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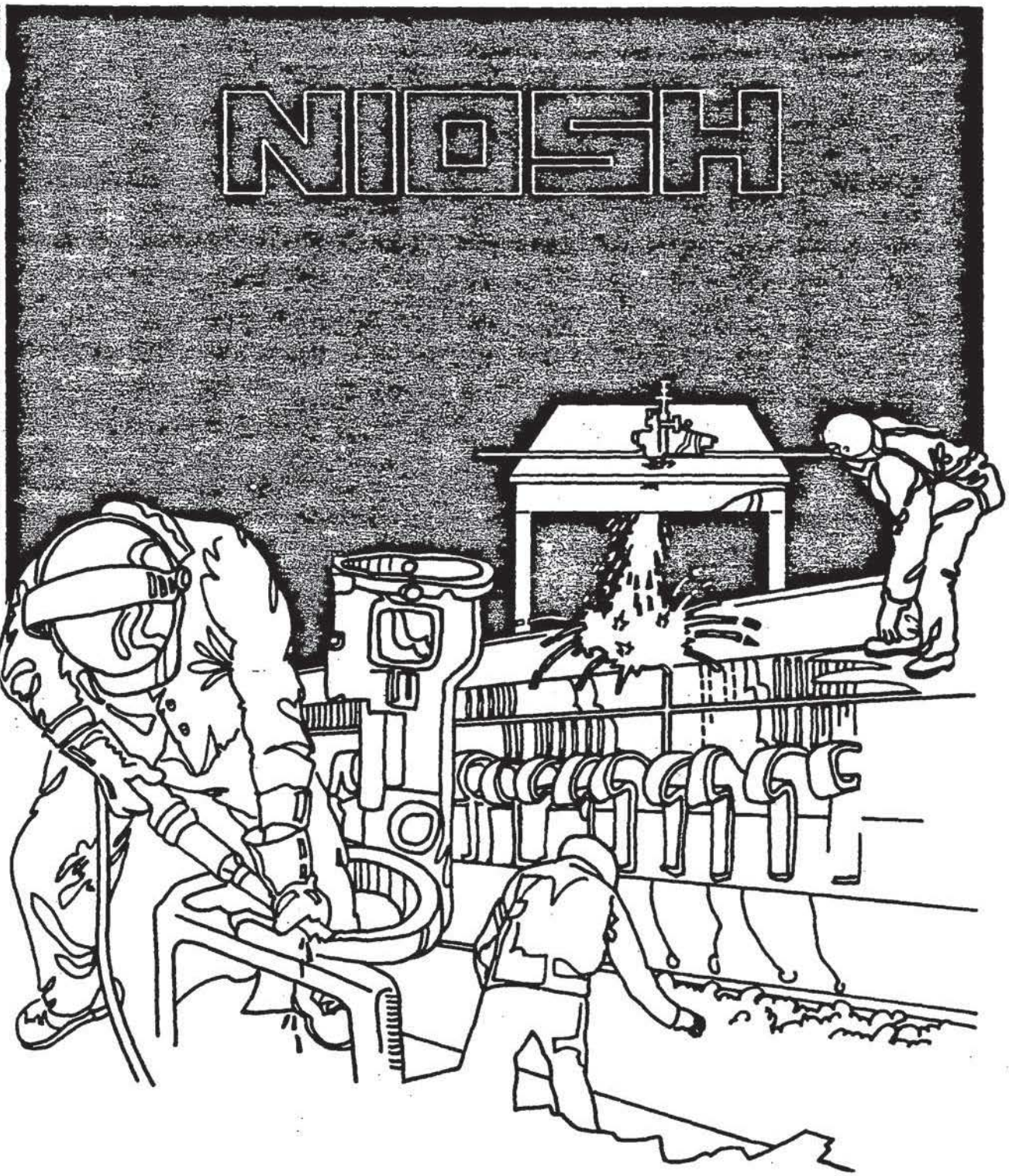

Health Hazard Evaluation Report

HETA 84-099-1514
C.F. & I. STEEL
PUEBLO, COLORADO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 84-099-1514
OCTOBER 1984
C.F. & I. STEEL
PUEBLO, COLORADO

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I. SUMMARY

In December 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from Local 2102 of the United Steel Workers of America, Pueblo, Colorado, to evaluate lead exposures to workers in the galvanizing department of C.F. & I. Steel, Pueblo, Colorado.

