Weld Fume Control Methodology
An Approach to Proper Weld Fume Control Solutions
Agenda

• Exposure assessment
• Why fume extraction
• Where does welding fume come from
• How do you control welding fume
  • Substitution
  • Isolation
  • Ventilation
• Safe Work Practices
• Questions
Exposure Assessment
Industrial Hygiene Exposure Assessment

• How do I know if I meet performance-based requirements?

  Ultimately, the only way is to have a qualified individual conduct personal exposure monitoring.
OSHA compliance strategy for performance based standards

- Determine if hazard may be present
- Measure exposure.
- Evaluate controls options… if needed. (engineering/ work practices preferred)
- Implement usable and feasible solutions (“practicable”)
- Determine potential exposure via skin and ingestion. (Qualitative assessment)
- Worker communications and training (required)
- Recordkeeping (evidence of compliance)
Exposure Assessment
Qualitative

Information gathering

- MSDS
- Observation of workplace & process
- Determination of SEGs (Similar Exposure Groups)
- Review of engineering controls
- Work practice controls
- Input from employees
- Past sampling data
- Acceptable (insignificant), significant, unacceptable, uncertain
Qualitative Exposure Assessments

• Compare estimated or anticipated exposure to OEL
• Early identification (prior to initial exposure) of health risks in newly planned facilities, equipment and hazardous materials
• Reassessments
Qualitative Exposure Assessment Process

- Qualitative Exposure Assessment
  - Unacceptable
    - Implement Controls
  - Unknown
  - Significant
    - Quantitative Assessment
  - Insignificant
    - No Action
Qualitative Exposure Assessment

Relevant Information

1. SEG: Department, Job, Task, Environmental Agent
2. Job: Who and number of employees
3. Environmental Agent
4. Duration of exposure: Incidental, short-term, partial-shift, full-shift
5. Frequency of exposure: Incidental, rare, infrequent, frequent, days/year
6. Peak exposure: Number/day
7. Exposure level estimate: % OEL
8. Exposure variability: Erratic, large variation, small variation, consistent
9. Exposure Control
10. Decision: Unacceptable, Significant, Insignificant, Unknown
MSDS Comments

• ANSI Z400.1 – 16
  Section Standardized Format

• Global Harmonization Standard (GHS) – nearly identical
Qualitative Exposure Assessment –
Common Welding Material Exposures

**Stainless Steel**: Iron, Chromium, Chromium VI, Nickel, Copper, Manganese, Vanadium, CO/UV

**Mild Steel**: Iron, Manganese, (trace) Chromium, (trace) Chromium VI, fluorides, CO/UV

**Aluminum**: Aluminum, Chromium, (trace) Chromium VI, Nickel, Copper, Manganese, Ozone, Zinc, (UV)

**SAW Flux**: Fluorides, Crystalline Silica (handling)

**Galvanized**: Zinc

**Note**: Fume particles are predominantly complex metallic oxides
Qualitative Exposure Assessment – Welding Processes

- Percent fume produced by different welding processes (as % of pounds of consumable used)

  Submerged Arc (SAW) 0.02 – 0.1%
  MIG Wire (GMAW) 0.3 – 0.8%
  Cored Wire (FCAW-GS) 0.8 – 1.5%
  Stick (SMAW) 1.0 – 2.5%
  Cored Wire (FCAW-SS) 1.3 – 4.0%

- Estimates indicate SMAW and GMAW on mild steel, stainless steel, and aluminum are performed by 70% of welders
• **Objective:** differentiate “acceptable” from “unacceptable”.

• If exposure occurs 12 or more days per year, establish minimum baseline data.

• Personal monitoring; random sampling strategy
Exposure Assessments
Quantitative

- Sampling strategy of Similar Exposure Groups (SEGs)
- Personal samples vs. area samples
  - Personal samples collected in the employee’s breathing or hearing zone
- Air samples are usually analyzed by an AIHA accredited independent lab –
Exposure Assessments
Quantitative
Criteria for a Minimum Baseline

FOR A GIVEN HOMOGENOUS EXPOSURE GROUP:

BEGIN: QUALITATIVE ASSESSMENT INDICATES EXPOSURES CAN EXCEED 30% OEL OR 82 dBA

COLLECT FIVE (5) OR MORE RANDOM SAMPLES (n)

ARE TWO (2) OR MORE SAMPLES >0EL AND REMAINING SAMPLES > 50% OEL OR 82 dBA?

