U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 79-60-690

STEIGER TRACTOR, INC.
FARGO, NORTH DAKOTA

May 1980

I. SUMMARY

In May 1979 the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate occupational exposures to welding and paint fumes at Steiger Tractor, Inc., Fargo, North Dakota. Pre- and post-shift pulmonary function tests were performed on welders and painters. Venous blood samples were obtained for whole blood lead analysis.

Workers were overexposed to lead, iron oxide, and manganese. Pulmonary function tests suggested that the welders may be developing some obstructive pulmonary changes. There was no statistically significant differences in pre- and post-shift pulmonary function. There were increased blood lead levels in painters and sanders. The highest blood lead level found was 43 micrograms per deciliter (ug/dl).

On the basis of environmental and medical data, a health hazard existed from overexposures to lead, iron oxide, and manganese. Recommendations on ventilation, work practices, and biological monitoring procedures necessary to control these hazards are included on page 7.

II. INTRODUCTION

NIOSH received a request from the International Association of Machinist's and Aerospace Workers Local Union 2525, Fargo, North Dakota, to determine if there was a health hazard from welding and painting at Steiger Tractor, Inc., Fargo, North Dakota, during the manufacture of large farm tractors.[1] An environmental and medical survey was conducted on May 15-17, 1979, to evaluate potential exposures.

[1]Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 19 U.S.C. 669(a)(6), authorizes the Secretary of Health and Human Services, following a written request by any employer or authorized representative to employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

III. BACKGROUND

Previous hazard evaluations (Nos. 75-30-266 and 77-58-428) were conducted at this plant in 1975 and 1977. The plant manufactures approximately 20 large farm tractors per day. Many parts of the tractor, such as engines, transmissions, and differentials, are purchased from other vendors. The tractors are assembled at this plant. The assembly line process requires extensive welding, cutting, and painting of iron. The areas of concern during this evaluation included welding and cutting operations as well as paint stations and paint booths. Results of environmental air samples were given to union and management officials in October 1979.

IV. METHODS AND MATERIALS

A. Environmental

Lead, iron oxide, manganese, copper, and chromium breathing zone air samples were collected on 37 mm AA filters using vacuum pumps operated at 1.5 liters per minute and analyzed according to NIOSH Method P and CAM No. 173. Xylene, toluene, methyl ethyl ketone (MEK), and 1,1,1-trichloroethane were collected on charcoal tubes and analyzed according to NIOSH Method P and CAM No. 127.

B. Medical

The medical study involved the day shift workers. All workers in what environmentally seemed to be high exposure areas were encouraged to participate. Any other day shift workers wishing to participate were included. Medical studies were conducted in an office trailer located near the plant gate. Table 1 details the composition of the study group by job category, smoking habits, and age. All workers were white males except for one white female.

Participating workers were administered questionnaires (Appendix A) consisting of a relatively non-directed portion which included identifying data, a work history and general questions about possibly work-related health problems and other health problems. This was followed by a brief questionnaire directed at acute symptomatology which was administered pre-shift, post-shift, and, in the case of the painters, the next morning.

Venous blood samples were obtained in vacuum tubes containing EDTA for blood lead determinations. Analysis utilized the Delves' Cup method. (Reference 1) Pre- and post-shift pulmonary function testing was performed using two Modistor[2] pneumotachygraph machines. Predicted values were calculated using the formulas of Morris. (References 2 and 3)

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[2] Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

V. EVALUATION CRITERIA

A. Environmental

Three sources of criteria used to assess the workroom concentrations of the following chemicals are: (1) Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910.1025), January 1978; (2) recommended Threshold Limit Values (TLVs) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH), 1979; and (3) NIOSH criteria for recommended standards.

	Permissible Exposure Limits 8-Hour Time-Weighted Exposure Basis (mg/M^3)
Lead	0.05 (OSHA)
Iron Oxide	5.0 (OSHA)
Manganese (fume)	1.0 (TLV)
Chromium	0.025 (NIOSH)
Copper	0.2 (TLV)
Xylene	435 (NIOSH)
Toluene	375 (NIOSH)
MEK	590 (TLV)
1,1,1-trichloroethane	1900 (TLV)

mg/M^3 = milligrams of substance per cubic meter of air

Occupational health standards are established at levels designed to protect individuals occupationally exposed to toxic substances on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

B. Toxicological

Lead

Inhalation of lead dust and fumes is the major route of lead exposure in industry. A secondary source of exposure may be from ingestion of lead dust contamination on food, cigarettes, or other objects. Once absorbed lead is excreted from the body very slowly, the absorbed lead 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.

