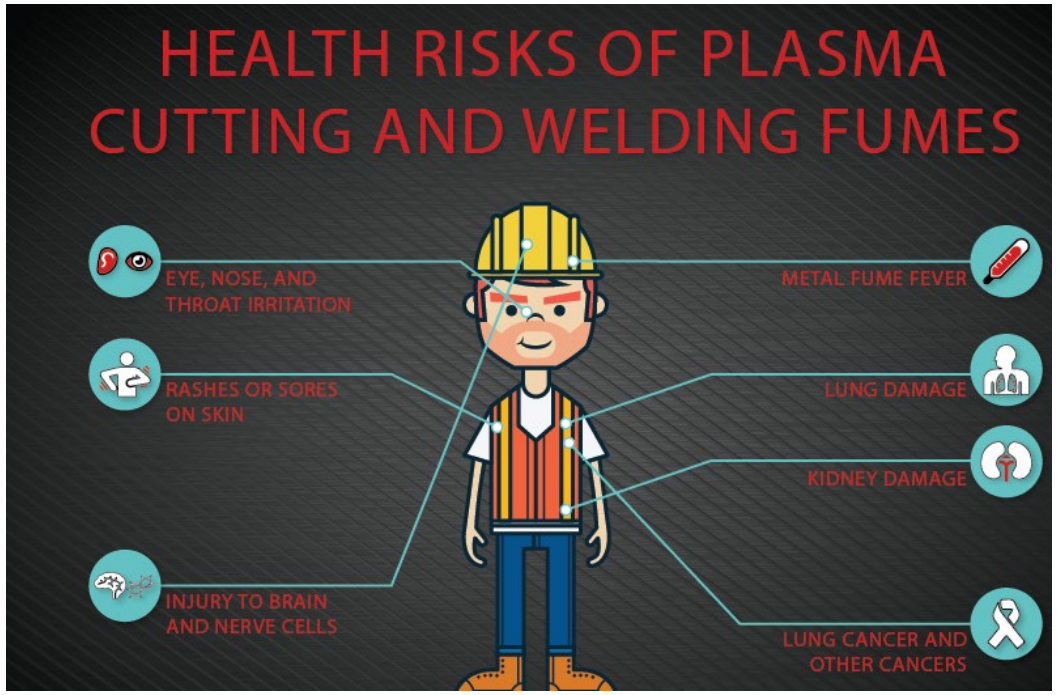


Figure 5 –Health risks of plasma cutting and welding fumes. Source: https://www.isystemsweb.com/wp-content/uploads/2016/09/Plasma-cutting-and-Welding-fume_paper-1.pdf

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# How is welding fume controlled?

When potential hazard cannot be removed/replaced/enclosed, the approach is a barrier to exposure or, local exhaust ventilation to remove the fumes and/or air contaminant from the workplace.

What else?

Change welding procedure;

- Stick to MIG or even better TIG

Use welding wires/rods designed for lower fume generation;

Change power source;

Change shielding gas;

Fume removal / extraction.

Figure 6 - Fume extraction torch. Source: https://www.westermans.com/sifgun-fume-extraction-torch.aspx

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# Fume Removal / Extraction

Low Vacuum (High Volume)

- remove large amount of air at low velocity and low vacuum pressure.
- If access to the joint prevents the use of fume guns or suction heads, low vacuum is recommended.
- If weldment smokes after welding, due to die oils or paint, fume guns will not work (they are removed after welding).

Figure 7 - Portable low vacuum Extractor.
Source:https://uedata.amazon.com/Mobiflex-100-NF-Portable-Vacuum-Single/dp/B001TG703E

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# Fume Removal / Extraction

High Vacuum (Low Volume)

- capture fume as close as possible to the arc, using integrated fume extraction guns or heads that use small diameter hose 3–5 cm, about 10 to 15cm from the welding arc.
- Fume is captured before it reaches the operators breathing zone.


Figure 8 –High vacuum base Unit. Source: https://www.lincolnelectric.com/en-us/equipment/weld-fume-control/Pages/portable-units.aspx

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| More intensive ventilation may De necessary fore.g. | Less intense ventilation may be sufficient fot e.g. |
|---|---|
| • especiolly high gos flow rotes<br>• especiolly high current intensihes<br>• ContaminaIJon of wotkpiece surfaces<br>• unfavourable spaţial condiţiona, (e.g. confined spaces. unfavourable flow conditions) | • especiolly smoli gas flow rates<br>• especiolly bw cutrent intensities<br>• favourable spaţial conditions e.g. high halls, favourable flow conditions<br>• favourable flow conditions (e.g. for roof openings and air supply in the floor areal<br>• Cootings for which o neutral expertise verified thot hozardous substances are only generated in bw quantities |

Table 2 –Criteria for selection of ventilation. Source: ISIM

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# Respiratory Protection Program

Written respiratory protection program, with worksite-specific procedures and elements for required respirator use, including:

- Procedures for selecting respirators;
- Medical evaluations of employees that use respirators;
- Testing for tight-fitting respirators;
- Procedures for proper use of respirators.

Figure 9 – Respirator. Source: https://www.cromweld.com/best-welding-respirators

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# Types of Respiratory Protective Equipment

Dust, Fume and Mist Respirators:

- Mechanical filter respirators: protection against airborne matter (dusts, mists, metal fumes and smoke);
- Mechanical filter respirators do not provide protection against gases, vapors, or oxygen deficiency;


Figure 10 – Mechanical filter respirators. Retrieved from https://www.totaltools.com.au/safety/respiratory-protection/32055-prochoice-respirator-dust-mist-mask-with-valve-12-pack-pc321

# Types of Respiratory Protective Equipment

Air Supplied Hood:

- Where user requires protection against air flow, for cooling purposes;
- Not to be used in situations where user would be endangered;

Airline Respirator:

- Full face mask supplied with breathing air by a compressor;
- Care to prevent damage to the hose and regulator while in use.

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# Identify and Evaluate Potential Hazards

Surveillance audits/measurements to be conducted periodically (check for conformity and establish a risk free environment).

Apropiate Personal Protective Equipment  to be worn and regularly checked.

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# European, National Regulations and Recommendations

- EN ISO 15011-4: Health and safety in welding and allied processes. Laboratory method for sampling fume and gases. Fume data sheets
- EN ISO 15012-1, -2 & -4: Health and safety in welding and allied processes -- Equipment for capture and separation of welding fume - Part 1: Requirements for testing and marking of separation efficiency
- EN ISO 21904-3:2018: Health and safety in welding and allied processes. Requirements, testing and marking of equipment for air filtration. Determination of the capture efficiency of on-torch welding fume extraction devices
- EN ISO 10882-1: Health and safety in welding and allied processes. Sampling of airborne particles and gases in the operator's breathing zone. Sampling of airborne particles
- EN ISO 17652-4: Welding. Test for shop primers in relation to welding and allied processes. Emission of fumes and gases.

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