



Guidance for National Labour Inspectors (NLIs) on addressing health risks from Welding Fume

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Healthy Workplaces Campaign 2018-19 - Manage dangerous substances in the workplace

HWC Summit 2019 Bilbao, Spain



EU2019.FI



Background to Guidance for National Labour Inspectors (NLIs)

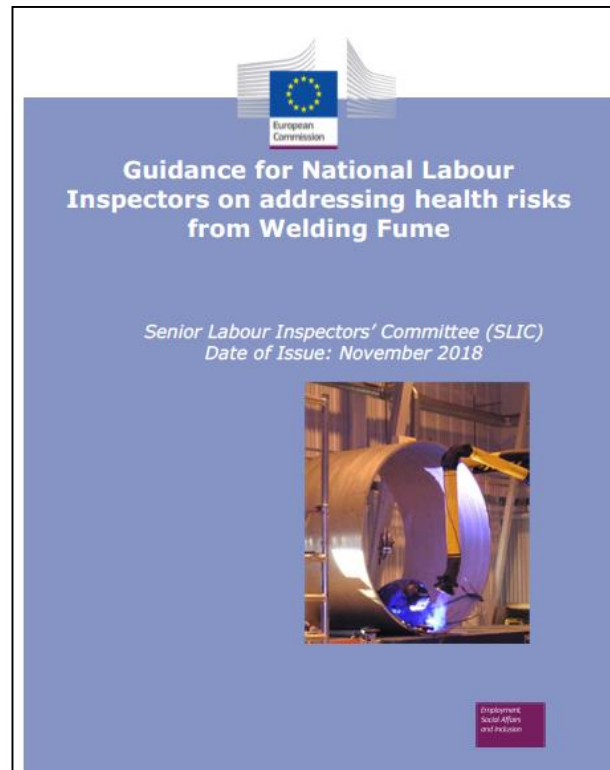


- **Senior Labour Inspectors Committee (SLIC) – CHEMEX working group chaired by Kären Clayton (HSE UK).**
- **CHEMEX Long Latency Sub Group (LLSG) established in 2014 – to redress balance between safety & health. Chaired by Dr Chris Snaith (HSE UK).**
- **LLSG members from IE, NL, BE, SE, ES and IT**
- **Priority topics identified – respirable crystalline silica (RCS), welding fume etc.**
 - Address topics that are pan-European occupational health issues, increase NLI confidence and inspection interventions via practical knowledge transfer.
- **Guidance for NLIs on RCS developed and published October 2016 – Formally launched under Dutch Presidency.**



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- Published November 2018 (CIRCA BC – EN only)
- **Similar structure to RCS guidance:**
 - **Part 1** – Background, health effects, welding, legal framework, exposure assessment & controls, health surveillance, key information for NLIs, further information sources etc.
 - **Part 2** – Welding Fume Task Sheets (9 in total) including inspector safety advice.
 - **Appendix 1** – NL Welding inspection decision tool
 - **Appendix 2** – List of LLSG member organisations



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■ Why welding fume?

- 2 Million welders in EU (EWI*) plus other workers undertaking welding (maintenance, construction, etc.), i.e. widespread across member states
- High potential for exposure to hazardous substances:
 - Various toxic/carcinogenic metals (Al, Co, Cr, Cr(VI), CU, FE, Mg, Mn, Ni etc.)
 - UV radiation generating O₃, nitric oxide (NO) and Nitrogen dioxide (NO₂). Carbon monoxide (CO) and carbon dioxide (CO₂) can also be produced
 - Exposures can be complicated by: surface coatings, contaminants and degreasing agents
- Range of general hazards – electric shock, confined spaces, noise, arc eye and other eye injuries, musculoskeletal, etc.

*EWI: European welders Institute



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Health effects from exposure to welding fume

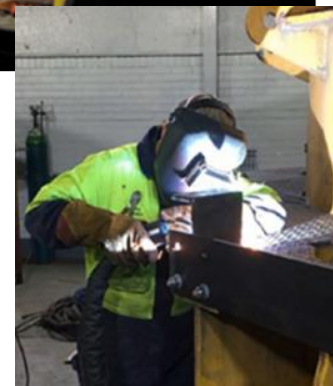
- **Primarily the respiratory system**
- **Acute & long term (chronic) effects**
 - Acute – upper respiratory tract irritancy; irritant induced asthma; temporary lung function reduction; metal fume fever; acute pneumonia, CO effects, asphyxiation
 - Chronic – COPD, Welders Lung, Occupational Asthma and Lung Cancer
 - Other health effects – Neurological (Mn), Ototoxic effects (Noise/MN), Reprotoxic effects (Mn), Depression and sexual dysfunction
 - Skin effects – contact with consumables e.g. contact dermatitis from Ni/Cr.
- **NLIs urged to address exposure to welding fume due to the profound health effects caused.**



