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TITLE

FUME LEVELS DURING METAL CUTTING AND WELDING ACTIVITIES, CALCIUM CHLORIDE PLANT MAINTENANCE UNIT, MIDLAND, 1984.

REV 8(E)

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DESCRIPTIVE SUMMARY WITH CONCLUSIONS

Airborne concentrations of total particulate exceeded current exposure guidelines during welding and torch cutting activities in the shelf drier. Respiratory protection was recommended and used during periodic renovation of the shelf drier and other projects involving significant amounts of welding in confined spaces. Fume concentrations of individual metals were dependent on the base metal being welded, but exposure guidelines can be expected to be exceeded when welding on stainless steel in confined spaces such as the drier. Vapor concentrations of nitrogen dioxide, carbon monoxide, sulfur dioxide, ozone and chlorine were monitored but usually not detected, even in the confined spaces of the shelf drier. Breathing zone samples, which were obtained on the outside of the welder's face shield, represented a "worst case" for welding fume exposure.

Employee exposure to welding fumes in the shop were within current guidelines due to natural ventilation and use of local exhaust ventilation. The benefit of local exhaust ventilation can be greatly increased by keeping the exhaust duct within 12 inches or less of the weld point, as indicated by measured air velocities.

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INTRODUCTION

The maintenance crew for the Calcium Chloride Plant has significant exposure to torch cutting and welding fumes as part of their work. Potential exposures result from routine welding in the shop, as well as from larger projects such as periodic repair of the Calcium Chloride shelf drier. In 1984 both shelf drier repair and routine welding tasks in the shop were monitored to evaluate potential employee exposures to welding and cutting fumes.

CONCLUSIONS AND RECOMMENDATIONS

1. Employees have potential for over exposure to total particulate during welding and torch cutting activities in confined spaces based on the data in this report. Total particulate concentrations exceeded current guidelines during repair work in the calcium chloride shelf drier even though visible fumes were minimal and the drier was a large vessel with good air movement. Use of respiratory protection was recommended for use in the drier and is recommended for any project involving significant welding in a confined space. Respiratory protection was worn by most employees.

2. Potential employee exposure to individual metal fumes during welding and torch cutting activities was very dependent on the base metal used. Employee exposures to fumes from mild steel were generally within current guidelines for iron. Fumes from stainless steel contained relatively large concentrations of manganese, nickel, and chrome, in addition to iron. Use of respiratory protection is recommended when welding on stainless steel in confined spaces as protection against metal fumes as well as total particulate.

3. Vapor concentrations of nitrogen dioxide, carbon monoxide, sulfur dioxide, and ozone were monitored during representative cutting and welding activities and were either very low or not detected. Based on the data in this report, these vapors should not be of concern during most welding or torch cutting activities. Chlorine vapors which could have been potentially released from residual calcium chloride on steel surfaces, were not detected during welding activities.

4. Employee exposure to welding fumes in the shop were within current guidelines due to natural ventilation and use of local exhaust ventilation.

5. Local exhaust ventilation available in the shop should be placed within 12 inches of the weld point if possible. Exhaust inlets are currently positioned about 18 inches from the weld point. This extra 6 inches of distance results in roughly a 50% drop in the ability of the exhaust air to capture the welding fumes.

6. Air samples representing employee's potential fume exposure were obtained outside the welder's mask for practical reasons. Exposure concentrations measured inside the face shield are normally 30 to 50 percent lower than concentrations measured

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outside because of protection provided by the face shield. Thus, the potential exposure concentrations in this report could be considered worst case concentrations.

EVALUATION CRITERIA

A summary report, HEH 2.1-1-58(10), explaining Industrial Hygiene Guides (IHG) for various chemical and physical agents is available from the U.S. Area Industrial Hygiene Laboratory. The following chemical and physical agents were of interest in this project.

