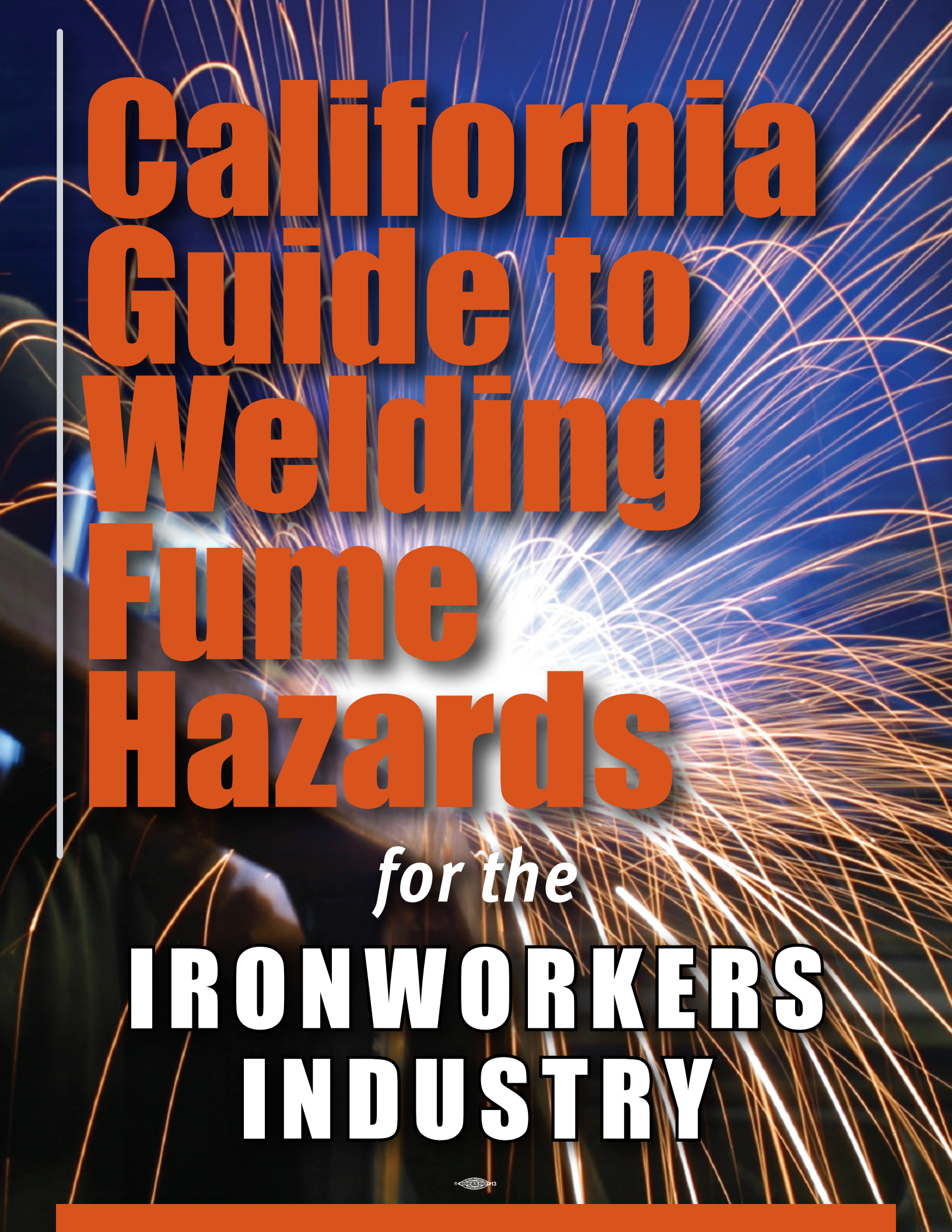

California Guide to Welding Fume Hazards

for the

IRONWORKERS INDUSTRY

California Guide to Welding Fume Hazards

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The purpose of the guide is to provide the employer with information to assist in the recognition and avoidance of potential hazards associated with the welding process and common operations. The Employer understands that the information provided in this guide may not reflect the conditions at the work place that may be unsafe or dangerous, and additional air sampling tests and evaluation may be warranted. The California Field Ironworkers Administrative Trust does not warrant, represent or guarantee in any manner that all unsafe or potentially hazardous conditions have been discovered. The California Field Ironworkers Administrative Trust makes no warranty, representation or guaranty as to the content, accuracy or completeness of the information provided to the Employer, makes no warranty that the information may be relied upon for any reason, including that the Employer's workplace is free from any hazards or unsafe conditions.

California Guide to Welding Fume Hazards

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CALIFORNIA FIELD IRONWORKERS ADMINISTRATIVE TRUST FUND BOARD OF TRUSTEES

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Special thanks to the Board of Trustees for the California Field Ironworkers Administrative Trust Fund for their commitment to improving safety performance and allocation of resources for the research and development of this guide. The following mentioned individuals combined their many talents to produce this guide: Len Welsh, Director of California OSHA; Pete Stafford, Director, Center to Protect Worker Rights; Dave McEuen, President, California Erectors Bay Area; and Jim Kegebein, Industrial Hygienist, Kegebein Consulting.

California Guide to Welding Fume Hazards Mission

The mission of the California Guide to Welding Fume Hazards is to provide union contractors and ironworkers with current welding fume information, including identifying metals used, consumables used, fume exposures and how to control.

This was accomplished by conducting field industrial hygiene welding fumes surveys. Surveys were conducted on four different metals (mild steel, stainless steel, galvanized steel and rebar) and two different work environments (outside and in shop). Each survey provides information on the:

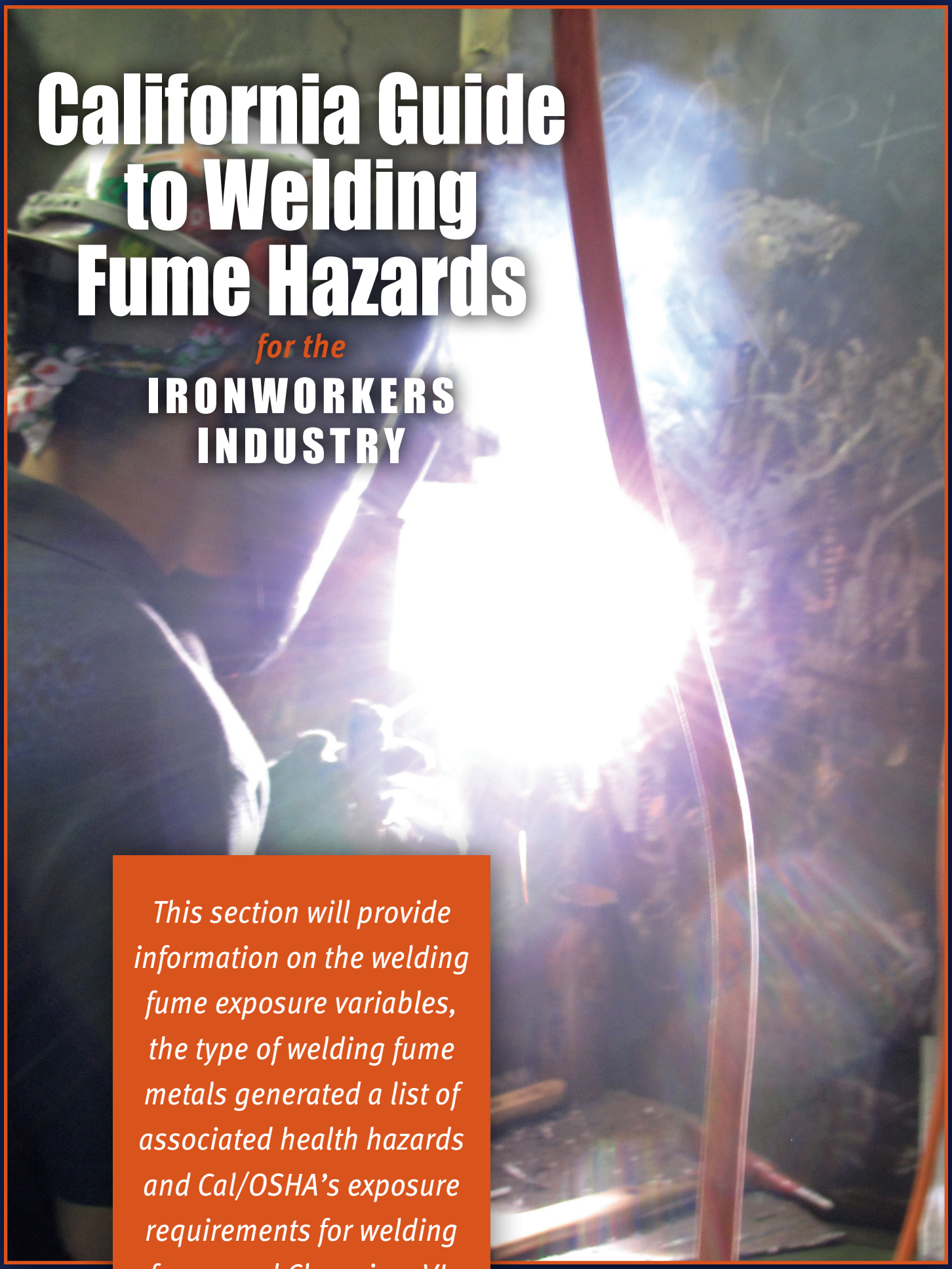
- **Type of Welding**
- **Metals Welded**
- **Consumables Used**
- **Task Specific Environments**
- **Representative Welding Fume Breathing and Area Zone Samples**
- **Date and Time Samples**
- **Analytical Method**
- **Welding Fume Metal Exposure Database**

Industrial hygiene air sampling and laboratory practices were followed by using an American Industrial Hygiene Association accredited laboratory and National Institute of Occupational Safety and Health sampling and analytical protocol for the specific metals sampled. The field welding fume exposure sampling method followed the OSHA Technical Manual for welding fume sampling under the welding hood when possible.

1 Welding Fume Metals, Potential Health Hazards and California Occupational Health Hazards

SPECIFIC ITEMS ADDRESSED

- *Describe Types of Metals Welded*
- *Identify Consumables Used*
- *Cal/OSHA Welding Fume Requirements*
- *Chromium VI Overview*
- *List of Associated Health Hazards*



California Guide to Welding Fume Hazards

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This section will provide information on the welding fume exposure variables, the type of welding fume metals generated a list of associated health hazards and Cal/OSHA's exposure requirements for welding fumes and Chromium VI.

Metal Fume Exposure Variables

1

Welding and cutting fume metal exposure has many variables. When determining welding fume exposure, the following should be used as a guide.

1. **What is being welded?**
   - Base metal joined or cut
   - Consumable filler metals and flux
   - Shield gases used
   - Metal coatings/paints/plating/epoxies...etc.
   - Cleaning agents/solvents
   - Others
2. **What type of welding or cutting is needed?**
   - MIG
   - TIG
   - Stick
   - Oxy
   - Plasma
   - Others
3. **What is the work/task environment?**
   - Confined space
   - Number of welders
   - Helpers
   - Air movement
   - Length of task
   - Body position
   - Local exhaust ventilation
   - Arc time
   - Arc settings
   - Others
4. **What training has been conducted?**
   - Management
   - Supervisor
   - Employee
   - Client/Customer
   - Others

Welding fume exposure potential hazards are based on the above and proximity, intensity, frequency and duration of welding.

Welding Fumes Metals

The following metals are potentially produced when welding cutting or heating, grinding, sanding, chipping on mild steel, stainless steel and galvanized steel.

1. **Aluminum**
2. **Anitimony**
3. **Arsenic**
4. **Barium**
5. **Beryllium**
6. **Cadmium**
7. **Calcium**
8. **Chromium**
9. **Chromium VI**
10. **Cobalt**
11. **Copper**
12. **Iron Oxide**
13. **Lead**
14. **Magnesium**
15. **Manganese**
16. **Nickel**
17. **Potassium**
18. **Sodium**
19. **Thallium**
20. **Vanadium**
21. **Zinc Oxide**
22. **Total welding fumes**
23. **Total dust**

NOTE: Material Safety Data Sheets for the base metal and consumables should be reviewed for specific task.

1 OSHA Welding Fume Standards

The following is an explanation of how Cal/OSHA currently assigns Permissible Exposure Limits (PELs) and some discussion on Manganese and welding fumes.

Section 5155, Airborne Contaminants, establishes minimum requirements for controlling employee exposure to specific airborne contaminants. This Section specifies several types of airborne exposure limits, requirements for control of skin and eye contact, workplace environmental monitoring through measurement or calculation, and medical surveillance requirements. California periodically amends the airborne contaminants table (Table AC-1) in this regulation to keep the standard consistent with current information regarding the harmful effects of exposure from these substances and other new substances not listed. The standard was last revised in 2001. In this revision, the substances chosen for review were taken from the 1997, 1998, 1999, 2000, and the 2001 editions of the Threshold Limit Values (TLVs) published by the American Conference of Governmental Industrial Hygienists (ACGIH). In 2007, Cal/OSHA has begun the process of PEL review with several advisory committees.

So that said, the ACGIH has been around since the mid 1940's and is a respected toxicological resource. They publish "Threshold Limit Values" yearly, with significant documentation.

Federal OSHA does not have a revision mechanism like Cal/OSHA and as a result some of the Federal OSHA PELs are from the 1960's. The current Cal/OSHA PEL for manganese is 0.2 milligrams per cubic meter (mg/m3) and the Federal OSHA PEL is 5 mg/m3.

One of the issues with welding fumes airborne hazard determination is the fume could be 10-20 different type of metals and each metal will have its own PEL.

FEDERAL AND CAL/OSHA WELDING FUME PERMISSIBLE EXPOSURE LIMITS

Metals	Cal/OSHA PEL's 8Hr. TWA Mg/m3	Fed OSHA PEL's 8Hr. TWA Mg/m3
Aluminum	5	10
Antimony	0.5	0.5
Arsenic	0.01	0.01
Barium	0.5	0.5
Beryllium	0.0002	0.002
Cadmium	0.005	0.005
Calcium	2	5
Chromium	0.5	1
Chromium VI	0.005	0.005
Cobalt	0.02	0.1
Copper	0.1	0.1
Iron Oxide	5	10
Lead	0.005	0.005
Magnesium	10	15
Manganese	0.2	5
Nickel	1	1
Potassium	2	na
Sodium	na	na
Thallium	0.1	0.1
Vanadium	0.05	0.1
Zinc Oxide	5	5
Total Welding Fumes	5	na
Total Dust	10	15

NOTE: *The 2009 TLV for Manganese has a Notice of Intended Change to 0.02 mg/m3 from 0.2 mg/m3.*

Chromium VI Overview 1

29 CFR 1926.1126 Chrom VI

On February 28, 2006 the Occupational Safety and Health Administration (OSHA) published the final Chromium (VI) Standard. The new permissible exposure limit (PEL) for Cr(VI) is 0.005 milligrams per cubic meter (mg/m3). There are three standards for different industries General Industry, Construction, and Shipyards. The standard requires workplace controls including respiratory protection. For a complete copy of the standard refer to OSHA's website at www.osha.gov.

What is Chrom VI?

Chrom VI is a metal that can occur naturally in rocks and most commonly produced by industrial process. When heated chrom VI has the ability to gain electrons from other elements (a strong oxidizer), which means it can react easily with other elements. Because of its ability to react with other elements it can produce hard coatings, which is why it is used in paints for cars, boats, and airplanes. This property is also what makes Chromium a health hazard.

What type of contaminant is Chrom VI?

Chrom VI is a metal particle.

What Chrom VI exposures are covered in the standard?

Chrom VI exposures from any source (including grinding, cutting, heating sanding, welding, etc.) are covered by the standard, except exposures from:

- Portland cement.
- Application of regulated pesticides such as treatment of wood with pesticides.
- Exposures resulting from sawing or sanding treated wood are covered by the standard.

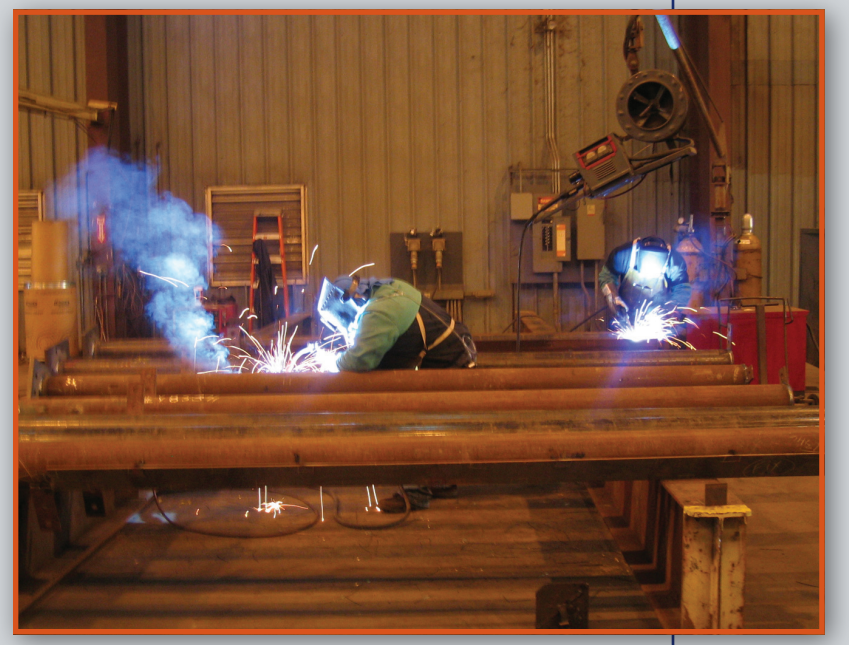
What are the main applications affected?

Welding-especially on stainless steel, spraying heavy duty coatings and paints, and chrome plating.

Key Issues with New Standard

Permissible exposure limit (PEL) 0.005 mg/m3. Medical surveillances required at 0.0025mg/m3. Enforcement starts for employers of 20 or more November 27, 2006. If action level is exceeded the employer must:

- Provide controls such as local exhaust ventilation, respiratory protection/eye protection (goggles/ fresh air hood).
- Provide protective clothing at no cost to employees and ensure hazard does not leave the project. Bags or containers for discarded clothing, possible laundering facility.



- Hygiene areas for eating and drinking change rooms, storage of eating and drinking materials to include cigarettes/cosmetics etc.
- Medical surveillance similar to lead exposure.
- Record keeping – air monitoring data for each employees working in area.
- Limited access to regulated areas.
- Hazard Communication training.

1 Welding Fume Health Hazards

The American Welding Society, *Effects of Welding on Health,* Volume I, 1979, has identified over 80 different types of welding and allied processes in commercial use. Each with its own potential safety and health hazard. It should be noted that there are many potential health hazards associated with welding, including metal particulates and gases, electrical, heat, noise vibration, ultraviolet and visible light. This guide will only look at the metal fumes.

The welding process produces metal fumes and gases that may cause adverse long term health risk. Exposure to different types of welding fumes produce different health effects.

The following health information are examples of general Acute (short term) and Chronic (long term) welding related health concerns.

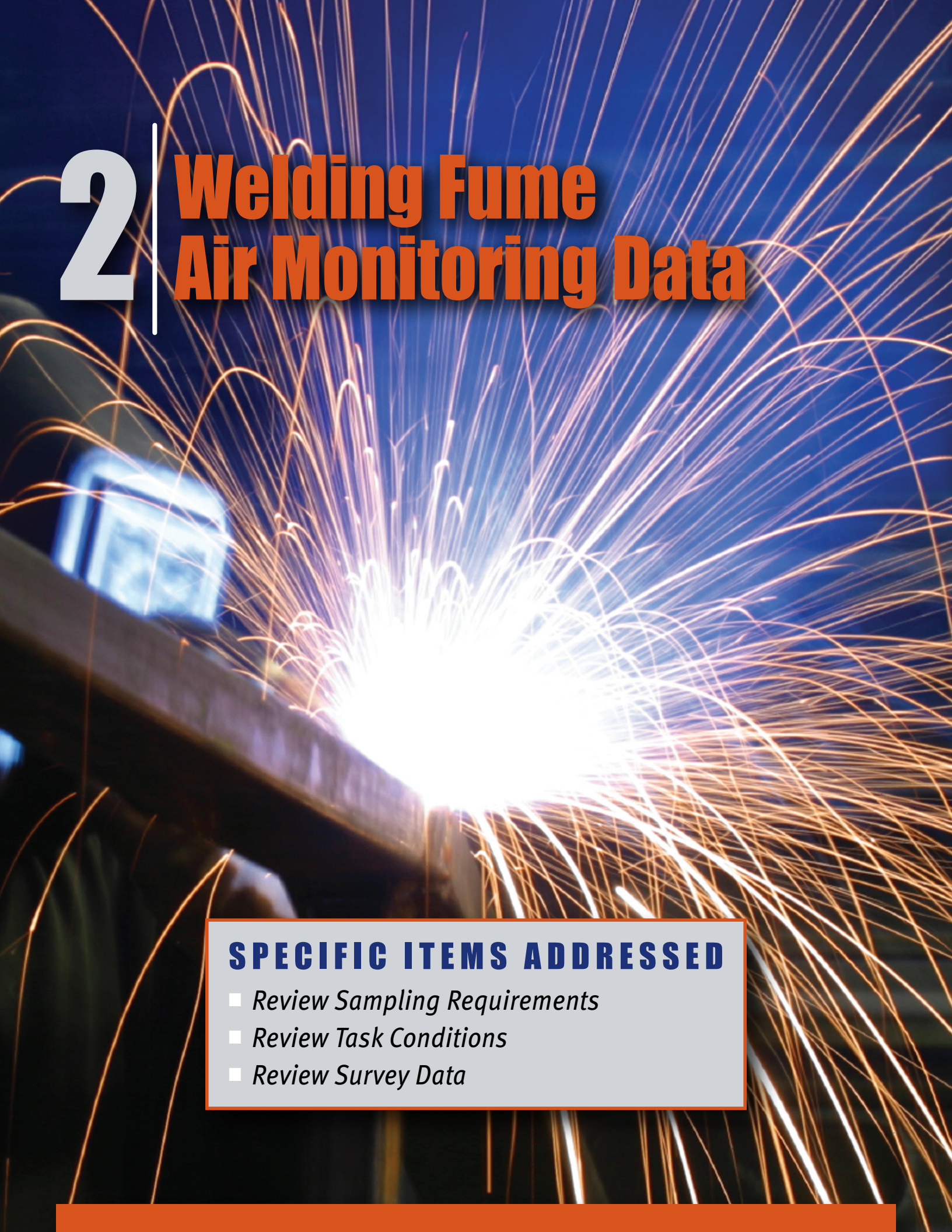
1. Acute exposure to welding fumes can result eye, nose, and throat irritation, fever, chills, headache, nausea, shortness of breath, muscle pain, and a metallic taste in the mouth.
2. Chronic exposure to welding fumes can result in respiratory effects including coughing, wheezing, and decreased pulmonary function.

WELDING FUME HEALTH HAZARDS

Metals	Cas #	Health Hazard
Aluminum Oxide	7429-90-5	Pneumoconiosis, lower respiratory tract irritation and neuorotoxicity, not suspected as a human carcinogen
Antimony	7440-36-0	Skin and upper respiratory tract irritation
Arsenic	7440-38-2	Lung cancer, confirmed human carcinogen
Barium	7440-39-3	Eye, skin and gastrointestinal irritation , muscular stim, not suspected as a human carcinogen
Beryllium	7440-41-7	Skin sensitizer, beryllium sensitization; beryllium disease, confirmed human carcinogen
Cadmium	7440-43-9	Kidney damage, suspected human carcinogen
Calcium Oxide	1305-78-8	Upper respiratory tract irritation
Chromium	7440-47-3	Upper respiratory tract and skin irritation
Chromium VI	7440-47-3	Lung cancer, confirmed human carcinogen
Cobalt	7440-48-4	Asthma, pulmonary function, myocardial effect, confirmed animal carcinogen with unknown relevance to humans
Copper	7440-50-8	Irritation, gastrointestinal
Iron Oxide	1309-37-1	Pneumoconiosis, not suspected as a human carcinogen
Lead	7439-92-1	Male reproductive damage, teratogenic effect, vasoconstriction, suspected human carcinogen
Magnesium Oxide	1309-48-4	Not suspected as a human carcinogen
Manganese	7439-96-5	Central nervous system impairment (neurobehavioral and neuropsychological changes), not suspected as a human carcinogen
Nickel	7440-02-0	Dermatitis, pneumoconiosis, not suspected as a human carcinogen
Potassium	7440-9-7	NA
Selenium	7782-49-2	Eye and upper respirator irritation
Sodium	7440-23-5	NA
Thallium	7440-28-0	Skin and alopecia
Vanadium	1314-62-1	Upper and lower respiratory tract irritation
Zinc Oxide	7440-66-6	Metal fume fever

The source for the chemical abstract number(CAS) and health hazards was the 2009 "Threshold Limit Values and Biological Exposure Indices," booklet by American Conference of Governmental Industrial Hygienist.

Notes



2 Welding Fume Air Monitoring Data

SPECIFIC ITEMS ADDRESSED

- *Review Sampling Requirements*
- *Review Task Conditions*
- *Review Survey Data*

California Guide to Welding Fume Hazards

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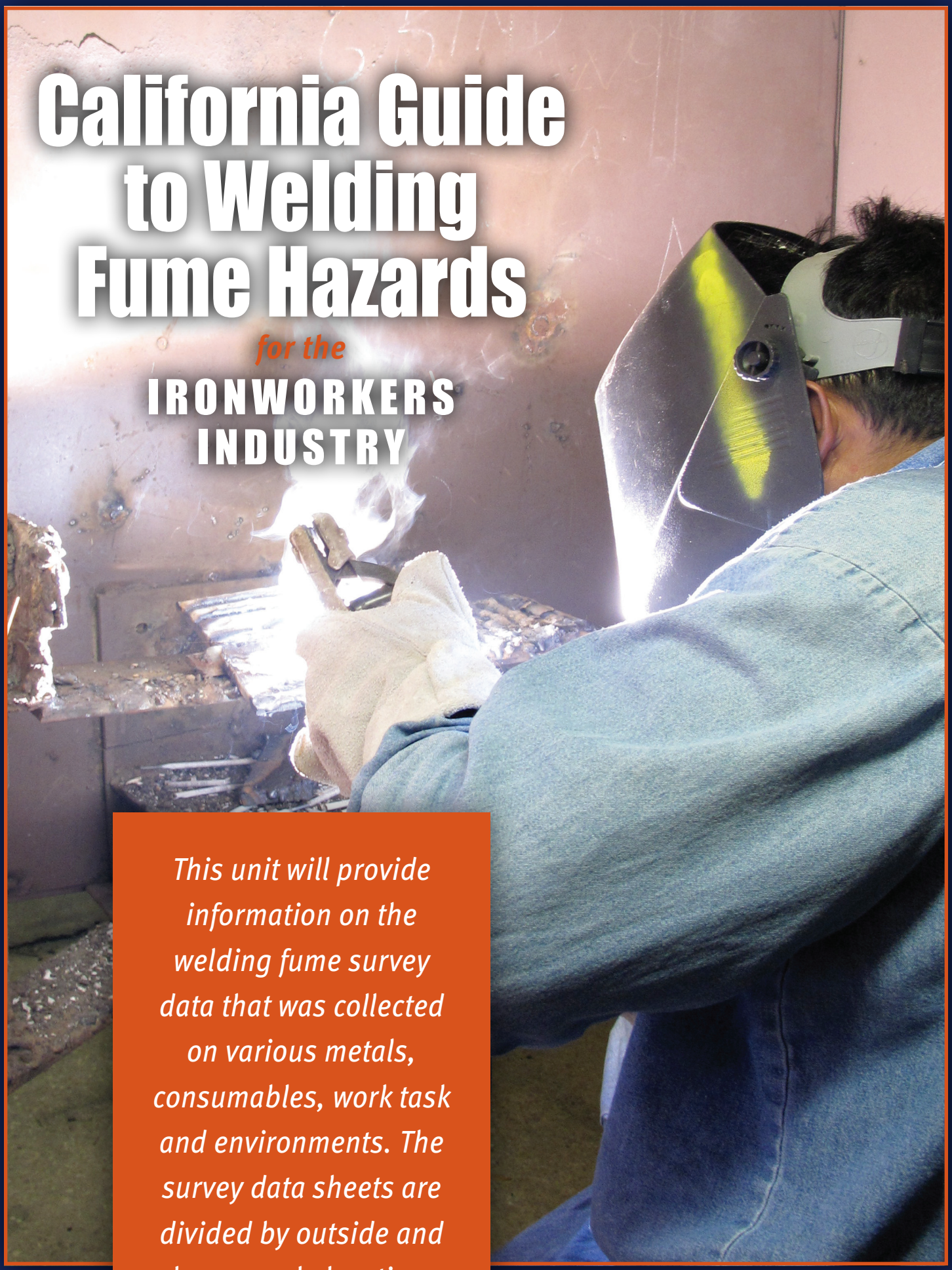


This unit will provide information on the welding fume survey data that was collected on various metals, consumables, work task and environments. The survey data sheets are divided by outside and shop sample locations.