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Welding Methods

- **Various common methods explained in Part 1**
 - Metal inert gas (MIG)
 - Tungsten Inert gas (TIG)
 - Flux – cored arc welding (FCAW)
 - Shielded metal arc welding (SMAW)
- **Also explain to NLIs other operations that can produce similar fumes**
 - Plasma cutting
 - Lazer cutting
 - Flame cutting
 - Arc-air gouging



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Legal Framework outlined for NLIs

- Framework Directive
- Council Directive 98/24/EC (Chemicals Agents Directive e.g. Ni, Mn)
- Council Directive EU 2004/34 (Carcinogens & Mutagens Directive) e.g. Cr(VI)
- Occupational Exposure Limit Values
- Hierarchy of Control emphasised, particularly elimination and substitution of hazards – See Table 3 of guidance

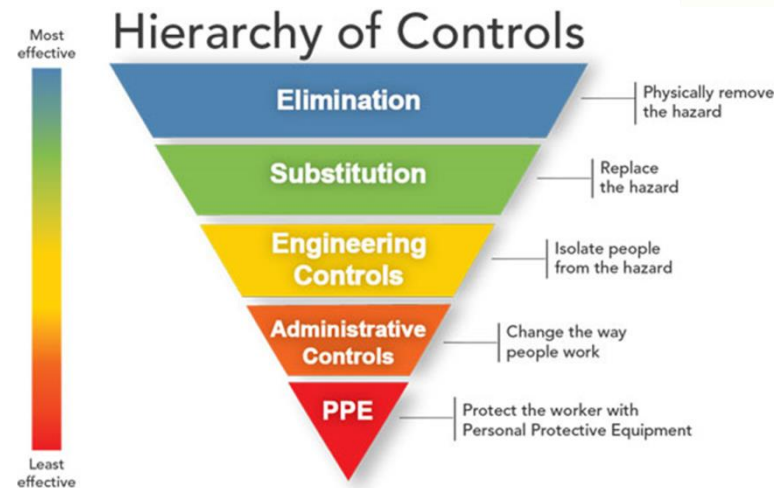


Table 3: Practical considerations for inspectors when assessing implementation of the Hierarchy of Control

← Decreasing effectiveness	Control	Method	Comments
	Elimination	Is process required? ✓ Cold cut, e.g. guillotine ✓ Redesign of the job so there is less need to weld	<i>No fume</i> <i>Less fume, due to use of pre-cast components or extruded shapes</i>
	Substitution	Can a cleaner process be used? ✓ MMA to MIG/MAG; MIG to TIG ✓ Flame cut to plasma cut to laser cut	<i>Less fume, reduced post-weld grinding</i> <i>Less fume, easier to control, better quality cut</i>
		Can different consumable be used? ✓ Cleaner rods/wires	<i>Less fume</i>
	Process change	Can it be automated? ✓ Robotic Welding, CNC cutting	<i>Usually enclosed and distant from worker, lower exposure</i>
		Can the workpiece be better positioned? ✓ Use of jigs rigs, etc. may require better planning	<i>Worker not in fume plume</i>
		Is the workpiece clean? ✓ Remove grease, flash rust, debris or surface coatings prior to welding	<i>Fume only from weld, not other sources</i>
		Can the process be enclosed? -	<i>Associated with automation</i>
	Ventilation	Can fume be extracted at source (LEV)? ✓ On-gun extraction ✓ Extracted benches – rear slots ✓ Flexible or hinged arm	<i>Only applicable to MIG/MAG, requires training of workers to proper use, very effective</i> <i>Very effective for smaller components</i> <i>Requires maintenance and testing effectiveness</i> <i>Requires worker to reposition with weld</i> <i>Flexible ducting & capture hoods are prone to damage</i> <i>Capture hood design need to be appropriate for weld</i> <i>Requires maintenance and testing effectiveness</i> <i>As above</i>
		Can fume be extracted by general ventilation? ✓ Wall or roof fans	<i>Not recommended as effectiveness is low and does not remove fume from workers at source. Can result in accumulation in some areas</i>
	Administrative control & work practices	Can number of exposed workers be reduced? ✓ Use dedicated area for welding with restricted access	<i>Isolates nearby workers from the welding plume</i>
		What information, instruction & training is required? ✓ in addition to technical training for the equipment used, workers must receive Health & Safety training	<i>Correct use of equipment to minimise fume production & exposure</i> <i>Training in the use and maintenance of LEV and RPE</i>
	Respiratory Protective Equipment (RPE)	Is this appropriate exposure control? ✓ If other engineering controls are not adequate	<i>Must be appropriate to fume hazards and wearer (fit properly)</i> <i>Workers with facial hair must use positive pressure RPE (e.g. battery powered respirator with welding visor or helmet)</i>