INDUSTRIAL HYGIENE GUIDES

MATERIAL	TWA	EXCURSION	SOURCE
Iron oxide (as iron)	5 mg/m^3	10	ACGIH
Calcium oxide (CaO)	2 mg/m^3	--	ACGIH
Manganese fume (as Mn)	1 mg/m^3	3	ACGIH
Nickel oxide (as metallic nickel)	1 mg/m^3	--	ACGIH
Chromium compounds (as chromium)	0.05 mg/m^3	--	ACGIH
Copper fume (as CuO)	0.2 mg/m^3	--	ACGIH
Titanium dioxide (as titanium)	10 mg/m^3	20	ACGIH
Zinc oxide fume (ZnO)	5 mg/m^3	10	ACGIH
Welding fume (as total particulate)	5 mg/m^3	--	ACGIH
Nitrogen dioxide	3 ppm	5	ACGIH
Carbon monoxide	50 ppm	400	ACGIH
Sulfur dioxide	2 ppm	5	ACGIH
Ozone	0.1 ppm	0.3	ACGIH
Chlorine (ceiling)	1 ppm	--	OSHA

HAZARD REVIEW

Iron Oxide Fumes

Inhalation of iron oxide fumes causes mottling of the lungs, which shows up as generalized discrete densities on chest x-ray films. This mottling of the lungs, called siderosis, is considered to be a benign pneumoconiosis because it does not lead to the proliferation of lung fibrosis and loss of respiratory function, or other severe lung diseases.

Nickel Compounds

When introduced into the bodies of animals in the pleural cavity, in muscle tissue, and in subcutaneous tissue, finely divided metallic nickel has been shown to cause cancer. Absorption of some nickel compounds into body tissue greatly increases the likelihood of toxic effects. Fortunately, nickel oxide (such as formed during welding on stainless steel) and metallic nickel are insoluble compounds. Although

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cancer is of minimal concern with nickel welding fumes, skin contact with metallic nickel or nickel compounds can cause a dematitis called "nickel itch." Symptoms usually begin with a sensation of burning and itching in the hand, followed by erythema (reddening of the skin) and a nodular eruption on the web of the fingers, wrists, and forearms.

Copper

Acute exposures to copper metal fumes or salts leave a sweetish, metallic taste and cause a number of adverse effects, including; salivation, nausea, vomiting, gastric pain, diarrhea, cramps and prostration. In chronic exposures, the liver, kidneys, and spleen may be injured and anemia may develop.

Aluminum

There are no clinical studies implicating aluminum oxide as a cause of pneumoconiosis in man, and the exposure limits established were with respect to "inert" or nuisance dust.

Chromium

Chromium compounds act as allergens which may cause dermatitis. Acute exposure to dust or mist may cause coughing, headache, labored breathing, fever, loss of weight, ulceration and perforation of the nasal septum. Although hexavalent chromium has usually been present in manufacturing plants where lung cancer incidence was high, experimental evidence has been reported indicating that trivalent chromium possesses carcinogenic properties.

Manganese Fume

The symptoms and effects of short overexposures to manganese fumes or manganese oxide are assumed to be the same as those for long term exposures. Long term exposure, months or years, to manganese can affect the central nervous system. In addition, a high incidence of pneumonia has been found in workers exposed to manganese fume. It has also been suggested that manganese oxide fumes generated during welding caused an increase of stomach-intestinal problems, such as ulcers, in welders.

Calcium Oxide

No published animal or human toxicity studies exist. Experience has shown the fume or dust to be irritating to moist membranes such as in the nose, throat, and eyes.

Titanium Dioxide

One major use of titanium dioxide is in welding rod coatings. Extensive studies indicate that titanium dioxide is inert in the body. This means it is not absorbed and exerts no toxic effect. The material is regarded as a nuisance dust or fume, and if not inhaled in gross amounts it does not pose a danger to employee health.

PROCESS AND JOB DESCRIPTION

The shelf drier in the Calcium Chloride Plant was one of several steps in the process of converting calcium chloride slurry to a dry flake product. The drier was a large tank constructed of mild steel, approximately 26 feet in diameter by 50 feet high. Inside were a series of shelves, each shelf originally about two feet above the other. Over the course of many years the steel in the drier has gradually corroded and been replaced, particularly the shelves in the lower third of the drier. In some cases deteriorated shelves have been removed and not replaced, and as a result, the spacing between the bottom third of the shelves was approximately four feet.

Wet product cake was dried by drawing air across the top of the shelves on which the wet cake lay. Two Ducon units on top of the drier provided air movement, with total air flow controlled by blast gates at the inlet of the Ducons. Ambient air entered the drier through a screen covered inlet under the bottom shelf. The shelves acted as baffles, first forcing the air around the outer perimeter, then through a hole in the core of the shelf above. Product dried as it was exposed to air and dropped from shelf to shelf by rakes. Each shelf could be reached or inspected through access doors on the east side of the drier.