On March 14 and 15, 1984, NIOSH investigators conducted an environmental and medical investigation to determine exposures to lead and zinc and to measure the blood levels of lead and free erythrocyte protoporphyrin (FEP).

All three work shifts were studied. Each shift had nine workers and 100 percent of the workers participated in both the medical and environmental phases of the evaluation. Twenty-seven breathing zone air samples were collected, one on each worker, for the entire work shift. Lead and zinc analyses were performed on each air sample. One third of the lead samples exceeded the Occupational Safety and Health Administrations (OHSA) standard of 50 ug/m^3; concentrations of lead ranged from less than 3 to 190 ug/m^3. The average for the 27 samples was 40 ug/m^3. All zinc airborne concentrations were below the evaluation criteria of 5000 ug/m^3. Zinc levels ranged from 10 to 290 ug/m^3. The average was 60 ug/m^3.

Twenty-six workers were medically evaluated for blood lead and free erythrocyte protoporphyrin (FEP). Average blood lead for the group was 33.3 ug/dl whole blood and average FEP (geometric mean) was 50.4 ug/dl whole blood. Of the 26 workers included in this table, 17 had normal blood leads and normal FEPs, 4 had normal leads but elevated FEPs, 2 had elevated blood leads with normal FEPs, and 4 had both blood lead and FEP elevated. Smokers had statistically significantly higher blood leads (mean 38.9 ug/dl) than did non-smokers (31.3 ug/dl).

Nine (9) of 26 workers gave a history of high blood pressure. The only statistically significant difference between those with high blood pressure and those without was average age. Those with high blood pressure averaged 56.4 years old ($\pm$ 5.2) whereas those without only averaged 44.9 years old ($\pm$ 9.2) ($p=0.0038$). They also average 5 years more on the job, but the difference was not statistically significant. This suggests that the incidence of high blood pressure relates more to age (as is the case in the general population) than to working in the galvanized wire department. Seven (7) of the 26 workers had musculo-skeletal complaints (arthritis, bursitis, back problems) but their laboratory findings were not different from those of the workers without such problems.

On the basis of the medical and environmental data and personal interviews, NIOSH investigators concluded that a health hazard from exposure to lead existed at the time of this survey. Recommendations on lowering the blood lead levels are included in this report.

KEYWORDS: SIC (3312), lead, zinc, blood lead, FEP

II. INTRODUCTION

In December 1983, the National Institute for Occupational Safety and Health (NIOSH), received a request from the United Steel Workers of America local 2102 who work at C.F. & I. Steel Pueblo, Colorado, to evaluate lead exposures in the galvanizing department. Part of the requestor's concern was with reportedly low blood lead values recorded in the company's blood lead monitoring program. An environmental and medical evaluation were done concurrently on March 14 and 15, 1984. Environmental results were made available to company and union on May 2, 1984, at the time of a plant visit for another study. A health hazard evaluation, number 79-30-669, was performed on October 8-12, 1979. Only 30% of the breathing zone air samples exceeded the evaluation criteria at that time. Blood lead values were higher in hazard evaluation 79-30-669 than this study. The mean blood lead value in 1979 was 27.34 ug/dl. In 1984 the average was 33.3 ug/dl.

Due to computer problems, there was a delay of several months in obtaining the company's blood lead monitoring data. Workers were notified of their individual blood lead and free erythrocyte protoporphyrin (FEP) results by individual letters on April 25, 1984. A summary of the medical results was sent to the company and the union on April 30, 1984. Individual blood lead and FEP results without identifiers were sent to both company and union on May 11, 1984 to honor a company request for the additional information.