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Part 2 –Welding fume task sheets

Inspector safety addressed

- Welding flash (arc eye), burns from hot metals & sparks, noise, etc.

Each task sheet (2-9) has six sections & good/poor practice photo examples:

1. General comments
2. Recommended controls
3. Possible actions by NLI
4. Designing out risks
5. Maintenance of control equipment and RPE
6. Other benefits

Task Sheet 1 addresses welding general hazards

- Electric shock, confined spaces, noise, MSDs, etc.

TS1 Gas tungsten arc welding (GTAW) – also known as Tungsten Inert Gas (TIG) Page 1 of 2

General comment	GTAW/TIG welding generates very little visible particulate fume, but does produce ozone & oxides of nitrogen [nitrogen monoxide (NO) and nitrogen dioxide (NO ₂)]. These gases can be irritating to the upper respiratory tract (URT) and worsen any pre-existing bronchial conditions. Ozone production is greater when welding stainless steel and aluminium. The fume composition is directly related to the used metal and the surface material. With metals containing chromium & nickel, the health hazard is greater due to asthma- and cancer-causing components of the particulate fume. Any visible fume is most likely to arise from surface contamination of the metal.
Recommended controls for welding fume	<ul style="list-style-type: none">• Local exhaust ventilation (LEV) or respiratory protective equipment (RPE) is not normally required. General Ventilation for indoor work. However, LEV or RPE is normally required when, for example:• There is a significant amount of visible fume or the task is carried out in a poorly ventilated area; Or welding galvanised materials.
Possible Actions by National Labour Inspector	Medium Health Risk - Consider action in situations when undertaken in an enclosed working area or materials with a surface coating, including galvanised metal. Low Health Risk - No action required where all controls are present and effective.
Design Out Risks	<ul style="list-style-type: none">• Automation or remote control will increase distance of worker from weld arc• Using a lower electrical current during welding reduces ozone production.• Use of the correct set-up & operating parameters of welding equipment also minimise fume production.• Ensure metal components are free from surface coatings or contamination.• If de-greasing agents are used then use alternatives to chlorinated degreasing solvents which can react to produce phosgene gas• Shield the welding arc to minimise the available air which can react to produce ozone.• If necessary, provide training of operators on control measures to ensure they understand their contribution and limitations and how to use them effectively.
Maintenance of control equipment & respiratory protective equipment (RPE)	If LEV and/or RPE is used: <ul style="list-style-type: none">• Make sure the extraction flow rate is right for the work• Carry out thorough examination and testing on extraction system as required• Inspect and maintain re-usable RPE, use disposable RPE just once• Workers should be trained in the correct operation of the equipment and use of RPE
Other benefits	



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■ Appendix 1 – NLI Welding Inspector Decision Tool

- Not an exposure assessment but assists NLIs judgement of workplace.
- Semi – quantitative tool - gives an indication of level of enforcement that may be required.
- Four key factors addressed
 - a) Fume composition
 - b) Fume concentration
 - c) Exposure Time
 - d) Location or working environment and
- (e) Control factors

Factors **a+b+c+d** multiplied by **e**

Low = <7 , Medium = 8-20; High>20

Guides level of enforcement

Factors

1. Fume composition (a)

The composition is determined by the base metal & compatible consumable [wire or rod], together with a number of potential contaminants & coatings. These can be assigned a rating or numerical value, based on the likely health effects.