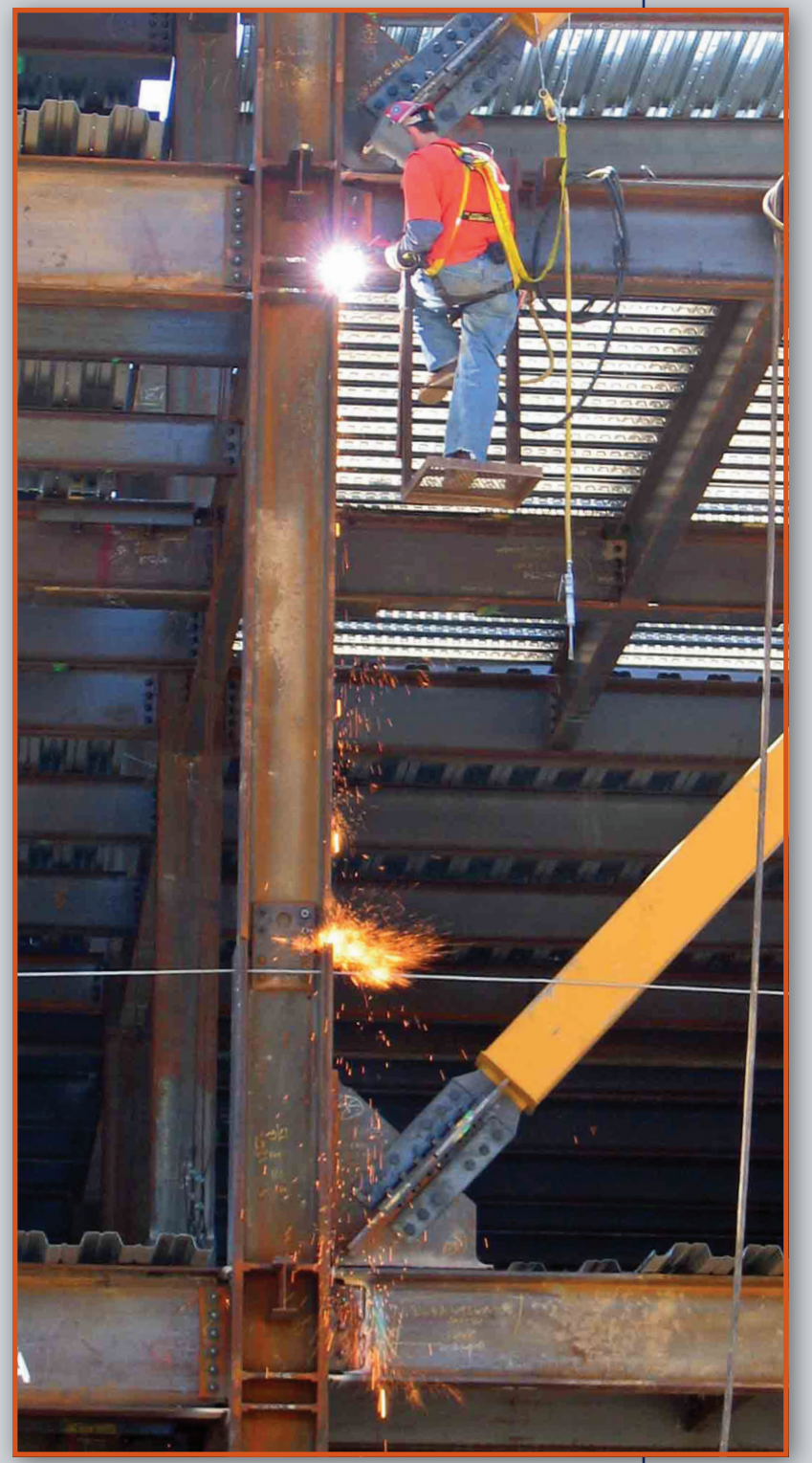
Cal/OSHA, 5206 Chromium Standard

PERFORMANCE-ORIENTED OPTION

The employer shall determine the 8 hour TWA exposure for each employee on the basis of any combination of air monitoring data, historical monitoring data, or objective data sufficient to accurately characterize employee exposure to chromium (VI).

Historical Monitoring Data means data from chromium (VI) monitoring conducted prior to September 19, 2006, obtained during work operations conducted under workplace conditions closely resembling the processes, types of material, control methods, work practices, and environmental conditions in the employer's current operations.

Objective Data means information such as air monitoring data from industry-wide surveys or calculations based on the composition or chemical and physical properties of a substance demonstrating the employee exposure to chromium (VI) associated with a particular product or material or a specific process, operation or activity. The data must reflect workplace conditions closely resembling the processes, types of material, control methods, work practices, and environmental conditions in the employer's current operations.



2 Welding Fume Sample Locations

1. Federal OSHA, Technical Manual, section "V," Sampling for Welding Fumes

"When sampling for welding fumes, the filter cassette must be placed inside the welding helmet to obtain an accurate measurement of the employee's exposure."

2. Federal MSHA, "Welding Fume Sampling"

"When sampling for welding fumes, the inspector will use a filter-cassette placed on the collar or shoulder so that it is beneath the helmet when the helmet is placed down."

3 & 4. American National Standard Institute, Z49.1, 2005, "Safety in Welding, Cutting and Allied Processes" and **American Welding Society,** F1.1, "Method for Sampling Airborne Particulates Generated by Welding And Allied Processes"

"When a helmet is worn, the samples shall be collected inside the helmet in the welder's breathing zone."

5. American Industrial Hygiene Association Press, "Welding Health and Safety," Chapter 8, Air Monitoring

"Given the sources variation and the variation in results reported in the literature, it may be prudent to perform air monitoring in side the hood, even in the face of some resistance by the welders to be monitored."

6. International Standard, ISO 10882-1, "Health and Safety in welding and allied processes — Sampling of airborne particles and gases in the operators breathing zone," Part 1: Sampling of airborne particles, section 8.2 Personal exposure measurement

"Personal sampling shall take place behind the welders face shield, if used."

7. Federal OSHA Instruction, "Inspection Procedures for the Chromium(VI) Standards,: Jan. 24, 08

"When collecting an air sample on a welder wearing a protective helmet, the sampling cassette shall be positioned inside the helmet."

8. NIOSH, "NIOSH Manual of Analytical Methods"

"NIOSH recommends that the best method available be used for making each measurement. Methods published by others, such as OSHA, MSHA, EPA, ASTM, ISO or commercial suppliers of sampling and analytical equipment, may have advantages over NIOSH methods for a given sampling situation."

Welding Fume Sample Location

Prior to usage or air monitoring the specific base metal and consumable Material Safety Data Sheets (MSDSs) must be reviewed to identify specific hazards.

Welding samples were collected when galvanized, mild and stainless steel were welded. Samples were also taken when cutting rebar and plasma cutting stainless steel. The following is a list of consumables by case number that were sampled:

Consumable	Case #
E2209-16	28, 29, 30,40, 41,41, 42, 66, 68, 69, 70, 71, 72, 73,74, 75, 76, 79, 83, 84, 85, 86, 87, 88, 89
E6010	105, 107
E7018	54, 98, 99, 100, 101, 113, 114,115, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152
E9018	7, 8, 10
ENICROMO-4	37, 38, 39, 77, 78, 80, 81, 82, 89, 90, 91, 93, 94, 95
E70T	6,11, 12, 13, 14, 15,16, 17, 18, 23, 24, 27, 43, 44, 52, 62, 63, 64, 65, 131, 132, 133
E71T	1, 2, 3, 4, 5, 11, 2, 13, 14,15, 16, 17, 18, 23, 43, 44, 52,109, 110, 117, 118, 119, 120, 121, 122, 123, 127
ER308	45, 46, 47, 48, 108
ER495-6	103, 104, 106
ER705	154, 155, 156
ER4043	153
XLH70	49, 50, 51, 53
203NI	97, 124, 125, 126, 127, 128, 129, 130
232	21, 22, 114, 115, 116, 120
305	21, 22
311	19, 20
960 FLUX	55, 56, 59, 60, 61
Air Carbon Arc	4, 11, 12, 13, 24, 27
Plamsa Cutting	31, 32, 33, 34, 35, 36, 96
Rebar Cutting	9
Rebar Welding	7, 98, 99, 100, 101

NOTE: *No samples were collected in confined spaces. Outside Case #1-44 and Inside Case #45-156.*

ADDITIONAL SAMPLING INFORMATION

CAL/OSHA, Chromium VI.

Scheduled monitoring option. Section 5206 (d)

The employer shall perform initial monitoring to determine the 8-hour TWA exposure for each employee on the basis of a sufficient number of personal breathing zone air samples to accurately characterize full shift exposure on each shift, for each job classification, in each work area. Where an employer does representative sampling instead of sampling all employees in order to meet this requirement, ***the employer shall sample the employee(s) expected to have the highest chromium (VI) exposures****.*

Accuracy of measurement.

Where air monitoring is performed to comply with the requirements of this section, the employer shall use a method of monitoring and analysis that can measure chromium (VI) to within an ***accuracy of plus or minus 25 percent (25%)*** *and can produce accurate measurements to within a statistical confidence level of 95 percent for airborne concentrations at or above the action level.*

The following data sheets represent a variety of welding fume samples. The metals sampled included mild steel, stainless steel and galvanized steel. Additionally, there are data sheets for cutting and welding rebar and plasma cutting of stainless steel.

All sample collection methods followed current Industrial Hygiene Practices for sampling welding fumes.

All sample analysis were conducted by an American Industrial Hygiene Association Certified laboratory.

2 Case Study #1 – Outdoor Galvanized Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E71T-8 wire

Base Metal: galvanized steel

Type of Weld: varied

Environment: outdoor, wind speed 0-200 fpm, Hospital construction, steel erection phase

Sample Location: breathing zone, under hood

Sample Date: Aug 2006

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 483 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.045	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0042	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	0.002	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0019	N	N
Iron Oxide	5	10	0.48	N	N
Lead	0.05	0.05	0.0032	N	N
Magnesium	10	15	0.084	N	N
Manganese	0.2	5C	0.037	N	N
Nickel	1	1	0.00063	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	1.4	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #2 – Outdoor Galvanized to Carbon Steel

2

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E71T-8

Base Metal: carbon and galvanized steel-roof supports

Type of Weld: flat

Environment: outdoor, Office structure, wind speed 0-200 fpm

Sample Location: breathing zone under hood

Sample Date: Aug 2006

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 450 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.32	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0098	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.039	N	N
Chromium	0.5	1	0.0043	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0031	N	N
Iron Oxide	5	10	1.8	N	N
Lead	0.05	0.05	0.022	N	N
Magnesium	10	15	0.51	N	N
Manganese	0.2	5C	0.13	N	N
Nickel	1	1	0.021	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	4.4	N	N
Total Welding Fumes	5	NA	NT	**YES**	N
Total Dust	10	15	11	**YES**	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #3 – Outdoor Galvanized to Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E71T-8 wire

Base Metal: carbon & galvanized steel

Type of Weld: horizontal

Environment: outdoor, Office structure, wind speed 0-200 fpm

Samples Location: breathing zone not under hood

Sample Date: Aug 2006

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 420 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.16	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0083	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.05	N	N
Chromium	0.5	1	0.0025	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0026	N	N
Iron Oxide	5	10	1.4	N	N
Lead	0.05	0.05	0.0099	N	N
Magnesium	10	15	0.33	N	N
Manganese	0.2	5C	0.098	N	N
Nickel	1	1	0.00073	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	2.3	N	N
Total Welding Fumes	5	NA	NT	**YES**	N
Total Dust	10	15	7.1	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #4 – Outdoor Galvanized to Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: Air Carbon Arc and E71-8
Base Metal: galvanized & carbon steel
Type of Weld: varied
Environment: outdoor, wind speed 0-200 fpm
Sample Location: breathing zone under hood

Sample Date: Aug 2006
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 237 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.031	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.00015	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0024	N	N
Iron Oxide	5	10	0.32	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.071	N	N
Manganese	0.2	5C	0.016	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	1	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #5 – Outdoor Galvanized to Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E71T-11 wire

Base Metal: carbon & galvanized steel

Type of Weld: varied

Environment: outdoor, Hospital Construction, steel erection, wind speed 0-60 fpm

Sample Location: breathing zone under hood

Sample Date: June 2006

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 490 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0068	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NA	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.00043	N	N
Iron Oxide	5	10	0.093	N	N
Lead	0.05	0.05	0.0016	N	N
Magnesium	10	15	0.015	N	N
Manganese	0.2	5C	0.0029	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.3	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	0.63	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #6 – Outdoor Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E70T
Base Metal: carbon steel
Type of Weld: flat
Environment: wind speed 0-60 fpm
Sample Location: breathing zone, under hood

Sample Date: Aug 2006
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 477 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.12	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0989	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	0.024	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	0.0017	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0031	N	N
Iron Oxide	5	10	1	N	N
Lead	0.05	0.05	0.00083	N	N
Magnesium	10	15	0.39	N	N
Manganese	0.2	5C	0.1	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.013	N	N
Total Welding Fumes	5	NA	NT	**YES**	N
Total Dust	10	15	4.7	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #7 – Welding Rebar

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: SAW E9018
Base Metal: rebar
Type of Weld: flat-5 sticks
Environment: outdoor, wind speed 0-250 fpm

Sample Location: breathing zone, under hood
Sample Date: April 2007
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 61 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	ND	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.0025	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #8 – Welding and Cutting Rebar

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: SMAW -E9018

Base Metal: rebar

Type of Weld: flat

Environment: outdoor, wind speed 0-250 fpm

Sample Location: area breathing zone, 5 feet off ground, 10 feet from weld

Sample Date: April 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 58 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	10	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	NA	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	ND	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.0052	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #9 – Cutting Rebar

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: rebar, 90+ cuts
Base Metal: carbon steel
Type of Weld: flat
Environment: outside, wind speed 0-250 fpm

Sample Location: breathing zone
Sample Date: April 2007
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 119 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.05	0.05	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0056	N	N
Iron Oxide	5	10	0.22	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5	0.0014	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Fumes	5	NA	ND	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #10 – Welding and Cutting Rebar

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: SMAW-E9018 stick

Base Metal: rebar

Type of Weld: horizontal

Environment: outdoor, wind speed 0-250 fpm

Samples Location: area breathing zone, 5 feet from cutting and welding

Sample Date: April 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 64 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.005	0.005	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	0.11	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.01	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #11 – Outdoor Column Spicing with Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E71T & E70T & Air Carbon Arc
Base Metal: carbon steel
Type of Weld: varied
Environment: outdoor, wind speed 0-200 fpm

Sample Location: breathing zone, not under hood
Sample Date: Aug 2006
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 466 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.049	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.00076	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.023	N	N
Chromium	0.5	1	0.002	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.013	N	N
Iron Oxide	5	10	0.71	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.031	N	N
Manganese	0.2	5C	0.066	N	N
Nickel	1	1	0.001	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.0064	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	2.5	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #12 – Outside Welding Structural Welding and Cutting

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E71T-8 & E70T & Air Carbon Arc

Base Metal: carbon steel

Type of Weld: varied

Environment: outdoor, Hospital construction, steel erection phase, wind speed 0-200 fpm

Sample Location: general area breathing zone

Sample Date: June 2006

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 486 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.0078	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.022	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	0.02	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.00041	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #13 – Outside Structural Welding and Cutting

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E71T-8, E70T-6 and Air Carbon Arc
Base Metal: carbon steel
Type of Weld: varied
Environment: outdoor, wind speed 0-200 fpm

Sample Location: area breathing zone
Sample Date: Aug 2006
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 442 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.02	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	0.014	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.00031	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	0.32	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #14 – Outside Welding

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E71T-8 and E70T-6
Base Metal: carbon steel
Type of Weld: flat
Environment: outdoor, wind speed 0- 50fpm

Samples Location: breathing zone, not under hood
Sample Date: Aug 2006
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 468 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.12	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0043	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.033	N	N
Chromium	0.5	1	0.0022	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0077	N	N
Iron Oxide	5	10	0.97	N	N
Lead	0.05	0.05	0.00059	N	N
Magnesium	10	15	0.18	N	N
Manganese	0.2	5C	0.069	N	N
Nickel	1	1	0.00077	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.051	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	4.6	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #15 – Outside Welding Carbon Steel Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E71T-6 and E71T-8
Base Metal: carbon steel
Type of Weld: varied
Environment: outdoor, wind speed 0- 200fpm

Sample Location: breathing zone, not under hood
Sample Date: Aug 2006
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 484 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	ND	0.096	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	0.0013	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	ND	ND	0.024	N	N
Chromium	0.5	1	0.0018	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	0.0062	N	N
Iron Oxide	5	10	1	N	N
Lead	0.05	0.05	0.00086	N	N
Magnesium	10	15	0.076	N	N
Manganese	0.2	5C	0.18	N	N
Nickel	1	1	0.00047	N	N
Potassium	2	ND	0.032	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	ND	ND	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	0.014	N	N
Total Welding Fumes	5	ND	NT	N	N
Total Dust	10	15	3.2	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #16 – Outdoor Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E71T and E70T-6
Base Metal: carbon steel
Type of Weld: horizontal
Environment: outdoor, wind speed 0-200 fpm

Sample Location: breath zone, not under hood
Sample Date: Aug 2006
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 440 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.08	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.00031	N	N
Barium	0.5	0.5	0.0048	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.021	N	N
Chromium	0.5	1	0.0018	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.02	N	N
Iron Oxide	5	10	1.5	N	N
Lead	0.05	0.05	0.00056	N	N
Magnesium	10	15	0.14	N	N
Manganese	0.2	5C	0.072	N	N
Nickel	1	1	0.001	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.011	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	4.6	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #17 – Outdoor Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E71T and E70T-6
Base Metal: carbon steel
Type of Weld: horizontal
Environment: wind speed 0-200 fpm

Sample Location: outdoor, breath zone, not under hood
Sample Date: June 2006
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 489 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.061	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0048	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0083	N	N
Iron Oxide	5	10	0.6	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.11	N	N
Manganese	0.2	5C	0.045	N	N
Nickel	1	1	0.00041	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.0046	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	2.5	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #18 – Outdoor Column Welding with Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E71T and E70T-6
Base Metal: carbon steel
Type of Weld: column spicing
Environment: outdoor, wind speed 0-50 fpm

Sample Location: breathing zone, not under hood
Sample Date: June 2006
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 485 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.035	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0009	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.002	N	N
Iron Oxide	5	10	0.26	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.02	N	N
Manganese	0.2	5C	0.038	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	0.99	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #19 – Outdoor Parking Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 311 wire
Base Metal: mild steel
Type of Weld: varied
Environment: outdoor, parking structure construction, steel erection phase

Sample Location: breathing zone, under hood
Sample Date: Oct 2007
Analytical Method: Mod NIOSH 7303

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 464 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.24	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.54	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	2.9	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	1.9	N	N
Manganese	0.2	5C	0.205	YES	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #20 – Outdoor Parking Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 311 wire
Base Metal: mild steel
Type of Weld: varied
Environment: outdoor, parking structure construction, steel erection phase

Sample Location: breathing zone, under hood
Sample Date: Oct 2007
Analytical Method: Mod NIOSH 7303

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 472 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.152	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.38	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	1.45	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	1.01	N	N
Manganese	0.2	5C	0.129	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #21 – Outdoor Parking Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 305 and 232 wire

Base Metal: mild steel

Type of Weld: varied

Environment: outdoor, parking structure construction, steel erection phase

Sample Location: breathing zone, under hood

Sample Date: Oct 2007

Analytical Method: Mod NIOSH 7303

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 482 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.18	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0097	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	1.2	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.17	N	N
Manganese	0.2	5C	0.15	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #22 – Outdoor Parking Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 305 and 232 wire
Base Metal: mild steel
Type of Weld: varied
Environment: outdoor, parking structure construction, steel erection phase

Sample Location: breathing zone, under hood
Sample Date: Oct 2007
Analytical Method: Mod NIOSH 7303

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 481 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.78	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.04	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	4.7	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.76	N	N
Manganese	0.2	5C	0.66	YES	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	YES	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #23 – Outdoor Carbon Steel Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: Carbon arc, E71T-8 and E70T-6

Base Metal: Carbon Steel

Type of Weld: varied

Environment: outdoor, wind speed 0-5 mph, Hospital construction, steel erection phase

Sample Location: breathing zone, under hood

Sample Date: Sept. 28, 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 478 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.079	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0062	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	0.0035	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0097	N	N
Iron Oxide	5	10	1.5	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.079	N	N
Manganese	0.2	5C	0.037	N	N
Nickel	1	1	0.0015	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.027	N	N
Total Welding Fumes	5	NA	NT	**YES**	N
Total Dust	10	15	3.6	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #24 – Outdoor Carbon Steel Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: Carbon arc and E70T-6

Base Metal: Carbon Steel

Type of Weld: varied

Environment: outdoor, wind speed 0-5 mph, Hospital construction, steel erection phase

Sample Location: breathing zone, under hood

Sample Date: Sept.28, 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 483 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.11	N	N
Antimony	0.5	0.5	0.00055	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0067	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.038	N	N
Iron Oxide	5	10	3.1	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.039	N	N
Manganese	0.2	5C	0.077	N	N
Nickel	1	1	0.0045	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.021	N	N
Total Welding Fumes	5	NA	ND	**YES**	N
Total Dust	10	15	6.0	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #25 – Outdoor Carbon Steel Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: None

Base Metal: Carbon Steel

Type of Weld: varied

Environment: outdoor, wind speed 0-5 mph, Hospital construction, steel erection phase

Sample Location: inside crew trailer

Sample Date: Sept. 28, 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 459 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	0.021	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.0051	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	0.18	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #26 – Outdoor Carbon Steel Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70T-8 and E71-6

Base Metal: Carbon Steel

Type of Weld: varied

Environment: outdoor, wind speed 0-5 mph, Hospital construction, steel erection phase

Sample Location: breathing zone, under hood

Sample Date: Sept 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	Void-filter lost	N	N
Antimony	0.5	0.5	Void-filter lost	N	N
Arsenic	0.01	0.01	Void-filter lost	N	N
Barium	0.5	0.5	Void-filter lost	N	N
Beryllium	0.0002	0.002	Void-filter lost	N	N
Cadmium	0.005	0.005	Void-filter lost	N	N
Calcium	2	5	Void-filter lost	N	N
Chromium	0.5	1	Void-filter lost	N	N
Chromium VI	0.0025 AL	0.0025 AL	Void-filter lost	N	N
Cobalt	0.02	0.1	Void-filter lost	N	N
Copper	0.1	0.1	Void-filter lost	N	N
Iron Oxide	5	10	Void-filter lost	N	N
Lead	0.05	0.05	Void-filter lost	N	N
Magnesium	10	15	Void-filter lost	N	N
Manganese	0.2	5C	Void-filter lost	N	N
Nickel	1	1	Void-filter lost	N	N
Potassium	2	NA	Void-filter lost	N	N
Selenium	0.2	0.2	Void-filter lost	N	N
Sodium	NA	NA	Void-filter lost	N	N
Thallium	0.1	0.1	Void-filter lost	N	N
Vanadium	0.05	0.1C	Void-filter lost	N	N
Zinc Oxide	5	5	Void-filter lost	N	N
Total Welding Fumes	5	NA	Void-filter lost	N	N
Total Dust	10	15	Void-filter lost	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #27 – Outdoor Carbon Steel Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: Carbon arc and E70T-6

Base Metal: Carbon Steel

Type of Weld: varied

Environment: outdoor, wind speed 0-5 mph, Hospital construction, steel erection phase

Sample Location: breathing zone, under hood

Sample Date: Sept 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 479 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.045	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0042	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	0.002	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0019	N	N
Iron Oxide	5	10	0.48	N	N
Lead	0.05	0.05	0.0032	N	N
Magnesium	10	15	0.084	N	N
Manganese	0.2	5C	0.037	N	N
Nickel	1	1	0.00063	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	1.4	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #28 – Outdoor Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16
Base Metal: stainless steel
Type of Weld: flat
Environment: outdoor-4mph

Sample Location: breathing zone, under hood
Sample Date: Oct 2007
Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0022	**YES**	**YES**
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #29 – Outdoor Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16
Base Metal: stainless steel
Type of Weld: flat
Environment: outdoor, 4 mph

Sample Location: general breathing zone, 6 feet from weld
Sample Date: Aug 2007
Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0022	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #30 – Outdoor Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16
Base Metal: stainless steel
Type of Weld: flat
Environment: outdoor, 4mph

Sample Location: breathing zone, under hood
Sample Date: Aug 2007
Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.036	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #31 – Outdoor Plasma Cutting Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable:

Base Metal: stainless steel, C-276 alloy plate

Type of Weld: plasma cutting

Environment: outdoor, 4mph

Sample Location: area breathing zone, 2 feet from weld

Sample Date: Aug 2007

Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	‹0.0008	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #32 – Outdoor Plasma Cutting Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable:
Base Metal: stainless steel, c-276 alloy plate
Type of Weld: plasma cutting
Environment: outdoor, 4 mph

Sample Location: area breathing zone, 3 feet from cut
Sample Date: Aug 2007
Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0095	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #33 – Outdoor Plasma Cutting Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable:
Base Metal: stainless steel,C-276 alloy plate
Type of Weld: plasma cutting
Environment: outdoor, 4 mph

Sample Location: area breathing zone, 6 feet from cut
Sample Date: Aug 2007
Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	‹0.0008	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.8	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #34 – Outdoor Plasma Cutting Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable:
Base Metal: stainless steel, C-276 alloy plate
Type of Weld: flat
Environment: area breathing zone, 3 feet from weld

Sample Location: breathing zone, under hood
Sample Date: Sept 2007
Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00024	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.2	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #35 – Outdoor Plasma Cutting Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable:
Base Metal: stainless steel, C276 alloy plate
Type of Weld: plasma cut
Environment: outdoor

Sample Location: area breathing zone, 3 feet from cut
Sample Date: Sept 2007
Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00023	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	<1	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #36 – Outdoor Plasma Cutting Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable:
Base Metal: stainless steel, C276 alloy plate
Type of Weld: plasma cutting
Environment: outdoor

Sample Location: area breathing zone, 6 feet from cut
Sample Date: Sept 2007
Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	<0.0001	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	<0.2	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #37 – Outdoor Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: EniCrMo-4(276)AP 0.45 wire, argon/ carbon dioxide shield

Base Metal: stainless steel, C276 alloy plate

Type of Weld: flat

Environment: outdoor

Sample Location: breathing zone, under hood

Sample Date: Sept 2007

Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0031	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	0.97	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #38 – Outdoor Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: EniCrMo-4(276)AP 0.45 wire, argon/carbon dioxide shield

Base Metal: stainless steel, C276 alloy plate

Type of Weld: flat

Environment: outdoor

Sample Location: area breathing zone, 3 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.002	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #39 – Outdoor Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: EniCrMo-4(276)AP 0.45 wire, argon/ carbon dioxide shield

Base Metal: stainless steel, C276 alloy plate

Type of Weld: flat

Environment: outdoor

Sample Location: area breathing zone, 6 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.002	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	<0.1	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #40 – Outdoor Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 -1/8 stick
Base Metal: stainless steel, C276 alloy plate
Type of Weld: flat
Environment: outdoor

Sample Location: breathing zone, under hood
Sample Date: Sept 2007
Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.007	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	<0.2	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #41 – Outdoor Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16-1/8 stick
Base Metal: stainless steel,C276 alloy plate
Type of Weld: flat
Environment: outdoor

Sample Location: area breathing zone, under hood
Sample Date: Sept 2007
Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0049	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.2	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #42 – Outdoor Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16-1/8 stick
Base Metal: stainless steel, C276 alloy plate
Type of Weld: flat
Environment: outdoor

Sample Location: area breathing zone, 6 feet from weld
Sample Date: Sept 2007
Analytical Method: OSHA ID-215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00075	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.2	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #43 – Outdoor Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E71T and E70T-6
Base Metal: carbon steel
Type of Weld: horizontal

Environment: wind speed 0-200 fpm
Sample Location: outdoor, breath zone, not under hood

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 489 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	10	0.061	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0048	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0083	N	N
Iron Oxide	5	10	0.6	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.11	N	N
Manganese	0.2	5C	0.045	N	N
Nickel	1	1	0.00041	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1	ND	N	N
Zinc Oxide	5	5	0.0046	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	2.5	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Date Sampled: Sept 2007.

Case Study #44 – Outdoor Column Welding with Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E71T and E70T-6
Base Metal: carbon steel
Type of Weld: column spicing

Environment: outdoor, wind speed 0-50 fpm
Sample Location: breathing zone, not under hood

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 477 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	10	0.035	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0009	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.002	N	N
Iron Oxide	5	10	0.26	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.02	N	N
Manganese	0.2	5C	0.038	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	0.99	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Date Sampled: Sept 2007.