Blood lead levels below 40 µg/100ml 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 µg/100ml. Lead levels between 40-60 µg/100ml in lead exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60 to 100 µg/100ml represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 µg/100ml are considered dangerous and often require hospitalization and medical treatment.

The new OSHA standard for lead in air is 50 $\mu g/M^3$ on an 8-hour time-weighted average for daily exposure. The standard also dictates that in four years workers with blood lead levels greater than 50 µg/100ml must be immediately removed from further lead exposure and in some circumstances workers with lead levels less than 50 µg/100ml must also be removed. At present medical removal of workers is necessary at blood lead levels of 70/µg/100ml or greater. Removed workers have protection for wage, benefits, and seniority for up to eighteen months until their blood levels adequately decline and they can return to lead exposure areas.

Manganese -- Chronic manganese poisoning is a clearly characterized disease which results from the inhalation of fumes or dust of manganese. The central nervous system is the chief site of damage. If cases are removed from exposure, some improvement frequently occurs. However, there may be some residual disturbance in gait and speech. When the disease is well established, the result is permanent disability.

Iron Oxide and Welding and Cutting Fumes -- Iron oxide is relatively non-toxic. Chronic exposures to high concentrations do cause a disease called siderosis. The main complication of this disease is that it prevents getting a good X-ray of the lungs in case another lung disease occurs. Siderosis does not decrease pulmonary function or cause any other metabolic disturbances. Sufficient exposure to iron oxide fumes can cause metal fume fever. This is characterized by fever, chills, and a "flu-like" illness lasting overnight. Tolerance builds rapidly, but also declines rapidly, so attacks are most likely after a person has been off work for a few days.

However, welding and cutting fumes also contain a number of other substances which vary depending on what is being welded or cut, what the work is coated with, what flux is being used, and what type of welding or cutting is being done. Most of these substances will be irritating to the mucus membranes of the eyes, nose, and throat, and to the bronchi, possibly leading to a chronic bronchitis. Besides toxic effects from specific alloying or coating metals from specific ingredients of fluxes, or from specific ingredients of paints (such as lead), the temperatures

involved in welding or cutting will break down organic solvents, lubricants and paints to an irritating mixture of aldehydes and other decomposition products. Arc welding, in particular, also produces variable amounts of ozone and oxides of nitrogen, both of which irritate mucus membranes and the bronchi, and in sufficient concentrations can damage the lungs.

Copper -- Copper exposures may occur by ingestion and inhalation. Copper is an irritant to the eyes, nose and respiratory tract. It causes perforation of nasal septum, metal fume fever, and dermatitis. Ingestion may produce nausea, vomiting, and diarrhea. Chronic exposures may produce pigment cirrhosis of the liver. Maintaining a worker's exposure below 0.1 mg/M^3 for an 8-hour time weighted average (TWA) should protect the worker from any of these effects. (Reference 4)

Chromium -- The most toxic route of entry is by inhalation--followed by percutaneous. Chromium is very corrosive and is a strong sensitizer. Perforation of nasal septum is seen frequently. Chromium VI is often a contaminant of metallic chromium. Chromium VI is a known carcinogen. Adequate ventilation and frequent monitoring of the work environment is necessary to prevent overexposures. No eating and smoking should be allowed in the work area. Workers sensitized should be removed from the work place. (Reference 5)

Xylene -- Xylene vapor is an irritant of the eyes, mucous membranes, and skin. Gastrointestinal disturbances such as anorexia, nausea, vomiting, and abdominal pain can also occur. Narcosis may occur at high concentrations.

Toluene -- Toluene is slightly irritating to the eyes and mucous membranes. It is toxic by ingestion, inhalation, and skin absorption. Acute poisoning from toluene vapors is rare. Inhalation of 200 parts per million for an 8-hour period will cause impairment of coordination and reaction time. Toluene produces narcosis. There have been reports of chronic poisoning described as anemia and leucopenia. Biopsy showed bone marrow hypoplasia. (Reference 6)

1,1,1-trichloroethane -- This is a narcotic in high concentrations. It is slightly irritating to the eyes and other mucous membranes. The most toxic route of entry is by inhalation.

