



# Weld Fume Control Methodology

*An Approach to Proper  
Weld Fume Control Solutions*

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# 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



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# Performance Based Standards

## OSHA Regulatory Standards

### 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

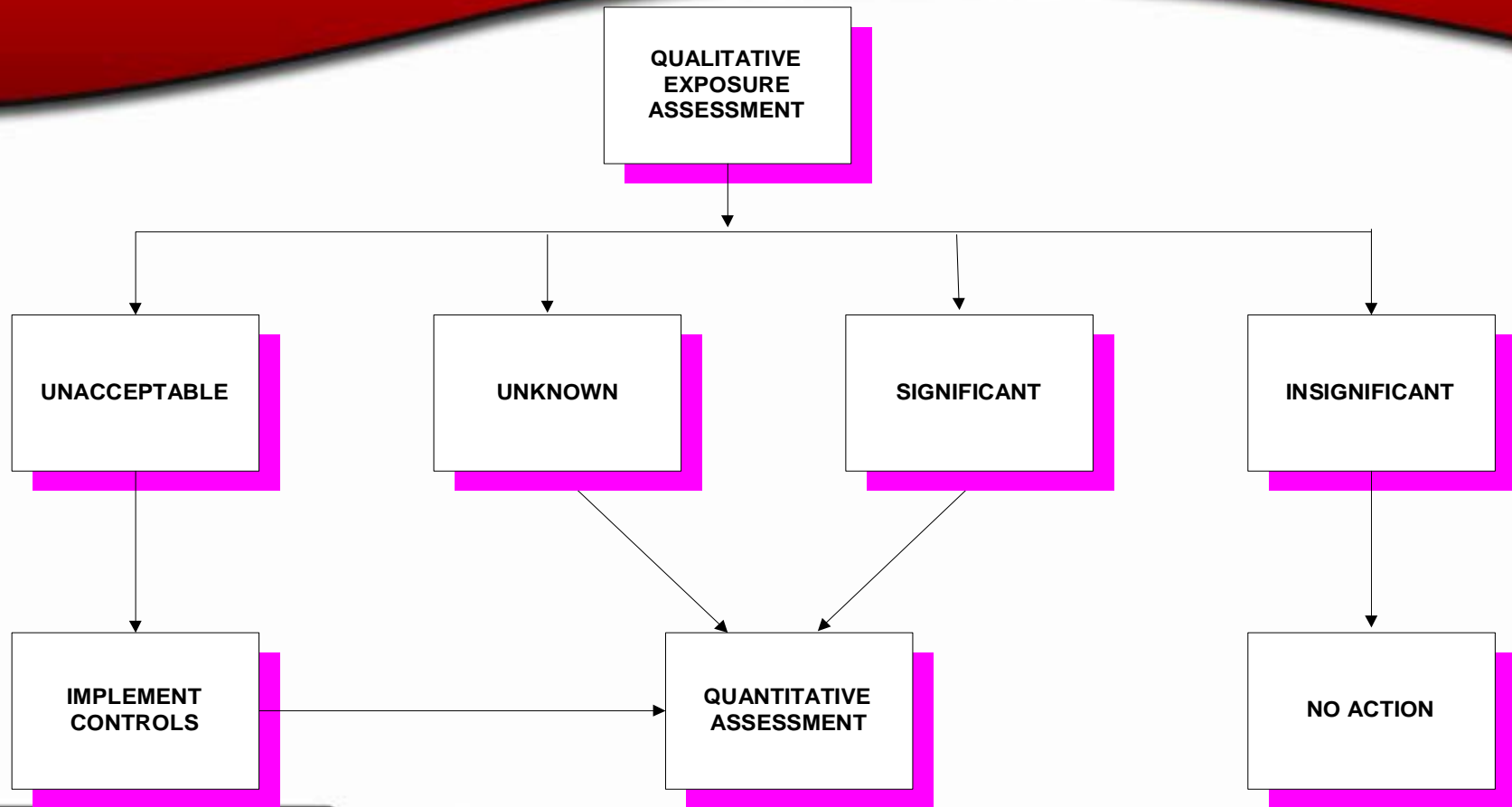
- Compare estimated or anticipated exposure to OEL
- Early identification (prior to initial exposure) of health risks in newly planned facilities, equipment and hazardous materials
- Reassessments



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# Qualitative Exposure Assessment Process





# 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

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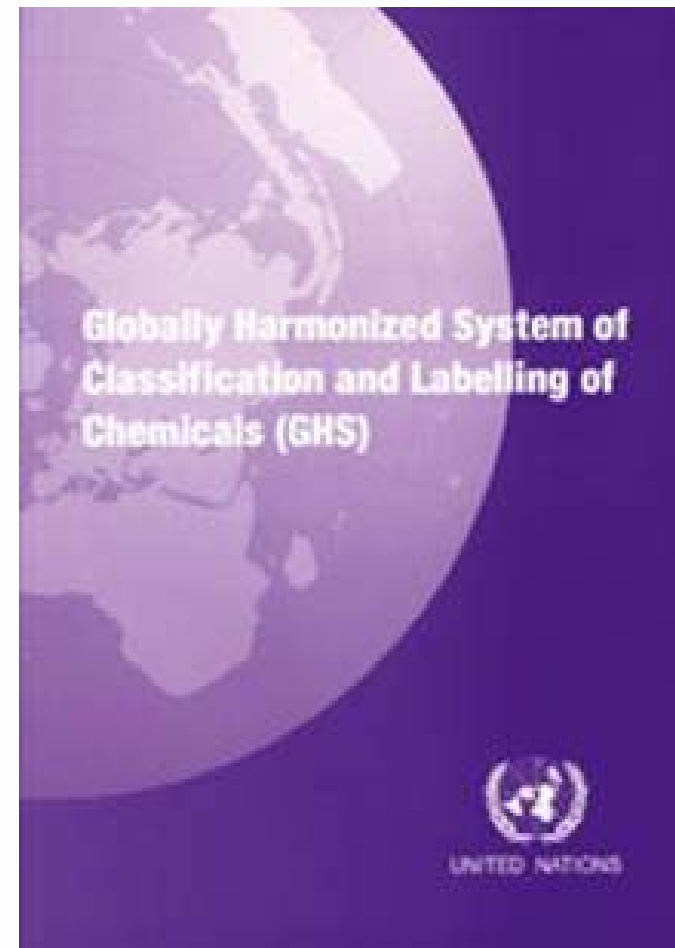
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# MSDS Comments