2 Case Study #45 – Shop Welding Stainless Steel Handrails

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: Mig ER308si
Base Metal: stainless steel-handrails
Type of Weld: varied
Environment: shop, closed high bay, wind speed 0-5 fpm

Sample Location: breathing zone, not under hood
Sample Date: Nov 2006
Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 262 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0084	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #46 – Shop Welding with Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: ER308si

Base Metal: stainless steel-handrails

Type of Weld: flat

Environment: shop, closed high bay, wind speed 0-5 fpm

Sample Location: general area breathing zone -20 feet from welding

Sample Date: Nov 2006

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 292 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	0.0042	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	NA	N	N
Copper	0.1	0.1	0.0017	N	N
Iron Oxide	5	10	0.2	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.013	N	N
Nickel	1	1	0.0021	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.0240	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #47 – Shop Welding Stainless Steel Handrails

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: MIG-ER308si
Base Metal: stainless steel-handrails
Type of Weld: horizontal
Environment: shop, closed high bay, wind speed 0-5 fpm

Samples Location: general area breathing zone, 20 feet from Weld
Sample Date: Sept 2006
Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 292 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	<0.00004	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #4 8– Shop Welding Stainless Handrails

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: MIG-ER308si

Base Metal: stainless steel-hand rail

Type of Weld: varied

Environment: shop, closed high bay, wind speed 0-5 fpm

Sample Location: general area breathing zone, 20 feet from weld

Sample Date: Sept 2006

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 292 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	<0.00004	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #49 – Shop Welding Carbon Steel Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: XLH70 Gas Shielded Cored Wire

Base Metal: carbon steel

Type of Weld: varied

Environment: shop, close high bay, wind speed 0-10 fpm

Sample Location: area breathing zone under 20 feet from welding

Sample Date: Nov 2006

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 230 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	<0.00004	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #50 – Shop Welding Carbon Steel Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: XLH70 Gas Shielded Cored Wire

Base Metal: carbon steel

Type of Weld: horizontal

Environment: shop, closed high bay, wind speed 0-10 fpm

Sample Location: breath zone, not under hood

Sample Date: Dec 2006

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 223 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	0.00048	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0032	N	N
Iron Oxide	5	10	0.19	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.014	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #51 – Shop Welding Carbon Steel Structure

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: XLH70 Gas Shielded Cored Wire

Base Metal: steel

Type of Weld: horizontal

Environment: shop, closed high bay, wind speed 0-10 fpm

Sample Location: breath zone, not under hood

Sample Date: Dec 2006

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 223 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.059	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.0012	N	N
Barium	0.5	0.5	0.0024	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.25	N	N
Chromium	0.5	1	0.0048	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.015	N	N
Iron Oxide	5	10	3.9	N	N
Lead	0.05	0.05	0.0015	N	N
Magnesium	10	15	0.21	N	N
Manganese	0.2	5C	0.71	YES	N
Nickel	1	1	0.0028	N	N
Potassium	2	NA	0.074	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.0014	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #52 – Outdoor Column Welding with Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: FCAW E 71T-8 & E70T-6
Base Metal: carbon steel
Type of Weld: flats
Environment: outdoor, wind speed 0-50 fpm

Sample Location: breathing zone, not under hood
Sample Date: Dec 2006
Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 489 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.032	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.00063	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.025	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0046	N	N
Iron Oxide	5	10	0.32	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.025	N	N
Manganese	0.2	5C	0.046	N	N
Nickel	1	1	0.00032	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.0039	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	1.4	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #53 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: XLH 70 Outershield

Base Metal: carbon steel

Type of Weld: flat

Environment: shop, closed high bay, wind speed 0-5 fpm

Sample Location: breathing zone, not under hood

Sample Date: Dec 2006

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 236 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.0023	N	N
Antimony	0.5	0.5	NA	N	N
Arsenic	0.01	0.01	0.00082	N	N
Barium	0.5	0.5	0.00092	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.077	N	N
Iron Oxide	5	10	5.1	YES	N
Lead	0.05	0.05	0.00097	N	N
Magnesium	10	15	0.022	N	N
Manganese	0.2	5C	0.43	YES	N
Nickel	1	1	0.003	N	N
Potassium	2	NA	0.048	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.0093	N	N
Total Welding Fumes	5	NA	NT	YES	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #54 – Stiffner to a Flange

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: SMAW-E7018
Base Metal: carbon steel
Type of Weld: flat
Environment: shop

Sample Location: welder
Sample Date: July 2006
Analytical Method:

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 411 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00056	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #55 – Automatic Welder SAW L-61 with 960 Flux

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: 960 flux
Base Metal: carbon steel
Type of Weld: automatic welder
Environment: shop

Samples Location: welder
Sample Date: July 2006
Analytical Method:

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 407 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	10	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00017	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #56 – Box Welding SAW L-61 with 960 Flux

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: SAW L-61 with 960flux
Base Metal: carbon steel
Type of Weld: varied
Environment: shop

Sample Location: on the box welder
Sample Date: July 2006
Analytical Method:

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 425 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	10	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0001	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #57 – Welding with Flux Core

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: flux core
Base Metal: carbon steel
Type of Weld: varied
Environment: shop

Sample Location:
Sample Date: July 2006
Analytical Method:

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 418 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00105	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #58 – Sub Arc Welding

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: sub arc welding
Base Metal: carbon steel
Type of Weld: varied
Environment: shop

Sample Location: welder
Sample Date: July 2006
Analytical Method:

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 411 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00245	**YES**	**YES**
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

2 Case Study #59 – SAW L-61 with 960 Flux

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: SAW L-61 with 960 flux
Base Metal: carbon steel
Type of Weld: varied
Environment: shop

Sample Location: welder
Sample Date: July 2006
Analytical Method:

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 424 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00241	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #60 – SAW L-61 with 960 Flux

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: SAW L-61 with960 flux
Base Metal: carbon steel
Type of Weld: varied
Environment: shop

Samples Location: burner
Sample Date: July 2006
Analytical Method:

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 422 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00065	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #61 – SAW L-61 with 960 Flux

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: SAW L-61 With 960 Flux
Base Metal: carbon steel
Type of Weld: varied
Environment: shop
Sample Location: welder
Sample Date: April 2007

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 418 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00153	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #62 – Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: Air Carbon Arc & E70T6

Base Metal: carbon steel

Type of Weld: flat

Environment: open high bay, two walls, wind speed 0-150 fpm

Sample Location: breathing zone, under hood

Sample Date: April 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 148 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.14	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0022	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	0.0081	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.044	N	N
Iron Oxide	5	10	5.1	YES	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.071	N	N
Manganese	0.2	5C	0.13	N	N
Nickel	1	1	0.0045	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.0076	N	N
Total Welding Fumes	5	NA	NT	YES	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #63 – Welding with E70T6 and Air Carbon Arc

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: Air Carbon Arc & FCAW E70T6

Base Metal: carbon steel

Type of Weld: flat

Environment: open high bay, 2 walls, wind speed 0-150 fpm

Sample Location: breathing zone, not under hood

Sample Date: April 2006

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 162 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.29	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0032	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	0.0099	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.068	N	N
Iron Oxide	5	10	7.0	YES	N
Lead	0.05	0.05	0.0022	N	N
Magnesium	10	15	0.23	N	N
Manganese	0.2	5C	0.39	YES	N
Nickel	1	1	0.0059	N	N
Potassium	2	NA	0.054	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.09	N	N
Total Welding Fumes	5	NA	NT	YES	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #64 – Welding Carbon Steel with E70T6 and Air Carbon Arc

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: Air Carbon Arc & FCAW E70T6

Base Metal: carbon steel

Type of Weld: flats

Environment: outdoor, wind speed 0-150 fpm

Sample Location: area breathing zone, 20 feet from each welder

Sample Date: April 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 152 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0036	N	N
Iron Oxide	5	10	0.34	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.010	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #65 – Box Welding SAW L-61 with 960 Flux

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: SAW L-61 with 960 flux
Base Metal: carbon steel
Type of Weld: varied
Environment: shop-air mover in confined space

Sample Location: welder
Sample Date: July 2006
Analytical Method:

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 413 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00049	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #66 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, no ventilation

Sample Location: breathing zone, inside 3M respirator hood/speed glass-9000,PAPR hood

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	‹0.0008	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹1	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #67 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, no ventilation

Sample Location: area breathing zone, booth 5, 5 feet from weld, 5 feet above floor

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 42 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0045	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.6	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #68 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, no ventilation

Sample Location: area breathing zone, back wall, 5 feet from weld ,5 feet above floor

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 15 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	‹0.0002	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.4	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #69 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, no ventilation

Sample Location: area breathing zone, back wall 5 feet from weld, 5 feet above floor

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 15 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	‹0.0008	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹1	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #70 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test semi trailer, one welder in booth 4, no ventilation

Sample Location: area breathing zone back wall, 5 feet off floor, 10 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 105 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	0.015	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0078	N	N
Iron Oxide	5	10	1.08	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.037	N	N
Nickel	1	1	0.056	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	1.4	N	N

LEGEND

AL: *Action Limit*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #71 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, no ventilation

Sample Location: area breathing zone, 5 feet above floor, 3 feet above weld

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 80 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.13	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	3.3	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #72 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, mini-flex high mode

Sample Location: area breathing zone, inside hood 3M L-905-PAPR

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 67 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	‹0.0008	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹1	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #73 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, mini-flex 2-4 inches from weld

Sample Location: area breathing zone, booth 5, 5 feet above floor 7 feet from weld

Sample Date: Aug 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0015	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.4	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #74 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, mini-flex in high mode

Sample Location: area breathing zone, 3 feet above weld

Sample Date: Aug 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.1	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	2.5	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #75 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, no ventilation

Sample Location: area breathing zone, back wall, 5 feet above floor, 7 feet from weld

Sample Date: Sept 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 67 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	0.051	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	0.02652	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	4.76	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #76 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, mini-flex, high mode

Sample Location: area breathing zone, booth 3, 5 feet above floor, 3 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 65 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0044	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.4	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #77 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276)AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, no ventilation

Sample Location: area breathing zone, booth 3, 3 feet above floor

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0038	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	1.1	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #78 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276)AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, no ventilation

Sample Location: area breathing zone

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.019	**YES**	**YES**
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	3.9	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #79 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, mini-flex high mode

Sample Location: area breathing zone, back wall, 5 feet from weld, 5 feet above floor

Sample Date: Sept 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	0.0032	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	<2	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #80 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276)AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, no ventilation

Sample Location: breathing zone, inside 3M respirator hood/speed glass-9000,PAPR hood

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 87 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00072	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	0.49	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #81 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276) AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, no ventilation

Sample Location: breathing zone, inside 3M respirator hood/speed glass-9000,PAPR, 1/2 outside PAPR

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0077	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	3.9	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #82 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276)AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, mini-flex high mode

Sample Location: breathing zone, welding helmet with respirator

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 62 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00825	**YES**	**YES**
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.4	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #83 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, hepa vac

Sample Location: breathing zone, under welding helmet

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0027	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	0.31	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #84 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, wall fan ventilation

Sample Location: area breathing zone, 3 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0024	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	<1	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #85 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, wall fan ventilation

Sample Location: area breathing zone, 6 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00034	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	<1	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #86 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276)AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, wall fan ventilation

Sample Location: breathing zone, under welding hood

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00057	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	0.39	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #87 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, wall fan ventilation

Sample Location: breathing zone, under welding hood

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0044	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	0.23	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #88 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, no ventilation

Sample Location: area breathing zone, 3 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0089	YES	YES
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	0.23	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #89 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E2209-16 Midalloy-1/8 inch stick

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, wan fan f ventilation

Sample Location: area breathing zone, 6 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.0021	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	2.9	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #90 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276)AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, wall fan ventilation

Sample Location: area breathing zone, 6 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00013	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.2	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #91 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276)AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, wall fan ventilation

Sample Location: area breathing zone, 3 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00035	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.2	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #92 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276)AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, wall fan and heap vac ventilation

Sample Location: area breathing zone, 3 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00019	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.2	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #93 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276)AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, wall fan and heap vac ventilation

Sample Location: breathing zone, under welding hood

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 20 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00031	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	NT	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #94 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276)AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, wall fan ventilation

Sample Location: hepa exhaust

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	0.00013	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.2	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #95 – Welding Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ENiCrMo-4(276)AP 0.45 inch wire, argon/carbon dioxide shield

Base Metal: stainless steel plate

Type of Weld: flat

Environment: 8 booth weld test trailer, one welder in booth 4, wall fan ventilation

Sample Location: area breathing zone, 6 feet from weld

Sample Date: Sept 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	‹0.0008	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹0.2	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #96 – Plasma Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: stainless steel plate
Base Metal: stainless steel plate
Type of Weld: plasma cut
Environment: outdoor

Sample Location: area breathing zone, 6 feet from cut
Sample Date: Sept 2007
Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 120 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	N	N
Antimony	0.5	0.5	NT	N	N
Arsenic	0.01	0.01	NT	N	N
Barium	0.5	0.5	NT	N	N
Beryllium	0.0002	0.002	NT	N	N
Cadmium	0.005	0.005	NT	N	N
Calcium	2	5	NT	N	N
Chromium	0.5	1	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	‹0.0001	N	N
Cobalt	0.02	0.1	NT	N	N
Copper	0.1	0.1	NT	N	N
Iron Oxide	5	10	NT	N	N
Lead	0.05	0.05	NT	N	N
Magnesium	10	15	NT	N	N
Manganese	0.2	5C	NT	N	N
Nickel	1	1	NT	N	N
Potassium	2	NA	NT	N	N
Selenium	0.2	0.2	NT	N	N
Sodium	NA	NA	NT	N	N
Thallium	0.1	0.1	NT	N	N
Vanadium	0.05	0.1C	NT	N	N
Zinc Oxide	5	5	NT	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	‹1	N	N

LEGEND

AL: *Action Level*
C: *Ceiling*
Cal/OSHA: *California Occupational Safety & Health Administration*
8-hr TWA: *Eight hour Time Weighted Average*
Fed OSHA: *Federal Occupational Safety & Health Administration*
FPM: *Feet per minute*
Mg/m3: *milligrams per cubic meter*
NA: *Not applicable*
ND: *Not detected*
NT: *Not tested*
PEL: *Permissible Exposure Limit*

Case Study #97 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 203 flux core wire

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, 25 vented booths, 400 cfm per booth-25 welders

Sample Location: breathing zone, under and outside hood

Sample Date: Nov 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 174.5 minutes TWA Mg/m3	Outside Hood 172 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	NT	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	NT	NT	N	N
Manganese	0.2	5C	0.124	0.151	N	N
Nickel	1	1	ND	ND	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	N	N
Total Dust	10	15	2.27	2.82	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #98 – Welding Rebar

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E7018

Base Metal: mild steel #8 rebar

Type of Weld: flat and vertical

Environment: weld test center, 25 vented booths, 400 cfm per booth-25 welders

Sample Location: breathing zone, under and outside hood

Sample Date: Nov 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 207 minutes TWA Mg/m3	Outside Hood 209 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	NT	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	NT	NT	N	N
Manganese	0.2	5C	0.0269	0.0339	N	N
Nickel	1	1	ND	ND	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	N	N
Total Dust	10	15	0.601	0.828	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #99 – Welding Rebar

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E7018 stick

Base Metal: mild steel rebar

Type of Weld: flat

Environment: weld test center, 25 vented booths, 400 cfm per booth-25 welders

Sample Location: breathing zone, under and outside hood

Sample Date: Nov 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 201.5 minutes TWA Mg/m3	Outside Hood 197 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	NT	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	NT	NT	N	N
Manganese	0.2	5C	0.124	0.151	N	N
Nickel	1	1	ND	ND	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	N	N
Total Dust	10	15	2.27	2.82	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #100 – Welding Rebar

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E7018 stick

Base Metal: mild steel #8 rebar

Type of Weld: flat and vertical

Environment: weld test center, 25 vented booths, 400 cfm per booth-25 welders

Sample Location: breathing zone, under and outside hood

Sample Date: Nov 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 232 minutes TWA Mg/m3	Outside Hood 235 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	NT	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	NT	NT	N	N
Manganese	0.2	5C	0.102	0.0103	N	N
Nickel	1	1	ND	ND	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	N	N
Total Dust	10	15	0.369	0.551	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #101 – Welding Rebar

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E7018 stick

Base Metal: mild steel rebar

Type of Weld: flat

Environment: weld test center, 25 vented booths, 400 cfm per booth-25 welders

Sample Location: breathing zone, under and outside hood

Sample Date: Nov 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 253.5 minutes TWA Mg/m3	Outside Hood 238 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	NT	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	NT	NT	N	N
Manganese	0.2	5C	0.109	0.159	N	N
Nickel	1	1	ND	0.000614	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	N	N
Total Dust	10	15	0.389	2.82	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #102 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 233 flux core wire

Base Metal: milds steel plate

Type of Weld: flat

Environment: weld test center, 25 vented booths, 400 cfm per booth-25 welders

Sample Location: breathing zone, under and outside hood

Sample Date: Nov 2007

Analytical Method: OSHA ID215

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 218.5 minutes TWA Mg/m3	Outside Hood 218 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	NT	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	NT	NT	N	N
Manganese	0.2	5C	0.0307	0.0476	N	N
Nickel	1	1	0.00639	0.00927	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	N	N
Total Dust	10	15	1.34	2.03	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #103 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ER495-6

Base Metal: mild steel plate-stairs

Type of Weld: flat

Environment: fab shop, high bay, no local exhaust ventilation

Sample Location: breathing zone, under and outside hood

Sample Date: Nov 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 287 minutes TWA Mg/m3	Outside Hood 282.5 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	NT	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	NT	NT	N	N
Manganese	0.2	5C	0.105	0.358	YES	N
Nickel	1	1	0.000949	0.00266	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	YES	N
Total Dust	10	15	2.96	9.2	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #104 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ER495-6 and carbon arc

Base Metal: mild steel

Type of Weld: flat

Environment: fab shop, high bay, no ventilation used

Sample Location: breathing zone, under and outside hood

Sample Date: Dec 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 278.5 minutes TWA Mg/m3	Outside Hood 280 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	NT	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	NT	NT	N	N
Manganese	0.2	5C	0.140	0.341	YES	N
Nickel	1	1	ND	0.000848	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	YES	N
Total Dust	10	15	2.31	5.51	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #105 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E6013

Base Metal: mild steel handrails

Type of Weld: flat

Environment: fab shop, high bay, no ventilation

Sample Location: breathing zone, under and outside hood

Sample Date: Nov 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 277 minutes TWA Mg/m3	Outside Hood 278.5 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	NT	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	NT	NT	N	N
Manganese	0.2	5C	0.0346	0.0612	N	N
Nickel	1	1	ND	ND	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	N	N
Total Dust	10	15	3.75	1.57	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #106 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ER495-6 and carbon arc

Base Metal: mild steel plate stairs

Type of Weld: flat

Environment: fab shop, high bay no ventilation

Sample Location: breathing zone, under and outside hood

Sample Date: Dec 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 362 minutes TWA Mg/m3	Outside Hood 366 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	NT	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	ND	ND	N	N
Manganese	0.2	5C	0.188	0.356	YES	N
Nickel	1	1	0.000432	0.000830	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	YES	N
Total Dust	10	15	3.93	7.33	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #107 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E6013

Base Metal: mild steel handrails

Type of Weld: flat

Environment: fab shop, high bay no ventilation

Sample Location: breathing zone, under and outside hood

Sample Date: Dec 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 385.5 minutes TWA Mg/m3	Outside Hood 368.5 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	NT	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	ND	ND	N	N
Manganese	0.2	5C	0.0512	0.0811	N	N
Nickel	1	1	ND	ND	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	N	N
Total Dust	10	15	1.08	2.01	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #108 – Stainless Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ER308

Base Metal: stainless steel

Type of Weld: flat

Environment: fab shop, high bay, local exhaust ventilation

Sample Location: breathing zone, under and outside hood

Sample Date: Dec 2007

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 38.5 minutes TWA Mg/m3	Outside Hood 38.5 minutes TWA Mg/m3	At or Above PEL's	
					Cal/OSHA	Fed OSHA
Aluminum	5	NA	NT	NT	N	N
Antimony	0.5	0.5	NT	NT	N	N
Arsenic	0.01	0.01	ND	ND	N	N
Barium	0.5	0.5	NT	NT	N	N
Beryllium	0.0002	0.002	ND	ND	N	N
Cadmium	0.005	0.005	ND	ND	N	N
Calcium	2	5	NT	NT	N	N
Chromium	0.5	1	NT	NT	N	N
Chromium VI	0.0025 AL	0.0025 AL	‹0.000319	0.000818	N	N
Cobalt	0.02	0.1	NT	NT	N	N
Copper	0.1	0.1	NT	NT	N	N
Iron Oxide	5	10	NT	NT	N	N
Lead	0.05	0.05	ND	ND	N	N
Magnesium	10	15	ND	ND	N	N
Manganese	0.2	5C	NT	NT	N	N
Nickel	1	1	NT	NT	N	N
Potassium	2	NA	NT	NT	N	N
Selenium	0.2	0.2	NT	NT	N	N
Sodium	NA	NA	NT	NT	N	N
Thallium	0.1	0.1	NT	NT	N	N
Vanadium	0.05	0.1C	NT	NT	N	N
Zinc Oxide	5	5	NT	NT	N	N
Total Welding Fumes	5	NA	NT	NT	N	N
Total Dust	10	15	‹1.28	‹1.26	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #109 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E71T-8

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: breathing zone, under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 236 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.056	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.002	N	N
Barium	0.5	0.5	0.00144	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.7	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0052	N	N
Iron Oxide	5	10	0.156	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.033	N	N
Manganese	0.2	5C	0.26	YES	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.8	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	7	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #110 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E71T-8

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: breathing zone, under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 234 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.065	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.002	N	N
Barium	0.5	0.5	0.0095	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0072	N	N
Iron Oxide	5	10	1.3	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.13	N	N
Manganese	0.2	5C	0.077	N	N
Nickel	1	1	0.00014	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.22	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	3.8	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #111 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E6010

Base Metal: mild steel plate s

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: breathing zone, under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 236 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.031	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0036	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.7	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0066	N	N
Iron Oxide	5	10	1.3	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.05	N	N
Manganese	0.2	5C	0.053	N	N
Nickel	1	1	0.0011	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.08	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	2.4	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #112 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E6010

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: breathing zone, under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 235 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0029	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.7	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0084	N	N
Iron Oxide	5	10	1.2	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.024	N	N
Manganese	0.2	5C	0.06	N	N
Nickel	1	1	0.0012	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.096	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	2.9	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #113 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E7018

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: breathing zone, under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 238 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0028	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.7	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0043	N	N
Iron Oxide	5	10	0.87	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.075	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.2	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.093	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	2.7	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #114 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E7018, E6010, 232

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders, hallway,

Sample Location: hallway, outside welding room, 5 feet above floor

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 241 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	ND	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.0013	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #115 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E7018, E6010, 232

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders,

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 233 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0012	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0022	N	N
Iron Oxide	5	10	0.44	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.022	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.06	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	1.04	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #116 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 232

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 236 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.138	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.0018	N	N
Barium	0.5	0.5	0.086	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.5	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0103	N	N
Iron Oxide	5	10	6.4	YES	N
Lead	0.05	0.05	0.0032	N	N
Magnesium	10	15	1.86	N	N
Manganese	0.2	5C	0.62	YES	N
Nickel	1	1	0.0022	N	N
Potassium	2	NA	0.42	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.026	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	30	YES	YES

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

NOTE: This sample may have been contaminated by other shop activities. The source of arsenic and lead contributing to this exposure was not determined. This welding fume data cannot be reproduce or republish by anyone.

Case Study #117 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70-T-8

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders,

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 232 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.124	N	N
Antimony	0.5	0.5	0.003	N	N
Arsenic	0.01	0.01	0.003	N	N
Barium	0.5	0.5	0.00152	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.44	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0103	N	N
Iron Oxide	5	10	0.132	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.0106	N	N
Manganese	0.2	5C	0.26	YES	N
Nickel	1	1	0.0034	N	N
Potassium	2	NA	0.42	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.156	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	10	YES	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

NOTE: This sample may have been contaminated by other shop activities. The source of arsenic contributing to this exposure was not determined. This welding fume data cannot be reproduce or republish by anyone.

Case Study #118 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70-T-8

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: hallway, 5 feet above floor

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 230 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.03	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.006	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.27	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0022	N	N
Iron Oxide	5	10	0.56	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.048	N	N
Manganese	0.2	5C	0.078	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.21	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.021	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	2.1	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #119 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70-T-8

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders,

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 236 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.027	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0052	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.29	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0032	N	N
Iron Oxide	5	10	0.71	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.042	N	N
Manganese	0.2	5C	0.09	N	N
Nickel	1	1	0.0009	N	N
Potassium	2	NA	0.24	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.045	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	1.7	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #120 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70-T-8 AND 232

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders,

Sample Location: area breathing zone on desk

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 233 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.38	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0078	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0024	N	N
Iron Oxide	5	10	0.68	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.054	N	N
Manganese	0.2	5C	0.054	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.36	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	3	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #121 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70-T-8

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 231 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0028	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.34	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0067	N	N
Iron Oxide	5	10	0.58	N	N
Lead	0.05	0.05	0.0051	N	N
Magnesium	10	15	0.024	N	N
Manganese	0.2	5C	0.058	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.24	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.028	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	2.6	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

NOTE: The source of lead contributing to this exposure was not determined. This welding fume data cannot be reproduce or republish by anyone.

