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Arc Welding Safety

...because there's so much more to enjoy.

Carl Peters, Director of Technical Training, The Lincoln Electric Company
Doug Dunbar, CSP, CIH, EHS Department, The Lincoln Electric Company

AISC • February 28, 2014

This presentation has been tailored to the applications in the welding industry and focuses on the application of industrial hygiene principles and may discuss OSHA's intent and general requirements. It is not inclusive of all potential requirements based on specific applications.

Please refer to the applicable standard for a full discussion of the regulatory requirements.



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Lincoln Electric Company

- Founded 1895 in Cleveland by John C. Lincoln.
- 1st 100 years: closely held
-1995 listed on NASDAQ
- Arc welding remains our core business.
-The world leader in the design, development and manufacture of arc welding products.



ANSI/AWS Precautionary Label

	<p>FUMES AND GASES can be hazardous to your health.</p> <ul style="list-style-type: none"> • Keep your head out of the fumes. • Use enough ventilation or exhaust at the arc to keep fumes and gases from your breathing zone and general area.
	<p>ELECTRIC SHOCK can kill.</p> <ul style="list-style-type: none"> • Do not permit electrically live parts or electrodes to contact skin . . . or clothing or gloves if they are wet. • Insulate yourself from work and ground. • Always wear dry insulating gloves. • Do not use standard AC welders when welding in damp locations or with wet clothing, on metal structures or in cramped positions (sitting, kneeling or lying) if there is a high risk of unavoidable or accidental contact with the workpiece or ground. Use the following equipment: Semiautomatic DC Constant Voltage (Wire) Welder • DC Manual (Stick) Welder • AC Welder with Reduced Voltage Output.
	<p>WELDING SPARKS may start a fire or cause an explosion.</p> <ul style="list-style-type: none"> • Do not weld near flammable material. • Do not weld on closed containers.
	<p>ARC RAYS can injure eyes and burn skin.</p> <ul style="list-style-type: none"> • Wear correct eye, ear and body protection.
	<p>FIRST AID: If exposed to excess welding fumes, remove to fresh air. In case of arc rays, or electric shock, employ normal first aid techniques and call a physician immediately.</p> <p>READ AND FOLLOW THE MANUFACTURER'S INSTRUCTIONS, MATERIAL SAFETY DATA SHEET (MSDS) AND YOUR EMPLOYER'S SAFETY PRACTICES BEFORE USING THIS PRODUCT.</p> <p>Read American National Standard Z49.1, "Safety in Welding and Cutting," available from the American Welding Society, 550 N.W. Le Jeune Rd., Miami Florida 33126-5699; OSHA Safety and Health Standards, 29 CFR 1910, available from Superintendent of Documents, U.S. Government Printing Office, P.O. Box 371954, Pittsburgh, PA 15250; or CSA Standard W117.2 M-87 Code for safety in welding and cutting and allied processes.</p>



Sources of Information: Welding Safety

- The American Welding Society's *ANSI Z49.1: Safety in Welding and Cutting*
 - Free download at www.aws.org/technical/facts

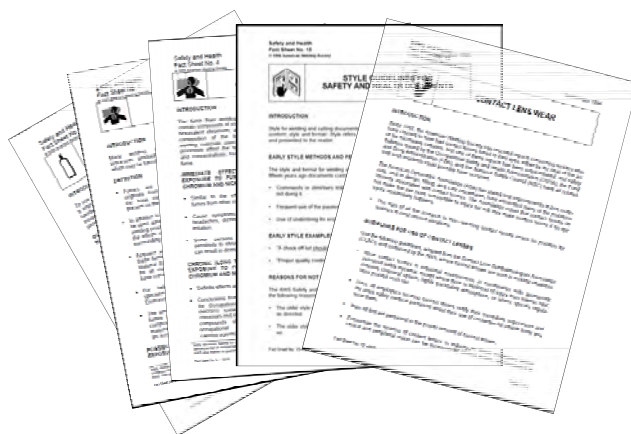


- Lincoln Electric's E205 document, *Arc Welding Safety*; and *Welding Safety Interactive DVD*
 - free download at www.lincolnelectric.com



Sources of Information: Welding Safety

- AWS Safety & Health Fact Sheets (available free of charge from www.aws.org)



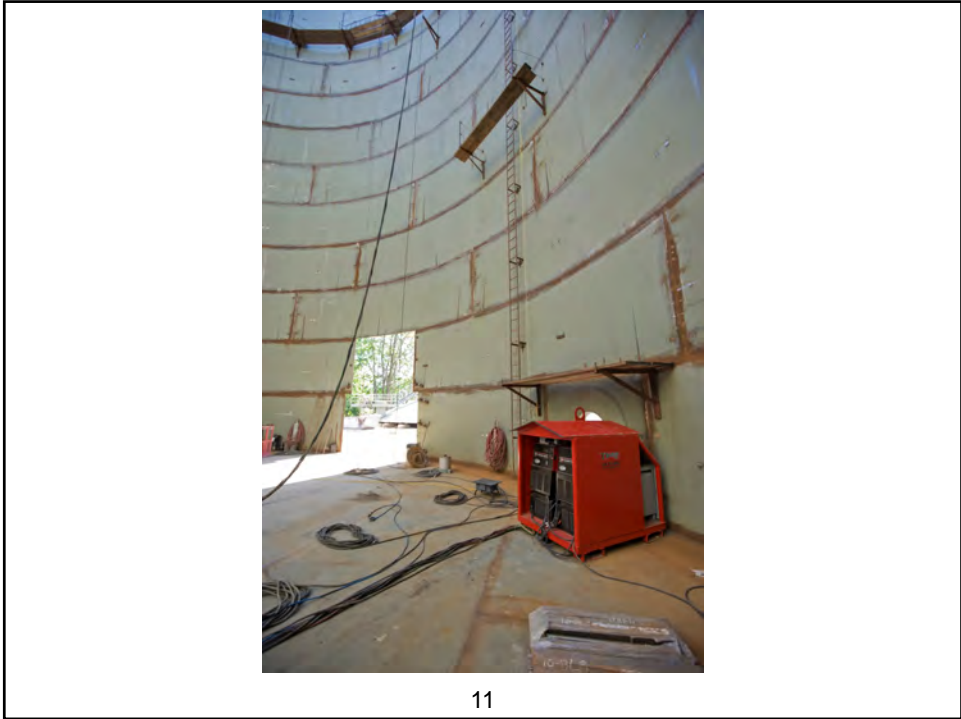
Electric Shock

- Electric shock can kill.
- Do not touch live electrical parts.
 - Primary Voltage: 230, 460 volt input power
 - Secondary Voltage: 6 to 100 volts for welding
- Insulate yourself from work and ground.
- Follow all warnings on welding equipment.



Do not make repairs yourself—alert your instructor immediately!





Be sure electrical devices and cables are in good working condition.