In May of 1984 a partial drier renovation took place. Because the close spacing of the shelves restricted worker movement, one of the first project objectives was to cut access holes in the south side of the drier. These holes spanned several shelves and were large enough to allow the passage of large pieces of steel. Work was simultaneously performed in two zones of the drier, one zone about 10 feet above the other. The lower zone was shelf #3, the upper zone involved shelves #9 and #10. Once deteriorated steel had been removed, new steel was taken into the drier through the access holes and welded in place. New steel was cut to proper dimensions and shapes at outlying shops before delivery to the shelf drier work site.

There were essentially no dead air pockets in the shelf drier because its design forced air to flow across the shelves. One Ducon scrubber was operated "wide open" to provide ventilation in the drier. Operation of only one Ducon was a compromise between high air movement and comfort for the workers. On cool days, high air movement made working in the drier uncomfortable. Air which had been drawn through the drier was continuously monitored for oxygen content before being exhausted. An alarm, connected to the oxygen monitor, was placed in the general work area of the maintenance crews to warn of a decrease in oxygen content. The access holes in the drier wall greatly improved ventilation in the two work zones. Additional ventilation was provided by leaving open normal access openings in these same two work zones. All openings in other areas of the drier were closed, particularly above the work zones. Initial air velocity measurements in the drier indicated a range of air movement between 10 and 150 ft/min. A good deal of this fluctuation was due to strong fluctuating May wind currents outside the drier. Based on air velocity measurements at access openings, there were 35 air changes in the drier per hour.

Later measurements of air velocity, when most of the shelving had been removed and the work areas were more open, indicated a steady fluctuation of air velocities between 20 to 200 ft/min.

Both shielded metal arc welding (stick welding) and gas shielded arc welding (MIG welding) were used in the drier renovation. The technique of arc welding involved a building-up of electrical charge on a rod or wire electrode. When the electrode was placed near enough to the base metal part to be repaired, an arc jumped across the air gap and generated enough heat to melt both the electrode tip and the base metal. The electrode was gradually consumed as metal from the electrode was deposited on the base metal. The main difference between stick and MIG arc welding was in the electrode. Stick electrodes, in general, were short metal rods heavily coated with various substances such as cellulose, clays and gums, calcium fluoride, mineral silicates, metal carbonates, ferro manganese and ferro silicon, titanium dioxide, iron or manganese oxide, and iron powder. Much of the visible welding fumes were composed of these coatings, although the #6010 rod used on the shelf drier was 99% iron and had a minimal amount of coating on it. The purpose of the coatings were: 1) to act as a cleansing and deoxidizing agent, 2) release an inert gas to protect the molten metal from oxidizing, and 3) form a protective slag over the molten metal until it cooled. The other form of arc welding, MIG welding, used a continously feed bare wire electrode, and the weld joint was shielded by an inert gas feed through the welding torch.

SURVEY METHODS

Both employee breathing zone and general work area air samples were obtained during normal work activities. Area samples were generally taken in the center of the work area at about head height. Breathing zone samples were obtained near the worker's head, but outside the welding face shield. These breathing zone samples were often a composite of several persons working intermittently in the same area. Because of the small space between shelves, personnel were often forced to crawl. Clothing and equipment had the potential for snagging on the drier. Working conditions were also cramped by the presence of several people and their tools in the same area, shelf fragments, and a maze of gas hoses or electrical cables. The half face respirators worn by the employees were connected with tubing to cartridges strapped in place on their backs. There was no room for cartridges under the welder's face shields, just as there was no room for a sample filter holder. For these reasons it was decided the most practical way to obtain air samples in employees' breathing zones was to hold the filter holder as close as possible to their heads. This method of sampling was used even though air samples from inside the welders' masks would have been more representative of potential fume exposure.

Fumes from metal welding and cutting activities were sampled by drawing local air through membrane filter papers at known air flowrates. The filter papers were weighed both before and after sampling to determine the weight of total particulate collected. Filter papers ranged in diameter from 47 to 50 millimeters and in pore size from 0.2 to 0.8 microns. Air sample flowrates varied from 19 to 44 liters-per minute depending on which of three Gast sliding vane vacuum pumps were used. Sampling rates were measured at the face of the filter paper holder using rotameters with rubber stopper adapters, and measurements were taken at both the beginning and end of the sample period.