Case Study #122 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70-T-8

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 236 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.005	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0039	N	N
Iron Oxide	5	10	0.37	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.025	N	N
Manganese	0.2	5C	0.021	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.064	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.007	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	1.5	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #123 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70-T-8

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 229 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.002	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0051	N	N
Iron Oxide	5	10	0.34	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.0024	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.096	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	1.5	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #124 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 203

Base Metal: mild steel plate

Type of Weld: varied

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 234 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.039	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.019	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.7	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	0.25	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.079	N	N
Manganese	0.2	5C	0.024	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	0.96	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #125 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 203

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders,

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 229 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	1.3	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.17	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.29	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.011	N	N
Iron Oxide	5	10	7	YES	N
Lead	0.05	0.05	0.0016	N	N
Magnesium	10	15	1.8	N	N
Manganese	0.2	5C	0.6	YES	N
Nickel	1	1	0.0065	N	N
Potassium	2	NA	0.054	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.016	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	21	YES	YES

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #126 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 203

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 223 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.6	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.136	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.7	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.012	N	N
Iron Oxide	5	10	6.2	YES	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.124	N	N
Manganese	0.2	5C	0.48	YES	N
Nickel	1	1	0.0028	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.02	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	17.5	YES	YES

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #127 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70-T-9 AND 203

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, 5 mph winds, 15 welders

Sample Location: area breathing zone on desk

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 227 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0069	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	ND	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.043	N	N
Manganese	0.2	5C	0.0011	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	0.4	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #128 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 203NI

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, no ventilation, 15 welders

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 223 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.51	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.0032	N	N
Barium	0.5	0.5	5	YES	YES
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	1.3	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.02	N	N
Iron Oxide	5	10	7	YES	N
Lead	0.05	0.05	0.0035	N	N
Magnesium	10	15	1.4	N	N
Manganese	0.2	5C	0.97	YES	N
Nickel	1	1	0.031	N	N
Potassium	2	NA	1.4	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	0.42	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	1.1	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	41	YES	YES

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #129 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 203

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, no ventilation, 15 welders

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 236 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.35	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.0025	N	N
Barium	0.5	0.5	3.5	YES	YES
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	1.4	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.017	N	N
Iron Oxide	5	10	6.6	YES	N
Lead	0.05	0.05	0.0033	N	N
Magnesium	10	15	1.1	N	N
Manganese	0.2	5C	0.77	YES	N
Nickel	1	1	0.032	N	N
Potassium	2	NA	1.1	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	0.35	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.89	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	24	YES	YES

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #130 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: 203 NI

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, no ventilation, 15 welders

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 223 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.33	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.0028	N	N
Barium	0.5	0.5	3.1	YES	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	0.00059	N	N
Calcium	2	5	1.2	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0016	N	N
Iron Oxide	5	10	5.6	YES	N
Lead	0.05	0.05	0.0032	N	N
Magnesium	10	15	1.0	N	N
Manganese	0.2	5C	0.72	YES	N
Nickel	1	1	0.012	N	N
Potassium	2	NA	1.1	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	0.37	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.89	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	26	YES	YES

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #131 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70-T-8

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, no ventilation, 15 welders

Sample Location: area breathing zone on desk

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 225 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.39	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.0028	N	N
Barium	0.5	0.5	3.7	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	1.5	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.012	N	N
Iron Oxide	5	10	5.4	YES	N
Lead	0.05	0.05	0.0036	N	N
Magnesium	10	15	1.2	N	N
Manganese	0.2	5C	0.79	YES	N
Nickel	1	1	0.015	N	N
Potassium	2	NA	1.4	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	0.43	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	1.1	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	29	YES	YES

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #132 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70-T-8

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, no ventilation, 15 welders

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 223 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.26	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.0023	N	N
Barium	0.5	0.5	2.5	YES	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	1.1	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0094	N	N
Iron Oxide	5	10	4	N	N
Lead	0.05	0.05	0.0024	N	N
Magnesium	10	15	0.83	N	N
Manganese	0.2	5C	0.63	YES	N
Nickel	1	1	0.0098	N	N
Potassium	2	NA	1.1	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	0.36	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.85	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	17	YES	YES

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #133 – Welding Mild Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: E70-T-8

Base Metal: mild steel plate

Type of Weld: flat

Environment: weld test center, high bay 15 booths, no ventilation, 15 welders

Sample Location: breathing zone under hood

Sample Date: April 08

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Under Hood 225 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.24	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.0024	N	N
Barium	0.5	0.5	2.3	YES	YES
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	1.1	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0084	N	N
Iron Oxide	5	10	3.8	N	N
Lead	0.05	0.05	0.00243	N	N
Magnesium	10	15	0.76	N	N
Manganese	0.2	5C	0.57	YES	N
Nickel	1	1	0.0071	N	N
Potassium	2	NA	0.96	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	0.35	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	3.8	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	16	YES	YES

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #134 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 30 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0072	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.048	N	N
Iron Oxide	5	10	3	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.42	**YES**	N
Nickel	1	1	ND	N	N
Potassium	2	NA	1.2	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.061	N	N
Total Welding Fumes	5	NA	ND	**YES**	N
Total Dust	10	15	12	**YES**	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #135 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 112 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.0018	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.025	N	N
Iron Oxide	5	10	0.34	N	N
Lead	0.05	0.05	0.0023	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.11	N	N
Nickel	1	1	0.00025	N	N
Potassium	2	NA	0.29	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.03	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	3.2	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #136 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 105 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.41	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.014	N	N
Iron Oxide	5	10	0.57	N	N
Lead	0.05	0.05	0.0019	N	N
Magnesium	10	15	0.04	N	N
Manganese	0.2	5C	0.082	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.22	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.017	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	2.5	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

2 Case Study #137 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: general breathing zone

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 123 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.002	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	0.35	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.024	N	N
Iron Oxide	5	10	0.93	N	N
Lead	0.05	0.05	0.00024	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.14	N	N
Nickel	1	1	0.00024	N	N
Potassium	2	NA	0.38	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.029	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	3.8	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #138 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 127 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0013	N	N
Iron Oxide	5	10	0.36	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.075	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.2	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	2	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #139 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 126 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0025	N	N
Iron Oxide	5	10	0.15	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.021	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #140 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 122 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	0.065	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.0029	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #141 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 110 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0082	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	0.21	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.029	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.084	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #142 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: general breathing zone

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 118 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	ND	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	ND	N	N
Nickel	1	1	0.0019	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #143 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 121 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	0.13	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	ND	N	N
Nickel	1	1	0.016	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.051	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #144 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: general breathing zone

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 123 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	ND	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.0055	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.017	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #145 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: general breathing zone

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 119 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	0.091	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.0066	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.014	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	1.1	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #146 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 9 welders, possible contaminated metal

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 117 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0011	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.017	N	N
Iron Oxide	5	10	ND	N	N
Lead	0.05	0.05	0.21	YES	YES
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	ND	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

NOTE: The source of lead contributing to this exposure was not determined. This welding fume data cannot be reproduce or republish by anyone.

2 Case Study #147 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 3 welders

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 123 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0017	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0039	N	N
Iron Oxide	5	10	0.21	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.021	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.04	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	2	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #148 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 6 welders,

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 122 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0017	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0024	N	N
Iron Oxide	5	10	0.49	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.097	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.24	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	4	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #149 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 6 welders

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 119 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0041	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.4	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.004	N	N
Iron Oxide	5	10	0.93	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.19	YES	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.43	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.015	N	N
Total Welding Fumes	5	NA	ND	YES	N
Total Dust	10	15	5.4	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #150 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 6 welders, possible contaminated metal

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 118 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.0014	N	N
Barium	0.5	0.5	0.003	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.51	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0078	N	N
Iron Oxide	5	10	1.3	N	N
Lead	0.05	0.05	0.0002	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.24	YES	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.59	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.021	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	1.2	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #151 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 6 welders, possible contaminated metal

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 124 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.0019	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	0.54	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	1.1	N	N
Lead	0.05	0.05	0.0019	N	N
Magnesium	10	15	0.035	N	N
Manganese	0.2	5C	0.19	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	0.48	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.014	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #152 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumables: E-7018-1

Base Metal: mild steel

Type of Weld: varied

Environment: weld test center, closed high bay, little ventilation, 6 welders, possible contaminated metal

Sample Location: general breathing zone

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 121 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	ND	N	N
Iron Oxide	5	10	0.14	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	ND	N	N
Nickel	1	1	0.029	N	N
Potassium	2	NA	0.073	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	ND	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #153 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ER4043

Base Metal: Aluminum

Type of Weld: varied

Environment: closed high bay with open garage doors and 48 inch floor fan, 4 welders

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 384 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	ND	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0026	N	N
Iron Oxide	5	10	0.17	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.01	N	N
Nickel	1	1	ND	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.0034	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #154 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ER70S-6

Base Metal: mild steel

Type of Weld: varied

Environment: closed high bay with open garage doors and some ventilation

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 378 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.001	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.036	N	N
Iron Oxide	5	10	2.9	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	ND	N	N
Manganese	0.2	5C	0.31	**YES**	N
Nickel	1	1	0.0015	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.013	N	N
Total Welding Fumes	5	NA	NT	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #155 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ER70S

Base Metal: mild steel

Type of Weld: varied

Environment: closed high bay with open garage doors and some ventilation, 4 welders

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 478 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	0.016	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	ND	N	N
Barium	0.5	0.5	0.00073	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.0099	N	N
Iron Oxide	5	10	0.98	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.018	N	N
Manganese	0.2	5C	0.061	N	N
Nickel	1	1	0.00078	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.0049	N	N
Total Welding Fumes	5	NA	ND	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

PEL: *Permissible Exposure Limit*

Case Study #156 – Shop Welding Carbon Steel

WELDING FUME TEST RESULTS

TESTING CONDITIONS

Consumable: ER70s-6

Base Metal: mild steel

Type of Weld: varied

Environment: closed high bay with open garage doors and some ventilation, 4 welders

Sample Location: breathing zone, under hood

Sample Date: Nov 2008

Analytical Method: Mod NIOSH 7300 & 0500, Mod OSHA 125GM

Metals	Cal/OSHA PEL's 8-hr. TWA Mg/m3	Fed OSHA PEL's 8-hr. TWA Mg/m3	Test Results 381 minutes TWA Mg/m3	At or Above PEL's	
				Cal/OSHA	Fed OSHA
Aluminum	5	NA	ND	N	N
Antimony	0.5	0.5	ND	N	N
Arsenic	0.01	0.01	0.00049	N	N
Barium	0.5	0.5	0.00057	N	N
Beryllium	0.0002	0.002	ND	N	N
Cadmium	0.005	0.005	ND	N	N
Calcium	2	5	ND	N	N
Chromium	0.5	1	ND	N	N
Chromium VI	0.0025 AL	0.0025 AL	NT	N	N
Cobalt	0.02	0.1	ND	N	N
Copper	0.1	0.1	0.025	N	N
Iron Oxide	5	10	2.4	N	N
Lead	0.05	0.05	ND	N	N
Magnesium	10	15	0.013	N	N
Manganese	0.2	5C	0.16	N	N
Nickel	1	1	0.0016	N	N
Potassium	2	NA	ND	N	N
Selenium	0.2	0.2	ND	N	N
Sodium	NA	NA	ND	N	N
Thallium	0.1	0.1	ND	N	N
Vanadium	0.05	0.1C	ND	N	N
Zinc Oxide	5	5	0.011	N	N
Total Welding Fumes	5	NA	2.7	N	N
Total Dust	10	15	ND	N	N

LEGEND

AL: *Action Level*

C: *Ceiling*

Cal/OSHA: *California Occupational Safety & Health Administration*

8-hr TWA: *Eight hour Time Weighted Average*

Fed OSHA: *Federal Occupational Safety & Health Administration*

FPM: *Feet per minute*

Mg/m3: *milligrams per cubic meter*

NA: *Not applicable*

ND: *Not detected*

NT: *Not tested*

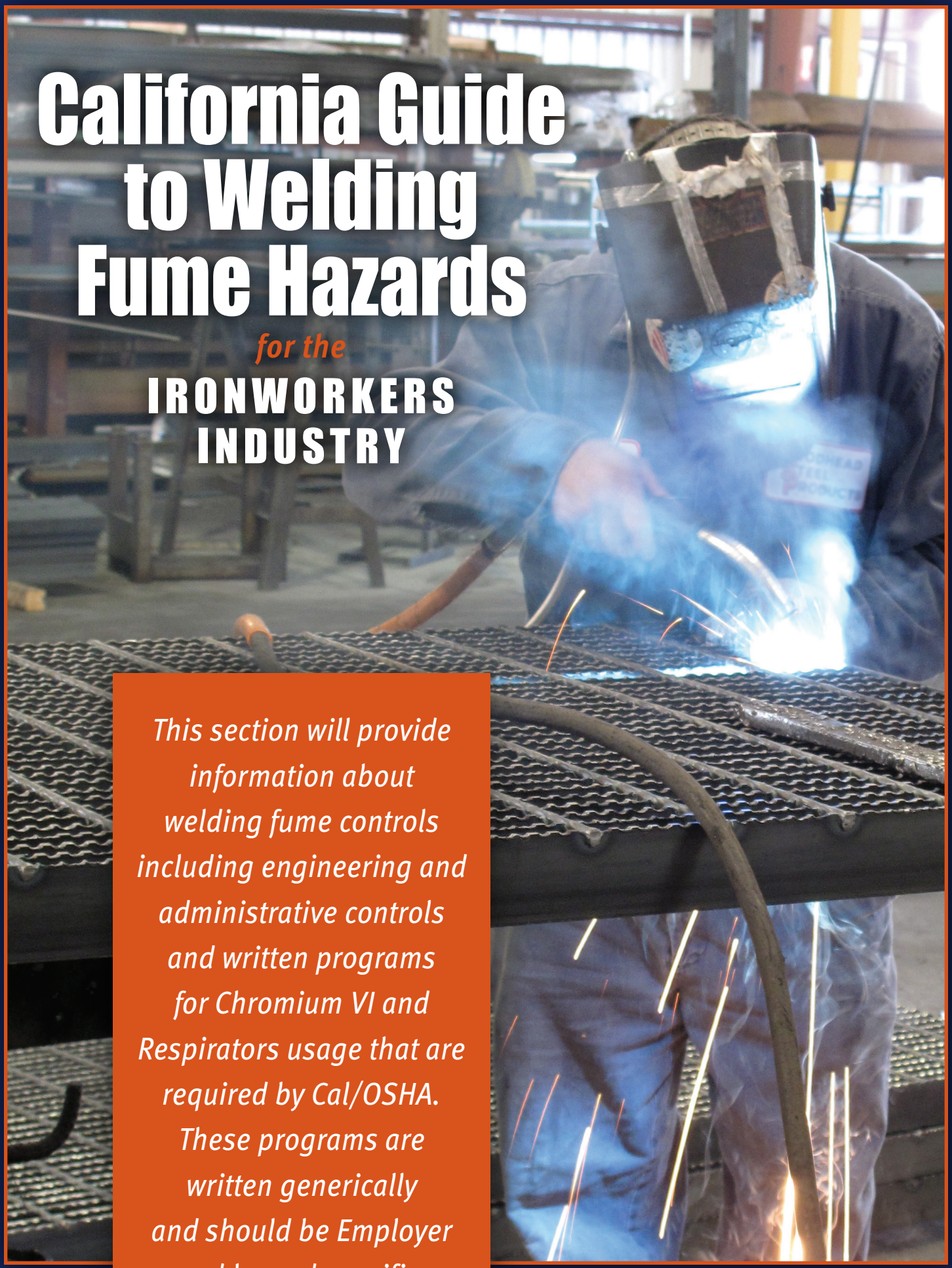
PEL: *Permissible Exposure Limit*

Notes

3 Welding Fume Controls

SPECIFIC ITEMS ADDRESSED

- *Engineering Controls*
- *Sample Respiratory Written Program*
- *Sample Chrom VI Written Program*



California Guide to Welding Fume Hazards

for the

IRONWORKERS INDUSTRY

This section will provide information about welding fume controls including engineering and administrative controls and written programs for Chromium VI and Respirators usage that are required by Cal/OSHA. These programs are written generically and should be Employer and hazard specific.

Welding Fume Controls 3

The main goal of controls is to prevent welding fume exposures through:

1. **Engineering Controls**
2. **Administrative Controls**
3. **Personal Protective Equipment**

All variables of the welding task must be studied to determine the most effective control, with special attention to the potential of oxygen-deficient atmospheres.

1. *Engineering Controls*

When feasible and practical the engineering controls for welding fumes are basically:

1. **Substitution.** Modify or replace current welding process, consumable, gas, welding procedure or equipment technology with an alternative process that generates less welding fumes and still meets welding specifications.
2. **Isolation.** Isolate and separate your welding operation, by automating/ventilating the welding process and/or by placing a barrier between the employee and the source.
3. **Ventilation.** Control the welding fume path between the source and the worker through source, local and/or general shop extraction/ventilation equipment.

General exhaust ventilation is not task specific whereas local exhaust is task specific. Other Cal/OSHA specific welding requirements include Sections 5150, Ventilation and Personal Protective Equipment Requirements for welding, Brazing and Cutting, 4648-4665 Compressed Gas and Air Equipment, 4794-4848 Gas Systems for Welding and Cutting, 4850-4853 Electric Welding, 5139-5223, Control of Hazardous Substances. Caution should be taken when using shield gases and other products that may not function properly with to much ventilation.

2. *Administrative Controls*

Administrative controls (or safe work practice controls) are changes in work procedures/practices such as written safety policies, rules, supervision, schedules, and training with the goal of reducing the duration, frequency, and severity of the welding fume exposure. Administrative Controls Safe work practices complement each level of Engineering Controls and are designed to safely control how the welding is performed. These practices include:

- **Training**
- **Body Position**
- **Amp Settings**
- **Housekeeping**

Material safety data Sheets (MSDS) should be current for base metals and consumables.

3. *Personal Protective Equipment*

When the above controls do not reduce welding fume exposure below the exposure limits, welders should wear respiratory protection. The respirator must be specified according to the concentration and type of welding fume airborne contamination present or expected at each work site. The powered air purifying respirators (PAPRs) provides the best combination of worker protection, comfort and productivity for the welder. When PAPRs are not feasible the proper use of other air-purifying respirators should be required.

Considerations of other task conditions such as heat stress, visibility and lighting, low temperatures and other safety issues will be factored into the selection process.

The following generic Respirator and Chromium VI written programs are provided as sample programs.

3 Respiratory Protection Program

EMPLOYER NAME

Regulatory Standard: Cal/OSHA Section 3409
ANSI Z88.2-1992, ANSI/Compressed Gas Association Commodity Specification for Air G-7.1-1989.

Reference Date: March 2007

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SAFETY TRAINING AND INSTRUCTION PROGRAM

BASIS: About 32 million workers are potentially exposed to one or more chemical hazards on a daily basis. There are an estimated 575,000 existing chemical products, and hundreds of new ones being introduced annually. This poses a serious problem for exposed workers and their employer. The OSHA Respiratory Protection Standard establishes uniform requirements to make sure that the respiratory hazards of all U.S. workplaces are evaluated, and that engineering controls, and work practice controls are implemented, and where not feasible, a respiratory protection program instituted.

GENERAL: EMPLOYER will ensure that respiratory hazards within our facility are evaluated, and that information concerning these hazards is transmitted to all employees. This standard practice instruction is intended to address comprehensively the issues of; evaluating the potential respiratory hazards, communicating information concerning these hazards, and establishing appropriate engineering, work practice, or respiratory protective measures for employees.

RESPONSIBILITY: EMPLOYER Safety Officer is responsible for all facets of this program and has full authority to make necessary decisions to ensure success of the program. The Safety Officer will develop written detailed instructions covering each of the basic elements in this program, and is the sole person authorized to amend these instructions. This company has expressly authorized the Safety Officer to halt any operation of the company where there is danger of serious personal injury.

Respiratory Protection Program

1.0 *Code of Safe Practices*

1.1 Whenever respiratory protective equipment and emergency use self-rescuer devices, are required, a written respiratory protection program shall be developed and implemented.

1.2 No employee can be assigned work that requires the use of a respirator unless it has been determined that the employee is physically able and trained to perform the work while using the designated equipment, with the exception of employees who voluntarily use filtering face pieces (dust masks).

1.3 The name of the Respirator Protection Administrator, respirator issuer(s), and responsible parties for the cleaning, inspection, and repair of respirators shall be determined and identified.

1.4 The Respiratory Protection Administrator shall determine the appropriate respiratory protection to be used, and based the information available (manufacture's data, site air monitoring data, work methods, etc.) develop the cartridge change-out schedule for air purifying respirators. Respirators are to be used on the project, along with cartridge change-out schedule and any supporting data shall be identified.

2.0 *Records*

2.1 Medical will be maintained by the physician or another licensed health care professional (PLHCP). An opportunity shall be afforded the employee to discuss the questionnaire and evaluation with the PLCHP. Medical records are to remain confidential. The location of the medical records shall be made available.

2.2 The location of all evaluations required to establish the program shall be identified in an outline of the contaminants of concern. The contaminant outline shall include the Permissible Exposure Limit (PEL) and Short Term Exposure Limit (STEL) for each contaminant.

2.3 Documentation of fit testing and verification of medical qualification shall be kept confidentially in location identified.

2.4 Both employee fit test records and employee Physician Statements must be submitted to EMPLOYER which will be responsible for maintaining a copy of these records in accordance with "Access to Employee Exposure and Medical Records" for a period of at least 30 years past employment. Regulatory requirements also indicate that the employer notify each employee annually of the "existence, location, and availability" of the records, the "person responsible for maintaining and providing access" to records and their rights to access them.

2.5 A current, written Respiratory Protection Program must be kept onsite. Any modifications or addition due to site-specific conditions shall be included.

3 Respiratory Protection Program

3.0 *Medical Evaluations*

3.1 No employee can be assigned work that requires a respirator until it has been determined that they are physically able to perform the work required while wearing a respirator. All employees required to wear a respirator shall be given a baseline and an annual medical assessment by a PLHCP. A variety of Health Care Professionals may perform this assessment, depending on the scope of practice permitted by the state's licensing, registration, or certification agencies. The PLHCP shall make the determination after evaluating the following employee information.

3.2 Complete a physical and fit test as specified by the PLHCP. This shall include:

- Respirator user wearer clearance form.
- A complete physical examination, with emphasis on the respiratory and cardiovascular systems and digestive tract.
- Blood pressure, pulse rate, height, weight, etc., taken by someone certified as an EMT or licensed as a registered nurse.

3.3 Additional physical testing and follow up examination as required by the PLHCP

3.4 X-rays, but only if required by a specific OSHA regulation (e.g.: acrylonitrile, asbestos)

3.5 Medical evaluations and fit testing are required to be completed annually or as required by changes in the employee's physical condition (some respiratory protection usage may require semi-annual fit testing per OSHA requirement).

3.6 After the evaluation, the attending physician will sign off on the appropriate form and forward it to the representative, who will issue a Qualification Card.

3.7 Medical evaluations/ reviews will be conducted every year or upon changes in the employees' physical condition. Routine X-rays should not be performed unless indicated by other aspects of the health assessment: otherwise, X-rays are required once every 3 years following the baseline X-ray.

4.0 *Training*

4.1 The EMPLOYER shall train each respiratory user in the proper respirator put on and take off techniques, user fit check methods, use, limitations, inspections, maintenance, cleaning, storage, and care of the respirators to be used. Training shall include what potential emergency situations may occur on site and use-specific bases and what actions the user should take if an emergency situation occurs. This training is to be repeated annually.

4.2 A training attendance roster must be completed and signed by the trainer and employee attending the training.

4.3 Prior to use, the Respirator Program Administrator shall perform, or cause to have performed, the appropriate fit test on each individual expected to become a respirator user. Fit testing, may not occur prior to the medical evaluation and approval for respirator use by the PLHCP.

4.4 Evaluation procedures used to determine the effectiveness of this procedure and respirator user's part in the evaluation shall be included in the training of employees.

5.0 *Refresher Training*

5.1 Refresher training will be administered at least annually, or when one of the following conditions occurs:

- Changes in the workplace or the type of respirator render previous training obsolete or inadequate.
- Deficiencies in an employee's demonstrated knowledge or use of the respirator indicate that the employee has not retained the requisite understanding or skill.
- Any other situation in which retraining appears necessary to ensure safe respirator use.

6.0 *Fit Test*

6.1 General – Each respirator shall be fit tested to the wearer to ensure minimum face piece leakage. The fit test shall be conducted for both half-and full-face respirators, ad needed. The fit test shall be performed in the respirator type, make, model, and size, the employee will wear. Only clean shaven persons will wear a respirator. As a minimum, qualitative fit testing shall be performed before workers use any tight fitting face piece (negative pressure) respirators. The preferred method, however, is quantitative. Employees shall be allowed to pick the most comfortable respirator from a selection including respirators of various sizes and models.

6.2 Frequency – Fit testing will be completed annually, expect when regulations require more frequent testing (i.e., when respirators are used for protection against asbestos, benzene, lead, vinyl chloride, etc.). Records of fit testing and medical qualification shall be maintained by the Respirator Program Administrator. Fit testing is also required if there is a change in facial appearance (i.e. gain loss of weight, extensive dental work, etc.), or when a type, make, model, or size change in respirator occurs.

6.3 Documentation – Each respirator fit test shall be documented.

6.4 Fit Test Methods

- Qualitative fit testing shall be performed and documented using a method prescribed by OSHA.
- Quantitative fit testing is mandatory with certain OSHA regulations and preferred in lieu of qualitative testing for all other application.
- Positive pressure respirators must be fit tested in the negative pressure mode, regardless of the mode normally used.

6.5 Annual Retest – Employees shall be notified by the _____, when annual re-testing is required.

7.0 *Cleaning, Maintenance, Storage and Inspection*

7.1 The project shall establish a system to ensure that respirators are properly stored, maintained, inspected, and cleaned according to manufacturer's recommendations.

7.2 Respirator users who have respirators assigned for their personal use must inspect and clean their respirators at least daily when used, or more frequently, if necessary.

7.3 Respirators, including self-contained breathing apparatus (SCBA) used for emergency purposes and respirators used for escape, will be inspected monthly or after each use, whichever is more frequent. These respirators will be protected from elements. A tag shall be maintained affixed to the device or its protective case or housing. Each inspection shall be logged on the tag and include:

- Inspector's initials
- Inspectors date
- Status and inspection findings with comment as necessary

7.4 Inspection information shall also be entered in the respiratory protection maintenance log.

7.5 The Employer will conduct and document frequent random inspections to ensure the respirators are properly maintained.

7.6 Respirators shall always be placed on a flat surface; respirators are not to be hung by their straps and shall be stores in a cool, dry location with moderate temperatures.

7.7 Respirators protection equipment shall not subjected to extreme temperatures, hot or cold, and shall be stored to protect against direct sunlight or heat, chemical contamination, or distortion of its pliable synthetic materials. Respirator parts from one respirator manufacturer shall not be interchanged those of another.

7.8 Respirators found to be defective during inspection shall be repaired, immediately or tagged "out of service," or discarded.

7.9 Air purifying chemical cartridges available for protection against specific chemical compounds are to be used for that hazard only. Further, the sorbent service life and, hence, the effectiveness will depend on the activity of the wearer (breathing rate etc.) and specific type, volatility, and concentration of the chemical.

7.10 All air-purifying respirators cleaned onsite shall be inspected frequently and results of inspection recorded on the respirator maintenance log.

7.11 Self-contained breathing apparatus and other emergency respirators shall additionally be inspected before each use and during periods of storage.

7.12 The complete air-line respiratory system will be inspected before each use.

7.13 Hose masks and blower when used, shall be inspected at least monthly and before each use for proper operation.

7.14 When replacing worn or deteriorated parts, only those made specifically for the device shall be used, and the repair work shall be recorded. Respirator certification is voided of parts other than the specified part for a specific respirator is used.

7.15 Air-purifying cartridges shall be placed when an End of Service Life Indicator (ESLI) indicates, or according to the replacement schedule specified for the job. They should be replaced at the first trace of contaminant odor, other user-detected warning property, or any increased resistance to breathing while wearing the respirator.

7.16 A written standard inspection and cleaning procedure shall be established for each type of respirator by EMPLOYER.

8.0 *Respirator Selection*

8.1 Respiratory protective devices will be used whenever engineering controls are not feasible and when airborne contaminants exceed or are anticipated to exceed published regulatory standards or project specific action levels as found. These devices will be specified according to the concentration and type of the airborne contamination present or expected at each work site. Consideration of other job site conditions such as heat stress, visibility and lighting, low temperatures, and other safety issues will be factored into the selection process.

8.2 Before a respirator can be issued to protect the worker from a respiratory hazard, EMPLOYER must be contacted to evaluate chemical or hazards present at the work area.

8.3 In the selection of respiratory protective equipment, the following factors will be considered:

- Nature and basis of the hazard (e.g., dust, mist, spray, fume, vapor, gas, or combination)
- Potential for an oxygen deficient atmosphere
- Potential for other Immediately Dangerous to Life and Health (IDLH) atmospheric conditions
- Extent of the hazard
- Contaminant(s) present
- Concentration of the contaminant(s)
- Characteristics and limitations of the available respirators
- Expected activity of the worker
- Fit Testing

8.4 The Following respiratory protective equipment will be used in atmospheres that are oxygen-deficient or immediately dangerous to life or health:

- Positive-pressure demand self contained breathing apparatus (SCBA)
- Positive-pressure demand combination air-line respirator with 15-minute escape (egress) provision.
- Air-line continuous flow, helmet, hood, or suit with escape provisions. ***NOTE:*** *All SCBAs must be inspected and documented every 30 days and after each use.*
- When the device is a combination SCBA and air-line respirator, either a manual or automatic valve will be provided to change to the self-contained air supply if the air-line supply fails.
- A standby person, equipped with an SCBA, is required for work in (IDLH) types of confined spaces that require an airline with escape pack respiratory protection (for purposes other than nuisance odor or nuisance dust). ***NOTE:*** *15 minute SCBA units will be used only for emergency egress and not for rescue work or re-entry.*

8.5 Atmosphere supplying respirators will be used in areas where the contaminant levels are expected or have been determined to exceed the maximum airborne concentration is unknown, or if the contaminant of concern is considered to have poor warning properties.)

8.6 Protection against particulate contaminants shall be selected based on particulate filter elements.

8.7 Respirators used in non-IDLH atmospheres require an (ESLI) or a change schedule documented and implanted that will ensure that filter cartridges are changed out before the end of their service life. The change out schedule is highly site-specific and will consider such factors as workplace contaminant concentration, the presence of other contaminants, airflow through the filters, temperature, and humidity.

9.0 *Use and Limitations*

9.1 Air-purifying respirators will not be used for rescue work when atmospheric contaminants are unknown; in IDLH or oxygen deficient environments; when the contaminants of concern have 'poor' warning properties; or when air monitoring data does not exist to document the ambient contaminant levels. Due to their inability to protect against oxygen deficiency.

9.2 Chemical cartridge respirators are intended for limited use in a toxic atmosphere. Regardless of the written change schedule cartridges will be changed whenever the wearer detects the odor of contaminant or has an increased resistance to breathing.

9.3 Respirators issued for the exclusive use of an employee will be marked with employee name.

9.4 Respirators user will not be allowed to select respirator type or cartridge, and will only use the respirator protection equipment specified by the EMPLOYER.

9.5 Canisters and cartridges will be specifically selected for the toxic gas and concentration to be encountered. Canister masks that bear the labor "ALL-SERVICE," "UNIVERSAL," or something similar will not be used.

9.6 An effective seal between the face piece and face to prevent inward leakage must be obtained. Air-purifying respirators, along with demand-type respirators, operate under negative pressure when the wearer inhales; thus, some inward leakage of contaminant may be possible in the absence of an airtight seal.

9.7 Temple bars of eyeglasses will not extend through the sealing edge of the fullface respirator. Full-face masks that have been developed with systems for mounting corrective lenses inside the face piece are preferred.