III. BACKGROUND

The galvanizing department produces galvanized wire by passing steel wire through molten lead below the vaporization temperature (approximately 600 degrees F). This gives the wire tensile strength. The wire is then passed through molten zinc which completes the galvanizing process. In the galvanizing department all workers were monitored eight hours for lead and zinc exposures.

A previous study was performed in this department on October 8-12, 1979, Health Hazard Evaluation 79-30-669.

IV. DESIGN AND METHODS

A. Environmental

The entire work force in the galvanizing department which included nine workers on three shifts for a total of twenty-seven were monitored for lead and zinc. Samples were collected on AA filters using vacuum pumps operated at 1.5 liters per minute. Samples were analyzed by atomic absorption spectroscopy using NIOSH method 173.

B. Medical

All available employees were interviewed for work history and medical problems and had blood drawn for blood lead and free erythrocyte protoporphyrin (FEP) determination. In addition the company's blood lead monitoring data were obtained for the past two and a half years. In analyzing the company data, it was obvious that the workers routinely had blood lead determinations twice a year in spring and fall. Elevated blood lead levels were repeated promptly. To avoid biasing the overall average, where there were two determinations in the same season, these were averaged and used as a single value in the overall average. Laboratory work for NIOSH was done by Environmental Sciences Associates, Inc., Bedford, Massachusetts using anodic stripping voltammetry for blood leads determination.

V. EVALUATION CRITERIA

A. Environmental

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding

OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based solely on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

	Permissible Exposure Limits ug/M^3 8-Hour Time-Weighted Exposure Basis		
	OSHA	NIOSH	TLV
Lead	50	50	150
Zinc	5000	5000	5000

ug/M^3 = micrograms of substance per cubic meter of air.

B. Medical

Blood lead levels below 40 ug/dl whole blood are considered to be normal levels which may result from daily environmental exposure. However, fetal damage in pregnant women may occur at blood lead levels as low as 30 ug/dl. Lead levels between 40-60 ug/dl in lead-exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60-100 ug/dl represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/dl are considered dangerous and often require hospitalization and medical treatment.

The Occupational Safety and Health Administration (OSHA) standard[1] for lead in air is 50 ug/M^3 calculated as an 8-hour time-weighted average for daily exposure. The standard also dictates that workers with blood lead levels greater than 60 ug/100 g whole blood (1 ug/deciliter is roughly equivalent to 1 ug/100 g whole blood) must be immediately removed from further lead exposure if confirmed by a follow-up test, and workers with average lead levels of 50 ug/100g or greater must also be removed. Removal is also possible on medical grounds. Removed workers have protection for wage, benefits, and seniority for up to 18 months until they can return to lead exposure areas.

Free erythrocyte protoporphyrin (FEP) levels of 16-50 ug/dl are considered within the normal range. Elevations can be due to interference with hemoglobin production caused by excessive lead exposure, anemia, and to a few other less likely diseases. Lead in increased levels leads to increased levels of FEP in the red cells. Because this occurs at the time the red cell is being formed, and once formed the red cell lasts about 120 days, the FEP gives an indication of average lead exposure over the past 3-4 months. This relationship is not particularly evident until elevated FEP levels are found. Alessio, et al.[2] has developed a formula for predicting blood lead levels from the FEP.

C. Toxicological

Lead[3,4]--Inhalation (breathing) of lead dust and fume is the major route of lead exposure in industry. A secondary source of exposure may be from ingestion (swallowing) of lead dust deposited on food, cigarettes, or other objects. Once absorbed, lead is excreted from the body very slowly. Absorbed lead interferes with red blood cell production and can damage the kidneys, peripheral and central nervous systems, and the blood forming organs (bone marrow). These effects may be felt as weakness, tiredness, irritability, digestive disturbances, high blood pressure, kidney damage, mental deficiency, or slowed reaction times. Chronic lead exposure is associated with infertility and with fetal damage in pregnant women.

Zinc--Zinc is an essential trace element for good nutrition. Overexposures to zinc fume may produce fever and chills (metal fume fever) which subsides within twelve hours but may leave a metallic taste. Ingestion of zinc salts can lead to a severe gastrointestinal upset.