ARE ALL SAMPLES >50% OEL OR 82 dBA?

Yes

MINIMUM BASELINE

COLLECT 8 - n ADDITIONAL SAMPLES

No

Yes

No
Industrial Hygiene Assessment of Welding Operations

- Industrial hygiene assessments are key to understanding employee exposures and applicable regulatory requirements.

- Basic industrial hygiene principles should be understood by management.

- Industrial hygiene is a broad technical field and assessments should be conducted by an experienced IH professional.

- Assessments should include both qualitative and quantitative analyses - and be thoroughly documented.
Industrial Hygiene Assessment of Welding Operations

- **Exposures assessed** to be potentially significant must be quantified.

- Results of quantitative sampling should satisfy statistical validation to qualify employee exposure.

- **Overexposures should be addressed** according to the Hierarchy of Control.

- Welders and other employees should be **involved** in the process.

- Provide ample **communication and training**.
Where Can I Find a Certified Industrial Hygienist?

http://www.abih.org/
http://www.abih.org/members/roster/rostersearch.cfm

http://www.aiha.org/Content
http://www.aiha.org/Content/AccessInfo/consult/consultantsearch.htm
Where Can I Find a Certified Industrial Hygienist?

Weld Fume Control Solutions

EXTRACTION AND FILTRATION OF WELDING FUME

Arc welding is a safe occupation when sufficient measures are taken to protect the welder from potential hazards. The operation of welding fume control equipment is affected by various factors including proper use and positioning of the equipment, maintenance of the equipment, and the specific welding procedure and application. Worker exposure level should be checked upon installation and periodically thereafter to be certain it is within applicable OSHA PEL and ACGIH TLV limits.

Lincoln Electric offers a complete line of portable, stationary, and engineered solutions for welding fume control. Our team of safety specialists can assist with your questions and concerns, and provide you with a full compliment of weld fume extraction solutions.
Why Fume Extraction?
Why fume extraction?

- Enhance Employer-Employee Relations
- Provide a Cleaner More Professional Work Environment
- Improve the Business’ Image in Marketplace
- Meet Guidelines & Regulations
- Reduce Energy Costs
Why fume extraction?

Enhance Employee-Employer Relations

• Center to Protect Workers’ Rights (CPWR)
• American Industrial Hygiene Association (AIHA)
Why fume extraction?

Providing a Cleaner Work Environment

– Progressive regions of the U.S. have led the way
  • California – Cal/OSHA sets own limits for welding fume components
  • Illinois – Chicagoland area has embraced environmental concerns and resultant action

– Organized labor is concerned about a clean work environment
  • Boilermakers, Ironworkers, Plumbers and Pipefitters, etc.
Where does welding fume come from?
Welding fume potentially consists of three ingredients:

1. Welding consumables (90-95% of fume)
2. Base metals
3. Coatings present on base material
Welding Fume
Where Does It Come From?

- Welding Fume exposure is determined by numerous factors:
  
  1. Base metal being welded
  2. Process, procedure and electrodes used
  3. Coatings on the metal being welded
  4. Number of welding arcs and volume of work area
  5. Quantity and amount of ventilation
  6. Position of the welders head with respect to the fume plume
  7. Presence of contaminants in the atmosphere

(adapted from Ashby 55)
How Do You Control Welding Fume?
Weld Fume Control Methodology

Source Extraction

Local Extraction

General Extraction & Circulation

Isolation

Ventilation

Substitution

Welding Fundamentals
Process/application

Safe Work Practice Controls

Personal Protection Equipment

Regulatory Assessment & Exposure Determination

Personal Protection Equipment
Welding Fume
How Do You Control It?