9.8 The wearer's use of spectacles or goggles should not interfere with half-mask face piece.

9.9 User seal checks shall be performed each time a use dons a respirator.

9.10 Follow the manufactures recommendations.

9.11 End of service life of cartridges exposed to chemicals can be evaluated by: if a chemical has a boiling point of greater than 70 degrees C and the concentration is less than 200 ppm then the service life of 8 hours at the normal work rate, service life is inversely proportional to work rate, reducing concentration by a factor of 10 will increase service life by a factor of 5 and humidity above 85% will reduce service life by 50%.

10.0 *Precautions*

10.1 Respirators usually provide a satisfactory pathway for speech transmission over short distances and relatively areas. An alternate form of communication between workers will be established respirators are to be used in high noise areas.

10.2 To prevent face pieces from fogging up in low temperature, anti-fog compounds may be used to coat the inside of the full-face-piece lens. Several respirator manufactures also provide nose cups for their full-face-piece for their full-face-piece respirators which channel the moisture-laden exhaled air directly out through the exhalation valves.

10.3 Pure oxygen will not be used for respiratory protection.

10.4 Hoses for air supply will be selected to resist chemicals to which they may be exposed.

10.5 All air fitting associated with air-line supply and SCBA equipment shall be incompatible with other gas systems onsite.

11.0 *Voluntary Use*

11.1 An employee may request to use a respirator in situations where respirator use is not required by regulations or by program procedure. In such a case, the employer must determine that such respirator use will not in itself create a hazard. Factors such as heat stress and limited visibility are among the issues to be considered. When voluntary respirator use is permitted, the following items apply:

11.2 EMPLOYER NAME may provide respirators at the request of the employees or permit employees to use their own respirators. If voluntary respirator use is allowed, the Company will provide the respirator users with the information contained in Appendix D ("Information for Employees Using Respirators When Not Required Under the Standard").

11.3 EMPLOYER NAME then allowing such use, must establish and implement those elements of a written respiratory protection program necessary to ensure that any employee using a respirator voluntarily is medically able to use that respirator, and that the respirator is cleaned, stored, and maintained so that its use does not present a health hazard to the user.

12.0 *Breathing-Air-Quality System*

12.1 Compressor Supplied Breathing Air – Compressed air that is used in supplied air respirators, such as SCBAs, shall be high purity. Breathing air shall meet all requirements of the American National Standards Institute (ANSI) for the minimum of Grade D breathing air. Pure oxygen shall never be substituted for compressed air. The specifications for Grade D breathing air, (Reference Compressed Gas Association), are:

- Oxygen content of 19.5 – 23.5 %
- Hydrocarbon (condensed) of 5 mg per cubic meter of air or less
- CO content of 10 ppm or less
- CO2 content of 1000 ppm or less
- Lack of noticeable odor
- Air supplied in cylinders shall not have a dew point greater then 50 degrees F (-45.6 degrees C).

12.2 Breathing air may be supplied to respirators from cylinders or compressor systems. Oxygen content shall not exceed 23.5%, except in systems specifically designed for oxygen distribution (this would only occur in recirculating or closed system SCBAs which will not be used on job sites unless specifically approved by the Respirator Program Administrator).

12.3 Where practical, breathing-air compressor shall be used. Compressors shall be situated so as to avoid entry of ambient contaminated air or exhaust into the breathing-air system and suitable in-line air. An oil-less compressor is preferred over an oil-lubricated compressor. All compressor systems shall be equipped and maintained in accordance with the manufacturer's specifications or better. Oil-lubricated compressors shall be equipped with a high-temperature shut off and/or an alarm system and alarm actuation system to safeguard against exposure to carbon monoxide, compressor failure, and monitor failure. If only a high-temperature alarm is used and continuous carbon monoxide monitors are highly recommended. Filters shall be entrained for removal of water and oil from the breathing air.

12.4 Additional requirements for compressor supplied breathing air are:

- System constructed to prevent entry of contaminated air into the breathing air system.
- Minimize moisture content so that the dew point at 1 atmosphere is 10 degrees F (5.56 degrees C) below ambient temperature.
- If equipped with in-line air-purifying sorbent beds and/or filters these sorbent beds and filters are to be maintained and cleaned and changed, according to the manufacturer's recommendations. A tag affixed to the compressor shall indicate the most recent change date and the signature of the individual authorized to make the change.

13.0 *Program Evaluation*

13.1 Overall respiratory protection program procedures and implementation will be reviewed on a periodic basis by the Respirator Program Administrator. The project respiratory protection program will be evaluated on an ongoing basis by the EMPLOYER to determine the program effectiveness. Evaluation will include the following:

- Review current airborne contaminant monitoring data to insure sufficient protection is afforded all respirator users
- Review of technical information
- Compliance with regulation
- Review of medical qualifications
- Review of medical requirements
- Review of training qualifications
- Review of training documents and plans
- Review of respirator fit-test documentation
- Review of reports of respirator or cartridge failures
- Review of maintenance and cleaning procedures and logs
- Review of inspection procedures
- Record keeping requirements
- Consultation with respirator wearers to determine their views on the effectiveness of the program

3 Respirator Clearance Card

Respirator User Clearance for: _____

Social Security Number: _____ Company: _____

The above named individual has completed the OSHA mandated medical questionnaire, appropriate medical exam(s) and respirator fit test on _____, _____.

1. Follow-up medical examination required: ☐ **YES** ☐ **NO**
   If yes: Consisting of the following tests/evaluations/results _____
   _____
   _____
   _____
   _____
2. This individual is medically fit for respirator use: ☐ **YES** ☐ **NO**
3. Pulmonary function test: ☐ **YES*** ☐ **NO**
   Type of PFT: ☐ **QLFT** ☐ **QNFT***
   QLFT: ☐ **ISA** ☐ **SACCHARIN** ☐ **BRITEX** ☐ **IS** ☐ **PASS** ☐ **FAIL** ☐ **NA**
   QNFT: ☐ **GA** ☐ **CNC (PORTACOUNT)*** ☐ **CNP** ☐ **FIT FACTOR** _____*

PREFERRED

The use of a respirator may be associated with other physical stresses, such as having to wear restrictive, protective clothing and to carry heavy equipment. Accordingly this fit test included these possibilities. If this is a new employee, information for questions 10 through 19 of part B of the medical questionnaire (if used) shall be supplied by a statement from the employer's site representative or their designee.

This test has been conducted according to Appendix A and using the information provided in the medical questionnaire mandated by Appendix C.

RECOMMENDATIONS ACCORDING TO ANSI Z 88.6

Class I _____ (no restrictions)

Class II _____ specific restrictions

Class III _____ (not permitted)

Class II restrictions

APPROVAL IS FOR THE FOLLOWING RESPIRATOR(S)

Type: _____

Air Purifying: ☐ **1/2FP** ☐ **FFP** ☐ **FILTFP PAPR ONLY**

Air Supplying: ☐ **SAE (AIRLINE)** ☐ **SCBA**

Brand: _____

Size: ☐ **SM** ☐ **MED** ☐ **LG** ☐ **XLG**

Other/Comments

_____ _____

(Signature of authorized PLHCP) (Date)

Instructions for use: *This appendix is copied directly from CAL/OSHA.*

App C – Respiratory Protection – Mandatory Medical Questionnaire

Answers to questions in Section 1, and to question 9 in Section 2 of Part A, do not require a medical examination.

To the employee:

Can you read (circle one): **YES NO**

To maintain your confidentiality, your employer or supervisor must not look at or review your answers, and your employer must tell you how to deliver or send this questionnaire to the health care professional who will review it.

Part A. Section 1. (Mandatory)

The following information must be provided by every employee who has been selected to use any type of respirator (please print).

1. Today's date: _____
2. Your name: _____
3. Your age (to nearest year): _____
4. Sex (circle one): **Male Female**
5. Your height: _____ ft. _____ in.
6. Your weight: _____ lbs.
7. Your job title: _____
8. A phone number where you can be reached by the health care professional who reviews this questionnaire (include the Area Code): _____
9. The best time to phone you at this number:

   _____
10. Has your employer told you how to contact the health care professional who will review this questionnaire (circle one): **YES NO**
11. Check the type of respirator you will use (you can check more than one category):
    a. _____ N, R, or P disposable respirator (filter-mask, non-cartridge type only).
    b. _____ Other type (for example, half-or full-facepeice type, powered-air purifying, supplied-air, self-contained breathing apparatus).
12. Have you worn a respirator (circle one): **YES NO**

    If "yes," what type(s): _____

    _____

    _____

    _____

Part A. Section 2. (Mandatory)

Questions 1 through 9 below must be answered by every employee who has been selected to use any type of respirator (please circle "yes" or "no").

1. Do you currently smoke tobacco, or have you smoked tobacco in the last month: **YES NO**
2. Have you ever had any of the following conditions?
   a. Seizures (fits): **YES NO**
   b. Diabetes (sugar disease): **YES NO**
   c. Allergic reactions that interfere with your breathing: **YES NO**
   d. Claustrophobia (fear of closed-in places): **YES NO**
   e. Trouble smelling odors: **YES NO**
3. Have you ever had any of the following pulmonary or lung problems?
   a. Asbestosis: **YES NO**
   b. Asthma: **YES NO**
   c. Chronic bronchitis: **YES NO**
   d. Emphysema: **YES NO**
   e. Pneumonia: **YES NO**
   f. Tuberculosis: **YES NO**
   g. Silicosis: **YES NO**
   h. Pneumothorax (collapsed lung): **YES NO**
   i. Lung cancer: **YES NO**
   j. Broken ribs: **YES NO**
   k. Any chest injuries or surgeries: **YES NO**
   l. Any other lung problem that you've been told about: **YES NO**

Respirator User Medical Questionnaire

4. Do you currently have any of the following symptoms of pulmonary or lung illness?
   a. Shortness of breath: **YES NO**
   b. Shortness of breath when walking fast on level ground or walking up a slight hill or incline: **YES NO**
   c. Shortness of breath when walking with other people at an ordinary pace on level ground: **YES NO**
   d. Have to stop for breath when walking at your own pace on level ground: **YES NO**
   e. Shortness of breath when washing or dressing yourself: **YES NO**
   f. Shortness of breath that interferes with your job: **YES NO**
   g. Coughing that produces phlegm (thick sputum): **YES NO**
   h. Coughing that wakes you early in the morning: **YES NO**
   i. Coughing that occurs mostly when you are lying down: **YES NO**
   j. Coughing up blood in the last month: **YES NO**
   k. Wheezing: **YES NO**
   l. Wheezing that interferes with your job: **YES NO**
   m. Chest pain when you breath deeply: **YES NO**
   n. Any other symptoms that you think may be related to lung problems: **YES NO**
5. Have you ever had any of the following cardiovascular or heart problems?
   a. Heart attack: **YES NO**
   b. Stroke: **YES NO**
   c. Angina: **YES NO**
   d. Heart failure: **YES NO**
   e. Swelling in your legs or feet (not caused by walking): **YES NO**
   f. Heart arrhythmia (heart beating irregularly): **YES NO**
   g. High blood pressure: **YES NO**
   h. Any other heart problem that you've been told about: **YES NO**
6. Have you ever had any of the following cardiovascular or heart symptoms?
   a. Frequent pain or tightness in your chest: **YES NO**
   b. Pain or tightness in your chest during physical activity: **YES NO**
   c. Pain or tightness in your chest that interferes with your job: **YES NO**
   d. In the past two years, have you noticed your heart skipping or missing a beat: **YES NO**
   e. Heartburn or indigestion that is not related to eating: **YES NO**
   f. Any other symptoms that you think may be related to heart or circulation problems: **YES NO**
7. Do you currently take medication for any of the following problems?
   a. Breathing or lung problems: **YES NO**
   b. Heart trouble: **YES NO**
   c. Blood pressure: **YES NO**
   d. Seizures (fits): **YES NO**
8. If you've used a respirator, have you ever had any of the following problems? (If you've ever used a respirator, check the following space and go to question 9:)
   a. Eye irritation: **YES NO**
   b. Skin allergies or rashes: **YES NO**
   c. Anxiety: **YES NO**
   d. General weakness or fatigue: **YES NO**
   e. Any other problem that interferes with your use of a respirator: **YES NO**
9. Would you like to talk to a health care professional who will review this questionnaire about your answers to this questionnaire: **YES NO**

Respirator User Medical Questionnaire

Questions 10 to 15 below must be answered by every employee who has been selected to use either a full-facepiece respirator or a self-contained breathing apparatus (SCBA). For employees who have been selected to use other types of respirators, answering these questions is voluntary.

10. Have you ever lost vision in either eye (temporarily or permanently): **YES NO**

11. Do you currently have any of the following vision problems?
    a. Wear contact lenses: **YES NO**
    b. Wear glasses: **YES NO**
    c. Color blind: **YES NO**
    d. Any other eye or vision problem: **YES NO**

12. Have you ever had an injury to your ears, including a broken ear drum: Yes No

13. Do you currently have any of the following hearing problems?
    a. Difficulty hearing: **YES NO**
    b. Wear a hearing aid: **YES NO**
    c. Any other hearing or ear problem: **YES NO**

14. Have you ever had a back injury: **YES NO**

15. Do you currently have any of the following musculoskeletal problems?
    a. Weakness in any of your arms, hands, legs, or feet: **YES NO**
    b. Back pain: **YES NO**
    c. Difficulty fully moving your arms and legs: **YES NO**
    d. Pain or stiffness when you lean forward or backward at the waist: **YES NO**
    e. Difficulty fully moving your head up or down: **YES NO**
    f. Difficulty fully moving your head side to side: **YES NO**
    g. Difficulty bending at your knees: **YES NO**
    h. Difficulty squatting to the ground: **YES NO**
    i. Climbing a flight of stairs or a ladder carrying more than 25 lbs: **YES NO**
    j. Any other muscle or skeletal problem that interferes with using a respirator: **YES NO**

Part B

Any of the following questions, and other questions not listed, may be added to the questionnaire at the discretion of the health care professional who will review the questionnaire.

1. In your present job, are you working at high altitudes (over 5,000 feet) or in a place that has lower than normal amounts of oxygen: **YES NO**

   If "yes," do you have feelings of dizziness, shortness of breath, pounding in your chest, or other symptoms when you're working under these conditions: **YES NO**

2. At work or at home, have you ever been exposed to hazardous solvents, hazardous airborne chemicals (e.g., gases, fumes, or dust), or have you come into skin contact with hazardous chemicals: **YES NO**

   If "yes," name the chemicals if you know them:

   _____

   _____

   _____

   _____

   _____

3. Have you ever worked with any of the materials, or under any of the conditions, listed below:
   a. Asbestos: **YES NO**
   b. Silica (e.g., in sandblasting): **YES NO**
   c. Tungsten/cobalt (e.g., grinding or welding this material): **YES NO**
   d. Beryllium: **YES NO**
   e. Aluminum: **YES NO**
   f. Coal (for example, mining): **YES NO**
   g. Iron: **YES NO**
   h. Tin: **YES NO**
   i. Dusty environments: **YES NO**
   j. Any other hazardous exposures: **YES NO**

   If "yes," describe the exposures: _____

   _____

   _____

   _____

   _____

Respirator User Medical Questionnaire

4. List any second jobs or side businesses you have:

   _____
   _____
   _____
   _____

5. List your previous occupations: _____

   _____
   _____
   _____
   _____

6. List your current and previous hobbies: _____

   _____
   _____
   _____
   _____

7. Have you been in the military services? **YES** **NO**

   If "yes," were you exposed to biological or chemical agents (either in training or combat): **YES** **NO**

8. Have you ever worked on a HAZMAT team? **YES** **NO**

9. Other than medications for breathing and lung problems, heart trouble, blood pressure, and seizures mentioned earlier in this questionnaire, are you taking any other medications for any reason (including over-the-counter medications): **YES** **NO**

   If "yes," name the medications if you know them:

   _____
   _____
   _____
   _____
   _____

10. Will you be using any of the following items with your respirator(s)?

    a. HEPA Filters: **YES** **NO**

    b. Canisters (for example, gas masks): **YES** **NO**

    c. Cartridges: **YES** **NO**

11. How often are you expected to use the respirator(s) (circle "yes" or "no" for all answers that apply to you)?:

    a. Escape only (no rescue): **YES** **NO**

    b. Emergency rescue only: **YES** **NO**

    c. Less than 5 hours per week: **YES** **NO**

    d. Less than 2 hours per day: **YES** **NO**

    e. 2 to 4 hours per day: **YES** **NO**

    f. Over 4 hours per day: **YES** **NO**

12. During the period you are using the respirator(s), is your work effort:

    a. Light (less than 200 kcal per hour): **YES** **NO**

    If "yes" how long does this period last during the average shift: _____hrs. _____mins.

    Examples of light work effort are sitting while writing, typing, drafting, or performing light assembly work; or standing while operating a drill press (1-3 lbs.) or controlling machines.

    b. Moderate (200 to 350 kcal per hour): **YES** **NO**

    If "yes" how long does this period last during the average shift: _____ hrs. _____ mins.

    Examples of moderate work effort are sitting while nailing or filing; driving a truck or bus in urban traffic; standing while drilling, nailing, performing assembly work, or transferring a moderate load (about 35 lbs.) at trunk level; walking on level surface about 2 mph or down a 5-degree grade about 3 mph; or pushing a wheelbarrow with a heavy load (about 100 lbs.) on a level surface.

    C. Heavy (above 350 kcal per hour): **YES** **NO**

    If "yes" how long does this period last during the average shift: _____hrs. _____mins.

    Examples of heavy work are lifting a heavy load (about 50 lbs.) from the floor to your waist or shoulder; working on a loading dock; shoveling; standing while bricklaying or chipping castings; walking up a 8-degree grade about 2 mph; climbing stairs with a heavy load (about 50 lbs.).

13. Will you be wearing protective clothing and/or equipment (other than the respirator) when you're using your respirator: **YES** **NO**

    If "yes" describe this protective clothing and/or equipment: _____

    _____
    _____
    _____
    _____

14. Will you be working under hot conditions (temperature exceeding 77 deg. F): **YES** **NO**

15. Will you be working under humid conditions: **YES** **NO**

Respirator User Medical Questionnaire

16. Describe the work you'll be doing while you're using your respirator: _____
    _____
    _____
    _____
    _____

17. Describe any special or hazardous conditions you might encounter when you're using your respirator(s) (for example, confines space, life-threatening gases):
    _____
    _____
    _____
    _____
    _____

18. Provide the following information, if you know it, for each toxic substance that you'll be exposed to when you're using your respirator(s):

    Name of the first toxic substance: _____

    Estimated maximum exposure level per shift: _____

    Duration of exposure per shift: _____

    Name of the second toxic substance: _____

    Estimated maximum exposure level per shift: _____

    Duration of exposure per shift: _____

    Name of the third toxic substance: _____

    Estimated maximum exposure level per shift: _____

    Duration of exposure per shift: _____

    The name of any other toxic substances that you'll be exposed to while using your respirator: _____
    _____
    _____
    _____
    _____

19. Describe any special responsibilities you'll have while using your respirator(s) that may effect the safety and well-being of others (for example, rescue, security):
    _____
    _____
    _____
    _____
    _____

Special Instructions:

Answers to questions 10 through 15 of part A are only required for full face respirator users. Part B of this questionnaire is not mandatory. The site EH&S representative and the PLHCP must agree as to which of the questions are appropriate.

New Hires: If this questionnaire is filled out prior to a prospective employee being hired, any answers to questions 10 through 19 of Part B must be supplied by EMPLOYER and shown to the employee when they fill out this form (depending which questions are used).

Existing Employees: This questionnaire must be allowed to be filled out during normal working hours at a time and place convenient to the employee.

Employee Statement of Medical Condition Form

_____

(Print Employee Name)

To the best of my knowledge, I, _____, have no medical conditions which could interfere with wearing a respirator while engaged in hazardous exposure situations. I understand that heart disease, high blood pressure, lung disease, or presence of a perforated ear-drum require specific medical evaluation by a physician before safe use of a respirator can be determined.

_____ _____

(Signature of Employee) (Date)

Report of Medical Evaluation

The employee listed above has been given an examination by me and at this time there is no medical contraindication to the employee named above wearing a respirator to allow in hazardous exposure environments.

Other comments: _____

_____

_____

_____

_____

_____

_____

_____

_____ _____

(Physician's Signature) (Date)

Respiratory Training Attendance Roster

Training Topic(s): _____

Training Method(s): _____

Trainer(s): _____

Date of Training: _____ Location: _____

I have understood the materials presented and have had my questions answered satisfactorily. In the event of any further questions, I know the employees to contact.

Employee Name (Please Print)	Social Security Number	Company	Employee Signature

3 Respirator Fit Test Record

Last Name: _____

First Name: _____

PORTACOUNT PLUS FIT TEST SOFTWARE FIT TEST REPORT

Last Name: _____

First Name: _____

SSN: _____

ID Number: _____

Test Date: _____ Next Test Due: _____

Operator Name: _____

Respirator Model: _____

- Type: _____

- Size: _____

- Manufacturer: _____

- Approval Number: _____

Notes: _____

Test Date: _____

Test Time: _____

TEST DATA

FIT FACTOR PASS LEVEL: 100

Ex.	Ambient (Part/cc)	Mask (Part/cc)	Fit Factor	Pass/Fail
NB	18400	0.27	67900.0	PASS
DB	16300	0.74	22000.0	PASS
SS	15200	0.19	79700.0	PASS
UD	14400	1.20	11900.0	PASS
T	13600	2.45	5550.0	PASS
G	12900	0.24	53700.0	PASS
B	12200	1.96	6220.0	PASS
NB	11700	1.33	8790.0	PASS

**Not included in overall Fit Factor*

Overall Fit Factor = 11400-0 PASS

Operator _____ Date _____

Name _____ Date _____

Chemicals Not Suitable for Chemical Cartridge Respirators

Chemical Name	Chemical Abstract Service Registry Number
Acrolein	107-02-8
Aniline	65-53-3
Arsine	7440-38-2
Bromine	314-40-9
Carbon Monoxide	630-08-0
Chloroform	67-66-3
Dimethylaniline	121-169-7
Dimethyl Sulfate	77-78-1
Hydrazine	302-01-2
Hydrogen Cyanide	74-90-8
Hydrogen Fluoride	7664-39-3
Hydrogen Selenide	7783-07-5
Hydrogen Sulfide	7783-06-4
Methanol	67-56-1
Methyl Bromide	74-83-9
Methyl Chloride	74-87-3
Mythylene Biphenyl Isocyanide	101-68-8
Nickel Carbonyl	13463-39-3
Nitro Compounds:	
- Nitrobenzene	98-95-3
- Nitrogen Oxides	10024-97-2
- Nitroglycerin	55-63-0
- Nitromethane	75-52-5
Ozone	10028-15-6
Phosgene	75-44-5
Phosphine	3803-51-2
Phosphorus Trichloride	7719-12-2
Stilbene	7803-52-3
Sulfur Chloride	10025-67-9
Toluene Diisocynate	584-84-9
Vinyl Chloride	75-01-4

Respirator Maintenance Log

Project Number	Project Location	Department

Name	Badge Number	Date	Washed & Cleaned	Cartidge Changed	Damaged Parts Replaced (If Any)	Initials

Part 2 – Respirator Cleaning Procedures

This part of Appendix F contains the cleaning procedures. Choose the method best for the site and include it as an appendix to the site specific procedure. Note that manufacturer specified procedures are an allowed alternative.

1. Respirator Cleaning Procedures (Mandatory). These procedures are provided for employer use when cleaning respirators. They are general in nature, and the employer as an alternative may use the cleaning recommendations provided by the manufacturer of the respirators used by their employees, provided such procedures are as effective as those listed here in Appendix B-2.
2. Equivalent effectiveness simply means that the procedures used must accomplish the objectives set forth in Appendix B-2, i.e., must ensure that the respirator is properly cleaned and disinfected in a manner that prevents damage to the respirator and does not cause harm to the user.

I. Procedures for Cleaning Respirator

A. Remove filters, cartridges, or canisters. Disassemble facepieces by removing speaking diaphragms, demand and pressure – demand valve assemblies, hoses, or any components recommended by the manufacturer. Discard or repair any defective parts.

B. Wash components in warm (43 deg. C [110 deg. F] maximum) water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.

C. Rinse components thoroughly in clean, warm (43 deg. C [110 deg. F] maximum), preferably running water. Drain.

D. When the cleaner used does not contain a disinfecting agent, respirator components should be immersed for two minutes in one of the following:

1. Hypochlorite solution (50 ppm of chlorine) made by adding approximately one milliliter of laundry bleach to one liter of water at 43 deg. C (11o deg. F); or,
2. Aqueous solution of iodine (50 ppm iodine) made by adding approximately 0.8 milliliters of tincture of iodine (6-8 grams ammonium and/or potassium iodide/100 cc of 45% alcohol) to one liter of water at 43 deg. C (110 deg. F); or,
3. Other commercially available cleansers of equivalent disinfectant quality when used as directed, if their use is recommended or approved by the respirator manufacturer.

E. Rinse components thoroughly in clean, warm (43 deg. C [110 deg. F] maximum), preferably running water. Drain. The importance of thorough rinsing cannot be overemphasized. Detergents or disinfectants that dry on facepeices may result in dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.

F. Components should be hand-dried with a clean lint-free cloth or air-dried.

G. Reassemble facepiece, replacing filters, cartridges, and canisters where necessary.

H. Test the respirator to ensure that all components work properly.

This appendix contains the fit test procedures required:

- General requirements in Part 1A
- Qualitative Fit Test Protocols in Part 1B
- Quantitative Fit Test Protocols in Part 1C

_____ prefers the use of the quantitative fit testing using Portacount equipment found in Part 1C. Portacount fit testing is available in most locations. In the event Portacount fit testing is not available, one of the other approved methods must be selected. The site Respiratory Protection Program Administrator must make this determination. If fit testing is contracted, the Respiratory Protection Program Administrator is required to review the method(s) used by the vendor, to ensure the chosen method(s) is used in accordance with the regulations.

An addendum to this appendix contains the form used for Portacount fit testing.

Part II of the appendix details the procedures for gaining approval of new fit test protocols and is not included in this document.

Fit Testing Procedures (Mandatory)

Part I. CAL/OSHA — Accepted Fit Test Protocols

A. Fit Testing Procedures — General Requirements

The employer shall conduct fit testing using the following procedures. The requirements in this appendix apply to all accepted fit test methods, both QLFT and QNFT.

1. The test subject shall be allowed to pick the most acceptable respirator from a sufficient number of respirator models and sized so that the respirator is acceptable to, and correctly fits, the user.
2. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to determine an acceptable fit. A mirror shall be available to assist the subject in evaluating the fit and positioning of the respirator. This instruction may not constitute the subject's formal training on respirator use, because it is only a review.
3. The test subject shall be informed that he/she is being asked to select the respirator that provides the most acceptable fit. Each respirator represents a different size and shape, and if fitted and used properly, will provide adequate protection.
4. The test subject shall be instructed to hold each chosen facepiece up to the face and eliminate those that obviously do not give an acceptable fit.
5. The more acceptable facepieces are noted in case the one selected proves unacceptable; the most comfortable mask is donned and worn at least five minutes to access comfort. Assistance in accessing comfort can be given discussing the points in the following item A.6. If the test subject is not familiar with using a particular respirator the test subject shall be directed to don the mask several times and to adjust the straps each time to become adept at setting proper tension on the straps.
6. Assessment of comfort shall include a review of the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator:
   (a) Position of the mask on the nose
   (b) Room for eye protection
   (c) Room to talk
   (d) Position of mask on face and cheeks
7. The following criteria shall be used to help determine the adequacy of the respirator fit:
   (a) Chin properly placed;
   (b) Adequate strap tension, not overly tightened;
   (c) Fit across nose bridge;
   (d) Respirator of proper size to span distance from nose to chin;
   (e) Tendency of respirator to slip;
   (f) Self-observation in mirror to evaluate fit and respiration position.
8. The test subject shall conduct a user seal check, either the negative and positive pressure seal checks described in Appendix B-1 of this section or those recommended by the respirator manufacturer which provide equivalent protections to the procedures in Appendix B-1. Before conducting the negative and positive pressure checks, the subject shall be told to seat the mask on the face by moving the head from side-to-side and up and down slowly while taking in a few slow deep breaths. Another facepiece shall be selected and retested if the test subject fails the user seal check tests.