- ANSI Z400.1 – 16  
Section Standardized  
Format
- Global Harmonization  
Standard (GHS) – nearly  
identical

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# Qualitative Exposure Assessment – Common Welding Material Exposures

<b>Stainless Steel:</b>	Iron, Chromium, Chromium VI, Nickel, Copper, Manganese, Vanadium, CO/UV
<b>Mild Steel:</b>	Iron, Manganese, (trace) Chromium, (trace) Chromium VI, fluorides, CO/UV
<b>Aluminum:</b>	Aluminum, Chromium, (trace) Chromium VI, Nickel, Copper, Manganese, Ozone, Zinc, (UV)
<b>SAW Flux:</b>	Fluorides, Crystalline Silica (handling)
<b>Galvanized:</b>	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%
<b>MIG Wire (GMAW)</b>	<b>0.3 – 0.8%</b>
Cored Wire (FCAW-GS)	0.8 – 1.5%
<b>Stick (SMAW)</b>	<b>1.0 – 2.5%</b>
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



# Exposure Assessments

## Quantitative

- **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



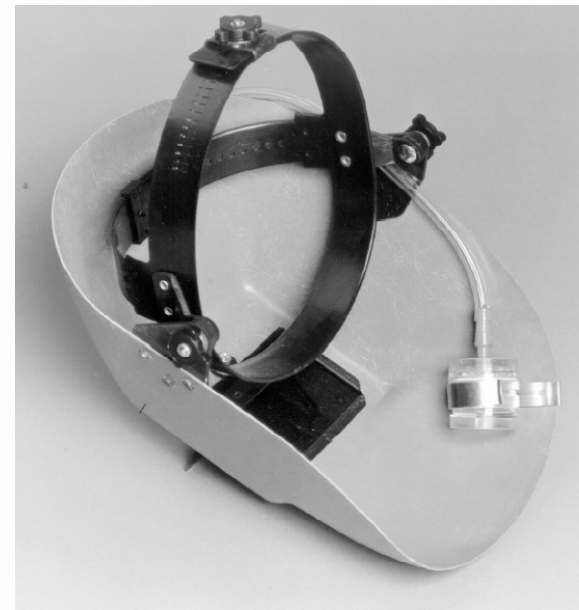
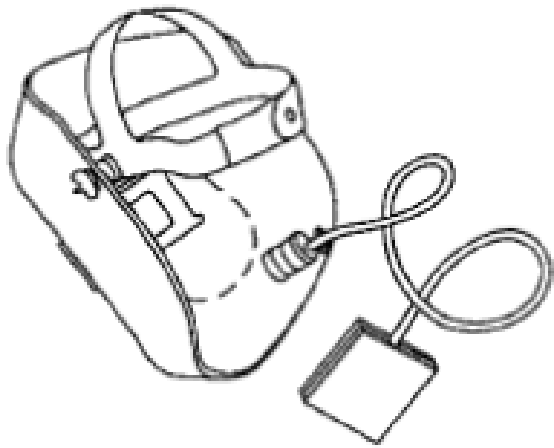
- Sampling strategy of Similar Exposure Groups (SEGs)
- Personal samples vs. area samples
  - Personal samples collected in the employee's breathing or hearing zone
- Air samples are usually analyzed by an AIHA accredited independent lab –

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# Exposure Assessments Quantitative