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Engine Driven Welders

Added Electrical Safety Features



- Voltage Reduction Device
 - Reduced OCV in CC-Stick mode below 32 V when not welding
 - Toggle Switch allows operator to turn VRD on and off.
 - Standard feature on the Vantage 400
 - Software available for V350 and V450



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Engine Driven Welders

Added Electrical Safety Features



- GFCI (Ground Fault Circuit Interrupter)
 - Protect against electric shock should someone come in contact with a hot wire and a path to ground
 - Senses the difference between the currents in the Hot and Neutral conductors
 - Fault testing

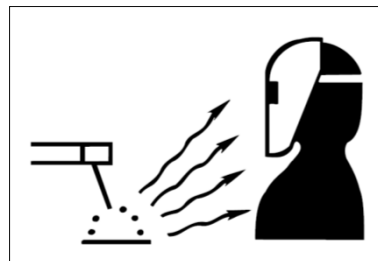


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Arc Rays

- Arc rays can injure eyes and burn skin.
- The welding arc is brighter than the sun.
- Precaution must be taken to protect your eyes and skin from UV radiation.
- Wear correct eye and body protection.



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PPE – Welding Gloves & Coverings

Protect Body from UV and Burns



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PPE – Welding Helmet & Lens

Guard Against “Arc Flash”

- Occurs when UV Rays Burn the Surface of Your Eyes
- Caused from Direct Exposure or Reflection Off Shiny Surfaces



Selecting Proper Filter Plate Shade Number

LENS SHADES SELECTION FOR SHIELDED METAL ARC WELDING				
Operation	Electrode Size in. (mm)	Arc Current (A)	Minimum Protective Shade	Suggested * Shade No. (Comfort)
Shielded Metal Arc Welding	Under 3/32 in (Under 2.4 mm)	Less than 60	7	10
	3/32 - 5/32 in (2.5 - 4.0 mm)	60-160	8	12
	5/32 - 1/4 in (4.0 - 6.4 mm)	160-250	10	12
	Over 1/4 in	250-550	11	14
	(Over 6.4 mm)			

* As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to a lighter shade which gives sufficient view of the weld zone without going below the minimum.



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Fire and Explosion Hazards

- Welding sparks can cause fires and explosions.
- Sparks and spatter from the welding arc can spray up to 35 feet from your work.
- Flammable materials should be removed from the welding area or shielded from sparks and spatter.
- Have a fire extinguisher ready.
- Inspect area for fires 30 minutes after welding.



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Fumes and Gases

- Fumes and gases can be hazardous to your health.
- Keep your head out of the fumes.
- Use enough ventilation, exhaust at the arc, or both, to keep fumes and gases from your breathing zone and the general area.
- See product labeling and MSDS for ventilation and respirator requirements.



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Knowing process fundamentals will help to understand:

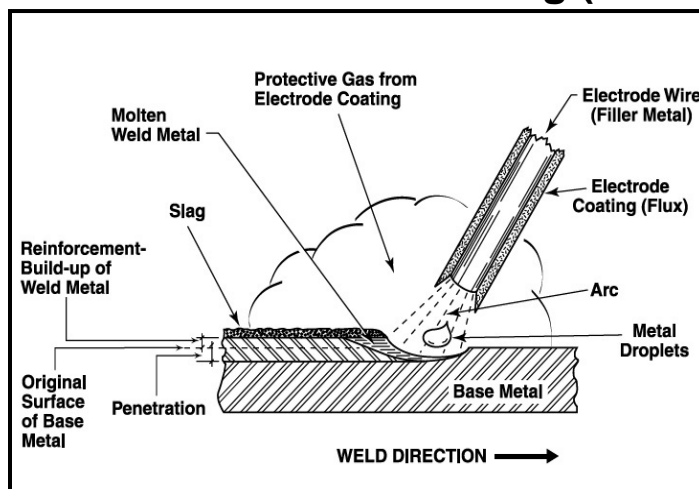
- How fumes and gases are generated
- How fumes and gases can be controlled



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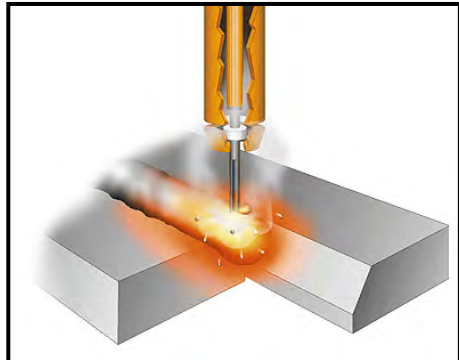
Shielded Metal Arc Welding (SMAW)