Total particulate sample weights were obtained by weighing the filter papers on a Mettler balance capable of reading 0.01 milligrams of material. The filters were dessicated before weighing to remove moisture from the particulate matter collected. Total weight of collected particulate was then divided by sample air volume to obtain total particulate concentrations in air. Once the project was complete, the metal content of all the filter samples was determined via atomic emission spectroscopy using induction coupled plasma as an excitation source. Analysis was performed by E. T. Wagoner and D. Plumb, and reported in AL-84-11578 and AL-84-13008 respectively.

Vapor concentrations of nitrogen oxides, carbon monoxide, sulfur dioxide, and ozone in the work environment were monitored periodically with Gastech direct reading detector tubes. Typically 100 to 500 Ml of air was drawn through each tube using a hand operated vacuum pump. The length of the color stain was translated into parts per million of chemical vapor according to manufacturer's instructions. All tubes were within their expiration date. Chlorine was also monitored at least once with a detector tube, but the primary method of monitoring was qualitative and based on the low odor threshold of chlorine.

DISCUSSION AND RESULTS

Renovation of the shelf drier proceeded in two phases. The first phase consisted of cutting out old metal with oxygen/actylene torches. The second phase involved welding new steel into positions where old metal had been removed. Most workers engaged in cutting or welding in the drier wore vapor/fume type respirators along with eye and skin protection. The practice of using respiratory protection was reinforced by initial air samples which indicated relatively high total particulate concentrations in air. No attempt was made to measure worker time weighted average (TWA) potential particulate exposure. Instead short term samples, both area and breathing zone, were taken in representative working conditions. A potential eight hour TWA employee exposure during torch cutting was calculated, however, based on the short term area and breathing zone samples, Table 1. This calculated potential exposure, 9.5 mg/m^3, assumed a work regime of 5.5 hours inside the drier and 3 hours outside. A mean total particulate concentration (iron oxide assumed) in air of 13.8 mg/m^3 was used for time inside the drier, and 0 mg/m^3 for time outside the drier. The mean particulate concentration inside the drier could be considered a worst case concentration, since it was obtained outside the welder's face shield.

The highest fume concentrations measured during torch cutting were at the beginning of the project, May 15, when work areas were most confined and ventilation from large access openings was not available. At that time, total particulate concentrations measured in the work area and breathing zone were 15 and 28 mg/m^3 respectively. Later the same day, after large access openings had been made in the drier wall, particulate concentrations dropped about 60%, Table 1. Since workers wore respiratory protection, measured fume concentrations did not represent actual employee exposures.

The same filter paper samples used to determine total particulate concentrations were eventually submitted for metal analysis. Based on this metal analysis, workers' potential exposures to individual metal fume concentrations during oxygen/actylene cutting were calculated, Table 2. As expected, iron and calcium comprised about 98% of the metal fumes during cutting. One interesting note about torch cutting is that metal fumes appear to have constituted only about 65% of the total particulate weight sampled in air. The remainder of the particulate matter was assumed to be calcium chloride dust and miscellaneous airborne materials.

Results of air samples taken during welding, Tables 3 and 4, differed only slightly from those taken during torch cutting. The major difference was in the composition of sampled particulate material. Iron was still the major component, representing about 80% by weight of total sampled metals, Table 4. However, manganese was as large a component in welding fumes as calcium, with each representing 9% of the total metals. Titanium was the next largest average component, at 2%. The significant presence of manganese and titanium was due to the welding rod used. Another significant difference between torch cutting and arc welding fumes was the slightly lower total percent of metal in the welding fumes, Table 3. Torch cutting fumes contained an average of approximately 65% metal fumes by weight, while welding fumes only contained an average of 50%. This lower concentration of metals in welding fumes was assumed to result from the additional presence of non-metallic materials, such as flux, in the welding electrodes. The difference in fumes generated by different types of base metals and stick electrodes is illustrated by the last sample reported in Table 4. This sample was taken inside a small tank constructed of stainless steel, and a high nickel content welding rod was used. In this sample iron was only the fifth largest metal component. The primary metal fume was manganese, nickel was second, and chrome and calcium were third.