VI. RESULTS AND DISCUSSION

Environmental

Twenty-seven breathing zone air samples were collected for lead and zinc. Results are presented in Table I.

One third of the lead samples exceeded the OSHA standard of 50 ug/m^3. Lead concentrations ranged from less than 3 to 190 ug/m^3 with an average of 40 ug/m^3. All zinc airborne concentrations were below the evaluation criteria of 5000 ug/m^3. The average was 60 ug/m^3.

Medical

A breakdown of workers studied is given in Table II. Although the differences between average age, average years in department, and percent smokers did not reach statistical significance, it should be noted that the laborers averaged considerably fewer years in the

galvanized wire department (12.8 years) than for the group as a whole (25.5 years). One of the three laborers had only been in the department for one week so his results are not included in further analysis.

Table III presents NIOSH's blood lead and FEP results by job title and by smoking status. Average blood lead for the group was 33.3 ug/dl whole blood and average FEP (geometric mean) was 50.4 ug/dl whole blood. Of the 26 workers included in this table, 17 had normal blood leads and normal FEPs, 4 had normal leads but elevated FEPs, 2 had elevated blood leads with normal FEPs, and 4 had both blood lead and FEP elevated. Predicted blood leads were calculated from FEPs using the formula of Alessio, et al[2]. The average difference between the observed and predicted lead values (- 2.7 ug/dl) was neither statistically nor clinically significant. The smokers had statistically significantly higher blood leads (mean 38.9 ug/dl) than did the non-smokers (31.3 ug/dl). Also there was a statistically significant difference in the difference between observed blood lead and the predicted blood lead, with smokers averaging 6.0 ug/dl higher and non-smokers 5.9 ug/dl lower. Note that the job categories with higher average lead levels are the ones with a greater percentage of smokers. This suggests that less care has been taken to keep smoking material free of lead contamination in the recent past. Overall exposure has probably been fairly stable over the past few months. Most of these workers have maintained their current jobs for several years.

Nine (9) of 26 workers gave a history of high blood pressure. The only statistically significant difference between those with high blood pressure and those without was average age. Those with high blood pressure averaged 56.4 years old (± 5.2) whereas those without only averaged 44.9 years old (± 9.2) (student t=3.447). The probability of this difference being due to chance is only 0.0038. They also average 5 years more on the job, but the difference was not statistically significant. This suggests that the incidence of high blood pressure relates more to age (as is the case in the general population) than to working in the galvanized wire department. Seven (7) of the 26 workers had musculoskeletal complaints (arthritis, bursitis, back problems) but their laboratory findings were not different from those of the workers without such problems.

Table IV compares NIOSH's blood lead results with those from the company's lead monitoring program. A comparison of the difference between NIOSH's blood leads and the company's average levels for 1982-1983 showed that NIOSH was statistically significantly higher (+ 6.7 ug/dl) although this amount probably has little clinical significance. The difference (+ 10.7 ug/dl) was slightly greater when the predicted blood leads were compared to the company averages. There was a statistically and clinically significant difference between the NIOSH blood leads and the company's 1984 leads (+ 14.1 ug/dl). This suggests that the company's 1984 values were lower than they should be. In the absence of a significant change in work practices the same

thing is suggested by the finding that the company's 1984 leads averaged 7.3 ug/dl lower than their 1982-1983 averages. According to the company the laboratory which did their blood leads in the past lost accreditation for doing blood leads in 1984, and so the company is now utilizing a different laboratory.

VII. CONCLUSIONS

The work force appears very stable. The incidence of hypertension appears to be more related to the aging of the work force than to lead exposures. The NIOSH blood lead findings in comparison with the company's blood lead monitoring data suggest that there is some occupational lead exposure which in the past has been kept under control by a reasonable lead monitoring program. In the spring of 1984 the laboratory which the company had been using for blood leads had difficulties with their lead determinations resulting in lower lead readings than the NIOSH findings indicated and lower than previous company data indicated. A different laboratory is now being used by the company. The NIOSH data also suggested that less attention is being paid to preventing smoking materials from being contaminated with lead dust than has been the case in the past. Although a few workers had blood lead levels a bit higher than desired, these are followed up by the company.