22



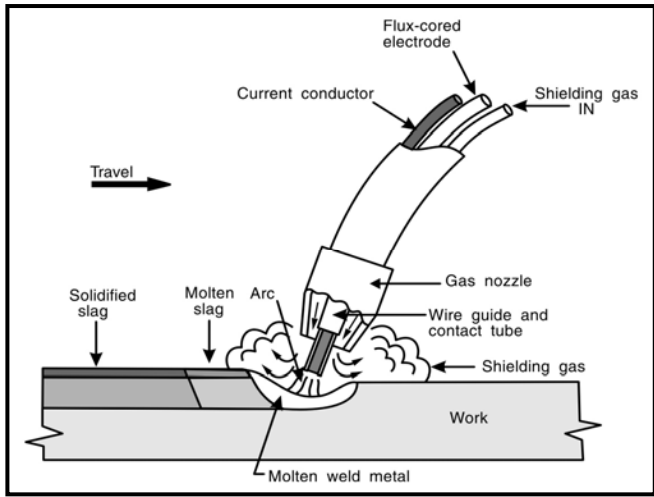
Self Shielded Flux Cored Welding



23



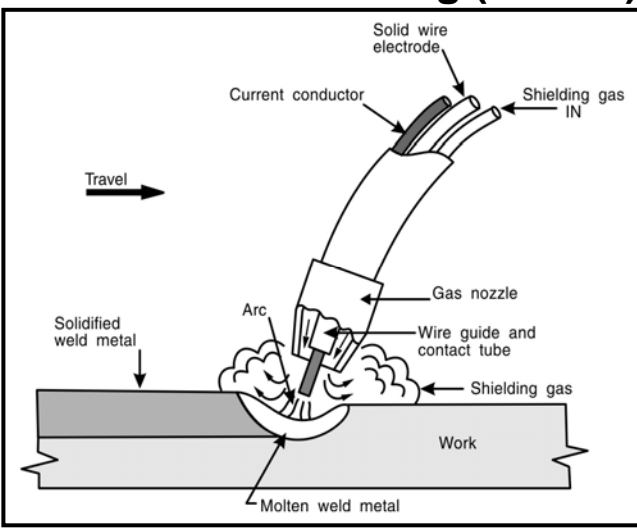
Gas Shielded Flux Cored Arc Welding



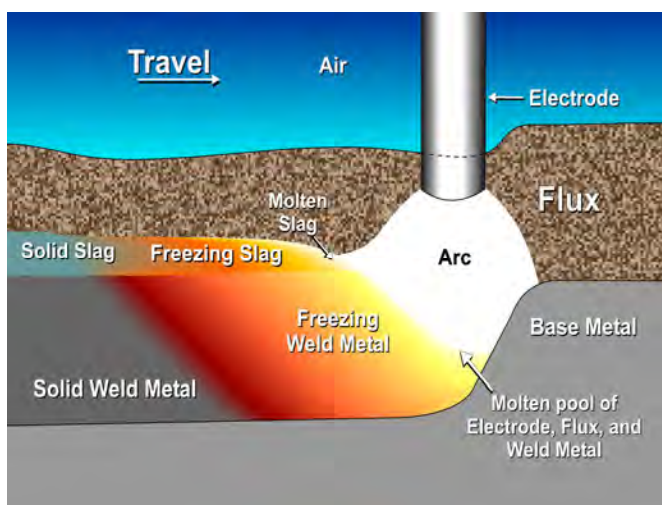
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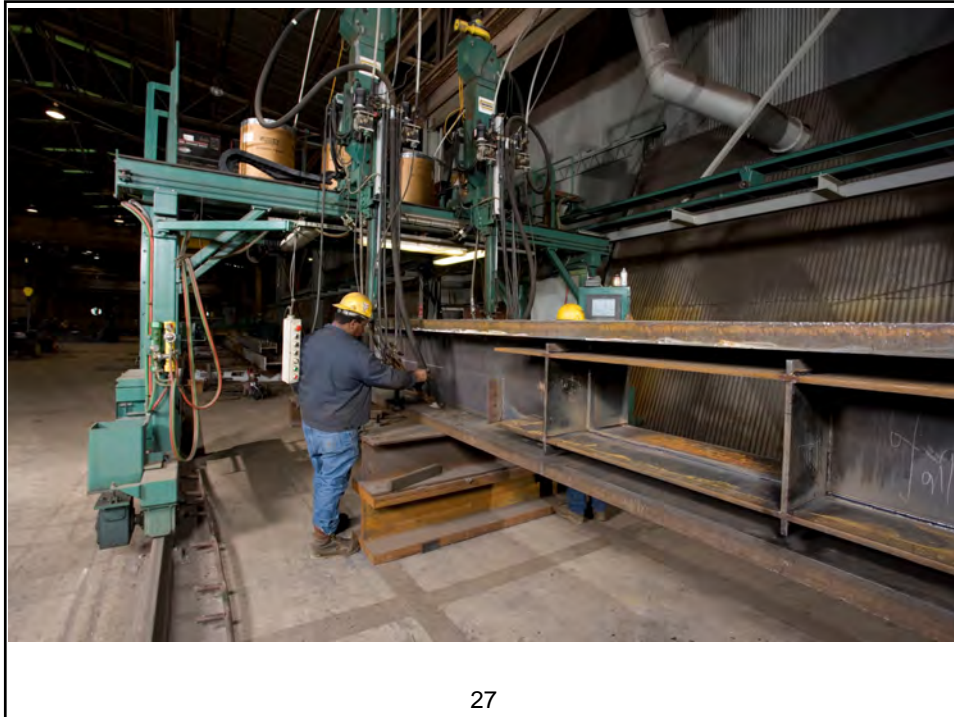


Gas Metal Arc Welding (GMAW)



Submerged Arc Welding (SAW)





Examples of Ventilation

- Natural Ventilation
- General area mechanical ventilation
- Overhead exhaust hoods
- Portable local exhaust devices
- Dowlraft tables
- Extractors built into the welding equipment
- Air-ventilated helmets





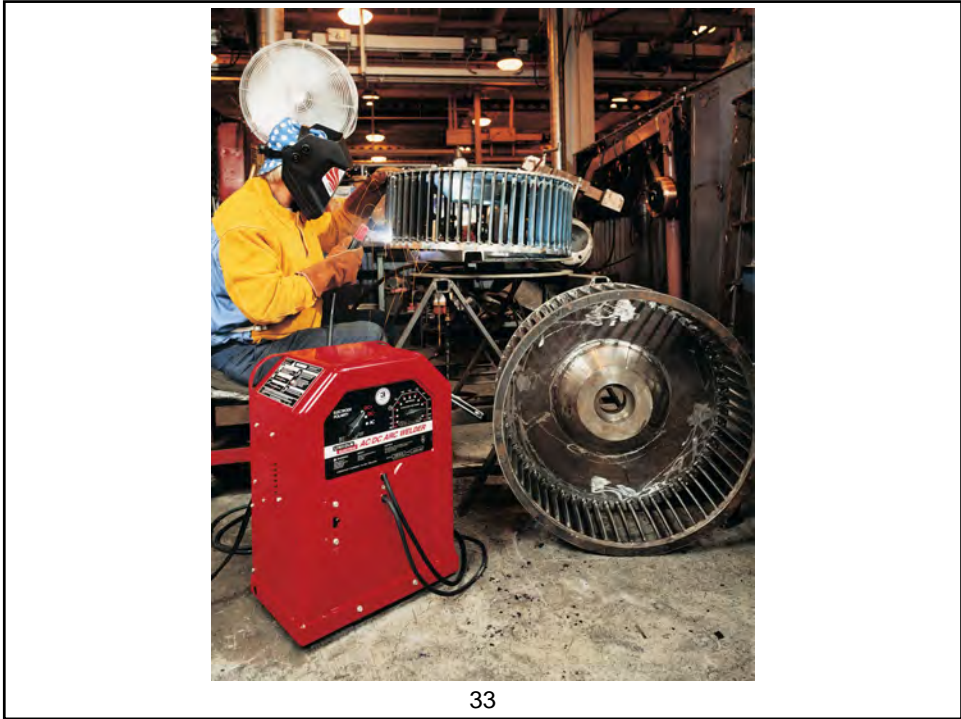


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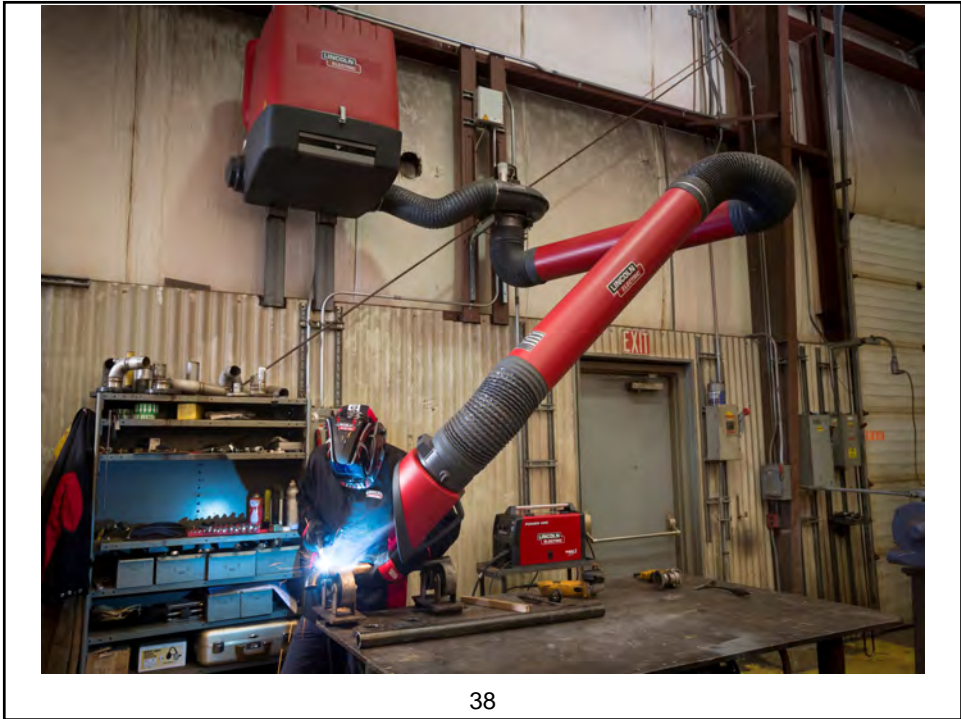