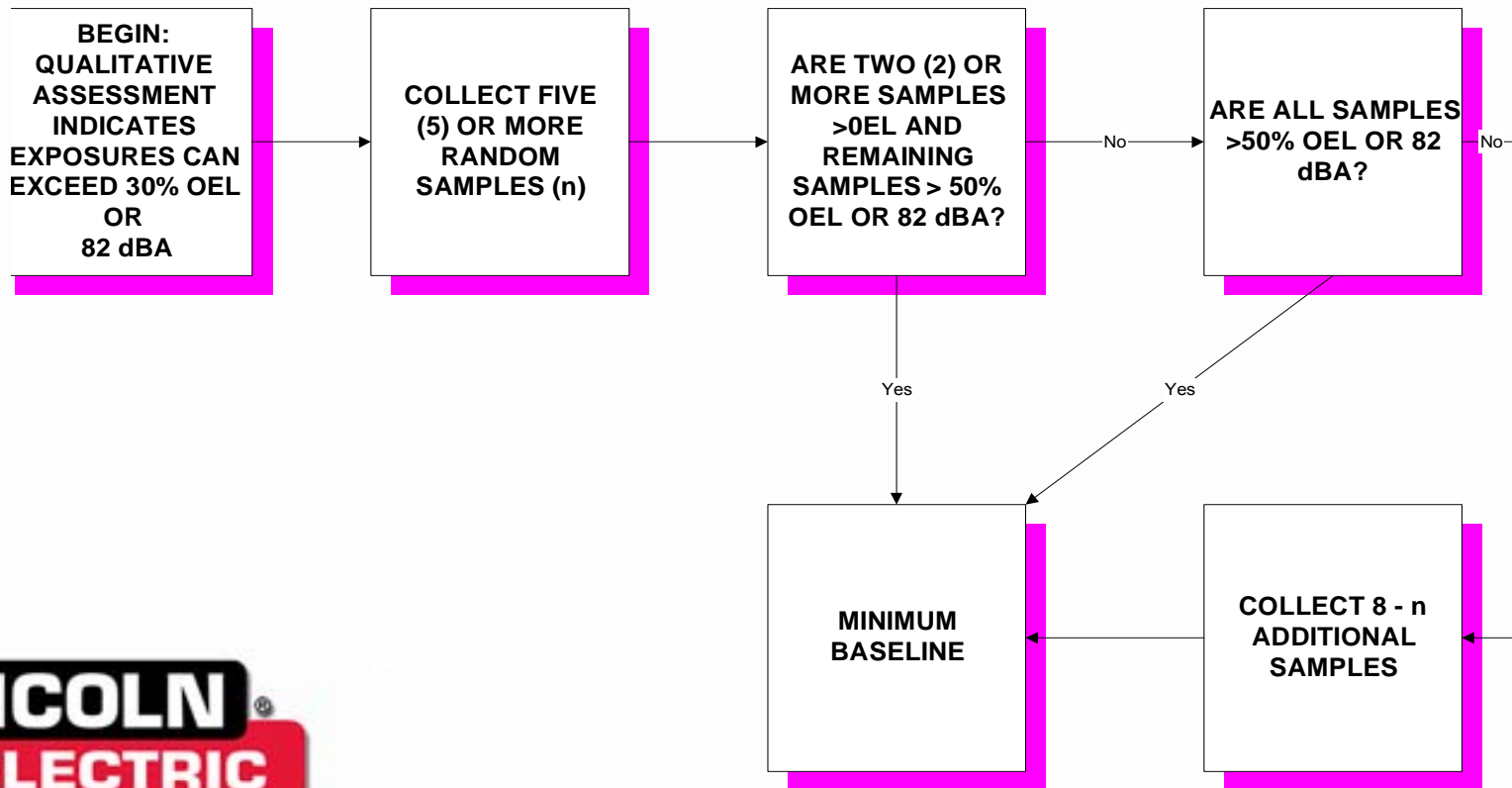


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# Criteria for a Minimum Baseline

FOR A GIVEN HOMOGENOUS EXPOSURE GROUP:





# Industrial Hygiene Assessment of Welding Operations



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- 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**

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# 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?



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[Home](#) > [Equipment](#) > [Weld Fume Control Solutions](#)

## Weld Fume Control Solutions

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▶ [Downdraft Tables](#)

▶ [Extraction Arms](#)

▶ [General Filtration](#)

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### 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.

[WELDING FUME CONTROL PRODUCTS](#)

### RELATED TOPICS

[ARC WELDING SAFETY](#) (+)

[MSDS](#) (+)

[CALCULATE ENERGY SAVINGS](#) (+)

[OSHA HEXAVALENT CHROMIUM](#) (+)

[INDUSTRIAL HYGIENIST SEARCH](#) (-)

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# Why Fume Extraction?

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# 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?

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# Welding Fume

## Where Does It 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



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# 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