C.F. & I. Steel provides adequate environmental air sampling of all areas of the galvanizing department. They provided NIOSH with copies of the environmental levels of lead and zinc taken on employees for the past year. Their data was very much identical to that found in the NIOSH evaluation.

Since blood lead values and environmental exposure concentrations were higher during this survey than the survey performed in 1979, the company should institute better environmental controls to help control this hazard.

VIII. RECOMMENDATIONS

1. Because there continues to be a potential for excessive lead exposure in this department, it is important that work practices to reduce likely lead exposure be followed faithfully, particularly keeping smoking material out of the work area and any other areas that might be contaminated with lead dust. It would probably be valuable to have refresher sessions on appropriate work practices every few years in addition to instructing new workers in the department on appropriate practices.

2. No eating, drinking, or smoking while on the job.

3. Hands should be washed thoroughly before eating & smoking.

4. Showers should be taken and clothes changed after each work shift.

XI. REFERENCES

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XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4576 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

TABLE I

Breathing Zone Air Concentrations of Lead (Pb)
and zinc (Zn)

C F &I Steel
Galvanizing Department
Pueblo, Colorado

March 14 & 15, 1984

SAMPLE #	JOB/LOCATION	SAMPLING TIME	LEAD Mg/M^3	ZINC Mg/M^3
1	Operator (Pan 4)	2:10 - 9:40	.04	.03
2	Wiper (Pan 1 - East)	2:15 - 9:26	.01	.02
3	Operator (Pan 3 - East)	2:17 - 9:28	.05	.14
4	Operator (Pan 3 - West)	2:20 - 9:21	.07	.05
5	Laborer (All Pans)	2:21 - 9:24	.03	.02
6	Trucker (Gas tender)	2:24 - 9:26	.01	.02
7	Wiper (Pan 1 - West)	2:26 - 9:20	*	.05
8	Reeler (Pan 1 - West)	9:28 - 9:20	.09	.01
9	Reeler (Pan 1 - East)	2:23 - 9:27	.06	.02
10	Operator (Pan 1 - East)	10:10 - 5:20am	.01	.05
11	Reeler (Pan 1 - West)	10:11 - 5:20	.19	.04
12	Reeler (Pan 1 - East)	10:17 - 5:16	.12	.07
13	Operator (Pan 1 - West)	10:25 - 5:22	.01	.11
14	Laborer (All Pans)	10:35 - 5:17	.02	.03
15	Trucker (Gas Tender)	10:58 - 5:17	*	.02
16	Operator (Pan 3 - West)	10:53 - 5:18	.07	.07
17	Operator (Pan 4)	10:47 - 5:17	.03	.10
18	Operator (Pan 3 - East)	10:40 - 5:21	.01	.04
19	Laborer (All Pans)	6:30 - 1:06pm	.03	.07
20	Reeler (Pan 1 - West)	6:25 - 1:17	*	.01
21	Operator (Pan 3 - West)	6:40 - 1:20	.07	.08
22	Reeler (Pan 1 - East)	6:17 - 1:02	.03	.09
23	Operator (Pan 4)	6:22 - 1:15	.07	.29
24	Trucker (Gas Tender)	6:35 - 1:27	.01	.10
25	Operator (Pan 1 - West)	6:03 - 1:18	.02	.10
26	Operator (Pan 1 - East)	6:10 - 1:05	.01	.06
27	Operator (Pan 3 - East)	6:42 - 1:14	.05	.08
	Evaluation Criteria		.05	5.0
	Laboratory Limit of Detection in mg		.003	.002