Although total particulate levels in air during welding, Table 3, exceeded the guideline in 4 out of 8 samples, the concentration of individual metals in air exceeded their respective guidelines in only 2 out of 8 samples, Table 4. The calculated, TWA potential exposure of employees to particulate matter while repairing the drier was 5.5 mg/m^3. The calculated TWA exposure assumed 65% of the workday was spent in the drier in an atmosphere containing 8.5 mg/m^3 of total particulate. Again, since most workers wore half-face respirators, their actual particulate exposure should have been negligible.

Gases liberated during cutting and welding were not expected to be a problem during the drier renovation. However, as a safety precaution, the respirator cartridge worn by most workers removed organic vapors and acid gases as well as fumes. Results of air samples taken under representative work conditions during this project, Table 5, verified that potential organic and acid vapor concentrations were too low to be of concern. The highest carbon monoxide concentration, 5 to 10 ppm, was a worst case sample taken with several workers cutting simultaneously inside the drier before the access panels were made in the outside wall. In subsequent samples carbon monoxide concentrations dropped to 2 ppm. The only other vapor detected was a trace of sulfur dioxide. Although chlorine vapors could have been released from residual calcium chloride on the drier shelves, its characteristic odor was not detected while sampling was being conducted for particulate concentrations.

In addition to the shelf drier renovation project, exposure to welding fume was also determined for routine work in the maintenance shop. On October 2, 1984, routine welding activity was simulated at 2 of the 3 work stations commonly used in 209 Building. The welding table on the west side of the shop had local exhaust ventilation available in the form of a Nederman wall-mounted exhaust fan with retractable fume extractor arm. The fan, which had been installed 6 months earlier, had a rating of one horsepower (largest available) and was capable of moving 1100 cubic feet of air per minute against 6.5 inches of (water) static pressure. The inlet of the retractable arm was placed in its typical position, about 1.5 feet above the welding table, and most welding fumes were captured as they rose upward, see Table 6. The sample at the west table represented the "best case" of local ventilation during normal welding activity. Other welding scenarios were sampled, including the influence of air currents from nearby outside doors, increased distance between work and exhaust inlet, and the use of a fan with two branch arms operating simultaneously. The fan with two fume extractor arms was located on the east wall of the shop and served two welding tables. This fan was identical to the fan on the west wall and had been installed at the same time. All air samples were obtained in the welder's general breathing zone, outside his mask. Sample duration times were less than 15 minutes, with actual weld time representing only 50% of normal welding activity. The rest of the time was spent changing rods, chipping slag, wire brushing and inspecting the weld. Actual weld time with continuous feed wire would be a slightly higher percent of normal welding activity, perhaps 60 to 70%.

Both total particulate and metal fume concentrations were well within current exposure guidelines during typical welding activity in 209 Building. Local exhaust ventilation and natural building ventilation combined to minimize employee exposure to welding fumes during normal working conditions. However, the use of local exhaust as close to the work as possible should be stressed, particularly on occasional days when two or more welders are engaged in heavy welding activity.
The effect of moving local exhaust ventilation away from the weld point, even a few inches, is shown in Figure 1 and is based on actual measurements made in 209 Building.

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Table 1. TOTAL PARTICULATE IN AIR CONCENTRATIONS DURING TORCH CUTTING IN SHELF DRIER, CALCIUM CHLORIDE PLANT, MIDLAND, 1984. HEH34.21-2-2(4).

Sample Description	Total Particulate Conc., mg/m^3	Metal Fumes as % of Total Particulate	Sampling Conditions Minutes	Air Flow ml/min	Sample Number
8 Hour Exposure Guideline (as iron)	5	--	--	--	--
8 Hour Calculated Exposure (as iron) if Respirator Not Worn (Respirators worn by most employees)	9.5	--	--	--	--
Area					
Center of drier, 3 persons cutting within 10 feet of sample, 5/15/84	15	65	48	21	15-1
Center of drier, 3 persons cutting within 10 feet of sample, openings now cut in walls, 5/15/84	6	66	35	19	15-4
Center of drier, all cutting work located 8 to 25 feet below sample, 4 persons cutting, 5/16/84	8	61	35	20	16-1
Center of drier, all cutting work located 4 to 20 feet above sample, 4 persons cutting, simultaneous with sample 16-1, 5/16/84	2	54	45	36	16-3
Breathing Zone (Outside respirator and welding mask)*					
Multiple breathing zones, access panels not yet cut out of side of drier, work area more confined than with later samples, taken simultaneous with sample 15-1, 5/15/84	28	71	25	25	15-2
Multiple breathing zones, access openings now in drier wall, 3 persons cutting, simultaneous with 15-4, 5/15/84	10	63	30	33	15-5
Multiple breathing zones, work area fairly open, good ventilation indicated by quickly dissipated cutting fumes, one welder cutting at a time, 5/16/84	10	70	35	26	16-2
Background Area					
Center of drier, employee break time, no visible haze: 5/15/84	0.4	92	25	27	15-3
5/16/84	1	60	28	22	16-4