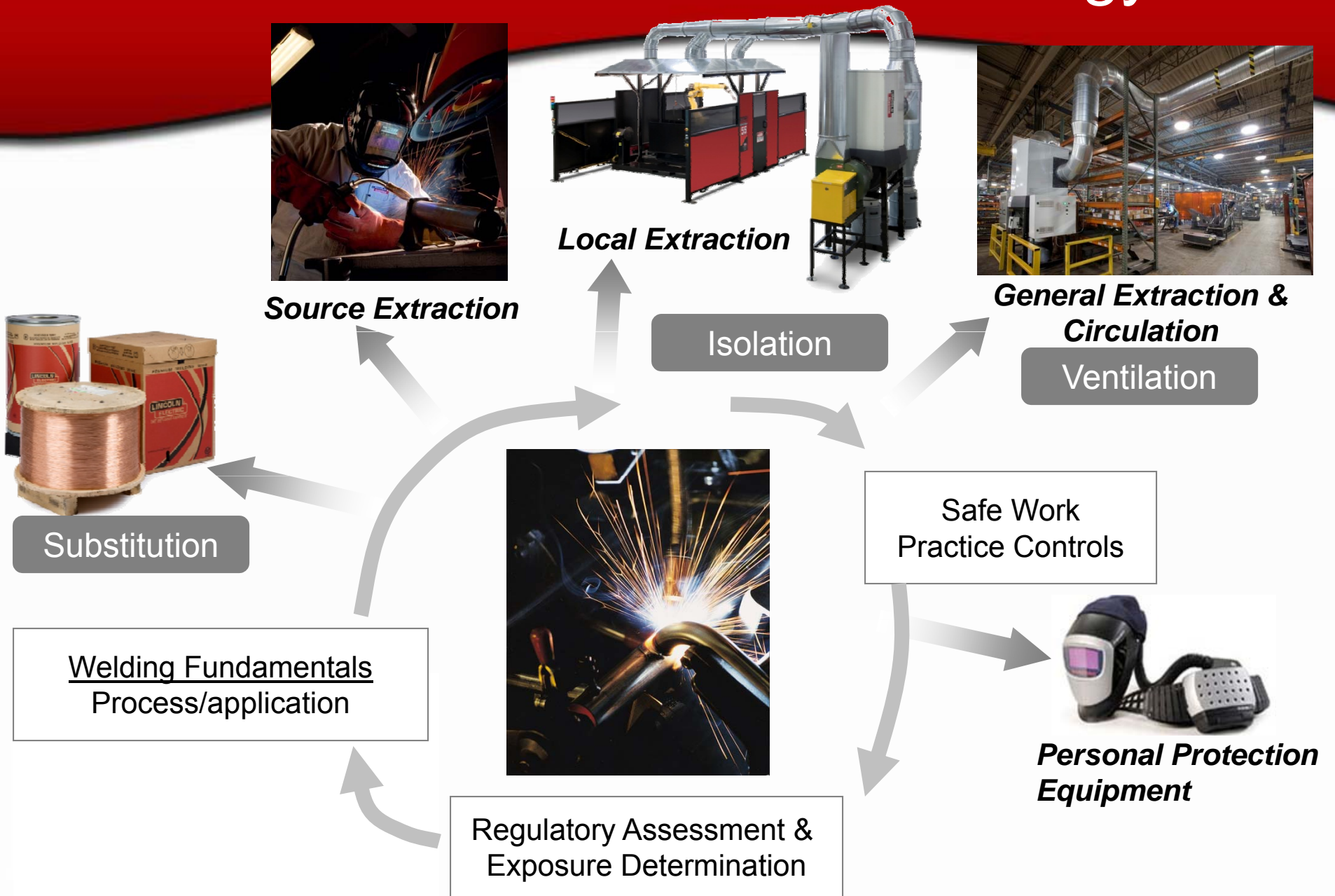
*(adapted from Ashby 55)*



# How Do You Control Welding Fume?



# Weld Fume Control Methodology



# 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



# Substitution

## Welding Processes and Consumables

- Is it feasible and practical to substitute a welding process, consumable, gas, procedure or equipment technology that generates less fume?

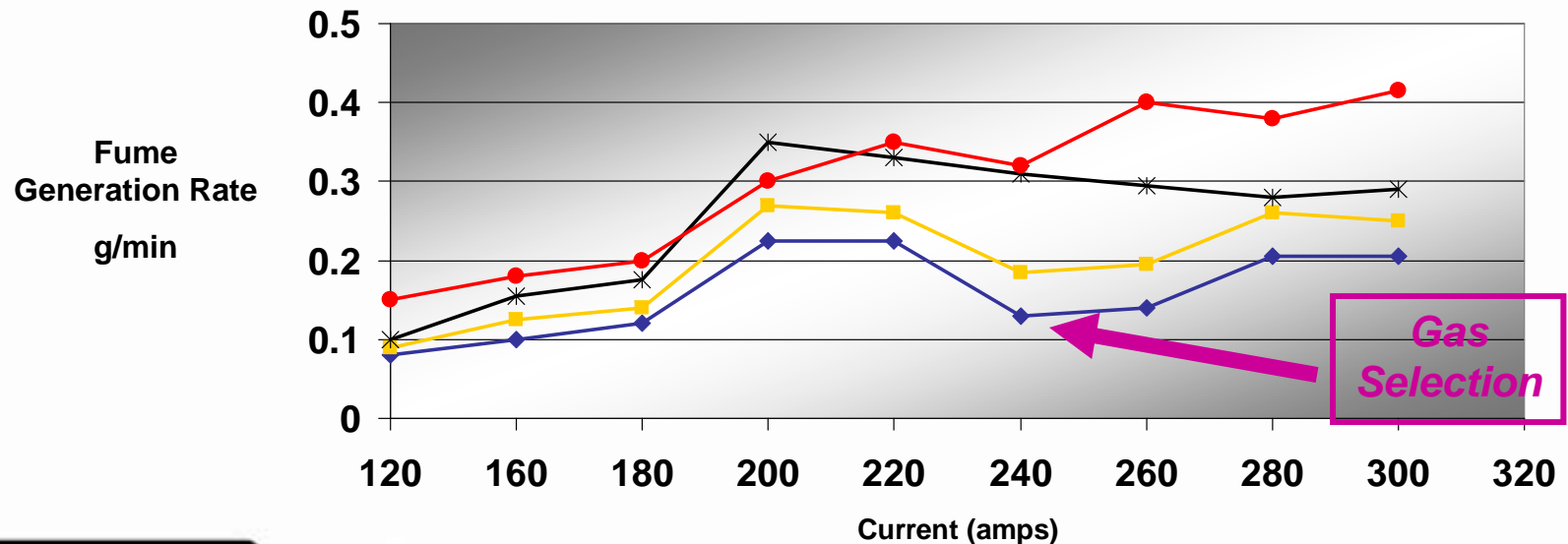




# Substitution

## Welding Procedure & Gas Selection

- GMAW (MIG welding)
  - Fume generation per shielding gas (g/min, 0.045" ER70S-3)
  - Impact of gas selection, welding procedures & transfer mode



- ◆ Ar-5CO<sub>2</sub>-2O<sub>2</sub>
- Ar-12CO<sub>2</sub>-2O<sub>2</sub>
- \* Ar-20CO<sub>2</sub>-2O<sub>2</sub>
- CO<sub>2</sub>

# Substitution

## Waveform Control Technology

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



# Substitution

## Waveform Control Technology

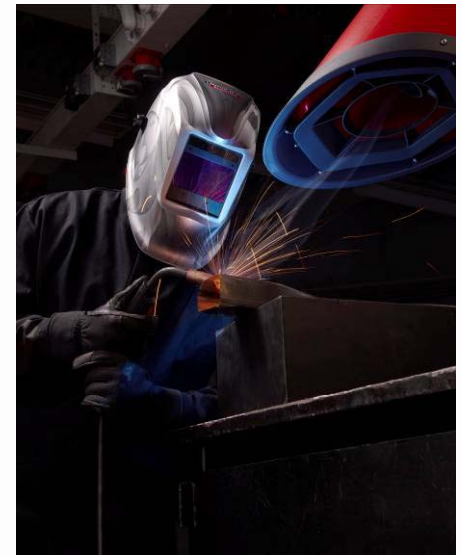
- STT<sup>®</sup> Major Achievements
  - Reduced spatter with 100% CO<sub>2</sub> shielding gas
  - Developed capability to use larger diameter electrodes
  - Ability to control welding current independent of wire feed speed
  - **Reduced fume**



Measurements per ANSI/AWS F1.2 - 1999



<b>STT PROCESS: FUME REDUCTION ANALYSIS</b>		
<i>Electrode &amp; Gas Combination</i>	<i>% Fume</i>	
	<i>Std. CV Short Arc</i>	<i>STT</i>
<i>0.045 E70S-3 &amp; 100% CO<sub>2</sub></i>	<i>1.49%</i>	<i>0.68%</i>
<i>0.045 308LHS &amp; 90% He, 7.5% Ar, 2.5% CO<sub>2</sub></i>	<i>0.57%</i>	<i>0.26%</i>