TABLE II

Characterization of Workers Studied in the Galvanized Wire Department

C F & I Steel Company
Pueblo, Colorado

March 14, 1984

Job	Numbers	Ave. Age & Std. Dev.		Ave. Yrs. in Dept. & Std. Dev.		% Smokers
Total Workers	27	49.0	± 9.5	25.5	± 11.1	25.9
Operators - All	10	47.5	± 12.0	26.5	± 10.4	30.0
Pan 1	2					
Pan 3	5					
Pan 4	3					
Reelers	6	49.8	± 6.3	27.8	± 6.9	50.0
Pan 1	5					
Unspecified	1					
Wipers	5	53.0	± 5.8	31.8	± 4.7	0
Pan 1	2					
Pan 3	1					
Unspecified	2					
Gas Tenders & Gas Tender-Fork Lift Operators	3	39.0	± 8.7	20.0	± 8.7	33.3
Laborers	3	56.0	± 4.0	12.8	± 21.8	0

NOTE: As one laborer had only been working in the galvanizing department for 1 week, his results were not included in the blood lead or FEP data analyses

TABLE III

NIOSH Blood Lead and Free Erythrocyte Protoporphyrin (FEP) Results for Galvanized Wire Department Workers with at least 6 Months in Department

C F & I Steel Company
Pueblo, Colorado

March 14, 1984

Job	Number	Blood Lead Mean ug/dl	Blood Lead Std.Dev. ug/dl	FEP Geometric Mean ug/dl	FEP Std.Dev. ug/dl	Predicted Lead Mean ug/dl	Predicted Lead Std.Dev. ug/dl	Observed - Predicted Lead Mean ug/dl	Observed - Predicted Lead Std.Dev. ug/dl
Total Workers	26	33.3	± 8.8	50.4	29.8 to 85.5	36.1	± 7.6	- 2.7	± 8.6
BY JOB									
Operators	10	33.6	± 9.7	54.7	28.9 to 103.3	37.2	± 9.4	- 3.6	± 8.7
Reelers	6	37.7	± 10.0	53.0	26.1 to 107.6	36.8	± 10.1	+ 0.8	± 9.9
Wipers	5	30.4	± 11.0	49.1	37.1 65.0	35.6	± 3.8	- 5.2	± 7.9
Others	5	30.6	± 7.3	41.6	33.3 to 52.1	33.4	± 3.0	- 2.8	± 8.9
BY SMOKING STATUS									
Current Smokers	7	38.9	± 6.5	40.5	27.8 to 59.0	32.9	± 5.2	+ 6.0	± 2.9
Non-Smokers	19	31.3	± 8.7	54.7	31.3 to 95.7	37.3	± 8.1	- 5.9	± 95.7

Statistically Significant Differences
Smokers vs. Non-Smokers

	Difference in Means	Student t	Probability of Chance
Blood Leads (ug/dl)	+ 7.6 ug/dl	2.0729	0.049
Observed Lead - Predicted Lead	+ 11.9 ug/dl	3.9645	less than 0.001

TABLE IV

Comparison of NIOSH Blood Lead Results and Company Lead Monitoring Data for 19 Galvanized Wire Department Workers with at least 6 Months in Department

C F & I Steel Company
Pueblo, Colorado

March 14, 1984

Parameter	Mean ug/dl	Standard Deviation	Statistical Significance Student t	Probability of Chance
Number of Workers = 19				
NIOSH Blood Lead	33.4	± 8.3		
NIOSH FEP	55.2 *	32.0 to 95.5		
NIOSH Predicted Lead	37.4	± 7.9		
NIOSH Observed - Predicted Lead	- 4.0	± 8.6	- 2.0253	0.060
Company Average '82 - '83 Blood Lead	26.7	± 7.3		
Company Spring '84 Lead	19.4	± 5.7		
NIOSH Lead - Co. '82-'83 Lead	+ 6.7	± 6.7	4.3788	less than 0.001
NIOSH Predicted Lead - Company '82-'83 Lead	+ 10.7	± 10.2	4.5544	less than 0.001
NIOSH Lead - Co. '84 Lead	+ 14.1	± 4.4	13.9120	less than 0.001
Company '82-'83 Lead - Company '84 Lead	+ 7.3	± 5.2	6.1590	less than 0.001

* Geometric Mean

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