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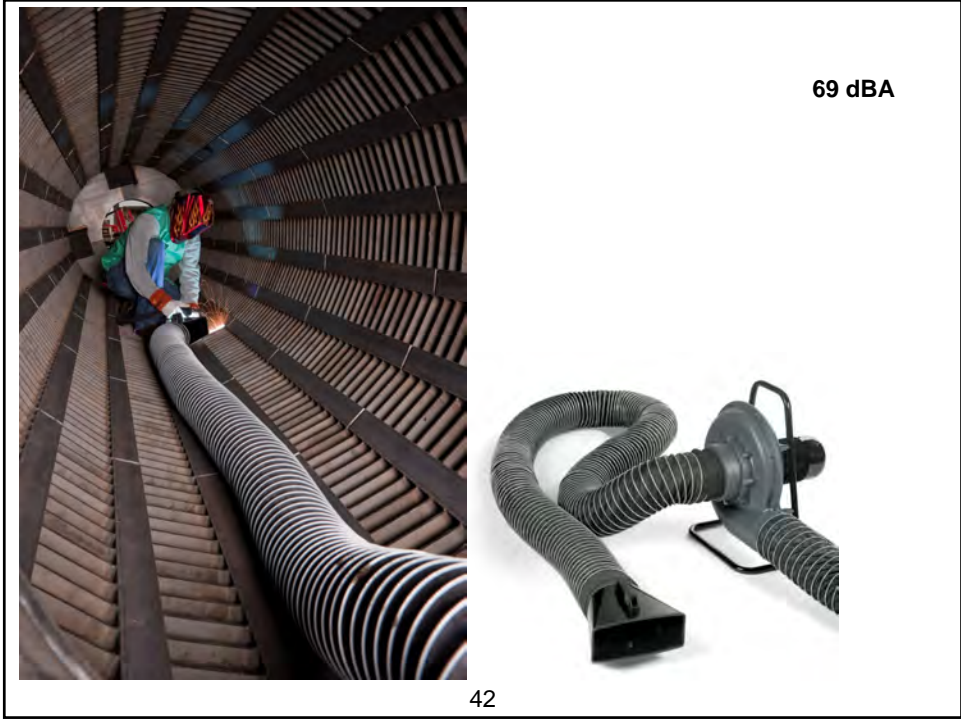
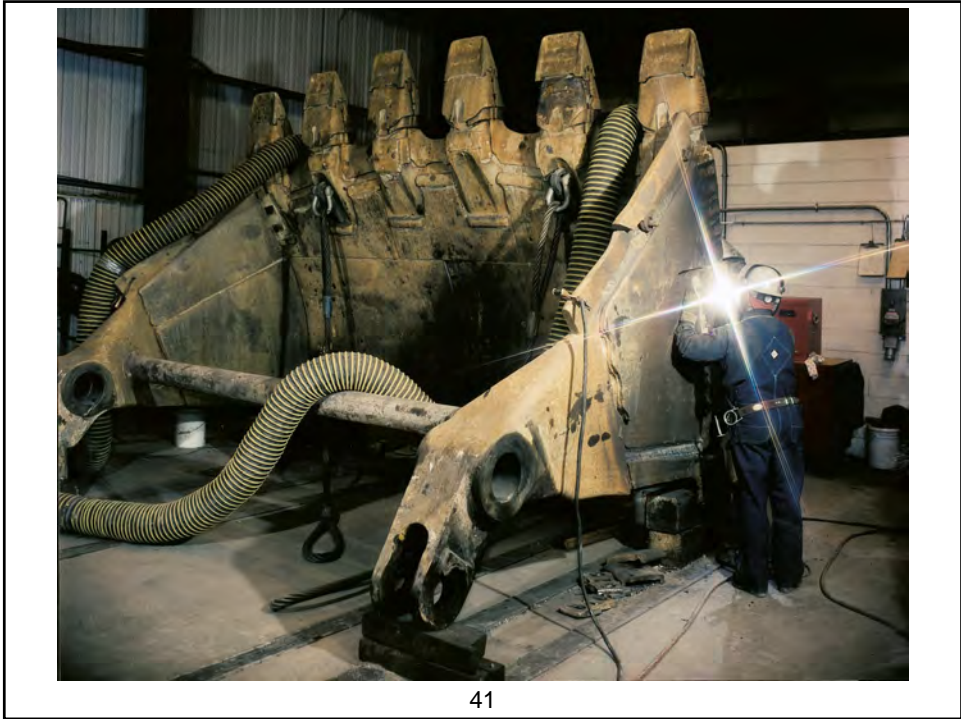














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Self Shielded Fume Extractor Gun



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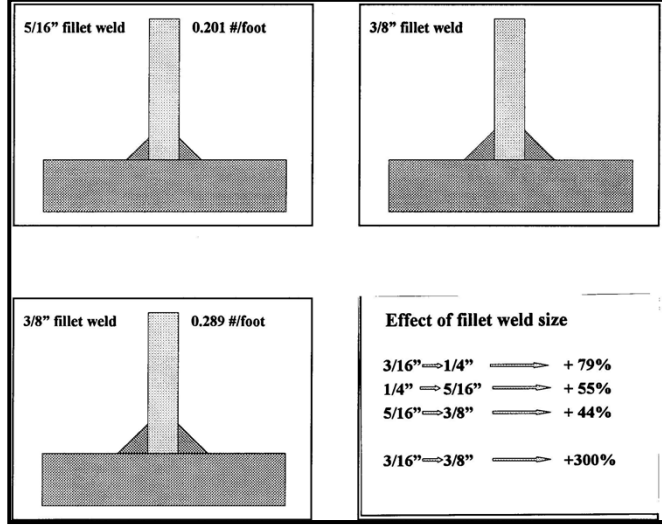