9. The test shall be conducted if there is any hair growth between the skin and the face piece sealing surface, such as stubble beard growth, beard, mustache or sideburns which cross the respirator sealing surface. Any type of apparel that interferes with a satisfactory fit shall be altered and removed.
10. If a test subject exhibits difficulty in breathing during tests, he or she shall be referred to a physician or other licensed health care professional, as appropriate, to determine whether the test subject can wear a respirator while performing his or her duties.
11. If the employer finds the fit of the respirator unacceptable, the test subject shall be given the opportunity to select a different respirator and to be retested.
12. Exercise regimen. Prior to the commencement of the fit test, the test subject shall be given a description of the fit test and the test subject's responsibilities during the test procedure. The description of the process shall include a description of the test exercises that the subject will be performing. The respirator to be tested shall be worn for at least 5 minutes before the start of the fit test.
13. The fit test shall be performed while the test subject is wearing any applicable safety equipment that may be worn during actual respirator use that could interfere with respirator fit.
14. Test Exercises.
    (a) The following test exercises are to be preformed for all fit testing methods prescribed in this appendix, except for the CNP method. A separate fit testing exercise regimen is contained in the CNP protocol. The test subject shall perform exercises, in the test environment, in the following manner:
        (1) **Normal breathing.** In a normal breathing position, without talking, the subject shall breathe normally.
        (2) **Deep breathing.** In a normal standing position, the subject shall breathe slowly and deeply, taking caution so as not to hyperventilate.
        (3) **Turning head side to side.** Standing in place the subject shall slowly turn his/her from side to side between the extreme positions on each side. The head shall be held at each extreme momentarily so the subject can inhale at each side.
        (4) **Moving head up and down.** Standing in place, the subject shall slowly move his/her head up and down. The subject shall be instructed to inhale in the up position (i.e., when looking toward the ceiling).
        (5) **Talking.** The subject shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor. The subject can read from a prepared text such as the Rainbow Passage, count back from 100, or recite a memorized poem or song.

            Rainbow Passage: *"When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow."*
        (6) **Grimace.** The test subject shall grimace by smiling or frowning. (This applies only to QNFT testing; it is not performed for QLFT)
        (7) **Bending over.** The test subject shall bend at the waist as if he/she were to touch his/her toes. Jogging in place shall be substituted for this exercise in those test environments such as shroud type QNFT or QLFT units that do not permit bending over at the waist.
        (8) **Normal Breathing.** Same as exercise (1).
    (b) Each test exercise shall be performed for one minute except for the grimace exercise, which shall be performed for 15 seconds. The test shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become unacceptable, another model of respirator shall be tried. The respirator shall not be adjusted once the fit test exercises begin. Any adjustment voids the test, and the fit test must be repeated.

B. Qualitative Fit Test (QLFT) Protocols

1. General
   (a) The employer shall ensure that persons administering QLFT are able to prepare test solutions, calibrate equipment and perform tests properly, recognize invalid tests, and ensure that test equipment is in proper working order.
   (b) The employer shall ensure that QLFT equipment is kept clean and well maintained so as to operate within the parameters for which it is designed.
2. Isoamyl Acetate Protocol

   NOTE: This protocol is not appropriate to use for the fit testing of particulate respirators. If used to fit test particulate respirators, the respirator must be equipped with an organic vapor filter.

   (a) Odor Threshold Screening. Odor threshold screening, performed without wearing a respirator, is intended to determine if the individual tested can detect the odor of Isoamyl acetate at low levels.
      (1) Three 1-liter glass jars with metal lids are required.
      (2) Odor-free water (e.g., distilled or spring water) at approximately 25 deg. C (77 deg. F) shall be used for the solutions.
      (3) The Isoamyl acetate (IAA) (also known as isopentyl acetate) stock solution is prepared by adding 1 mL of pure IAA to 800 mL of odor-free water in a 1 liter jar, closing the lid and shaking for 30 seconds. A new solution shall be prepared at least weekly.
      (4) The screening test shall be conducted in a room separate from the room used for the actual fit testing. The two rooms shall be well ventilated to prevent the odor of IAA from becoming evident in the general room air where testing takes place.
      (5) The odor test solution is prepared in a second jar by placing 0.4 mL of the stock solution into 500 mL of odor-free water using a clean dropper or pipette. The solution shall be shaken for 30 seconds and allowed to stand two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution shall be used for only one day.
      (6) A test blank shall be prepared in a third jar by adding 500 cc of odor-free water.
      (7) The odor test and test blank jar lids shall be labeled (e.g., 1 and 2) for jar identification. Labels shall be placed on the lids so that they can be peeled off periodically and switched to maintain the integrity of the test.
      (8) The following instruction shall be typed on a card and placed on the table in front of the two test jars (i.e., 1 and 2): "The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, and then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains the banana oil."
      (9) The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test was performed, in order to prevent olfactory fatigue in the subject.
      (10) If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA qualitative fit test shall not be preformed.
      (11) If the test subject correctly identifies the jar containing the odor test solution, the test subject may proceed to respirator selection and fit testing.
   (b) Isoamyl Acetate Fit Test
      (1) The fit test chamber shall be a clear 55-gallon drum liner suspended inverted over a 2-foot diameter frame so that the top of the chamber is about 6 inches above the test subject's head. If no drum liner is available, a similar chamber shall be constructed using plastic sheeting. The inside top center of the chamber shall have a small hook attached.
      (2) Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors.

(3) After selecting, donning, and properly adjusting a respirator, the test subject shall where it to the fit testing room. The room shall be separate from the room used for odor threshold screening and respirator selection, and shall be well ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.

(4) A copy of the test exercises and any prepared text from which the subject is to read shall be taped to the inside of the test chamber.

(5) Upon entering the test chamber, the test subject shall be given a 6-inch by 5-inch piece of paper towel, or other porous, absorbent, single-ply material, folded in half and wetted with 0.75 mL of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber. An IAA test swab or ampule may be substituted for the IAA wetted paper towel provided it has been demonstrated that the alternative IAA source will generate an IAA test atmosphere with a concentration equivalent to that generated by the paper towel method.

(6) Allow two minutes for the IAA test concentration to stabilize before starting the fit test exercises. This would be an appropriate time to talk with the test subject; to explain the fit test, the importance of his/her cooperation, and the purpose for the test exercises; or to demonstrate some of the exercises.

(7) If at any time during the test, the subject detects the banana-like odor of IAA, the test is failed. The subject shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

(8) If the test is failed, the subject shall return to the selection room and remove the respirator. The test subject shall repeat the odor sensitivity test, select and put on another respirator, return to the test area and again begin the fit test procedure described in (b)(1) through (7) above. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait at least 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

(9) If the subject passes the test, the efficiency of the test procedure shall be demonstrated by having the subject break the respirator face seal and take a breath before exiting the chamber.

(10) When the test subject leaves the chamber, the subject shall remove the saturated towel and return it to the person conducting the test, so that there is no significant IAA concentration buildup in the chamber during subsequent tests. The used towels shall be kept in a self-sealing plastic bag to keep the test area from being contaminated.

3. Saccharin Solution Aerosol Protocol. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) Taste threshold screening. The saccharin taste threshold screening, performed without wearing a respirator, is intended to determine whether the individual being tested can detect the taste of saccharin.

(1) During threshold screening as well as during fit testing, subjects shall wear an enclosure about the head and shoulders that is approximately 12 inches in diameter by 14 inches tall with at least the front portion clear that allows free movements of the head when a respirator is worn. An enclosure substantially similar to the 3m hood assembly, parts # FT 14 and # FT 15 combined is adequate.

(2) The test enclosure shall have a ¾ inch (1.9 cm) hole in the front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

(3) The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his/her slightly open mouth with tongue extended. The subject is instructed to report when he/she detects a sweet taste.

(4) Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the threshold check solution into the enclosure. The nozzle is directed away from the nose and mouth of the person. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

(5) The threshold check solution is prepared by dissolving 0.83 gram of sodium saccharin USP in 100 mL of warm water. It can be prepared by putting 1 mL of the fit test solution (see (b) (5) below) in 100mL of distilled water.

(6) To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely, then released and allowed to fully expand.

(7) Ten squeezes are repeated rapidly and then the test subject is asked whether the saccharin can be tasted. If the test subject reports tasting the sweet taste during the ten squeezes, the screening test is completed. The taste threshold is noted as ten regardless of the number of squeezes actually completed.

(8) If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted. If the test subject reports tasting the sweet taste during the second ten squeezes, the screening test is completed. The taste threshold is noted as twenty regardless of the number of squeezes actually completed.

(9) If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted. If the test subject reports tasting the sweet taste during the third set of ten squeezes, the screening test is completed. The taste threshold is noted as thirty regardless of the number of squeezes actually completed.

(10) The test conductor will take note of the number of squeezes required to solicit a taste response.

(11) If the saccharin is not tasted after thirty squeezes (step 10), the test subject is unable to taste saccharin and may not perform the saccharin fit test.

Note to paragraph 3. (a): If the test subject eats or drinks something sweet before the screening test, he/she may be unable to taste the weak saccharin solution.

(12) If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

(13) Correct use of the nebulizer means that approximately 1 mL of liquid is used at a time in the nebulizer body.

(14) The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every 4 hours.

(b) Saccharin solution aerosol fit test procedure.

(1) The test subject may not eat, drink (except plain water), smoke, or chew gum for 15 minutes before the test.

(2) The fit test uses the same enclosure described in 3. (a) above.

(3) The test subject shall don the enclosure while wearing the respirator selected in section I. A. of this appendix. The respirator shall be properly adjusted and equipped with a particulate filter(s).

(4) A second DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from screening test solution nebulizer.

(5) The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 mL of warm water.

(6) As before, the test subject shall breathe through the slightly open mouth with tongue extended, ad report if he/she tasted the sweet taste of saccharin.

(7) The nebulizer is inserted into the hole in the front of the enclosure and an initial concentration of saccharin fit test solution is sprayed into the enclosure using the same number of squeezes (either 10, 20, or 30 squeezes) based on the number of squeezes required to elicit a taste response as noted during the screening test. A minimum of 10 squeezes is required.

(8) After generating the aerosol, the test subject shall be instructed to perform the exercises in section I. A. 14. of this appendix.

(9) Every 30 seconds the aerosol concentration shall be replenished using one half the original number of squeezes used initially (e.g., 5, 10, or 15).

(10) The test subject shall indicate to the test conductor if at any time during the fit test the taste of saccharin is detected. If the test subject does not report tasting the saccharin, the test is passed.

(11) If the taste of saccharin is detected, the fit is deemed unsatisfactory and the test is failed. A different respirator shall be tried and the entire test procedure is repeated (taste threshold screening and fit testing).

(12) Since the nebulizer has a tendency to clog during use, the test operator must make periodic checks of the nebulizer to ensure that it is not clogged. If clogging is found at the end of the test session, the test is invalid.

4. Bitrex™ (Denatonium Benzoate) Solution Aerosol Qualitative Fit Test Protocol. The Britex™ (Denatonium benzoate) solution aerosol QLFT protocol uses the published saccharin test protocol because that protocol is widely accepted. Britex is routinely used as a taste aversion agent in household liquids which children should not be drinking and is endorsed by the American Medical Association, the National Safety Council, and the American Association of Poison Control Centers. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) Taste Threshold Screening. The Britex threshold screening, performed without wearing a respirator, is intended to determine whether the individual being tested can detect the taste of Britex.

(1) During threshold screening as well as during fit testing, subjects shall wear an enclosure about the head and shoulders that is approximately 12 inches (30.5 cm) in diameter by 14 inches (35.6cm) tall. The front portion of the enclosure shall be clear from the respirator and allow free movement of the head when a respirator is worn. An enclosure substantially similar to the 3m hood assembly, parts #FT 14 and # FT 15 combined is adequate.

(2) The test enclosure shall have a ¾ inch (1.9 cm) hole in the front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

(3) The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his or her slightly open mouth with tongue extended. The subject is instructed to report when he/she detects a bitter taste.

(4) Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the Threshold Check Solution into the enclosure. This Nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

(5) The Threshold Check Solution is prepared by adding 13.5 milligrams of Britex to 100 mL of 5% salt (NaC1) solution in distilled water.

(6) To produce the aerosol, the nebulizer bulb is firmly squeezed so that the bulb collapses completely, and then is released and allowed to fully expand.

(7) An initial ten squeezes are repeated rapidly and the test subject is again asked whether the Britex can be tasted. If the test subject reports tasting the bitter taste during the ten squeezes, the screening test is completed. The taste threshold is noted as ten regardless of the number of squeezes actually completed.

(8) If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the Britex is tasted. If the test subject reports tasting the bitter taste during the second ten squeezes, the screening test is completed. The taste threshold is noted as twenty regardless of the number of squeezes actually completed.

(9) If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the Britex is tasted. If the test subject reports tasting the bitter taste during the third set of ten squeezes, the screening test is completed. The taste threshold is noted as thirty regardless of the number of squeezes actually completed.

(10) The test conductor will take note of the number of squeezes required to solicit a taste response.

(11) If the Britex is not tasted after 30 squeezes (step 10), the test subject is unable to taste Britex and may not perform the Britex fit test.

(12) If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

(13) Correct use of the nebulizer means that approximately 1 mL of liquid is used at a time in the nebulizer body.

(14) The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every four hours.

(b) Britex Solution Aerosol Fit Test Procedure

(1) The test subject may not eat, drink (except for plain water), smoke, or chew gum for 15 minutes before test.

(2) The fit test uses the same enclosure as that described in 4. (a) above.

(3) The test subject shall don the enclosure while wearing the respirator selected according to section I. A. of this appendix. The respirator shall be properly adjusted and equipped with any type particulate filter(s).

(4) A second DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent is used to spray the fit test solution into the enclosure. The nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

(5) The fit test solution is prepared by adding 337.5 mg of Britex to 200 mL of a 5% salt (NaC1) solution in warm water.

(6) As before, the test subject shall breathe through his or her slightly open mouth with tongue extended, and be instructed to report if he/she can taste the bitter taste of Britex.

(7) The nebulizer is inserted into the hole in the front of the enclosure and an initial concentration of the fit test solution is sprayed into the enclosure using the same number of squeezes (either 10, 20, or 30 squeezes) based on the number of squeezes required to elicit a taste responses as noted during the screening test.

(8) After generating the aerosol, the test subject shall be instructed to perform the exercises in section I. A. 14 of this appendix.

(9) Every 30 seconds the aerosol concentration shall be replenished using one half the number of squeezes used initially (e.g., 5, 10, 15).

(10) The test subject shall indicate to the test conductor if at any time during the fit test the taste of Britex is detected. If the test subject does not report tasting the Britex, the test is passed.

(11) I the taste of Britex is detected, the fit is deemed unsatisfactory and the test is failed. A different respirator shall be tried and the entire procedure is repeated (taste threshold screening and fit testing).

5. Irritant Smoke (Stannic Chloride) Protocol. This qualitative fit test uses a person's response to the irritating chemicals released in the "smoke" produced by a stannic chloride ventilation smoke tube to detect leakage into the respirator.

(a) General Requirements and Precautions

(1) The respirator to be tested shall be equipped with high efficiency particulate air (HEPA) or P100 series filter(s).

(2) Only stannic chloride smoke tubes shall be used for this protocol.

(3) No form of test enclosure or hood for the test subject shall be used.

(4) The smoke can be irritating to the eyes, lungs, and nasal passages. The test conductor shall take precautions to minimize the test subject's exposure to irritant smoke. Sensitivity varies, and certain individuals may respond to a greater degree to irritant smoke. Care shall be taken when performing the sensitivity screening checks that determine whether the test subject can detect irritant smoke to use only the minimum amount of smoke necessary to elicit a response from the test subject.

(5) The fit test shall be performed in an area with adequate ventilation to prevent exposure of the person conducting the fit test or the build-up of irritant smoke in the general atmosphere.

(b) Sensitivity Screening Check. The person to be tested must demonstrate his or her ability to detect a weal concentration of the irritant smoke.

(1) The test operator shall break both ends of a ventilation smoke tube containing stannic chloride, and attach one end of the smoke tube to a low flow air pump set to deliver 200 mL per minute, or an aspirator squeezes bulb. The test operator shall cover the other end of the smoke tube with a short piece of tubing to prevent potential injury from the jagged end of the smoke tube.

(2) The test operator shall advise the test subject that the smoke can be irritating to the eyes, lungs, and nasal passages and instruct the subject to keep his/her eyes closed while the test is being performed.

(3) The test subject shall be allowed to smell a weak concentration of the irritant smoke before the respirator is donned to become familiar with its irritating properties and to determine if he/she can detect the irritating properties of the smoke. The test operator shall carefully direct a small amount of the irritant smoke in the test subject's direction to determine that he/she can detect it.

(c) Irritant Smoke Fit Test Procedure

(1) The person being fit tested shall don the respirator without assistance, and perform the required user seal check(s).

(2) The test subject shall be instructed to keep his/her eyes closed.

(3) The test operator shall direct the stream of irritant smoke from the smoke tube toward the face seal area of the test subject, using the low flow pump or the squeezes bulb. The test operator shall begin at least 12 inches from the facepiece and move the smoke stream around the whole perimeter of the mask. The operator shall gradually make two more passes around the perimeter of the mask, moving to within six inches of the respirator.

(4) If the person being tested has not has an involuntary response and/or detected the irritant smoke, proceed with the test exercises.

(5) The exercises identified in section I. A. 14. of this appendix shall be performed by the test subject while the respirator seal is being continually challenged by the smoke, directed around the perimeter of the respirator at a distance of six inches.

(6) If the person being fit tested reports detecting the irritant smoke at any time, the test is failed. The person being retested must repeat the entire sensitivity check and fit test procedure.

(7) Each test subject passing the irritant smoke test without evidence of response (involuntary cough, irritation) shall be given a second sensitivity screening check, with the smoke from the same smoke tube used during the fit test, once the respirator has been removed, to determine whether he/she still reacts to the smoke. Failure to evoke a response shall void the fit test.

(8) If a response is produced during this second sensitivity check, then the fit test is passed.

The individual who uses a tight-fitting respirator is to perform a user seal check to ensure that an adequate seal is achieved each time the respirator is put on. Either the positive and negative pressure checks listed in this appendix, or the respirator manufacturer's recommended user seal check method shall be used. User seal checks are not substitutes for qualitative or quantitative fit tests.

I. Facepiece Positive and/or Negative Pressure Checks

A. Positive pressure check. Close off the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and carefully replacing it after the test.

B. Negative pressure check. Close off the inlet opening of the canister or cartridge(s) by covering with the palm of the hand(s) or by replacing the filter seal(s), inhale gently so that the facepiece collapses slightly, and hold the breathe for ten seconds. The design of the inlet opening of some cartridges cannot be effectively covered with the palm of the hand. The test can be performed by covering the inlet opening of the cartridge with a thin latex or nitrile glove. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

II. Manufacturer's Recommended User Seal Check Procedures

The respirator manufacturer's recommended procedures for performing a user seal check may be used instead of the positive and/or negative pressure check procedures provided that the employer demonstrates that the manufacturer's procedures are equally effective.

C. Quantitative Fit Test (QNFT) Protocols

The following quantitative fit testing fit testing procedures have been demonstrated to be acceptable: Quantitative fit testing using a non-hazardous test aerosol (such as corn oil, polyethylene glycol 400 [PEG 400], di-2-ethyl hexyl sebacate [DEHS], or sodium chloride) generated into a test chamber, and employing instrumentation to quantify the fit of the respirator; Quantitative fit testing using ambient aerosol as the test agent and appropriate instrumentation (condensation nuclei counter) to quantify the respirator fit; Quantitative fit testing using controlled negative pressure and appropriate instrumentation to measure the volumetric leak rate of a facepiece to quantify the respirator fit.

1. General

(a) The employer shall ensure that persons administrating QNFT are able to calibrate equipment and perform tests properly, recognize invalid tests, calculate fit factors properly, and ensure that test equipment is in proper working order.

(b) The employer shall ensure that QNFT equipment is kept clean, and is maintained and calibrated according to the manufacturer's instructions so as to operate at the parameters for which it was designed.

2. Generated Aerosol Quantitative Fit Testing Protocol

(a) Apparatus

(1) Instrumentation. Aerosol generation, dilution, and measurement systems using particulates [corn oil, polyethylene glycol 400 (PEG 400), di-2-ethyl hexyls sebacate (DEHS) or sodium chloride] as test aerosols shall be used for quantitative fit testing.

(2) Test chamber. The test chamber shall be large enough to permit all test subjects to perform freely all required exercises without disturbing the test agent concentration or the measurement apparatus. The test chamber shall be equipped and constructed so that the test agent is effectively isolated from the ambient air, yet uniform in concentration throughout the chamber.

(3) When testing air-purifying respirators, the normal filter or cartridge element shall be replaced with a high efficiency particulate air (HEPA) or P100 series filter supplied by the same manufacturer.

(4) The sampling instrument shall be selected so that the computer record or strip chart record may be made of the test showing the rise and fall of the test agent concentration

with each inspiration and expiration at fit factors of at least 2,000. Integrators or computers that integrate the amount of test agent penetration leakage into the respirator for each exercise may be used provided a record of the readings made.

(5) The combination of substitute air-purifying elements, test agent and test agent concentration shall be such that the test subject is not exposed in excess of an established exposure limit for the test agent at any time during the testing process, based upon the length pf the exposure and the exposure limit duration.

(6) The sampling port on the test specimen respirator shall be placed and constructed so that no leakage occurs around the port (e.g., where the respirator is probed), a free air flow is allowed into the sampling line at all times, and there is no interference with the fit or performance of the respirator. The in-mask sampling device (probe) shall be designed and used so that the air sample is drawn from the breathing zone of the test subject, midway between the nose and mouth and with the probe facepiece cavity at least ¼ inch.

(7) The test setup shall permit the person administrating the test to observe the test subject inside the chamber during the test.

(8) The equipment generating the test atmosphere shall maintain the concentration of test agent constant within a 10 percent variation for the duration of the test.

(9) The time lag (interval between an event and the recording of the event on the strip chart or computer or integrator) shall be kept to a minimum. There shall be a clear association between the occurrence of an event and its being recorded.

(10) The sampling line tubing for the test chamber atmosphere and for the respirator sampling port shall be of equal diameter and of the same material. The length of the two lines shall be equal.

(11) The exhaust flow from the test chamber shall pass through an appropriate filter (i.e., high efficiency particulate filter) before release.

(12) When sodium chloride aerosol is used, the relative humidity inside the test chamber shall not exceed 50 percent.

(13) The limitations of instrument detection shall be taken into account when determining the fit factor.

(14) Test respirators shall be maintained in prior working order and be inspected regularly for deficiencies such as cracks or missing valves and gaskets.

(b) Procedural Requirements.

(1) When performing the initial user seal check using a positive or negative pressure check, the sampling line shall be crimped closed in order to avoid air pressure leakage during either of these pressure checks.

(2) The use of an abbreviated screening QLFT test is optional. Such a test may be utilized in order to quickly identify poor fitting respirators that passed the positive and/or negative pressure test and reduce the amount of QNFT time. The use of the CNC QNFT instrument in the count mode is another optional method to obtain a quick estimate of fit and eliminate poor fitting respirators before going on to perform a full QNFT.

(3) A reasonably stable test agent concentration shall be measured in the test chamber prior to testing. For canopy or shower curtain types of test units, the determination of the test agent's stability may be established after the test subject has entered the test environment.

(4) Immediately after the subject enters the test chamber, the test agent concentration inside the respirator shall be measured to ensure that the peak penetration does not exceed 5 percent for a half mask or 1 percent for a full facepiece respirator.

(5) A stable test agent concentration shall be obtained prior to the actual start of testing.

(6) Respirator restraining straps shall not be over-tightened for testing. The straps shall be adjusted by the wearer without assistance from other persons to give a reasonably comfortable fit typical of normal use. The respirator shall not be adjusted once the fit test exercises begin.

(7) The test shall be terminated whenever any single peak penetration exceeds 5 percent for half masks and 1 percent for full facepiece respirators. The test subject shall be refitted and retested.

(8) Calculations of fit factors.

(i) The fit factor shall be determined for the quantitative fit test by taking the ratio of the average chamber concentration to the concentration measured inside the respirator for each test exercise except the grimace exercise.

(ii) The average test chamber concentration shall be calculated as the arithmetic average of the concentration measured before and after each test (i.e., 7 exercises) or the arithmetic average of the concentration measured before and after each exercise of the true average measured continuously during the respirator sample.

(iii) The concentration of the challenge agent inside the respirator shall be determined by one of the following methods:

(A) Average peak penetration method means the method of determining test agent penetration into the respirator utilizing a strip chart recorder, integrator, or computer. The agent penetration is determined by an average of the peak heights on the graph or by computer integration, for each exercise except the grimace exercise. Integrators or computers that calculate the actual test agent penetration into the respirator for each exercise will also be considered to meet the requirements of the average peak penetration method.

(B) Maximum peak penetration method means the method of determining test agent penetration in the respirator as determined by strip chart recordings of the test. The highest peak penetration for a given exercise is taken to be representative of average penetration into the respirator for that exercise.

(C) Integration by calculation of the area under the individual peak for each exercise except the grimace exercise. This includes computerized integration.

(D) The calculation of the overall fit factor using individual exercise fit factors involves first converting the exercise fit factors to penetration values, determining the average, and then converting that result back to a fit factor. These procedures described in the following equation:

$$\text{Overall Fit Factor} = \frac{\text{Number of Exercises}}{1/ff1 + 1/ff2 + 1/ff3 + 1/ff4 + 1/ff5 + 1/ff6 + 1/ff7 + 1/ff8}$$

Where ff1, ff2, ff3, etc. are the fit factors for exercises 1, 2, 3, etc.

(9) The test subject shall not be permitted to wear a half mask or quarter facepiece respirator unless a minimum fit factor of 100 is obtained, or a full facepiece respirator unless a minimum fit factor of 500 is obtained.

(10) Filters used for quantitative fit testing shall be replaced whenever increased breathing resistance is encountered, or when the test agents has altered the integrity of the filter media.

3. Ambient aerosol condensation nuclei counter (CNC) quantitative fit testing protocol. The ambient aerosol condensation nuclei counter (CNC) quantitative fit testing (Portacount™) protocol quantitatively fit test respirators with the use of a probe. The probed respirator is only used for quantitative fit tests. A probed respirator gas a special sampling device, installed on the respirator that allows the probe to sample the air from inside the mask. A probed respirator is required for each make, style, model, and size that the employer uses and can be obtained from the respirator manufacturer or distributor. The CNC instrument manufacturer, TSI Inc., also provides probe attachments (TSI sampling adapters) that permit fit testing in an employee's own respirator. A minimum fit factor pass level of at least 100 is necessary for a half-mask respirator and a minimum fit factor pass level of at least 500 is required for a full facepiece negative pressure respirator. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.
   (a) Portacount Fit Test Requirements
      (1) Check the respirator to make sure the sampling probe and line are properly attached to the facepiece and that the respirator is fitted with a particulate filter capable of preventing significant penetration by the ambient particles used for the fit test (e.g., NIOSH 42 CFR 84 series 100, series 99, or series 95 particulate filter) per manufacturer's instruction.
      (2) Instruct the person to be tested to don the respirator for five minutes before the fit test starts. This purges the ambient particles trapped inside the respirator and permits the wearer to make certain the respirator is comfortable. This individual shall already have been trained on how to wear the respirator properly.
      (3) Check the following conditions for the adequacy of the respirator fit. Chin properly placed; adequate strap tension; not overly tightened; fit across nose bridge; respirator of proper size to span distance from nose to chin; tendency of the respirator to slip; and self-observation in a mirror to evaluate fit and respirator position.
      (4) Have the person wearing the respirator do a user seal check. If leakage is detected, determine the cause. If leakage is from a poorly fitting facepiece, try another size of the same model respirator, or another model of respirator.
      (5) Follow the manufacturer's instructions for operating the Portacount and proceed with the test.
      (6) The test subject shall be instructed to perform the exercises in section I. A. 14. of this appendix.
      (7) After the test exercises, the test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become unacceptable, another model of respirator shall be tried.
   (b) Portacount Test Instrument.
      (1) The Portacount will automatically stop and calculate the overall fit factor for the entire set of exercises. The overall fit factor is what counts. The pass or fail message will indicate whether or not the test was successful. If the test was a Pass, the fit test is over.
      (2) Since the pass or fail criterion of the Portacount is user programmable, the test operator shall ensure that the pass or fail criterion meet the requirements for minimum respirator performance in this Appendix.
      (3) A record of the test needs to be kept on file, assuming the fit test was successful. The record must contain the test subject's name; overall fit factor; make, model, style, and size of respirator used and date tested.
4. Controlled negative pressure (CNP) quantitative fit testing protocol. The CNP protocol provides an alternative to aerosol fit test methods. The CNP fit test method technology is based on exhausting air from a temporarily sealed respirator facepiece to generate and then maintain a constant negative

pressure inside the face piece. The rate of air exhaust is controlled so that a constant negative pressure is maintained in the respirator during the fit test. The level pressure is elected to replicate the mean respiratory pressure that causes leakage into the respirator under normal use conditions. With pressure held constant, air flow out of the respirator is equal to air flow into the respirator. Therefore, measurement of the exhaust stream that is required to hold the pressure in the temporarily sealed respirator constant yields a direct measure of leakage air flow into the respirator. The CNP fit test method measures leak rates through the facepiece as a method of determining the facepiece fit for negative pressure respirators. The CNP instrument manufacturer Dynatech Nevada also provides attachments (sampling manifolds) that replace the filter cartridges to permit fit testing in an employee's own respirator. To perform the test, the test subject closes his or her mouth and holds his/her breathe, after which an air pump removes air from the respirator facepiece at a pre-selected constant pressure. The facepiece fit is expressed as the leak rate through the facepiece, expressed as milliliters per minute. The quality and validity of the CNP fit tests are determined by the degree to which the in-mask pressure tracks the test pressure during the system measurement time of approximately five seconds. Instantaneous feedback in the form of a real-time pressure trace of the in-mask pressure is provided and used to determine test validity and quality. A minimum fit factor pass level of 100 is necessary for a half-mask respirator and a minimum fit factor of at least 500 is required for a full facepiece respirator. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) CNP Fit Test Requirements.