# 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

*Separate, Automate & Ventilate*



**Risk of Creating a  
Confined Space . . .  
*Precautions Necessary!***

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# Ventilation

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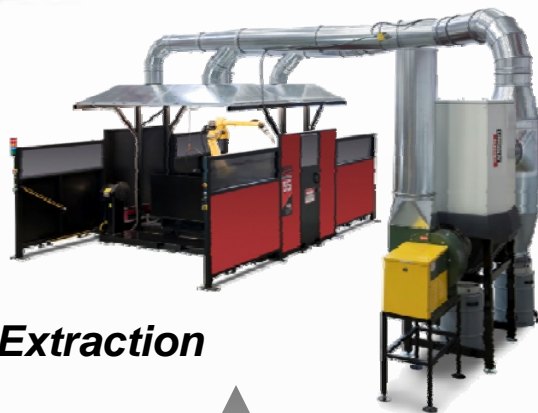


# Ventilation Overview

Not one solution will fit all applications!



**Source Extraction**



**Local Extraction**



**General Extraction & Circulation**





# Ventilation

**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.**



**Local Ventilation Systems for Welding and Cutting Processes**

System Type	Typical Airflow	Comments
<i>Welding gun with integral fume extraction</i>	<i>30-60 cfm (50-100 m<sup>3</sup>/h)</i>	<i>Extracts fume at the weld zone through GMAW and FCAW guns</i>
<i>High vacuum source capture nozzle</i>	<i>90-180 cfm (150-300 m<sup>3</sup>/h)</i>	<i>Captures fume through high-velocity, low-volume extraction nozzles; usually positioned by the welder</i>
<i>Flexible fume extraction arm</i>	<i>560-860 cfm (900-1400 m<sup>3</sup>/h)</i>	<i>Draws higher air volume and is easily positioned and repositioned by welder</i>
<i>Cross-draft welding table (slotted hood)</i>	<i>90-180 cfm per ft<sup>2</sup> (900-5000 m<sup>3</sup>/h per m<sup>2</sup>)</i>	<i>Excellent for controlling fume in a fixed location serving small part welding</i>
<i>Fixed exhaust hood</i>	<i>1470-1760 cfm (3300-5000 m<sup>3</sup>/h)</i>	<i>Used for overhead capture in fixed locations</i>
<i>Push-pull hood over welding robot</i>	<i>Varies with hood height and space</i>	<i>An engineered design to reduce exhaust air volume in a large, fixed welding zone</i>
<i>Canopy hood</i>	<i>Varies with hood design</i>	<i>Uses larger air volumes to control an area where source capture is impractical</i>
<i>Downdraft cutting table</i>	<i>150 cfm per ft<sup>2</sup> (2700 m<sup>3</sup>/h per m<sup>2</sup>)</i>	<i>Used in large, fixed, flat plane operations</i>



**AWS F3.2M/F3:2:2001 Ventilation Guide for Weld Fume approved by American National Standards Institute June 15, 2001**

# Ventilation

## Source Extraction



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



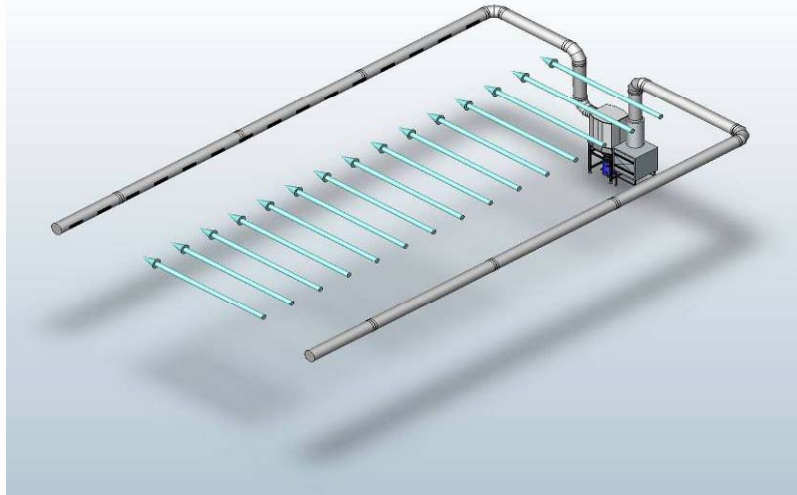
- Low Volume (High Vacuum)
  - LOW volume of air extracted
    - 30 - 180 CFM
  - Operates 2"- 4" from weld source
  - Fume Guns & Extraction Nozzles
  - Small, Compact & Flexible Systems

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# Ventilation

## General Extraction



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# 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