GMAW Fume Extractor Gun



47

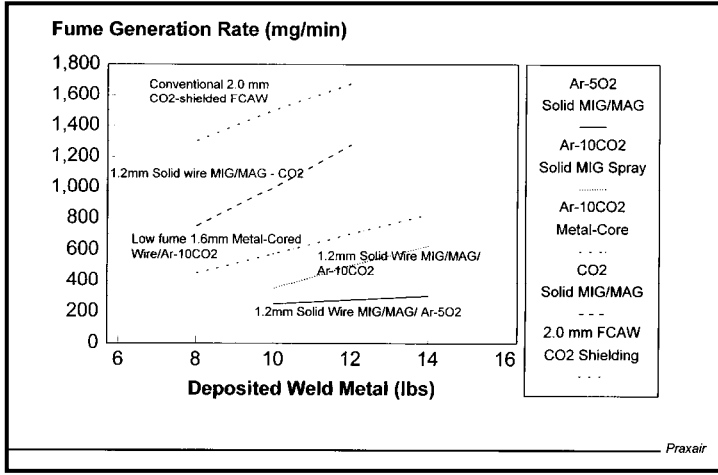
Understand Principles of Weld Detailing



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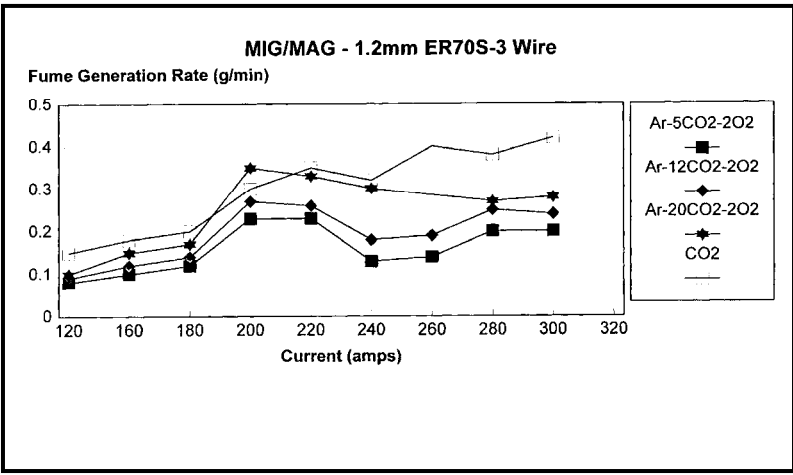


Consumable and Process Selection Affects Fume Generation



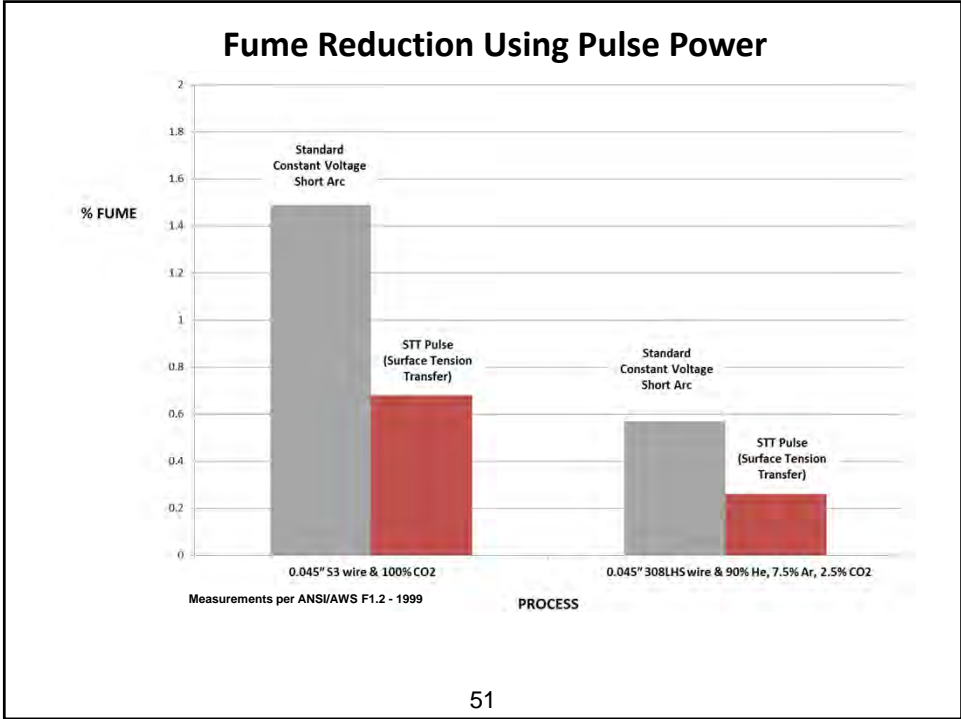
49

Shielding Gas Affects Fume Generation



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The fume plume contains small fume particles and gases. Sources include:

- Welding consumables
- Base metal coatings and platings
- Base metal

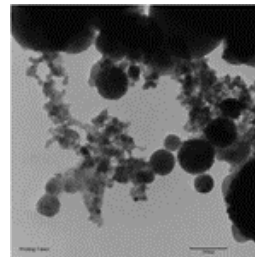


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The Metallurgy of Welding Fume

- Complex metallic oxides
- Prevalent shell—core structure



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Gases that result from an arc welding process present potential hazards:

- Primary:
 - Carbon monoxide (Density, Air = 1: 0.97)
 - Ozone (1.7)
 - NOx (Nitrogen Dioxide, Nitric Oxide) (2.1/0.97)
 - Thermal Decomposition of Surface Coatings
- Secondary:
 - Degreasing compounds decomposed to toxic gases by the arc rays
 - (Engine exhaust fumes)



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Performance Based Standards OSHA Regulatory Standards

Examples of chemical specific performance based standards:

- Lead - 29CFR 1910.1025
- Cadmium - 29CFR 1910.1027
- Asbestos – 29 CFR 1910.1001 & 1926.1101
- Hexavalent Chromium
 - General Industry - 29CFR 1910.1026
 - Construction - 29CFR 1926.1126
 - Shipyards - 29 CFR 1915.1026



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OSHA's Table Z – Limits for Air Contaminants

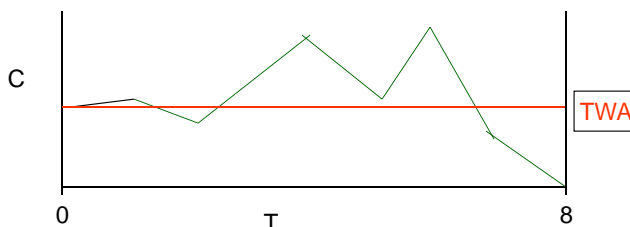
TABLE Z-1. - LIMITS FOR AIR CONTAMINANTS

Substance	CAS No. (c)	ppm (a) (1)	mg/m ³ (b) (1)	Skin designation
Acetaldehyde	75-07-0	200	360	
Acetic acid	64-19-7	10	25	
Acetic anhydride	108-24-7	5	20	
Acetone	67-64-1	1000	2400	
Acetonitrile	75-05-8	40	70	
2-Acetylaminofluorene; see 1910.1014	53-96-3			
Acetylene dichloride; see 1,2-Dichloroethylene				
Acetylene tetrabromide	79-27-6	1	14	
Acrolein	107-02-8	0.1	0.25	
Acrylamide	79-06-1		0.3	X
Acrylonitrile; see 1910.1045	107-13-1			
Aldrin	309-00-2		0.25	X
Allyl alcohol	107-18-6	2	5	X
Allyl chloride	107-05-1	1	3	
Allyl glycidyl ether (AGE)	106-92-3	(C) 10	(C) 45	
Allyl propyl disulfide	2179-59-1	2	12	
alpha-Alumina	1344-28-1		15	
Total dust			5	
Respirable fraction			5	
Aluminum Metal (as Al)	7429-90-5		15	
Total dust			5	
Respirable fraction			5	
4-Aminodiphenyl; see 1910.1011	92-67-1			



Time Weighted Average (TWA)

- Allowable time-weighted average concentration for a normal 8-hour workday. (Shifts may be 10 or 12 hours.)
- Sample results are reported as an 8-Hour TWA value.