(1) The instrument shall have a non-adjustable test pressure of 15.0 mm water pressure.

(2) The CNP system defaults selected for test pressure shall be set at 15 mm of water (0.58 inches of water) and the modeled respiratory flow rate shall be 53.8 liters per minute for performing fit tests.

(NOTE: CNP systems have built-in capability to conduct fit testing that is specific to unique work rate, mask, and gender situations that might apply in a specific workplace. Use of system default values, which were selected to represent respirator wear with medium cartridge resistance at a low-moderate work rate, will allow inter-test comparison of the respirator fit.)

(3) The individual who conducts the CNP fit testing shall be thoroughly trained to perform the test.

(4) The respirator filter or cartridge needs to be replaced with the CNP test manifold. The inhalation valve downstream from the manifold either needs to be temporarily removed or propped open.

(5) The test subject shall be trained to hold his or her breath for at least 20 seconds.

(6) The test subject shall don the test respirator without any assistance from the individual who conducts the CNP fit test.

(7) The QNFT protocol shall be followed according to section I.C.1. of this appendix with an exception for the CNP test exercises.

(b) CNP Test Exercises.

(1) **Normal Breathing.** In a normal standing position, without walking, the subject shall breathe normally for 1 minute. After the normal breathing exercise, the subject needs to hold head straight ahead and hold his or her breath for 10 seconds during the test measurement.

(2) **Deep Breathing.** In a normal standing position, the subject shall breathe slowly and deeply for 1 minute, being careful not to hyperventilate. After the deep breathing exercise, the subject shall hold his or her head straight ahead and hold his or her breath 10 seconds during test measurement.

(3) **Turning head side to side.** Standing in place, the subject shall slowly turn his or her head from side to side between the extreme momentarily so the subject can inhale at each side. After the turning head side to side exercise, the subject needs to hold head full left and hold his or her breath for 10 seconds during test measurement. Next, the subject needs to hold head full right and hold his or her breath for 10 seconds during test measurement.

(4) **Moving head up and down.** Standing in place, the subject shall slowly move his or her head up and down for 1 minute. The subject shall be instructed to inhale in the up position (i.e., when looking toward the ceiling). After moving the head up and down exercise, the subject shall hold his or her head full up and hold his or her breath for 10 seconds during the test measurement. Next, the subject shall hold his or her head full down and hold his or her breath for 10 seconds during test measurement.

(5) **Talking.** The subject shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor. The subject can read from a prepared text such as the Rainbow Passage, count backward from 100, or recite a memorized poem or song for 1 minute. After the talking exercise, the subject shall hold his or her head straight ahead and hold his or her breath for 10 seconds during the test measurement.

(6) **Grimace.** The test subject shall grimace by smiling or frowning for 15 seconds.

(7) **Bending Over.** The test subject shall bend at the waist as if he or she were to touch his or her toes for 1 minute. Jogging in place shall be substituted for this exercise in those test environments such as shroud-type QNFT units that prohibit bending at the waist. After the bending over exercise, the subject shall hold his or her head straight ahead and hold his or her breath for 10 seconds during the test measurement.

(8) **Normal Breathing.** The test subject shall remove and re-don the respirator within a 1-minute period. Then, in a normal standing position, without talking, the subject shall breathe normally for 1 minute. After the normal breathing exercise, the subject shall hold his or her head straight ahead and hold his or her breath for 10 seconds during the test measurement. After the test exercises, the test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become unacceptable, another model of a respirator shall be tried.

(c) CNP Test Instrument.

(1) The test instrument shall have an effective audio warning device when the test subject fails to hold his or her breath during the test. The test shall be terminated whenever the test subject failed to hold his or her breath. The test subject may be refitted and retested.

(2) A record of the test shall be kept on file, assuming the fit test was successful. The record must contain the test subject's name; overall fit factor; make, model, style, and size pf respirator used; and date tested.

Appendix D to (Non-Mandatory) Information for Employees Using Respirators When Not Required Under the Standard.

3 Employer Respiratory Protection

CODE OF SAFE PRACTICES

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker. Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If your employer provides respirators for your voluntary use, or if you provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not represent a hazard.

1. Read and observe all instructions provided by the manufacturer on use, maintenance, cleaning care, and warnings regarding the respirators limitations.
2. Choose respirators certified for the use to protect against the contaminants of concern. NIOSH, the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how much it will protect you.
3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes or smoke.
4. Keep track of your respirator so that you do not mistakenly use someone else's.

WRITTEN ASSESSMENT

1. A respirator is a protective face piece, hood or helmet that is designed to protect the wear against a variety of harmful airborne hazards?
   ☐ **TRUE** ☐ **FALSE**

2. Fit testing is conducted annually?
   ☐ **TRUE** ☐ **FALSE**

3. Field respirator inspections are conducted?
   ☐ **TRUE** ☐ **FALSE**

4. Medical examinations are conducted annually?
   ☐ **TRUE** ☐ **FALSE**

5. Training is specific to the respirator used?
   ☐ **TRUE** ☐ **FALSE**

6. Employees must pay for their respirators?
   ☐ **TRUE** ☐ **FALSE**

7. A dust respirator can be used in an IDLH environment?
   ☐ **TRUE** ☐ **FALSE**

8. Respirators can be stored on a nail when not in use?
   ☐ **TRUE** ☐ **FALSE**

9. Any respirator parts may be used for repairs?
   ☐ **TRUE** ☐ **FALSE**

10. Respirators must be certified by NIOSH?
    ☐ **TRUE** ☐ **FALSE**

11. A respirator is required when:
    ☐ **a.** Oxygen deficiency has been detected
    ☐ **b.** Engineering controls are not feasible
    ☐ **c.** Airborne hazards that exceed OSHA limits
    ☐ **d.** All of the above

12. A fit test is required when?
    ☐ **a.** Initial use
    ☐ **b.** When a different respirator facepiece is used
    ☐ **c.** At least annually
    ☐ **d.** All of the above

13. Which of the following factors can be used to determine the degree of hazards of an airborne toxic substance?
    ☐ **a.** Route of entry
    ☐ **b.** Environmental variables
    ☐ **c.** Physical state of the toxic hazard
    ☐ **d.** All of the above

14. What maintenance and care is required?
    ☐ **a.** Cleaning and disinfecting
    ☐ **b.** Proper storage
    ☐ **c.** Repair
    ☐ **d.** All the above

15. The four route of entry into the body are:
    ☐ **a.** Inhalation
    ☐ **b.** Absorption
    ☐ **c.** Injection
    ☐ **d.** Ingestion
    ☐ **e.** All the above

16. Air monitoring measures
    ☐ **a.** The amount of chemical that has been absorbed via the lungs
    ☐ **b.** The total exposure of both on and off the job
    ☐ **c.** None of the above
    ☐ **d.** All of the above

3 Compliance Steps

EMPLOYER: _____

STANDARD: Respiratory Protection Program DATE: _____

STEP 1	ORGANIZATION AND PREPARATION	COMPLETE
1-1	Review the CAL/OSHA General Duty Clause.	☐ YES ☐ NO
1-2	Review the CAL/OSHA Recordkeeping Requirements.	☐ YES ☐ NO
1-3	Review the OSHA Respiratory Protection Program Standard.	☐ YES ☐ NO
1-4	Identify potential assistants in select departments to help with the program.	☐ YES ☐ NO
1-5	Select assistants in departments to help with the program.	☐ YES ☐ NO
1-6	Review project parameters with management.	☐ YES ☐ NO
1-7	Conduct a program management meeting to begin the process.	☐ YES ☐ NO

STEP 2	EMPLOYEE TRAINING	COMPLETE
2-1	Develop an outline of training requirements.	☐ YES ☐ NO
2-2	Select training materials, videotapes, booklets, etc.	☐ YES ☐ NO
2-3	Select trainers or training source.	☐ YES ☐ NO
2-4	Develop a standardized training format to meet the requirement for a respiratory training program.	☐ YES ☐ NO
2-5	Conduct train-the- trainers sessions.	☐ YES ☐ NO
2-6	Train personnel in the provisions of the standard.	☐ YES ☐ NO
2-7	Document training to certify completion.	☐ YES ☐ NO

STEP 3	DEVELOP CONTROL PROCEDURES	COMPLETE
3-1	Establish and maintain a respiratory program whenever respirators are needed.	☐ YES ☐ NO
3-2	Design the program to establish clear goals and objectives.	☐ YES ☐ NO
3-3	Establish responsibility for the program and conduct follow-up at predetermined intervals.	☐ YES ☐ NO
3-4	Obtain support for program implementation from all levels of management.	☐ YES ☐ NO
3-5	Communicate the written program to affected personnel.	☐ YES ☐ NO
3-6	Provide respirators when they are necessary to protect employee health.	☐ YES ☐ NO
3-7	Ensure that the respirator provided is suitable for the intended use.	☐ YES ☐ NO
3-8	Ensure that employees use the respiratory protection in accordance with company instructions and training.	☐ YES ☐ NO
3-9	Ensure that the employee guards against damage to the respirator, and replaces it if it is suspect.	☐ YES ☐ NO
3-10	Ensure that the employee reports any trouble/malfunction of the respirator to his/her supervisor.	☐ YES ☐ NO
3-11	Engineer out respiratory hazards, using administrative controls and respirators as a last resort.	☐ YES ☐ NO
3-12	Ensure that inspections are conducted to find conditions and work practices that lead to accidents/illnesses.	☐ YES ☐ NO
3-13	Develop a regular cleaning/disinfection/maintenance schedule for respirators as required.	☐ YES ☐ NO
3-14	Establish an appropriate respirator storage area that is convenient, clean and sanitary	☐ YES ☐ NO
3-15	Establish routine medical surveillance to ensure that workers are physically able to wear a respirator.	☐ YES ☐ NO
3-16	Select respirators according to the specific hazard involved.	☐ YES ☐ NO
3-17	Select respirators in accordance with the manufacturer's instructions or other related requirements.	☐ YES ☐ NO
3-18	Ensure that breathing air compressors are equipped with the necessary safety and standby devices.	☐ YES ☐ NO
3-19	Ensure that breathing air meets all required standards for quality and storage.	☐ YES ☐ NO
3-20	Ensure that air line couplings are incompatible with outlets for other gas systems.	☐ YES ☐ NO
3-21	Conduct periodic checks of employees while wearing respirators to assure proper fit/protection.	☐ YES ☐ NO
3-22	Use optical inserts when vision correction is required to use full-faced respirators.	☐ YES ☐ NO
3-23	Ensure that respirators/equipment are properly maintained to retain the original state of effectiveness.	☐ YES ☐ NO
3-24	Develop a list of personnel qualified to perform respirator inspections and perform inspections as required.	☐ YES ☐ NO
3-25	Ensure that all negative pressure respirators are fitted properly using the required fit testing protocols.	☐ YES ☐ NO
3-26	Purchase only properly labeled and/or color coded chemical cartridges as regulated.	☐ YES ☐ NO
3-27	Ensure that all negative pressure respirators are fitted properly using the required fit testing protocols.	☐ YES ☐ NO
3-28	Comply with the required record keeping provisions.	☐ YES ☐ NO

STEP 4	PROGRAM CONTROL AND MONITORING	COMPLETE
4-1	Review corporate and individual procedures on an annual basis.	☐ YES ☐ NO
4-2	Consider impact(s) of facility expansion, new equipment, equipment modification, non-routine tasks etc.	☐ YES ☐ NO

EMPLOYER: _____ DATE: _____ OSHA: T8CCR5144

OVERVIEW: This module assesses the strengths/weaknesses in the Respiratory Protection Program.

OBJECTIVE: To ensure that respiratory hazards are evaluated, and that information concerning these hazards is transmitted to all affected employees. To establish uniform practices to ensure that where needed, engineering controls and work practice controls are implemented, and where are not feasible, a respiratory protection program is instituted, and that employee training has been established in accordance with T8CCR5144.

1	WRITTEN REQUIREMENTS	YES	NO	IMPROVE YES	IMPROVE NO	IMPORTANCE (1 Being the Highest)
1-1	Is a program for respiratory protection procedures and training in place?	☐	☐	☐	☐	1 2 3 4 5
1-2	Is the program reviewed on an annual/as needed basis?	☐	☐	☐	☐	1 2 3 4 5
1-3	Does it establish procedures used to select and use respirators?	☐	☐	☐	☐	1 2 3 4 5
1-4	Are NIOSH approved respirators provided at the employer's expense?	☐	☐	☐	☐	1 2 3 4 5
1-5	Does selected respiratory protection meet the following requirements:					
1-6	- Is it suitable for the hazard, inspected, maintained and stored properly?	☐	☐	☐	☐	1 2 3 4 5
1-7	- Is it kept clean, fully functional and sanitary?	☐	☐	☐	☐	1 2 3 4 5
1-8	Has a program administrator been appointed to oversee the program?	☐	☐	☐	☐	1 2 3 4 5
1-9	Do employees guard against damage to respirators and replace as needed?	☐	☐	☐	☐	1 2 3 4 5
1-10	Is the chief objective of the program to prevent atmospheric contamination?	☐	☐	☐	☐	1 2 3 4 5
1-11	Are respirators used as a last resort after engineering/administrative controls?	☐	☐	☐	☐	1 2 3 4 5
1-12	Is appropriate surveillance of the work area conditions/exposures maintained?	☐	☐	☐	☐	1 2 3 4 5
1-13	Are methods available to:					
1-14	- inspect, evaluate, and maintain the effectiveness of the program?	☐	☐	☐	☐	1 2 3 4 5
1-15	Are workers evaluated to certify that they can physically wear a respirator?	☐	☐	☐	☐	1 2 3 4 5
1-16	Does breathing air for supplied air respirators meet all requirements:					
1-17	- Are breathing air compressors used, and situated properly?	☐	☐	☐	☐	1 2 3 4 5
1-18	- Are all required filter/alarms systems in place?	☐	☐	☐	☐	1 2 3 4 5
1-19	- Are supplied air line couplings incompatible with other gas outlet systems?	☐	☐	☐	☐	1 2 3 4 5
1-20	Are respirators used only under the following conditions:					
1-21	- In regulated areas within the facility, in emergencies?	☐	☐	☐	☐	1 2 3 4 5
1-22	- Where engineering and work practice controls are inadequate?	☐	☐	☐	☐	1 2 3 4 5
1-23	- Where exposures exceed permissible limits?	☐	☐	☐	☐	1 2 3 4 5
1-24	- During maintenance/repair activities where other controls are not feasible?	☐	☐	☐	☐	1 2 3 4 5
1-25	- During intermittent operations where other controls are not feasible?	☐	☐	☐	☐	1 2 3 4 5
1-26	Does your program specify all required procedures for respirator use?	☐	☐	☐	☐	1 2 3 4 5
1-27	If hair growth is found to interfere with a face seal do you:					
1-28	- Ensure that the hair is removed or altered to allow a satisfactory fit?	☐	☐	☐	☐	1 2 3 4 5
1-29	- Is the employee provided a positive-pressure respirator?	☐	☐	☐	☐	1 2 3 4 5
1-30	Do full-face respirators have provisions for optical inserts?	☐	☐	☐	☐	1 2 3 4 5
1-31	Are contact lenses prohibited when wearing a respirator?	☐	☐	☐	☐	1 2 3 4 5

2	INSPECTION AND TESTING REQUIREMENTS	YES	NO	IMPROVE YES	IMPROVE NO	IMPORTANCE (1 Being the Highest)
2-1	Is the facepiece fit of the respirator checked by the wearer prior to each use?	☐	☐	☐	☐	1 2 3 4 5
2-2	Are periodic checks of respirators accomplished to ensure a proper fit?	☐	☐	☐	☐	1 2 3 4 5
2-3	Is respiratory equipment properly maintained to its original effectiveness?	☐	☐	☐	☐	1 2 3 4 5
2-4	Are respirators properly inspected prior to use to ensure effectiveness?	☐	☐	☐	☐	1 2 3 4 5
2-5	Do you have procedures for respirator disassembly/maintenance/cleaning?	☐	☐	☐	☐	1 2 3 4 5
2-6	Are random inspections of respirators conducted to ensure the following:					
2-7	- Proper use, selection, cleaning and maintenance?	☐	☐	☐	☐	1 2 3 4 5
2-8	Are emergency respirators inspected after each use and at least monthly?	☐	☐	☐	☐	1 2 3 4 5
2-9	Are routinely used respirators cleaned and disinfected as necessary?	☐	☐	☐	☐	1 2 3 4 5
2-10	Are SCBAs inspected as required on a monthly basis?	☐	☐	☐	☐	1 2 3 4 5
2-11	Do qualified personnel perform all required respirator repairs?	☐	☐	☐	☐	1 2 3 4 5

2	INSPECTION AND TESTING REQUIREMENTS (Cont'd)	YES	NO	IMPROVE YES	IMPROVE NO	IMPORTANCE (1 Being the Highest)
2-12	Is respiratory protection equipment stored carefully to protect against:					
2-13	- Dust, sunlight, heat, extreme cold, excessive moisture, or chemicals?	☐	☐	☐	☐	1 2 3 4 5
2-14	- Distortion of the facepiece and exhalation valve?	☐	☐	☐	☐	1 2 3 4 5
2-15	Are all chemical cartridges properly labeled and/or color coded prior to use?	☐	☐	☐	☐	1 2 3 4 5
2-16	Is each task/job with respiratory hazards evaluated to determine:					
2-17	- Worker protection requirements?	☐	☐	☐	☐	1 2 3 4 5
2-18	- OSHA standards to be evaluated for worker protection requirements?	☐	☐	☐	☐	1 2 3 4 5
2-19	Is respiratory protection selected after all criteria is identified & evaluated?	☐	☐	☐	☐	1 2 3 4 5
2-20	Is qualitative or quantitative fit testing accomplished prior to use as required?	☐	☐	☐	☐	1 2 3 4 5
2-21	Is fit testing accomplished both initially and at least every six months?	☐	☐	☐	☐	1 2 3 4 5
2-22	Are respirator fit factor cards issued to the test subject?	☐	☐	☐	☐	1 2 3 4 5
2-23	Is fit testing redone when the test subject has one or more of the following:					
2-24	- Weight change of 20 pounds or more?	☐	☐	☐	☐	1 2 3 4 5
2-25	- Significant facial scarring or anything that interferes with the facepiece seal?	☐	☐	☐	☐	1 2 3 4 5
2-26	- Significant dental changes?	☐	☐	☐	☐	1 2 3 4 5
2-27	- Reconstructive or cosmetic surgery?	☐	☐	☐	☐	1 2 3 4 5
2-28	Is a summary of all fit test results maintained properly for 3 years?	☐	☐	☐	☐	1 2 3 4 5

3	TRAINING REQUIREMENTS	YES	NO	IMPROVE YES	IMPROVE NO	IMPORTANCE (1 Being the Highest)
3-1	Has a standardized training format been developed to meet all requirements?	☐	☐	☐	☐	1 2 3 4 5
3-2	Are affected employees trained/retrained annually or as follows:					
3-3	- Before the employee is assigned duties that require respiratory protection?	☐	☐	☐	☐	1 2 3 4 5
3-4	- Before there is a change in assigned duties?	☐	☐	☐	☐	1 2 3 4 5
3-5	- When there is a change in job assignments that present new hazards?	☐	☐	☐	☐	1 2 3 4 5
3-6	- When these changes present a new hazard?	☐	☐	☐	☐	1 2 3 4 5
3-7	- When employee proficiency is in doubt?	☐	☐	☐	☐	1 2 3 4 5
3-8	- When accidents or close calls occur?	☐	☐	☐	☐	1 2 3 4 5
3-9	Does retraining establish proficiency and introduce new/revised procedures?	☐	☐	☐	☐	1 2 3 4 5
3-10	Are Employees adequately trained in the company's program?	☐	☐	☐	☐	1 2 3 4 5
3-11	Has all employee training been certified by the employer as required?	☐	☐	☐	☐	1 2 3 4 5
3-12	Affected employees, and engineers/maintenance personnel?	☐	☐	☐	☐	1 2 3 4 5
3-13	Supervisors, managers and healthcare providers?	☐	☐	☐	☐	1 2 3 4 5
3-14	Does the training program provide an overview of the potential job hazards:	☐	☐	☐	☐	1 2 3 4 5
3-15	Is it presented in the language and level of understanding of employees?	☐	☐	☐	☐	1 2 3 4 5
3-16	Are visitors watching operations trained to the level of the observed worker?	☐	☐	☐	☐	1 2 3 4 5
3-17	Does initial worker training involve instruction and hands-on training?	☐	☐	☐	☐	1 2 3 4 5
3-18	Is all training properly documented?	☐	☐	☐	☐	1 2 3 4 5

4	MONITORING REQUIREMENTS	YES	NO	IMPROVE YES	IMPROVE NO	IMPORTANCE (1 Being the Highest)
4-1	There are no specific monitoring requirements for this standard.	☐	☐	☐	☐	1 2 3 4 5

5	MEDICAL REQUIREMENTS	YES	NO	IMPROVE YES	IMPROVE NO	IMPORTANCE (1 Being the Highest)
5-1	There are no specific medical requirements for this standard.	☐	☐	☐	☐	1 2 3 4 5

6	COMPLIANCE/STANDARD DIRECTIVES	YES	NO	IMPROVE YES	IMPROVE NO	IMPORTANCE (1 Being the Highest)
6-1	There are no compliance standard directives for this standard	☐	☐	☐	☐	1 2 3 4 5

NOTES:

PRE-JOB HAZARD ANALYSIS

	Job No.	Date:
	Page of	JSA No.
Site:	Contractor:	Analysis By:
Job Description:		
Jobsite Superintendent:		
Location:		
Foreman:		
Approved By:		
Project Safety Representative:		

Activity	Potential Hazards	Recommended Action, Procedure, and/or Equipment
Respirator Use	Inhalation of potential hazardous dust, gases, mist, fumes, or vapors	Monitoring shall take place prior to employee access to determine the levels of contamination and the appropriate protection that will be required.
		Employees shall be trained in the proper use of PPE.
		Medical testing and recordkeeping shall comply with Cal/OSHA requirements
		Engineering controls shall be provided where possible.
		Cleaning and replacement materials shall be provided when required.
		Proper storage shall be provided.
		Pre shift inspections shall be performed.

3 Occupational Exposure to Chrom VI

COMPANY NAME

BASIS. This standard practice instruction establishes uniform requirements to ensure that procedures required by COMPANY NAME will control or eliminate the exposure of Chrom VI when welding, grinding, cutting or heating on stainless steel.

GENERAL: COMPANY NAME will ensure that all potential Chrom VI exposure hazards at our jobsites and within our facility(s) are evaluated and controlled. This procedure is intended to address the issues of working safely with Chrom VI by evaluating and identifying potential sources of Chrom VI exposure.

RESPONSIBILITY: The COMPANY NAME Management is responsible for this procedure and has full authority to make necessary decisions to ensure success. The Safety Offices is also authorized to amend these instructions and to halt any operation of the company where there is potential uncontrolled Chrom VI employee exposure.

CONTENTS OF THE CHROM VI HAZARD SAFETY PROGRAM

1. General Responsibility
2. Exposure Determination
3. Methods of Controls
4. Training
5. Regulated Areas
6. Medical Surveillance
7. Housekeeping and Disposal
8. Recordkeeping
9. Definitions
10. Attachments
A. Chrom VI Exposure Determination
B. Job Hazard Analysis
C. Training Instruction
D. Chrom VI Information Sheet
E. Training Assessment
F. Employee Notification Letter
G. Compliance Checklist
H. Code of Safe Practices
I. Pre-job Assessment

CR VI PROGRAM TRIGGERS

Employees with Potential CR6 Exposure

■ If **NO**	– Document and continue to access
■ If **YES**	– Begin exposure determination – Recordkeeping for 40 years

If <0.0005 milligrams per cubic meter (mg/m3)

■ If **YES**	– Exempt from standard – Recordkeeping
■ If **NO** & **<0.0025 mg/m3**	– No follow up air monitoring, unless change
■ If **>0.0025 mg/m3**	– Air monitoring every 6 months
■ If **greater than 30 days**	– Medical exams and recordkeeping

If >5ug/m3

■ If **NO**	– See above
■ If **YES**	– Engineering controls – Air monitoring 3 months – Regulated work areas

COMPANY NAME

1.0 Written program. COMPANY NAME will review and evaluate this standard practice instruction at least once every six months, or when changes occur that prompt revision of this document, or when site operational changes occur that require a revision of this document, or should the procedures ever fail. This written program will be communicated to all site:

- 1.1 Superintendent/General Supervisor
  - 1.1.1 Understands and monitors Chrom VI procedure to ensure compliance with this work practice controls.
- 1.2 Supervisors
  - 1.2.1 Ensures that the initial determination for potential Chrom VI exposure has been accomplished before work begins.
  - 1.2.2 Supervises the safe performance of Chrom VI work in accordance with this and other work practices.
  - 1.2.3 Assigns jobs only to Chrom VI qualified employees.
  - 1.2.4 Supervisors of COMPANY NAME will develop and maintain the following "Chrom VI Exposure Determination" for each job where there is a potential for Chrom VI exposure. The determination will include: (see attachment A)
    - 1.2.4.1 A description of each task.
    - 1.2.4.2 A list of equipment used in the task.
    - 1.2.4.3 Types of materials processed.
    - 1.2.4.4 Exposure controls that are in place.
    - 1.2.4.5 Crew size.
    - 1.2.4.6 Employee job responsibilities.
    - 1.2.4.7 Job Hazard Anaylsis
    - 1.2.4.8 Maintenance practices specific to the job.
- 1.3 Employee
  - 1.3.1 Uses the safety control and protective equipment as assigned and directed.
  - 1.3.2 Abides by the requirements of this work practice.
  - 1.3.3 Participates in the medical monitoring.
  - 1.3.4 Company Safety Director
  - 1.3.5 Coordinates the requirements of this program in accordance with the requirements.

2.0 Chromium Exposure Determination OSHA requires that each employer who has employee(s) with potential occupational exposure to Chrom VI prepare an exposure determination.

- 2.1 Means to achieve compliance. Each task with Chrom VI exposure potential, will have a Job Hazard Analysis(see attachment B) site developed with the specific controls, such as ventilation, respiratory protection, housekeeping processes, maintenance, storage and personal hygiene that will be used to achieve compliance, including engineering plans and studies used to determine methods selected for controlling exposure to Chrom VI.
- 2.3 Technology. Reports of the control equipment considered by COMPANY NAME to achieve compliance will be maintained per the manufactures guidelines.
- 2.4 Air monitoring data. Air monitoring data that documents the source of Chrom VI fumes will be reported to site employee/management and maintained by COMPANY NAME.
- 2.5 Implementation schedules. Data that supports the implementation of this program, control programs and/or equipment upgrades will be maintained for 40 years beyond the project.
- 2.6 The procedures for the air monitoring and laboratory evaluation follow current OSHA Technical Manual, NIOSH and AIHA practices for welding fume metals and Chrom VI.
- 2.7 Frequency of Air Monitoring Exposure monitoring will be conducted at the start of the operation that involves stainless steel welding, heating or cutting with potential Chrom VI exposure. The full shift or task Chrom VI exposure will be calculated as an 8 hour time weighted average.

Chrom VI Hazard Program

2.8 Air Monitoring shall be representative of the Chrom VI exposure for each job classification and work area.

2.8.1 If the initial determination (representatively sampled for at least seven continuous hours for each shift) reveals employee exposure below the action level, the monitoring need not be repeated.

2.8.2 If the initial determination reveals employee exposure to be at or above the action level, but below the permissible exposure limit, monitoring will be repeated at least every 6 months. The monitoring will continue until at least two consecutive measurements, taken at least 7 days apart, are below the action level, at which time the monitoring for that employee or operation may be discontinued.

2.8.3 If the initial monitoring reveals that employee exposure is above the permissible exposure limit, the monitoring shall be repeated every 3 months. The monitoring shall continue until at least two consecutive measurements, taken at least 7 days apart, are below the permissible exposure level, at which time the monitoring for that employee or operation may be discontinued.