• Exposure Assessment & Determination Testing
  – Industrial Hygiene Quantitative and Qualitative Exposure Assessments
    • TLV & PEL Values
    • Information gathering
  – Testing and Analysis
    • EPA Method 9
    • EPA Method 22
Substitution
Is it feasible and practical to substitute a welding process, consumable, gas, procedure or equipment technology that generates less fume?
• GMAW (MIG welding)
  – Fume generation per shielding gas (g/min, 0.045” ER70S-3)
  – Impact of gas selection, welding procedures & transfer mode
Substitution
Waveform Control Technology

• Unmatched control and customization leads to the development of lower fume generating weld processes
  – STT® – Surface Tension Transfer
    • Controlled heat input, spatter, and fumes
  – Power Mode™
    • Improved arc stability at low settings
      – Results are low heat input, virtually no spatter, and minimal fume generation
  – Rapid Arc™
    • High travel speeds with low spatter and relatively low fume generation at elevated parameter conditions


**STT® Major Achievements**

- Reduced spatter with 100% CO₂ shielding gas
- Developed capability to use larger diameter electrodes
- Ability to control welding current independent of wire feed speed
- Reduced fume

<table>
<thead>
<tr>
<th>Electrode &amp; Gas Combination</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fume</td>
</tr>
<tr>
<td>0.045 E70S-3 &amp; 100% CO2</td>
<td>1.49%</td>
</tr>
<tr>
<td>0.045 308LHS &amp; 90% He, 7.5% Ar, 2.5% CO2</td>
<td>0.57%</td>
</tr>
</tbody>
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Measurements per ANSI/AWS F1.2 - 1999
Isolation:

Enclosing the source of exposure, or placing a barrier between employees and the source of exposure
Isolation
Separate, Automate & Ventilate

• Is it feasible and practical to:
  – Switch from manual to automatic welding equipment and isolate the source of the fume
  – Controlled, contained local weld area or area within facility
    • Hoods with curtains or enclosures which extract residual fumes
    • Source extraction or PPE should be used if individuals are working within local, contained area
Isolation
Separate, Automate & Ventilate

Risk of Creating a Confined Space ... Precautions Necessary!
Ventilation
Ventilation Overview
Not one solution will fit all applications!
# Ventilation

## Local Ventilation Systems for Welding and Cutting Processes

<table>
<thead>
<tr>
<th>System Type</th>
<th>Typical Airflow</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Welding gun with integral fume extraction</td>
<td>30-60 cfm (50-100 m³/h)</td>
<td>Extracts fume at the weld zone through GMAW and FCAW guns</td>
</tr>
<tr>
<td>High vacuum source capture nozzle</td>
<td>90-180 cfm (150-300 m³/h)</td>
<td>Captures fume through high-velocity, low-volume extraction nozzles; usually positioned by the welder</td>
</tr>
<tr>
<td>Flexible fume extraction arm</td>
<td>560-860 cfm (900-1400 m³/h)</td>
<td>Draws higher air volume and is easily positioned and repositioned by welder</td>
</tr>
<tr>
<td>Cross-draft welding table (slotted hood)</td>
<td>90-180 cfm per ft² (900-5000 m³/h per m²)</td>
<td>Excellent for controlling fume in a fixed location serving small part welding</td>
</tr>
<tr>
<td>Fixed exhaust hood</td>
<td>1470-1760 cfm (3300-5000 m³/h)</td>
<td>Used for overhead capture in fixed locations</td>
</tr>
<tr>
<td>Push-pull hood over welding robot</td>
<td>Varies with hood height and space</td>
<td>An engineered design to reduce exhaust air volume in a large, fixed welding zone</td>
</tr>
<tr>
<td>Canopy hood</td>
<td>Varies with hood design</td>
<td>Uses larger air volumes to control an area where source capture is impractical</td>
</tr>
<tr>
<td>Downdraft cutting table</td>
<td>150 cfm per ft² (2700 m³/h per m²)</td>
<td>Used in large, fixed, flat plane operations</td>
</tr>
</tbody>
</table>

**OSHA 1910.252(c)(3)(i)**

Hoods. Freely movable hoods intended to be placed by the welder as near as practicable to the work being welded and provided with a rate of air-flow sufficient to maintain a velocity in the direction of the hood of 100 linear feet (30 m) per minute in the zone of welding when the hood is at its most remote distance from the point of welding.