*Fume concentrations measured outside of welding face shield have typically been 30 to 50% higher than inside because of protection provided by the face shield. Reported concentrations could be considered worst case.

Table 2. METAL FUME CONCENTRATIONS IN AIR FROM TORCH CUTTING INSIDE OF DRIER, CALCIUM CHLORIDE PLANT, MIDLAND, 1984, HEH34.21-2-2(4).

Sample Number	Total Particulate Conc., mg/M^3	Air Concentration of Individual Metal Fumes, mg/M^3 Iron	Calcium Oxide	Manganese	Nickel	Chrome	Copper Oxide
8 Hour TWA Exposure Guide	5*	5	2	1	1	0.05	0.2
Area Samples							
15-1	15	6.3	1.1	0.04	0.006	0.005	0.04
15-4	6	2.4	0.4	0.02	0.003	0.003	0.02
16-1	8	3.2	0.6	0.02	0.004	0.003	0.02
16-3	2	0.3	0.1	0.003	0.001	0.001	0.002
Breathing Zone (Outside respirator and welding mask)**							
15-2	28	12	2.8	0.07	0.01	0.008	0.08
15-5	10	4	0.7	0.02	0.004	0.003	0.02
16-2	10	5	0.7	0.03	0.004	0.003	0.01
Average of Major Component Metals in Cutting Fumes		88%	10% (as Ca)	0.5%	<0.4%	<0.4%	0.4% (as Cu)

*Guideline based on iron, the primary component of the fumes

**Fume concentrations measured outside of welding face shield have typically been 30 to 50% higher than inside because of protection provided by the face shield. Reported concentrations could be considered worst case.

Table 3. TOTAL PARTICULATE IN AIR CONCENTRATIONS DURING ARC WELDING IN SHELF DRIER, CALCIUM CHLORIDE PLANT, MIDLAND, 1984. HEH34.21-2-2(4).

Sample Description	Total Particulate Conc., mg/m^3	Metal Fumes as % of Total Particulate	Sampling Conditions: Minutes	Air Flow ml/min	Sample Number
8 Hour Exposure Guideline	5	--	--	--	--
8 Hour Calculated Exposure if Respirator Not Worn (Respirator worn by most employees)	5.5	--	--	--	--
Area					
Center of drier, 1 person stick welding within 6 feet of sample, good ventilation, no visible fumes near sample 5/21/84	1	51	45	44	21-3
Center of drier, all welding 8 to 25 feet below sample, 3 persons welding, 5/23/84	1	34	38	23	23-1
Center of drier, all welding 8 to 25 feet below sample, 5 persons welding, 5/30/84	4	54	30	35	30-2
Breathing Zone (Outside respirator and welding mask)*					
Master #62363, stick welding, taken simutaneoulsy with sample #21-3, 5/21/84	5	57	14	43	21-2
Master #60384, stick welding, only welder in area, 5/23/84	13	54	23	37	23-2
Two persons stick welding within 3 feet of each other, lot of visible fumes, ventilation fair, 5/25/84	10	57	15	23	25-1
Master #63263, continuous wire welding, single welder, lot of visible fumes, good ventilation, near access opening, 5/30/84	13	54	30	35	30-1
Master #53953, very confined work area inside stainless steel steam scrubber, lot of visible fumes, fair ventilation, 5/21/84	18	28	22	25	21-1

*Fume concentrations measured outside of welding face shield have typically been 30 to 50% higher than inside because of protection provided by the face shield. Reported concentrations could be considered worst case.