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# General Extraction

## Push Pull System

### Advantages:

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

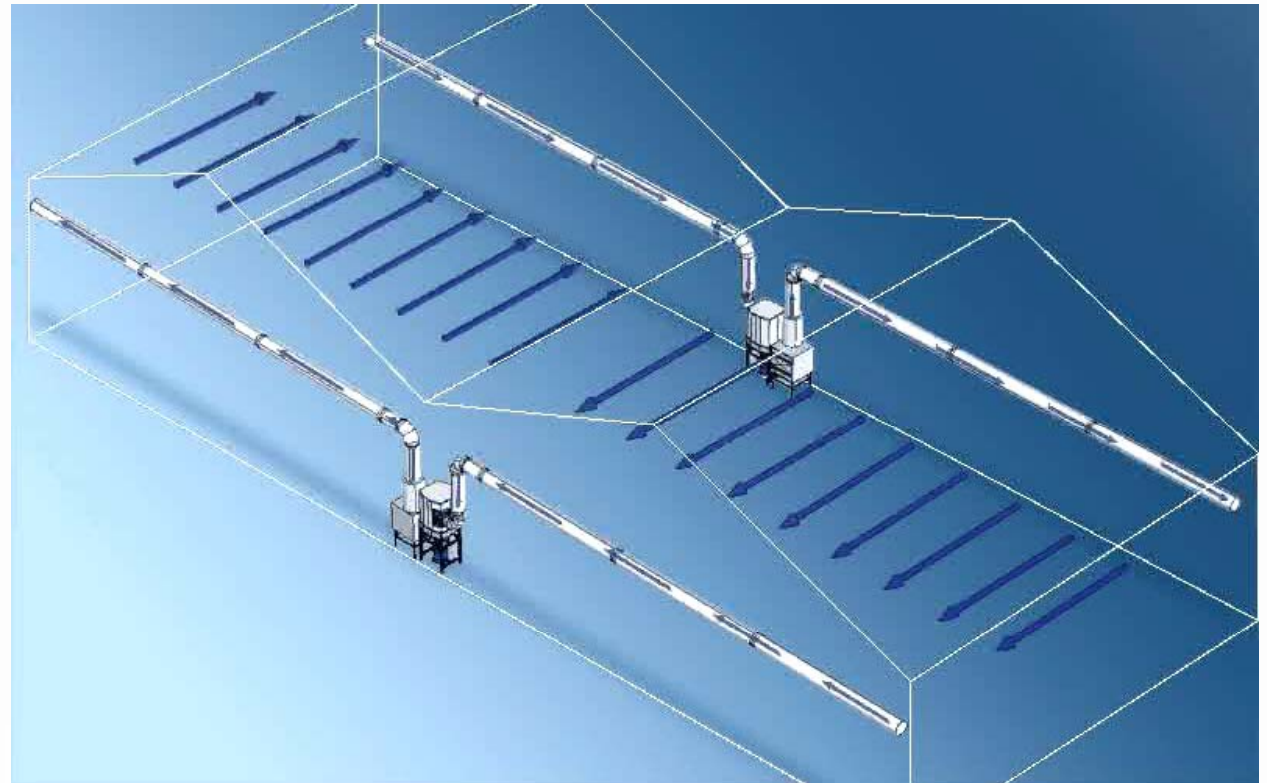
### Disadvantages:

- Source extraction or PPE still required if individuals are working within area



# General Shop Extraction

## Push Pull System



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# General Extraction

## *Push Pull System*



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# 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



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# General Shop Extraction

## Circulator™ System



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# Safe Work Practices



# 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.

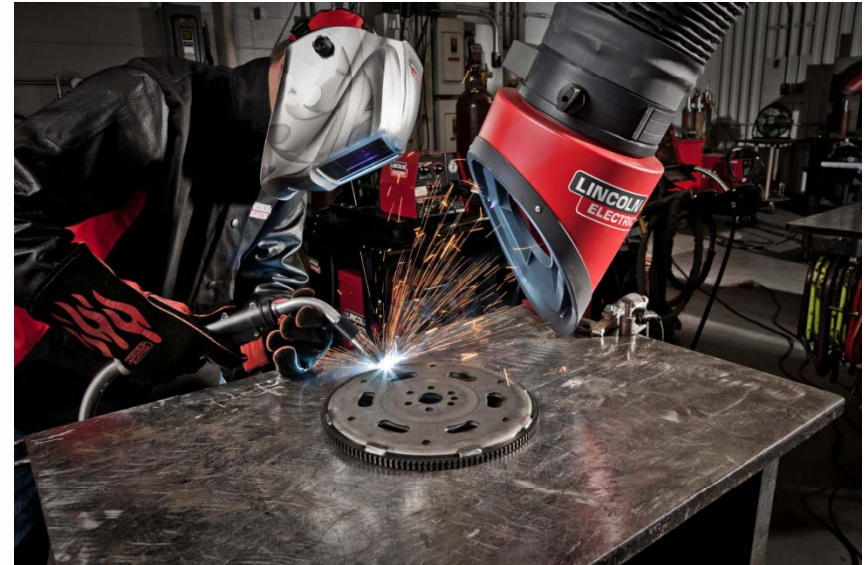


# Safe Work Practices

## Operator Technique



***INCORRECT***



***CORRECT***

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# Welding Safety Education

- Free Educator Training
- Cost Based Training Materials

**No Charge Teacher Observer Program**

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We appreciate what you are doing, so as a welding school instructor, you may be eligible to sign up for one free week of welding instruction including basic robotic training.

- Choose the dates that may help improve your program.
- Participate as one of the observers and also take training materials with you.
- Subject matters will include safety, quality and productivity needs of industry.
- Thinking about getting CWP certified? Consider taking the Lincoln Electric's CWP prep course (This program is prep for the AWS/CIP Prep Seminar).
- Classes held at Lincoln Electric's Central Headquarters in Cleveland, Ohio.

For course information go to:  
[www.lincolnelectric.com/knowledge/training/weldschool/](http://www.lincolnelectric.com/knowledge/training/weldschool/)

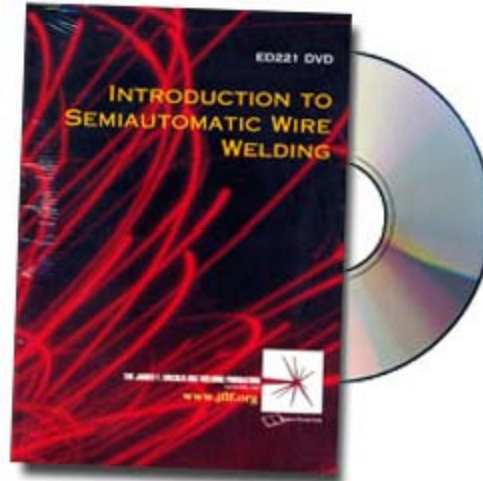
IGMIG GMAW or FCAW OGCW Robotic Programming

self study name

For more information, contact your local Lincoln Sales Representative (see reverse side), call The Lincoln Welding Center at 1-800-542-2252 or register online at [www.lincolnelectric.com/knowledge/training/weldschool/](http://www.lincolnelectric.com/knowledge/training/weldschool/). For the robotics program call 888-822-2278.