Permissible Exposure Limit (PEL)

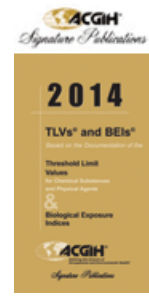
- Established by OSHA
- Typically an 8 Hour TWA
- May be expressed as a STEL or as a ceiling (C) exposure



ACGIH Threshold Limit Values – Chemical Substances and Physical Agents

Substance (OSHA No.) (Documentation date)	ACGIH TLVs				
	TWA	STEL	Relations	MM	TLV Basis
NO ₂ (documented since 1/24/84) (1/1981)	0.05 ppm	—	A1	114.98	Lung cancer
Chloroethyl methyl ether (107-30-2) (1971)	—	—	A2	10.00	Lung cancer
1-Chloro-1-ethoxyethane (80-55-8) (1971)	2 ppm	—	—	123.54	Eye or skin irrita
Chloroethylmethyl ether (75-19-2) (1971)	100 ppm	—	—	154.47	Carcinogen
Chloroethane (75-10-2) (1981)	0.7 ppm	—	A4	164.29	Eye or skin irrita
1-Chloro-2-propene (75-68-7) and 2-Chloro-2-propene (75-68-7) (1981)	1 ppm	—	None/A4	94.24	Liver can
2-Chloroethanol (107-08-1) (1981)	10 ppm	—	B4a	88.54	URT & upper
2-Chloroethoxyethane (108-28-1) (1/1981)	0.1 ppm	—	B4a	105.23	Upper respir
n-Chlorobenzene (108-90-4) (1971)	30 ppm	—	—	138.80	CHG upper respiratory
o-Chlorobenzene (95-49-8) (1971)	30 ppm	—	—	138.89	URT, eye, & skin ir
Chlorobenzene (95-49-8) (2004)	0.7 ppm (STEL)	—	B4a, A4, R4a	326.07	Chlorobenzene (URT)
Chlorobenzene (95-49-8) (1971)	0.5 ppm (STEL)	—	A1	—	Lung cancer

Substance (OSHA No.) (Documentation date)	ACGIH TLVs				
	TWA	STEL	Relations	MM	TLV Basis
Chlorine (7782-42-8) and organic compounds, as Cl ₂ (1981)	—	—	A4	—	URT & skin ir
Hydrogen chloride (7782-42-8) (1981)	—	—	A1, B3	—	URT & upper
Hydrogen cyanide (74-90-8) (1981)	—	—	A1	—	Lung cancer
Chlorine (7782-42-8) (1981)	—	—	A4, R4a	225.30	URT & skin ir
Chlorine (7782-42-8) (1971)	—	—	A4	182.08	URT &
Chlorine (7782-42-8) (1971)	—	—	A4	—	Lung dem, pain throa
Chlorine (7782-42-8) (1971)	—	—	A4	—	Lung dem, pain throa
Chlorine (7782-42-8) (1971)	—	—	A1, R4a	—	Cancer
Chlorine (7782-42-8) (1971)	—	—	A4, B3	58.93	Alveolar pain throa, respiratory ill
Chlorine (7782-42-8) (1971)	—	—	A4	—	URT
Chlorine (7782-42-8) (1971)	—	—	A4	—	Pain throa, upper dem
Chlorine (7782-42-8) (1971)	—	—	A4	—	Pain throa, lung dem



Threshold Limit Value (TLV)

Established by the American Conference of Governmental Industrial Hygienists (ACGIH) - expresses the maximum airborne concentration of a material which most workers can be exposed to daily throughout their working career without adverse health affects.

(More points about this—we'll discuss a bit later.)



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Performance Based Standards OSHA & ACGIH Exposure Limits

Chemical Agent	OSHA PEL mg/m ³ [ppm]	ACGIH TLV mg/m ³ [ppm]
Barium	0.5	0.5
Carbon Monoxide	55 [50]	29 [25]
Chromium (0)	1	0.5
Hexavalent Chromium	0.005	0.05
Copper Fume	0.1	0.2
Manganese	C5	0.02
Nitrogen Dioxide	[(C)5]	0.2
Ozone	0.2	0.05
Zinc Fume	5	5, STEL 10

OSHA – PEL (Permissible Exposure Limit), 8-hr TWA; Ceiling value (C) is not to be exceeded
American Conf. of Gov. Ind. Hygienist- TLV (Threshold Limit Value), 8-hr TWA



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Industrial Hygiene – First

- How do I know if I meet these performance-based requirements?
 - Ultimately, the only way is to have a qualified individual conduct personal exposure monitoring.



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Exposure Assessment Qualitative

Information gathering:

- M(SDS)
- 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



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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.



M(SDS) Comments

Performance Based Standard

CONTENT

QUALITY

New GHS 



AISC Webinar on GHS <http://www.aisc.org/hazcomwebinar>



Fundamental Elements of GHS

The two major elements of GHS are:

1. Hazard Classification according to GHS rules

- Applies to pure chemicals, mixtures and preparations

2. Hazard Communication via Labels and Safety

Data Sheets

- GHS prescribed format and content



GHS Label Requirements

New Pictograms for Labels & SDSs...

<p>Health Hazard</p> <ul style="list-style-type: none"> • Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity 	<p>Flame</p> <ul style="list-style-type: none"> • Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides 	<p>Exclamation Mark</p> <ul style="list-style-type: none"> • Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non-Mandatory)
<p>Gas Cylinder</p> <ul style="list-style-type: none"> • Gases Under Pressure 	<p>Corrosion</p> <ul style="list-style-type: none"> • Skin Corrosion/Burns • Eye Damage • Corrosive to Metals 	<p>Exploding Bomb</p> <ul style="list-style-type: none"> • Explosives • Self-Reactives • Organic Peroxides
<p>Flame Over Circle</p> <ul style="list-style-type: none"> • Oxidizers 	<p>Environment (Non-Mandatory)</p> <ul style="list-style-type: none"> • Aquatic Toxicity 	<p>Skull and Crossbones</p> <ul style="list-style-type: none"> • Acute Toxicity (fatal or toxic)

Pictogram Example



Pictogram Name:
Exclamation Mark



GHS SDS Requirements

- Under GHS, SDSs are presented in a 16 section format with a required ordering of sections:

1. Identification
2. Hazard(s) Identification
3. Composition/Ingredient Information
4. First-Aid Measures
5. Fire-Fighting Measures
6. Accidental Release Measures
7. Handling and Storage
8. Exposure Control/Personal Protection
9. Physical & Chemical Properties
10. Stability & Reactivity
11. Toxicological Information
12. Ecological Information
13. Disposal Considerations
14. Transport Information
15. Regulatory Information
16. Other Information

MSDS = SDS



- To be GHS compliant, an SDS needs all 16 sections.
Note: Country-specific variations exist.