Table 4. METAL FUME CONCENTRATIONS IN AIR FROM ARC WELDING INSIDE OF SHELF DRIER, CALCIUM CHLORIDE PLANT, MIDLAND, 1984. HEH34.21-2-2(4).

Sample Number	Total Particulate Conc., mg/m^3	Air Concentration of Individual Metal Fumes, mg/M^3 Iron	Calcium Oxide	Manganese	Nickel	Chrome	Titanium
8 Hour Exposure Guidline	5	5	2	1	1	0.05	10
Area Sample							
21-3	1	0.4	0.06	0.04	0.001	0.001	0.01
23-1	1	0.2	0.1	0.01	0.001	0.001	0.001
30-2	4	2	0.3	0.1	0.002	0.002	0.024
Breathing Zone (Outside respirator and welding mask)**							
21-2	5	2	0.1	0.08	0.006	0.005	0.04
23-2	13	4	0.3	0.4	0.004	0.004	0.05
25-1	10	3	0.4	0.3	0.004	0.005	0.07
30-1	13	4	0.3	1.2	0.004	0.006	0.2
21-1*	18	0.4	0.7	1.4	0.8	0.5	0.3
Average % of Major Component Metal in Welding Fumes, Excluding Sample 21-1		79%	9% (as Ca)	9%	<0.5%	<0.5%	2%
Percent of Major Component Metals in Cutting Fumes, Sample 21-1 Only		9%	13%	34%	20%	13%	7%

*Sample during welding in stainless steel tank instead of inside iron shelf drier.
**Fume concentrations measured outside of welding face shield have typically been 30 to 50% higher than inside because of protection provided by the face shield. Reported concentrations could be considered worst case.

Table 5. AREA VAPOR CONCENTRATIONS DURING TORCH CUTTING AND ARC WELDING, CALCIUM CHLORIDE PLANT, MIDLAND, 1984. HEH34.21-2-2(4)

Sample Description	Nitrogen Dioxide	Vapor concentration, ppm (vol/vol) Carbon Monoxide	Sulfur Dioxide	Ozone	Chlorine
8 Hour Exposure Guideline	3	50	5	0.1	1(C)*
Torch cutting, inside drier, 4 persons cutting intermittently within 12 feet of sample, taken simultaneous with sample 15-5 of Table 1, 5/15/84	ND(0.4)	5-10	ND(0.5)	ND(0.1)	--
Torch cutting, inside drier, sampled simultaneously with 16-2 of Table 1, 5/16/84	ND(0.2)	2	0.2	ND(0.1)	--
Arc welding, inside stainless steel steam scrubber, very confined work area, sampled simultaneously with 21-1 of Table 3, 5/21/84	ND(0.4)	2	ND(0.5)	ND(0.05)	ND(0.5

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Table 6. METAL FUME CONCENTRATIONS IN BREATHING ZONE* RESULTING FROM WELDING INSIDE MAINTENANCE SHOP, 209 BUILDING, CALCIUM CHLORIDE PLANT, MIDLAND, 1984. HEH34.21-2-2(4)

Sample Description	Total Particulate Conc., mg/m^3	Iron	Calcium Oxide	Man-ganese	Nickel	Zinc Oxide	Titanium	Metals as % of Total Particulate
Industrial Hygiene Guideline,								
8 Hour TWA	5	5	2	1	1	5	10	--
Short Term Duration	--	10	--	3	--	10	20	--
West table, exhaust inlet 1.5 feet above work area								
Large outside door closed, fume capture good (BEST CASE)	1.6	0.16	0.1	0.02	ND**	0.09	ND	20%
Large outside door open, fume capture intermittently disrupted by breeze	1.6	0.32	0.1	ND	0.02	0.02	ND	28%
East table, branch exhaust (2nd arm) also being used, outside door closed								
Exhaust inlet 1.5 feet away from work area, fume capture fair,	2.3	0.16	0.1	ND	ND	0.08	ND	13%
Exhaust inlet 2.5 feet away from work area, fume capture poor (WORST CASE)	2	0.23	0.06	ND	ND	0.06	ND	10%

*Fume concentrations measured outside of welding face shield have typically been 30 to 50% higher than inside because of protection provided by the face shield. Reported concentrations could be considered worst case.

**ND - Not detected at concentrations if 0.01 to 0.02 mg/m^3.