Ventilation
Source Extraction

- **High Volume (Low Vacuum)**
  - HIGH volume of air extracted
    - 560 - 860 CFM
  - Operates 6-12” from weld source
  - Flexible Extraction Arms

- **Low Volume (High Vacuum)**
  - LOW volume of air extracted
    - 30 - 180 CFM
  - Operates 2”- 4” from weld source
  - Fume Guns & Extraction Nozzles
  - Small, Compact & Flexible Systems

LINCOLN ELECTRIC
WELD FUME CONTROL
Ventilation
General Extraction
General Shop Extraction

Push Pull System

**Principle:** To move, extract and dilute welding smoke, motion must be created by pushing and/or pulling welding fume blanket

Technique will depend on facility layout and design

**Note:** Source extraction or PPE such as respirator should also be used
General Extraction

Push Pull System

Advantages:
- Extract residual fumes
- Extract fumes within automated weld processes
- Create air movement within facility

Disadvantages:
- Source extraction or PPE still required if individuals are working within area
General Shop Extraction

Push Pull System
General Extraction

Push Pull System
General Extraction

Circulator™ System

• Advantages:
  – Extract & dilute residual fumes in non-linear or irregular facility layouts and facilities with obstructions to airflow
  – Create air movement within facility

• Disadvantages:
  – Source extraction or PPE still required if individuals are working within area
  – Extraction capacity not as effective as e.g. push pull
General Shop Extraction

Circulator™ System
Safe Work Practices
Operator Safe Work Practices

- Fumes and gases can be dangerous to your health – keep away from your breathing zone area.
- Use enough ventilation or exhaust at the arc, or both, to keep fumes and gases from your breathing zone and general area.
- Use safe welding practices and use ventilation/exhaust equipment properly.
- Respiratory Protection – Use respirable respirator or air supplied respirator when welding in confined spaces or general work area when local exhaust or ventilation does not keep exposure below TLV.
Safe Work Practices
Operator Technique

INCORRECT  CORRECT
Welding Safety Education

- Free Educator Training
- Cost Based Training Materials
Welding Safety Reference Documents

- Everyone working in the welding industry should be made familiar with the ANSI Z49.1 document, “Safety in Welding and Cutting”

Available at no charge from AWS Free download at www.aws.org/technical/facts
Everyone working in the welding industry is welcome to download a copy of:

- Also available in Spanish

Lincoln Electric has also created and provides free copies of the Welding Safety Interactive DVD
• AWS Safety & Health Fact Sheets (available free of charge from www.aws.org)
Welding Fume Extraction Systems

- Welding Fume Extraction systems require on-going Maintenance!

- Employers responsibility to monitor use of Engineering Controls!

- Employee training is a must and should be ongoing and repetitive!
Works Referenced

Weld Fume Control Systems
Works Referenced


Lincoln Electric
Weld Fume Control Systems

For More Information, contact the weld fume control team at:

• Phone:
  • (888) 935-3878 ext. 4

• Email:
  WeldFumeControl@lincolnelectric.com

• The Lincoln Electric Website at:
  www.LincolnWeldFumeControl.com
Users and employers have the sole responsibility for and control over workplace conditions, including the manner in which work is performed and the safety measures taken. Always read and follow applicable OSHA regulations as well as all information on product labeling and material safety datasheets (MSDS available at http://www.lincolnelectric.com/products/msds/) when using Lincoln Electric products.

The operation of welding fume control equipment is affected by various factors including proper use and positioning of such equipment, maintenance of the equipment and the specific welding procedure and application involved. Users and employers should have an industrial hygienist check worker exposure levels to be certain that they are within applicable OSHA PEL and ACGIH TLV limits.

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