\*Please Note: Participant is responsible for their own transportation, collective gear, meals and accommodation expenses. Transportation expense (airfare, train, bus, etc.) and parking are not included. Limit one week class per year. Offer good for 2009-2010.

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## Parts of a Weld

### FILLET

### GROOVE

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## Fume Hood Positions

(Posiciones de tolva de recuperación)

### BESIDE THE WELD

(Al lado de la soldadura)

Welder's Position  
(Posición del soldador)

### ABOVE THE WELD

(Encima de la soldadura)

Welder's Position  
(Posición del soldador)

### AT THE BEGINNING OF THE WELD

(Al principio de la soldadura)

Welder's Position  
(Posición del soldador)

### Directly Over The Vertical Weld

(Directamente sobre la soldadura vertical)

Welder's Position  
(Posición del soldador)

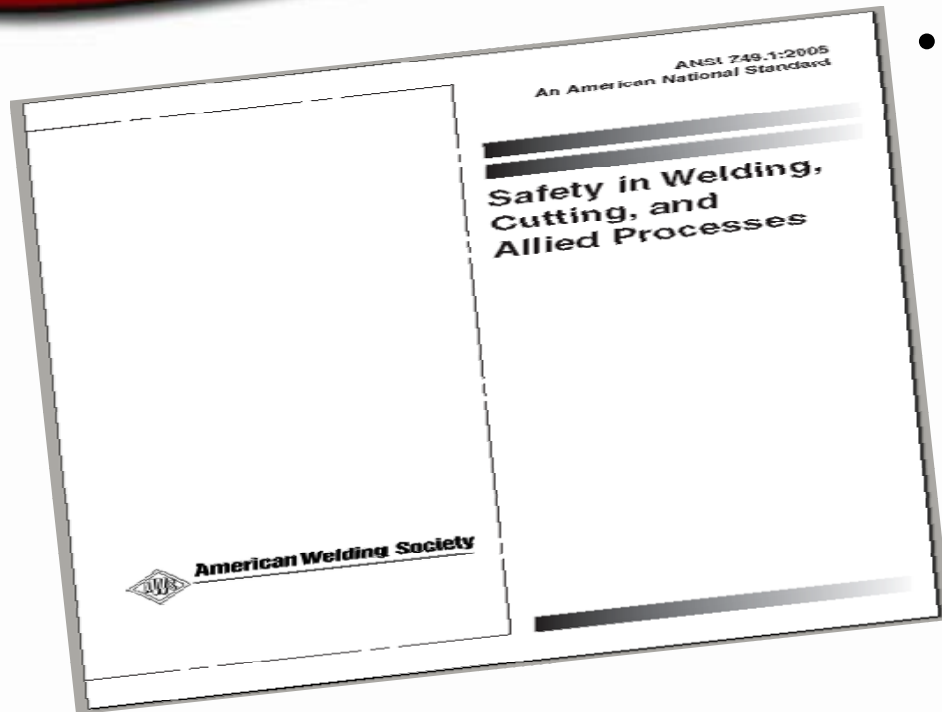
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[www.lincolnelectric.com/community/safety](http://www.lincolnelectric.com/community/safety)





# 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](http://www.aws.org/technical/facts)

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# Welding Safety Reference Documents



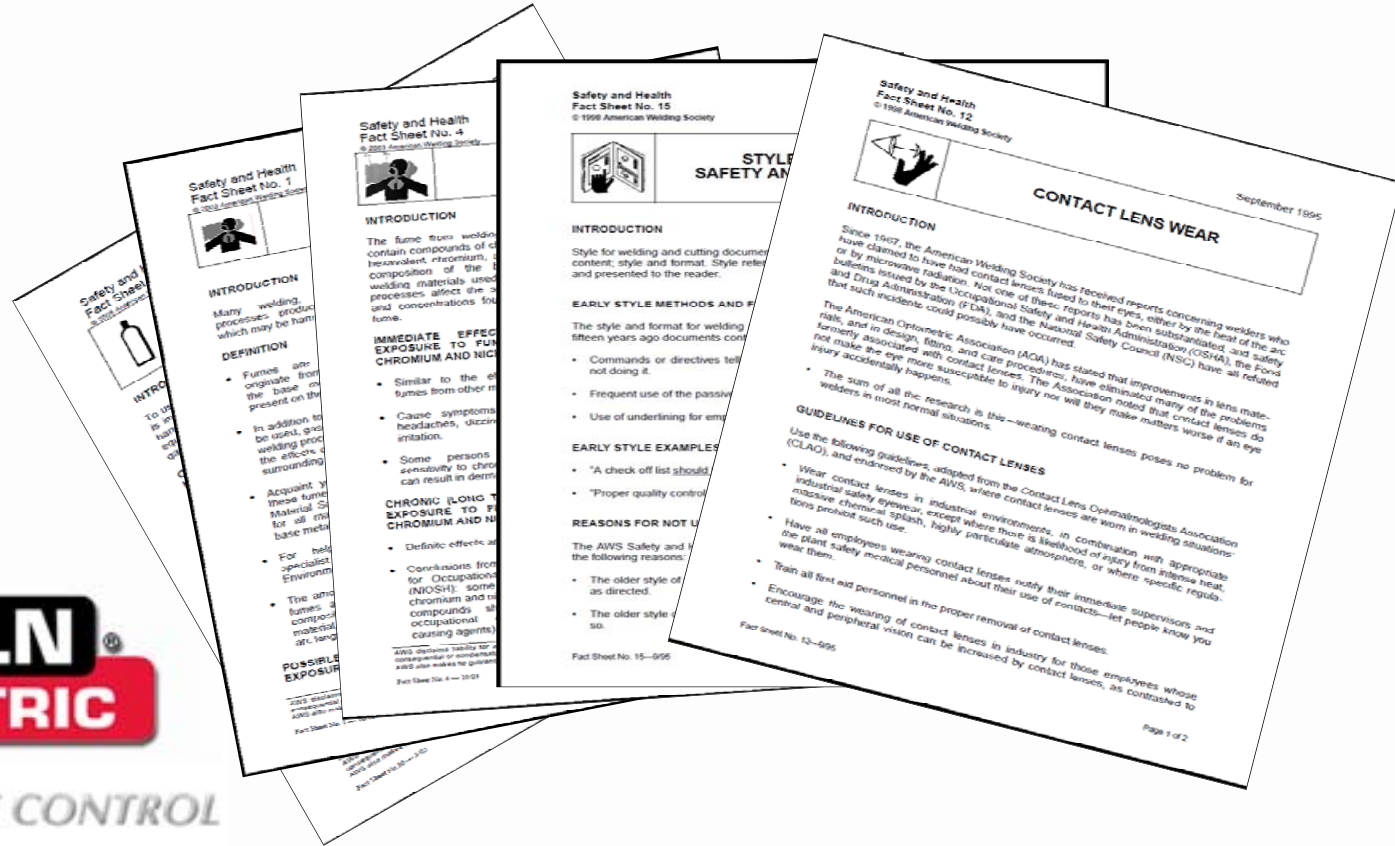
- Everyone working in the welding industry is welcome to download a copy of:
  - Lincoln Electric’s E205 document, “Arc Welding Safety” free of charge [www.lincolnelectric.com](http://www.lincolnelectric.com)
  - Also available in Spanish
- Lincoln Electric has also created and provides free copies of the Welding Safety Interactive DVD