Process/activity	Source	Hazardous substance(s)	Rating
GMAW/MIG/MAG	Shield gases + uV	Ar; He; Ar/CO ₂ ; Ozone	0.5
GMAW/MIG/MAG/SMAW/MMA	Mild steel	Fe; Mn	1
GMAW/MIG/MAG/SMAW/MMA	Stainless/chromium steel	Fe; Mn; Cr(VI); Cr(III); Ni	2
All welding	Surface debris, e.g. oil, grease	CO; CO ₂ ; aldehydes	1
All welding	Degreasing residues	HCl; phosgene; chlorinated hydrocarbons	1
SMAW/MMA	Anti-corrosion primers	Fe; Zn; (Cr)	1(2)
SMAW/MMA (repair/refurbishment)	Historic coatings	Pb; Cr;	2
FCAW	Flux	CO; NH ₄ ; Aldehydes	1

The rating is the sum of the values applicable, e.g. MIG on stainless with surface debris – 1 [ozone] + 2 [Cr(VI)/Ni] + 1 (surface debris) = 4

2. Fume Concentration (b)

In the absence of exposure monitoring data, it may be necessary to estimate the fume concentration from a visual appraisal. The following is a rough guide to select a 'Rating' for the Inspection Tool.

No persistent fume during welding	0
Light visible fume, slow dispersal, no evident accumulation	1
Visible fume, not dispersing, accumulation in some areas	2
Accumulation resulting in diminished visibility	X

Factors a & b tables from Appendix 1

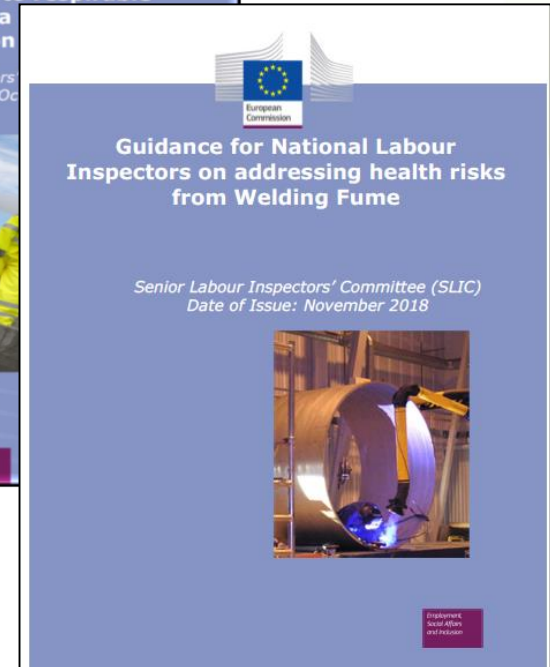
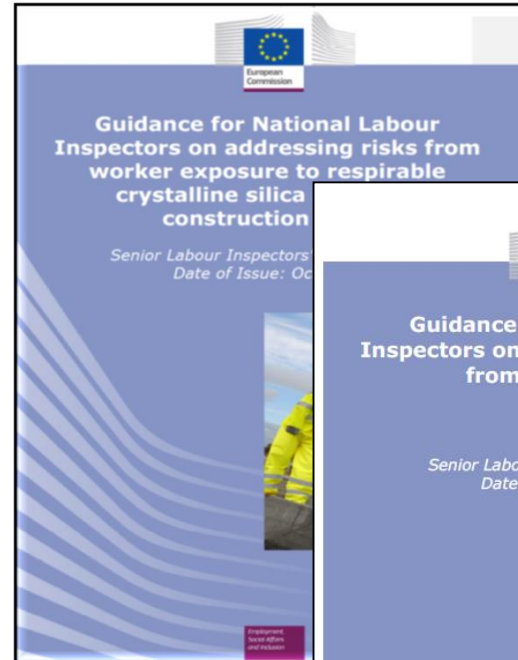
Example – Use of Welding Inspector Decision Tool – MIG welding on mild steel with no extraction

- **A) Fume composition** – Mild steel (Fe/Mn) - **1**
- **B) Fume concentration** - Visible fume, not dispersing – **2**
- **C) Exposure time (et)** – Full time manual welders (10-25% et) - **2**
- **D) Location or working environment** – Smaller workshop - **2**
- **E) Control factors** – No LEV – **3**
- **Result** – $a+b+c+d \times e = 21$ (**HIGH**)
- **Inspector Action (HIGH)** – **Consider immediate action when all controls missing/effective – stop work, use of notices, fines etc.**



Final Thoughts!

- CHEMEX remit is to support the SLIC in promoting consistency in the application and enforcement of the secondary EU law on health and safety of chemicals at work.
- Guidance produced by CHEMEX is for non-specialist NLIs but is made publicly available so that employers can understand what they need to do to protect their employees and comply with the law.
- CHEMEX evaluates published guidance using feedback questionnaires via the SLIC Knowledge Sharing Site (KSS).
- CHEMEX are currently working on new NLI guidance based around the Hierarchy of Control.



Thank You!