2.9 Basis of initial determination. An initial determination shall be made to determine the potential exposure to Chrom VI before any work in undertaken. The basis of the initial determination will include, but not be limited to, the following:

2.9.1 Past history and record of similar or like work operations which would indicate employee exposure to Chrom VI.

2.9.2 Previous measurements and records of airborne Chrom VI and analytical findings, observations, calculations or other information.

2.9.3 Analysis of paint or other materials and consumables involved in the specific work operation that may contribute to the Chrom VI exposure.

2.9.4 Employee complaints of symptoms that may be attributable to exposure to Chrom VI.

2.10 Monitoring for initial determination of exposure. As a minimum, COMPANY NAME will monitor a representative sample of employees who it is believed are exposed to the greatest airborne concentrations of Chrom VI.

2.11 Previous Data. Where measurements of airborne Chrom VI have been obtained in the preceding 12 months, this data may be used to fulfill initial monitoring requirements if it is representative and is accurate to a confidence level of 95%.

2.12 Performance Oriented Option Chrom VI exposure maybe determined by using any combination of air monitoring data, historical data or objective data that represents task Chrom VI exposure.

2.13 Positive Initial Determination and Initial Monitoring – when the initial determination shows that the possibility of employee Chrom VI exposure exists at or above the action level the Methods of Control will be followed and adhered to.

2.14 Negative Initial Determination – when a determination is made that no employee is exposed to airborne Chrom VI at or above the action level, this information will be documented. The documentation shall include at least the following:

2.14.1 Date of determination.

2.14.2 Location of determination.

2.14.3 Name and social security number of each employee monitored.

2.14.4 Records of past history and record of similar or like work operations which would indicate employee exposure to Chrom VI.

2.14.5 Records of previous measurements and records of airborne Chrom VI and analytical findings, observations, calculations or other information.

2.14.6 Records of analysis of paint or other materials involved in the specific work operation.

2.14.7 Records of employee complaints of symptoms which may be attributable to exposure to Chrom VI.

2.15 Unscheduled Air Monitoring - whenever there has been a production, process, control or personnel change or whenever the site has any reason to suspect a change that may result in new or additional exposures to Chrom VI, additional unscheduled air monitoring will be conducted.

2.16 Observation of monitoring. COMPANY NAME will provide employees or their representatives with the opportunity to observe air monitoring of employee exposures to Chrom VI. Observers will be entitled as a minimum to the following:

- 2.16.1 An explanation of the measurement procedure and required PPE.
- 2.16.2 To observe all steps related to the measurement procedure.
- 2.1.3 To record the results obtained.

2.17 Permissible Exposure Limit (PEL)

- 2.17.1 No employee will be exposed to Chrom VI at concentrations greater than 0.0025 mg/m3 of air averaged over an 8 hour period.
- 2.17.2 When respirators are used to supplement engineering and work practice controls to comply with the PEL and all the requirements of respiratory protection have been met, employee exposure, for the purpose of determining whether COMPANY NAME has complied with the PEL, may be considered to be at a level provided by the protection factor of the respirator for those periods the respirator is worn. Those periods may be averaged with exposure levels during periods when respirators are not worn to determine the employee's daily TWA exposure.

2.18 Employee Notification

- 2.18.1 Within 5 working days from data receipt the Chrom VI exposure information will be posted in each work location sampled. Employee will also receive written notification (see attachment C).

3. Methods of Control. If a process or task has a potential Chrom VI exposure, COMPANY NAME will use engineering controls, work practices and PPE to control and maintain employee exposure to Chrom VI below the action level. Employee rotation and compressed air clean up will not be used as a control methods.

3.1 Engineering Controls

- 3.1.1 Portable Welding exhaust units
- 3.1.2 Natural ventilation
- 3.1.2 Others

3.2 Work Practices

- 3.2.1 Review required consumables, welding type, metals used and work environment
- 3.2.2 Review maintenance
- 3.2.3 Review housekeeping activity
- 3.2.4 Task position
- 3.2.5 Others

3.3 Protective Equipment

- 3.3.1 Approved Chrom VI fume respirators (N95), PAPR or Air Supplied will be provided to employees following COMPANY NAME Respirator Program.
- 3.3.2 Respirators shall be used whenever engineering and work practice controls are not sufficient to reduce exposure to or below the permissible exposure limit.
- 3.3.3 Respirators shall be provided whenever an employee requests a respirator.
- 3.3.4 Respirators shall be used in accordance with the supervisor's instructions and the company Respiratory Protection Program.
- 3.3.5 Approved Chrom VI protective equipment and clothing will be provided when required. This equipment and clothing will be cleaned by trained employees and all waste containers will be Chrom VI waste labeled. Protective work clothing and equipment shall be provided to employees when required.
- 3.3.6 All protective clothing shall be removed only in designate change areas.

3.3.8 Contaminated protective clothing that is to be cleaned, laundered, or disposed of shall be placed in a closed container in the designated change area which prevents dispersion of Chrom VI outside the container. Containers of contaminated protective clothing and equipment shall be labeled as follows:

CAUTION: Clothing Contaminated With Chrom Vi. Do Not Remove Dust By Blowing With Compressed Air Or Shaking. Dispose Of Chrom Vi Contaminated Wash Water In Accordance With Applicable Local, State, Or Federal Regulations.

3.3.9 Any person who cleans or launders protective clothing or equipment, shall be informed, in writing, of the potentially harmful effect of exposure to Chrom VI.

3.3.10 The removal of Chrom VI from protective clothing or equipment by blowing, shaking, or any other means which disperses Chrom VI into the air is prohibited.

3.4 Hygiene Facilities and Practices.

3.4.1 Eating and Drinking. In areas where employees are exposed to Chrom VI, without regard to the use of respirators, the following shall apply:

3.4.1.1 Foods/beverages cannot be present or consumed.

3.4.1.2 Tobacco products cannot be present or used.

3.4.1.3 Cosmetics cannot be applied.

3.5 Designated Change Areas.

3.5.1 Clean, designated change areas shall be provided for employees who work in areas where their airborne exposure to Chrom VI is above the PEL. The airborne exposure is without regard to the use of respirators.

3.5.2 Designated change areas shall be equipped with separate storage facilities for protective work clothing and equipment and shall include a separate storage area for street clothes to prevent cross contamination.

3.6. Washing Facilities

3.6.1 Employees who work in areas where their airborne exposure to Chrom VI is above the PEL, without regard to the use of respirators, shall shower or wash at the end of the work shift.

3.6.2 The washing facilities shall be in accordance with CAL/OSHA section 5206, i.e., "Washing facilities. Such facilities shall be in near proximity to the worksite and shall be so equipped as to enable employees to remove such substances."

3.6.3 Employees who are required to shower or wash will not leave the jobsite wearing any clothing or equipment worn during the work shift.

3.7 Food and Beverage Consumption Areas

3.7.1 Food and beverage consumption areas will be sufficiently removed from the affected work area for the employees who work in areas where their airborne exposure to Chrom VI is above the PEL, without regard to the use of respirators.

3.7.2 Food and beverage consumption areas will be readily accessible to employees.

3.7.3 Employees who work in areas where there is airborne exposure to Chrom VI will wash their hands and face prior to eating, drinking, smoking, or applying cosmetics.

3.7.4 Employees will not enter food and beverage consumption areas with protective work clothing or equipment unless surface Chrom VI dust has been removed by vacuuming or other approved cleaning methods.

4.0 Employee Information and Training.

4.1 The COMPANY NAME will determine whether Chrom VI training required for specific jobs will be conducted in a classroom or on-the-job. The degree of training provided will be determined by the complexity of the task and the Chrom VI exposure hazards associated with the individual task.

4.1.1 Initial Training. Prior to job assignment, COMPANY NAME will provide training to ensure that the hazards associated with Chrom VI are understood by employees and that the knowledge, skills and control equipment required are acquired by employees. The training will as a minimum include: (see attachments C, D, E and F).

4.1.1.1 Each authorized employee will receive training in the recognition of Chrom VI hazards involved with particular task and the means necessary for safe work.

4.1.1.2 The contents of CAL/OSHA section 5206, appendices and all other pertinent information upon request.

4.1.1.3 The specific nature of the operation such as welding, cutting or heating stainless steel, which could result in exposure to Chrom VI above the action level.

4.1.1.4 The engineering controls and work practices associated with the employee's job assignment, including training of employees to follow good work practices. Fume exhaust equipment must be 2-4 inches from the weld.

4.1.1.5 The purpose, proper selection, fitting, use and limitation of respirators.

4.1.1.6 The purpose and a description of the medical surveillance program, and the medical removal protection program including information concerning the adverse health effects associated with excessive exposure to Chrom VI .

4.1.1.7 The contents of any compliance plan in effect.

4.1.1.8 The employee's right of access to records.

4.1.2 Chrom VI Refresher Training. Scheduled refresher training will be conducted on an as needed basis.

4.1.2.1 Retraining will be provided for all affected employees whenever there is a change in their Chrom VI job assignments, a change in control equipment personal protective equipment, equipment or processes that present a new hazard, when their work takes them into hazardous areas, or when there is a change in the Chrom VI safety procedures. Retraining will also be provided whenever a safety procedure fails resulting in a near-miss, illness, or injury.

4.1.2.2 Additional retraining shall also be conducted whenever a periodic inspection reveals, or whenever COMPANY NAME has reason to believe, that there are deviations from or inadequacies in the employee's knowledge of known hazards, or use of equipment or procedures.

4.1.2.3 The retraining shall reestablish employee proficiency and introduce new equipment, or revised control methods and procedures, as necessary.

4.1.3 Certification. COMPANY NAME shall certify that employee Chrom VI training has been accomplished and is being kept up to date. The certification shall contain a synopsis of the training conducted, each employee's name, and dates of training.

5. Regulated Areas

5.1 Signs shall be posted in each Chrom VI work area. The signs shall be illuminated and cleaned as necessary and read:
SKULL AND CROSS BONE
WARNING HAZARD
CHROM VI WORK AREA
NO SMOKING, EATING OR DRINKING

5.2 Fence

When welding, heating or cutting stainless steel, a fence will be erected to limit entry and exposure.

6. Medical Surveillance. The Chrom VI and Respirator medical surveillance provisions are provided to COMPANY NAME employees.

6.1 All medical examinations and procedures will be performed by or under the supervision of a licensed physician (PLHCP) and provided without cost to employees at a reasonable time and place. The medical will follow the CAL/OSHA requirements and a copy will be provided to the Medical Provider.

6.2 Employees will be provided Chrom VI medical examinations if they:

6.2.1 Have or may have work related Chrom VI exposure at or above the action level for 30 or more days a year

6.2.2 Experience signs or symptoms of the adverse health effects associated with Chrom VI

6.2.3 Exposed in an emergency

6.2.4 At termination of employment unless last Chrom VI medical is within the last 12 months

6.3 Medicals will be provided within 30 days of assignment, unless employee has had a Chrom exam within the last 12 months and/or annually if needed.

6.4 Examination criteria. The content and frequency will be at the discretion of the attending physician. Each examination as a minimum will include:

- Work history with emphasis on Chrom VI exposure and protection
- Medical history with emphasis on Chrom VI exposure
- A physical examination of skin and respiratory track
- Any other test required by the PLHCP
- Information from other employment related physical exams

6.5 The PLHCP will provide a written opinion within 30 days which includes:

6.5.1 The PLHCP medical opinion of the employee examined for Chrom VI exposure

6.5.2 Any limitations for Chrom VI exposure or PPE usage

6.5.3 A statement that the employee has been informed by the PLHCP of the exam results

6. 5. 3 The PLHCP will not reveal to COMPANY NAME unrelated Chrom VI exposure information.

6.6 COMPANY NAME will provide the employee the medical opinion with 2 weeks of receipt.

6.6.1 Cost. COMPANY NAME will bear the expense of the multiple physician review mechanism where it is used.

7.0 Housekeeping and Disposal

7.1 All surfaces shall be maintained as free as practicable of accumulations of Chrom VI using a HEPA vacuum.

7.2 Cleaning Floors.

7.2.1 Floors and other surfaces where Chrom VI accumulates shall not be cleaned by the use of compressed air or heavy sweeping. Care will be taken at all times to reduce the lofting of material into the ambient air.

7.2.2 When vacuuming or other equally effective methods are not feasible, wet methods, including wet sweeping, wet shoveling, or wet brushing, shall be used. Dry methods may be used only when vacuuming and wet methods are not practicable.

7.3 Vacuuming. When vacuuming methods are utilized, only a vacuum with an absolute filter shall be used and the residue collected shall be treated and disposed of as hazardous Chrom VI waste.

7.4 Disposal of Chrom VI waste will follow local, state and federal requirements.

8. Recordkeeping. COMPANY NAME will keep all records of exposure monitoring for airborne Chrom VI.

8.1 These records will include as a minimum the following:

- Name and job classification
- Chrom VI containing material
- Details of sampling and the analytic technique used
- Results of sampling
- Control system used
- Type of respiratory protection being worn
- MSDS
- Other Chrom VI information

8.2 Records of medical monitoring will include:

- Names of the employee, social security number and job task
- The physician's written opinion
- A copy of the results of the examination

8.3 Records retention. All of the above kinds of records must be kept for 40 years, after termination of employment.

8.3.1 Records will also be retained if the employee is temporarily removed from the job under the medical removal protection program. This record will include:

- The employees name and social security number
- How the removal was or is being accomplished
- Dates of removal from work and return
- Details of how each removal was or is being accomplished

9.0 Program Audit. This program will be audited annually or when there have been changes or program deficiencies have been noted. (see attachment G)

10.0 Definitions.

Action level means a concentration of airborne chromium (VI) of 0.0025 mg/m3 of air calculated as an 8 hour time weighted average (TWA).

Chromium (VI) [hexavalent chromium or Cr(VI) or Chrom VI] means chromium with a valence of positive six, in any form and in any compound.

Emergency means any occurrence that results, or is likely to result, in an uncontrolled release of chromium (VI). If an incidental release of chromium (VI) can be controlled at the time of release by employees in the immediate release area, or by maintenance personnel, it is not an emergency.

Employee exposure means the exposure to airborne chromium (VI) that would occur if the employee were not using a respirator.

High efficiency particulate air [HEPA] filter means a filter that is at least 99.97 percent efficient in removing mono dispersed particles of 0.3 micrometers in diameter or larger.

Historical monitoring data means data from chromium (VI) monitoring conducted prior to May 30, 2006, obtained during work operations conducted under workplace conditions closely resembling the processes, types of material, control methods, work practices, and environmental conditions in the employer's current operations.

Objective data means information such as air monitoring data from industry-wide surveys or calculations based on the composition or chemical and physical properties of a substance demonstrating the employee exposure to chromium (VI) associated with a particular product or material or a specific process, operation, or activity. The data must reflect workplace conditions closely resembling the processes, types of material, control methods, work practices, and environmental conditions in the employer's current operations.

Permissible Exposure Limit no employee shall not be exposed to airborne concentration of Chrom VI in excess of 0.005 mg/m3, calculated as an 8 hour time weighted average (TWA)

Physician or other licensed health care professional [PLHCP] is an individual whose legally permitted scope of practice (i.e., license, registration, or certification) allows him or her to independently provide or be delegated the responsibility to provide some or all of the particular health care services required.

Total Dust all inert or nuisance dust whether mineral, inorganic, or organic, not listed specifically by substance name are covered by the Particles Not Otherwise Regulated.

Attachment A – Chrom VI Exposure Determination

1. Description of each task with potential Chrom VI exposure _____

2. List of equipment used in the task _____

3. Types of materials processed _____

4. Exposure controls methods _____

5. Crew size (if applicable) _____

6. Employee job responsibilities _____

7. Job Hazard Analysis _____

8. Maintenance practices specific to the job _____

Attachment B – Job Hazard Analysis

PRE-JOB HAZARD ANALYSIS

Job No.		Date: ☐ New ☐ Revised
Page	of	JHA No.
Site:	Controlling Contractor:	Analysis By:
Job Description:		
Jobsite Superintendent:		
Location:		
Foreman:		
Approved By:		
Project Safety Representative:		

Activity	Potential Hazards	Recommended Action, Procedure, and/or Equipment
OCCUPATIONAL EXPOSURE TO CHROM VI during welding, cutting or heating.	Potential exposure to airborne Chrom VI fumes.	Chrom VI levels shall be determined before employees access work area.
		Employees shall be trained in the hazards of occupational Chrom VI exposure.
		Employees shall not eat, drink, or smoke in Chrom VI contaminated areas.
		Employees shall receive proper training in the use of PPE.
		Change rooms shall be provided for employees.
		Engineering controls shall be established to control employee exposure.
		A site specific Chrom VI hazard plan shall be kept at the jobsite and available to all employees.
		Medical exams and monitoring shall be provided according to Cal/OSHA specifications.
		Portable exhaust systems will be used

Attachment C – Exposure Notification Letter

COMPANY NAME

Project

Date

Employee Name

Address

Dear _____:

COMPANY NAME conducted Chrom VI exposure air sampling in your breathing zone on _____ (Date). Air monitoring indicated that your sampled Chrom VI exposure is _____ milligrams per cubic meter.

Your Chrom VI exposure exceeded the Cal/OSHA requirements. Your workplace Chrom VI exposure will be controlled to acceptable limits by _____ and/ or _____ .

Signed by

COMPANY NAME Site Representative

Attachment D – Specific Safety Training and Instruction

COMPANY NAME

Topic: Occupational Exposure to Chrom Vi

Source: CAL/OSHA section 5206
1910.134

Where there is a potential for exposure to Chrom VI, COMPANY NAME will ensure that the appropriate training is conducted, documented, and maintains a record of such training. The training will meet the following criteria:

1. Training will be conducted before an employee's assignment to work in an area where there is a potential for exposure at or above the AL to Chrom VI.
2. Training will be conducted in an understandable format for all affected employees.
3. Training will cover all the hazards of Chrom VI exposure in the workplace.
4. Training will include location, quantity, manner of use, release, and storage of Chrom VI in the workplace that could result in exposure, especially above the PEL.
5. Training will includes engineering controls and work practices to reduce the potential for exposure for each employee's job assignment.
6. Training will include measures that employees may take to protect themselves from exposure to Chrom VI, such as modification of smoking habits, hygiene practices, emergency procedures, and provisions for personal protective clothing and equipment.
7. Training will discuss the purpose, proper selection, use, and limitations of respiratory protection and protective clothing.
8. Training will cover medical surveillance program requirements.
9. Training will cover employee's rights and access to records.
10. Training will cover medical removal and medical surveillance criteria.
11. Respirator training will follow site written policy.

3 Attachment E – Chrom VI Information Sheet

What is Chrom VI?

Chrom VI is a metal particle and occurs naturally. Recently OSHA published a health standard for Chrom VI exposure in the work place. Chrom VI fumes are produced when welding or cutting stainless steel.

Where is Chrom VI in Construction?

The primary sources of Chrom VI in construction would be welding and hot work with stainless steel, non ferrous chromium high chrome alloys, chrom coated metal chromate chemicals and chromate pigments, coating, plating, painting or removal or application, treated wood, Portland cement and others. Areas of concern include confined space work, inside and outside work.

What are the Chrom VI Health Hazards

Employees who breathe Chrom compounds at their jobs for many years may be at increased risk of developing lung cancer. Breathing high levels of Chrom VI can irritate or damage the nose, throat, and lungs. Irritation or damage to the eyes and skin can occur if Chrom VI contacts these organs in high concentrations or for a prolonged period of time.

Cancer. All forms of Chrom VI are regarded as carcinogenic. The risk of developing lung cancer increases with the amount of Chrom VI inhaled and the length of time the employee is exposed

Eyes. Direct eye contact with chromic acid or chromate dusts can cause permanent eye damage.

Respiratory Tract. Chrom VI can irritate the nose, throat, and lungs. Repeated or prolonged exposure can damage the mucous membranes of the nasal passages and result in ulcers. In severe cases, exposure causes perforation of the septum (the wall separating the nasal passages). Breathing small amounts of Chrom VI even for long periods does not cause respiratory tract irritation in most people. Some employees become allergic to Chrom VI so that inhaling the chromate compounds can cause asthma symptoms such as wheezing and shortness of breath.

Skin. Prolonged skin contact can result in dermatitis and skin ulcers. Some workers develop an allergic sensitization to chromium. In sensitized employees, contact with even small amounts can cause a serious skin rash.

How is Exposure Determined?

Exposure is determined by an 8-hour Time Weighted Average (TWA) air sampling of the employees breathing zone by task. OSHA has determined that the breathing zone for welders is under the welding hood.

The Permissible Exposure Limit (PEL) for Chrom VI is 0.005 milligrams per cubic meter (mg/m3) with an Action Level (AL) of 0.0025 mg/m3, both based on an 8-hr. TWA.

How is Chrom VI Exposure Controlled?

There are several ways to reduce exposure to Chrom VI. Recommended controls vary. The preferred approach is to use engineering controls such as ventilation or equipment and process modification. If these controls are not sufficient, other controls may be implemented, including the use of respirators, eye protection, showering, and changing into street clothes before leaving the plant.

Some controls methods that have worked to reduce exposure are:

1. Small filtered exhaust systems to natural ventilation
2. Respirators, N95 filter or a R or P95 or PAPR
3. Work process change
4. Welder position and environmental conditions

What's in the Chrom VI Written Program?

The employer must provide a comprehensive written Chrom VI program that may include:

- Engineering Controls
- Exposure Determination
- Respiratory protection
- Recordkeeping
- Protective clothing
- Limited access to regulated areas
- Medical surveillance
- Hazard communication training
- Hygiene areas for eating and drinking, change rooms

Attachment G – Written Assessment Occupational Exposure to Chrom VI

COMPANY NAME

Employee Name: _____ Date: _____

1. You can eat food or drink beverages in a Chrom VI work area.
   ☐ **TRUE** ☐ **FALSE**

2. Employees have a right to see their medical file.
   ☐ **TRUE** ☐ **FALSE**

3. You must be trained on Chrom VI hazards before working with Chrom VI.
   ☐ **TRUE** ☐ **FALSE**

4. Chrom VI can not be absorbed through the skin.
   ☐ **TRUE** ☐ **FALSE**

5. You should read and follow a MSDS protection measures.
   ☐ **TRUE** ☐ **FALSE**

6. Chrom VI accumulated on clothing is not a threat to family members.
   ☐ **TRUE** ☐ **FALSE**

7. When welding or cutting on a Chrom VI coated surface you should?
   ☐ **a.** Not worry about it ,that's what the wind is for
   ☐ **b.** Wear the proper PPE and use controls
   ☐ **c.** Not weld on a Chrom VI coated surface
   ☐ **d.** All of the above

8. The company written Chrom VI program must include:
   ☐ **a.** Chrom VI medicals and air monitoring
   ☐ **b.** Employee training
   ☐ **c.** Engineering controls
   ☐ **d.** All of the above and more

9. When Chrom VI is found which control should be used first?
   ☐ **a.** Engineering
   ☐ **b.** Administrative
   ☐ **c.** PPE
   ☐ **d.** Nothing

10. If you do not understand the training requirements, you should:
    ☐ Do nothing, the exposure is probably not enough to worry about.
    ☐ Tell your supervisor immediately.
    ☐ Tell a co-worker, he may be able to explain it you.
    ☐ Wait until the next safety meeting.

11. Compressed air can be used for Chrom VI clean up?
    ☐ **TRUE** ☐ **FALSE**

12. Chrom VI exposure can occur when:
    ☐ **a.** welding stainless steel
    ☐ **b.** heating stainless steel
    ☐ **c.** plasma cutting stainless steel
    ☐ **d.** all of the above
    ☐ **e.** none of the above

SCALE

1. False	4. False	7. B	10. B
2. True	5. True	8. D	11. False
3. True	6. False	9. A	12. D

Attachment H – Employee Acknowledgement

By signing below, I acknowledge that I understand and agree to comply with COMPANY NAME "Chrom VI Hazard Safety Program" and Company Safety Policies and Procedures. I have reviewed a copy of the Program and have received a training orientation, identifying the safety requirements associated with the scope of work in this Program.

EMPLOYEE NAME _____ Print

_____ Sign

_____ Employee Number

_____ Date

Attachment I – Occupational Exposure to Chrom VI Compliance Checklist

COMPANY NAME

1. Is there Chrom VI on the jobsite?
   ☐ YES ☐ NO
2. Has the Chrom VI been tested?
   ☐ YES ☐ NO
3. Have employees been Chrom VI trained?
   ☐ YES ☐ NO
4. Have employees been informed of Chrom VI hazard controls?
   ☐ YES ☐ NO
5. Do employees eat food in the Chrom VI work area?
   ☐ YES ☐ NO
6. How is Chrom VI determined?
   ☐ YES ☐ NO
7. Is a site specific Chrom VI plan established?
   ☐ YES ☐ NO
8. Are medical exams following Cal/OSHA specifications?
   ☐ YES ☐ NO
9. Are engineering controls used?
   ☐ YES ☐ NO
10. Are employees provided change rooms, with showers?
    ☐ YES ☐ NO
11. Do employees use PPE?
    ☐ YES ☐ NO
12. Is PPE cleaned and maintained?
    ☐ YES ☐ NO
13. Does management understand the hazards of Chrom VI?
    ☐ YES ☐ NO
14. Are active records kept
    ☐ YES ☐ NO
15. Are medical records provided to employees?
    ☐ YES ☐ NO
16. How are medical and exposure records retained?
    ☐ YES ☐ NO
17. Training is taught in a language the employee understands?
    ☐ YES ☐ NO
18. Are engineering controls used?
    ☐ YES ☐ NO
19. Is an MSDS for Chrom VI available?
    ☐ YES ☐ NO

Attachment J – Code of Safe Practices Occupational Exposure to Chrom VI

COMPANY NAME

1. A site specific Chrom VI hazard plan will be developed before work begins.
2. Chrom VI levels will be determined before employees access the work area.
3. Employees will receive the appropriate training before accessing the work area.
4. Employees will be informed of the hazards associated with Chrom VI exposure.
5. Employees will not eat, drink, or smoke in Chrom VI contaminated areas.
6. Designated eating areas will be established and marked.
7. Employees will wash their hands thoroughly before eating, drinking, or smoking.
8. Change rooms equipped with showers may be available to all employees.
9. Engineering controls will be established to control employee exposure.
10. Employees will be provided with the appropriate PPE.
11. Employees will receive specific training in the proper use of PPE.
12. Personal Protective Equipment will be cleaned, maintained and disposed of as required.
13. Chrom VI and Respirator Medical exams and monitoring will be provided according to Cal/OSHA specifications.
14. Employees will understand and comply with the requirements of the Site Specific Safety Plan and specified training.
15. Material Safety Data Sheets will be provided and maintained at the project.
16. Employees will leave contaminated clothing and tools at the worksite.
17. Emergency procedures and evacuation locations shall be designated and posted.
18. Employees shall report all injuries and exposures to their supervisor immediately.

Attachment K – Chrom VI Welding, Heating or Cutting Pre Job General Task

PROJECT NAME _____

LOCATION _____

START DATE _____

COMPLETION DATE _____

CLIENT CONTACT _____

1. **Description of Task**

   Confined Space Work ☐ **YES** ☐ **NO**

2. **Materials Used**

   Metals _____

   _____

   Consumables _____

   _____

3. **Exposed Crew Size by Craft**

   Boilermakers _____

   _____

   Ironworker _____

   _____

   Labors _____

   _____

4. **Employee Responsibilities**

   _____

   _____

   _____

5. **Exposure Controls**

   Exhaust System _____

   _____

   HEPA Vacuum _____

   _____

   Respirator _____

   _____

6. **Job Hazard Analysis Program**

   _____

   _____

   _____

7. **List of Equipment**

   MIG _____

   _____

   TIG _____

   _____

   STICK _____

   _____

   GASES _____

   _____

8. **Maintenance Programs**

   Daily Respirator _____

   _____

   Exhaust Systems _____

   _____

9. **Record Keeping**

   Identify Gatekeeper _____

   _____

   _____

Notes

Notes

California Guide to Welding Fume Hazards

for the

IRONWORKERS INDUSTRY

The purpose of the guide is to provide the employer with information to assist in the recognition and avoidance of potential hazards associated with the welding process and common operations. The Employer understands that the information provided in this guide may not reflect the conditions at the work place that may be unsafe or dangerous, and additional air sampling tests and evaluation may be warranted. The California Field Ironworkers Administrative Trust does not warrant, represent or guarantee in any manner that all unsafe or potentially hazardous conditions have been discovered. The California Field Ironworkers Administrative Trust makes no warranty, representation or guaranty as to the content, accuracy or completeness of the information provided to the Employer, makes no warranty that the information may be relied upon for any reason, including that the Employer's workplace is free from any hazards or unsafe conditions.