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# Welding Safety Reference Documents

- AWS Safety & Health Fact Sheets (available free of charge from [www.aws.org](http://www.aws.org))



# Welding Fume

## Extraction Systems



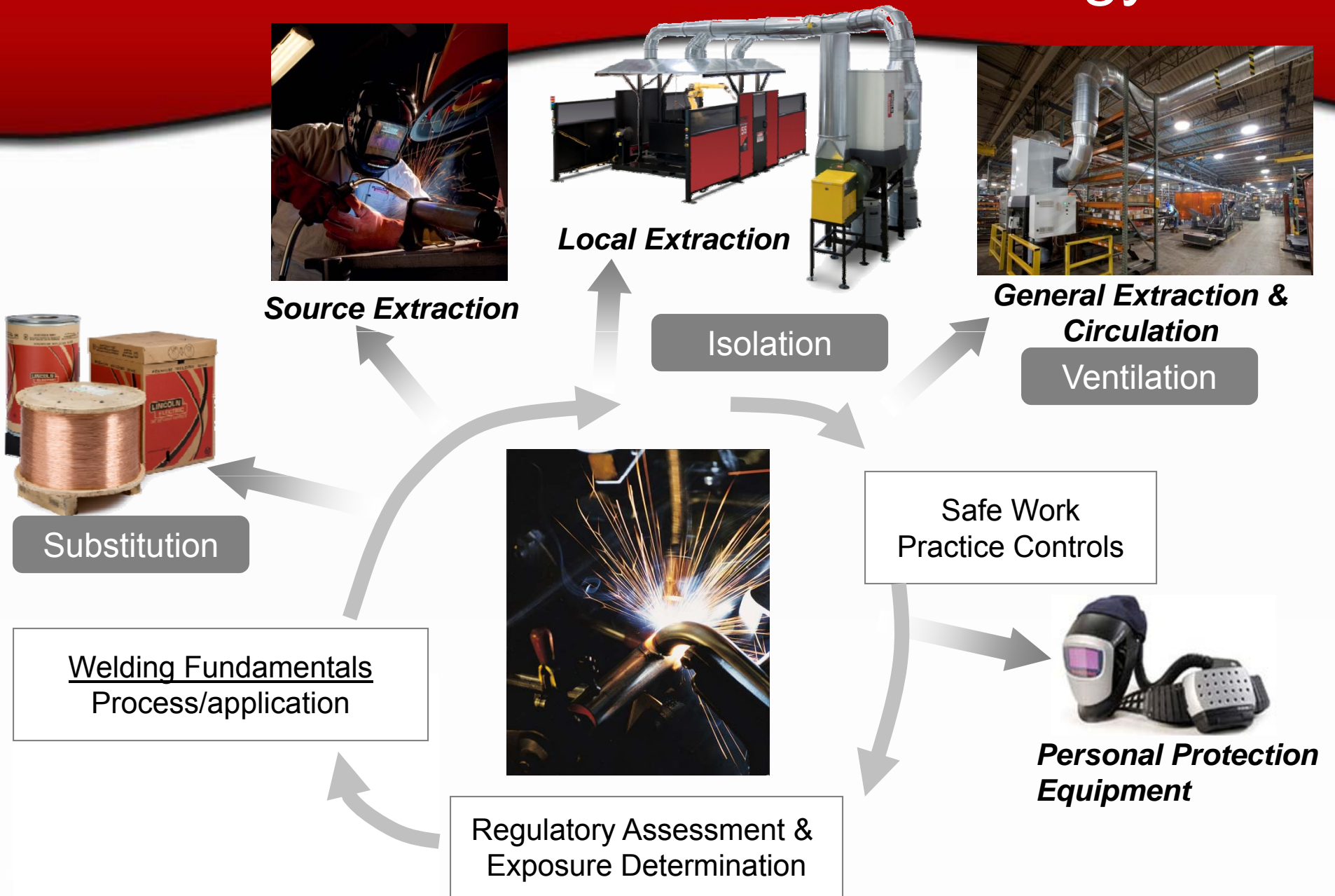
- Welding Fume Extraction systems require on-going Maintenance!
- Employers responsibility to monitor use of Engineering Controls!
- Employee training is a must and should be ongoing and repetitive!

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# Works Referenced

## Weld Fume Control Systems





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# Lincoln Electric

## Weld Fume Control Systems

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- **The Lincoln Electric Website at:**

[www.LincolnWeldFumeControl.com](http://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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