[Click for minimum GHS SDS requirements](#)



WARNING

Rules for welding consumables labeling, classification, and Safety Data Sheets have changed!

URGENT NEWS: The U.S. and other countries have adopted the United Nation's Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

AWS Workshop on Major Changes in Consumables Labeling and Safety Data Sheet Compliance
March 4-5, 2014 - AWS Headquarters, Miami

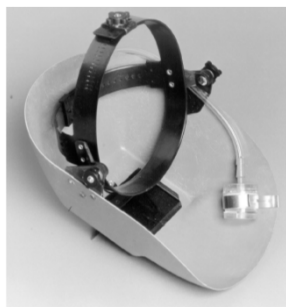
The AWS Safety and Health Committee will conduct a workshop for welding, brazing and thermal spray consumables manufacturers about meeting new requirements for product labeling and hazard communication. Some have estimated that the new GHS (Globally Harmonized System) Safety Data Sheet reporting requirements are four to eight times more laborious than those of a traditional MSDS in the U.S., for instance.

The workshop will be led by Denise A. Deeds, CH, from Industrial Health & Safety Consultants, Inc., and will provide the strategies your company can use to minimize the costs and risks of complying with the new regulations.

Cost is US\$250 for AWS members and US\$325 for nonmembers. Register at aws.org/conferences or call 90 +1 305 443-8532 ext. 223. Group hotel rates are available.



Exposure Assessments Quantitative



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ELECTRIC
 THE WELDING EXPERTS®

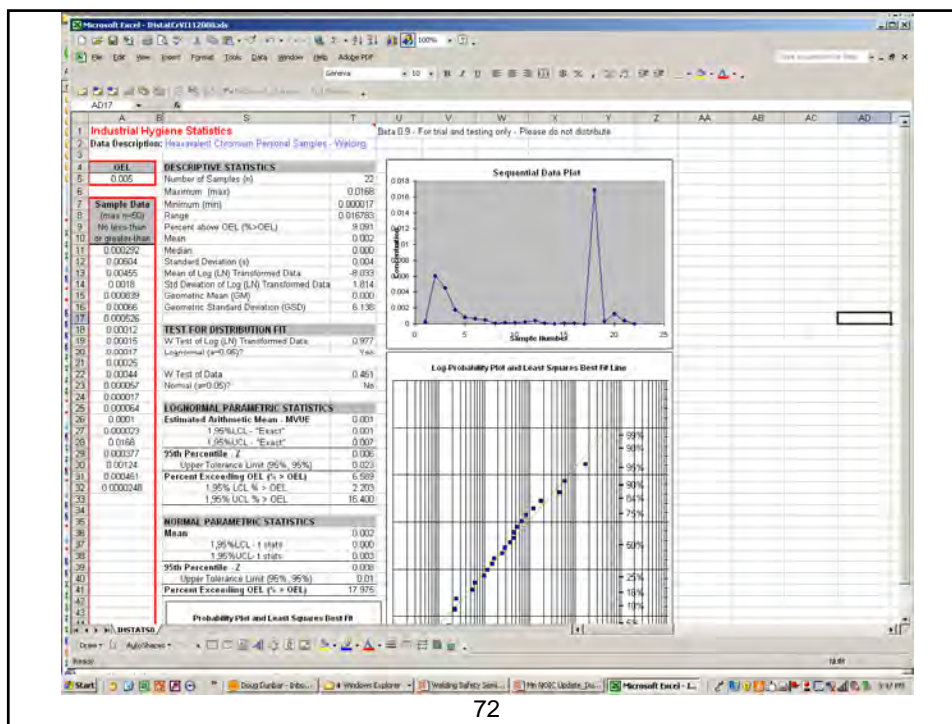
Exposure Assessments Quantitative

- 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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Methods of Control

- Substitution: reduce or eliminate fume by changing the welding process and/ or procedures
- Isolation: enclose or barricade the source
- Ventilation: local exhaust ventilation (LEV)
- Safe Work Practices: operator technique
- Personal Protection Equipment: respirators



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Chromium VI Compounds

- Man-made substances used in industrial applications.
- Hexavalent chromium compounds have many varied uses in industry and are often used for their anti-corrosive properties in metal coatings, protective paints, dyes, and pigments.
- Hexavalent chromium can be formed when performing “hot work” such as welding on stainless steel, melting chromium metal, or heating refractory bricks in kilns, or performing hot work on steel structures with chromates in the coatings.



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OSHA PEL

Permissible Exposure
Limit (PEL)
8-hour time-weighted average
exposure limit (TWA)

5 $\mu\text{g}/\text{m}^3$ TWA₈
in the air

Action Level (AL)
0.5 of PEL

2.5 $\mu\text{g}/\text{m}^3$ TWA₈
in the air



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Respirators

- Provide respiratory protection when:
 - Employee exposure to Cr VI is at, or exceeds the PEL.
 - Engineering and work practice controls are not sufficient to reduce exposure levels to or below the PEL (Must be in place).
 - An employee requests a respirator.



Half-Mask P-100
Respirator



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Respirators

- Powered Air Purifying Respirator (PAPR):
 - Can be an effective option
 - Higher Protection Factor
 - Positive Pressure
 - Mobility
 - Comfort



PAPR Welding
Helmet Respirator



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OSHA's Hexavalent Chromium Standards Resources

- OSHA Small Entity Compliance Guide:
http://www.osha.gov/Publications/OSHA_small_entity_comp.pdf
- LECO "OSHA Hexavalent Chromium Standards" Brochure:
<http://www.lincolnelectric.com/en-us/education-center/welding-safety/Pages/welding-safety.aspx>



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Update: ACGIH NOIC and TLV Adoption for Manganese



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Health Effects of Fumes

Manganese - Mn

- Occurs naturally in environment and, at low levels, is essential for maintaining good health.
- Very common component of earth's crust.
- Component in all mild steel products.
 - Largest user is steel industry (adds strength and hardness and removes sulfur contamination).
- Ingredient in most all welding consumables and most substrates as well.
- Prolonged overexposure alleged to cause neurological injury.
- Previous ACGIH TLV® was 0.2 mg/m³.



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Threshold Limit Value (TLV®)

- ACGIH term used to express the maximum airborne concentration of a material which most workers can be exposed to daily throughout their working career without adverse health effects.
- Not to be considered as a fine line between safe and unsafe exposures.
- Not a relative index of toxicity.
- Intended for use in the practice of industrial hygiene.
- Used as guidelines in the control of health hazards.



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manganese and inorganic compounds - page 14

TABLE 2. Summary of Human Studies with NOAEL and LOAEL Levels Considered in Establishing a Manganese TLV-TWA (studies in bold italics represent re-analysis of prior data)

Health Effects	Exposure Duration (yr)	NOAEL (mg/m ³)	LOAEL (mg/m ³)	Study Referenced Manganese Species
Respiratory (pneumonia)	NS		3.6 (T)	Lloyd Davies (1946) MnO ₂
Respiratory (cough, decreased lung function)	1-19 years		0.97 (T)	Rowe et al. (1987a, b)
Neurological (decreased reaction time, short-term memory, hand steadiness)		0.15 (R)	0.97 (T)	Mn salts and oxides <i>Clewett et al. (2003)</i>
Hematological			0.97 (T)	
Male reproduction (decreased fertility)			0.97 (T)	Lauwerys et al. (1955)
Respiratory	5.3 years (mean)		0.18 (R)	Roels et al. (1992)
Neurological (impaired visual time, eye-hand coordination, hand steadiness)		0.07 (R)	0.036 (R)	MnO ₂ <i>ATSDR (2000)</i>
			0.05 (R)	<i>Present analysis</i>
			0.02 (R)	<i>Present analysis</i>
			0.007 (R)	<i>Present analysis</i>
Endocrine			0.18 (R)	
Neurological (decreased reaction time, finger tapping)	1-35 years (2.6 median)		0.14 (T)	Iregren (1990) MnO ₂
		0.07 (R)		<i>ATSDR (2000)</i>
Neurological (postural sway with eyes closed)	1.1-15.7 years		1.59 (T)	Chia et al. (1993) MnO ₂
Neurological (decreased motor function)	16.7 years (mean)		0.037 (R)	Mergler et al. (1994) NS (Mn alloy workers)
Neurological (decreased finger tapping, symbol digit, digit span, additions)	1-30 years		NS	Luchini et al. (1995) Mn oxides
Neurological	12.7 years (mean)	0.051 (R) (median)		Carbo et al. (1999) NS
		0.09 (R)		<i>Clewett et al. (2003)</i>
Neurological (decreased behavioral tests)	11.5 years (mean)		0.097 (T)	Luchini et al. (1999) MnO ₂ , Mn ₂ O ₄
			0.038 (R)	
			(geo mean)	
Neurological (decreased behavioral tests)	18.2 years (mean)		0.01-0.04 (R)	Young et al. (2005) NS (Mn smelter)

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LECO Webpage

Lincoln Electric

Revised TLV for Manganese

Revised TLV for Manganese


The most comprehensive and current source of information on occupational health and safety hazards is the *NIOSH Pocket Guide to Chemical Hazards*. The latest edition published in 2012 includes the TLV-TWA for manganese. The TLV-TWA for manganese is 0.05 mg/m³ (as Mn).

The TLV-TWA for manganese is based on the most recent available and authoritative data on the health effects of manganese. The TLV-TWA for manganese is based on the most recent available and authoritative data on the health effects of manganese. The TLV-TWA for manganese is based on the most recent available and authoritative data on the health effects of manganese.


Frequently Asked Questions

1. Why the TLV-TWA for manganese is being revised? The TLV-TWA for manganese is being revised because of new data on the health effects of manganese.
2. What is the TLV-TWA for manganese? The TLV-TWA for manganese is 0.05 mg/m³ (as Mn).
3. How is the TLV-TWA for manganese calculated? The TLV-TWA for manganese is calculated based on the most recent available and authoritative data on the health effects of manganese.
4. What is the TLV-TWA for manganese based on? The TLV-TWA for manganese is based on the most recent available and authoritative data on the health effects of manganese.
5. How is the TLV-TWA for manganese being revised? The TLV-TWA for manganese is being revised because of new data on the health effects of manganese.
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9. How is the TLV-TWA for manganese being revised? The TLV-TWA for manganese is being revised because of new data on the health effects of manganese.
10. What is the TLV-TWA for manganese? The TLV-TWA for manganese is 0.05 mg/m³ (as Mn).

<http://www.lincolnelectric.com/en-us/education-center/welding-safety/Pages/revised-tlv-manganese.aspx>



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Bench Testing & Exposures Assessment Trials



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AWS F1.2 Method – Fume Collection Apparatus



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Bibliography and Suggested Reading

ANSI Z87.1, *Practice for Occupational and Educational Eye and Face Protection*, American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

Arc Welding and Your Health: A Handbook of Health Information for Welding, Published by The American Industrial Hygiene Association, 2700 Prosperity Avenue, Suite 250, Fairfax, VA 22031-4319.

NFPA Standard 51B, *Cutting and Welding Processes*, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9146, Quincy, MA 02269-9959.

The following publications are published by The American Welding Society, P.O. Box 351040, Miami, Florida 33135. Write for publications catalog:

ANSI/ASC, Standard Z49.1, *Safety in Welding and Cutting*.

AWS F1.1, *Method for Sampling Airborne Particulates Generated by Welding and Allied Processes*.

AWS F1.2, *Laboratory Method for Measuring Fume Generation Rates and Total Fume Emission of Welding and Allied Processes*.

AWS F1.3, *Evaluating Contaminants in the Welding Environment: A Strategic Sampling Guide*.

AWS F1.4, *Methods for Analysis of Airborne Particulates Generated by Welding and Allied Processes*.

AWS F1.5, *Methods for Sampling and Analyzing Gases from Welding and Allied Processes*.

AWS F4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping That Have Held Hazardous Substances*.

AWS SHF, *Safety and Health Facts Sheets*.

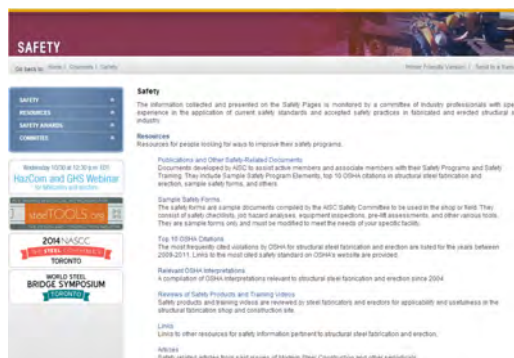


Questions?



AISC Safety Resources

- AISC Safety Website – www.aisc.org/safety
- Sample Safety Program Elements
- Safety Awards Program
- Sample Safety Forms
- Top 10 OSHA Citations
- OSHA Interpretations
- Safety Product Reviews
- Safety Details or 'Tool Box Talks'
- Daily Safety Focus
- And more



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Future Safety Webinars

We select safety webinar topics based on feedback provided by webinar participants. If you would like to see a certain topic presented in the future, make sure to complete to the feedback survey at the end of the webinar.



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There's always a solution in steel.

Thank You

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