Methyl Ethyl Ketone (MEK) -- MEK is very irritating to the eyes, nose, and upper respiratory system. At levels below the TLV, it may produce narcosis. Levels found during this study were far below the evaluation criteria.

C. Pulmonary Function Testing

The pulmonary function tests included measurements of forced vital capacity (FVC), one-second forced expiratory volume (FEV_1), and calculation of the ratio of FEV_1/FVC. FVC

measures the total amount of air one can force out of his lungs after breathing in as deeply as possible. FEV_1 measures the amount of air one can breath out in the first second. The FVC can be impaired by restrictive lung disease, such as pulmonary fibrosis. FEV_1 can be impaired by cigarette-related lung damage or some other conditions causing obstruction to air flow. Any condition that impairs FVC also impairs FEV_1, but the reverse is not true. Conditions that impair FEV_1 do not necessarily impair FVC. The FEV_1/FVC ratio is also used to help evaluate obstructive lung disease.

Some exposures to substances that irritate the lungs and bronchi will cause a temporary decrease in pulmonary function over the work shift.

In interpreting the results, the best test results are used. They are compaired to "predicted values" which takes into account age, height, sex, and race. Pulmonary function is considered "normal" if the best FEV_1 and the best FVC are each 80 percent or more of their respective predicted values and the FEV_1/FVC ratio using the best values is 70 percent or more. It is expected that a person's test results will vary somewhat from time to time. A drop in results over shift of less than 10 percent in FVC or FEV_1 and of less than 6 percent for FEV_1/FVC is considered within normal variation. A drop greater than this may indicate a problem with exposures to noxious substances in the work place.

VI. RESULTS

A. Environmental

Six out of seven painters monitored for lead were receiving exposures that exceeded the OSHA standard. All of the painters were wearing respirators that were not maintained. Painters had beards preventing proper respirator seal. Respirator filters were dirty and, in general, respirators were poorly maintained. Approximately 50 percent of the welders were greatly overexposed to iron oxide. Excessive manganese exposure was found on one welder. Many of the other welders were receiving levels of manganese that exceeded the action level. There was no local or general ventilation in the welding area. Most of the welding guns had local ventilation which was inoperative. Workers were also monitored for chromium, copper, xylene, toluene, MEK, and 1,1,1-trichloroethane. However, all concentrations were well below the evaluation criteria. Results of all environmental samples may be reviewed in Tables 2, 3, and 4.

Ventilation in this plant consists of local ventilation on individual welding guns. None of these systems were operating during this survey.

Paint booth ventilation was sufficient in the two water fall paint booths. There were three other filter paint booths; all of these booths were exhausting less than 100 linear feet per minute. These booths should exhaust 150 linear feet per minute from the painter's breathing zone and should have a face velocity of 200 linear feet per minute.

B. Medical and Discussion

Blood lead results and pulmonary function results are shown in Tables 5-7. There was no correlation between blood lead values and pulmonary function test results. The only statistically significant differences noted are a somewhat lower average FEV_1 among smokers than among non-smokers and a higher average blood lead among those working with paint then for the rest of the workers.

Lead -- The statistically significant higher average blood lead for painters and sander finisher suggests that those working with the paint are being sufficiently exposed to lead to absorb lead in excess of the general background exposure. Because the highest blood lead was only 43 µg/dl (just above the upper limit of normal), no clinical illness would be expected, although disregard for good industrial hygiene could allow blood lead levels to get out of hand.

Pulmonary Function Testing -- It is expected that the smokers would show some decrease in pulmonary function. This expected difference was seen for the group as a whole and for the painters. It is a little surprising that this difference was less definite among the welders, suggesting that the welding may be causing some obstructive pulmonary changes in non-smokers. (It may contribute to the changes found in smoking welders as well.)

Although, there were no statistically significant differences in clinically significant decreases in pulmonary function (Table 8). There is a suggestion of effects on the non-smoking welders, as half showed a clinically significant decrease in function over-shift. A few other individuals also demonstrated a clinically significant decrease in plumonary function over the work shift suggesting individual reaction to noxious substances in the work environment.

Indivdual follow-up of pulmonary function findings. (Individuals have been notified.) Consideration of a program of periodic pulmonary function testing and chest x-rays for welders and sanders, particulary if there is difficulty in improving the ventilation.

Symptoms -- Major symptoms developing over shift (Table 8, 8A, 8B) involved mucous membrane irritation, particularly among painters and welders, and chest complaints, particularly among welders and non-painters. The irritation tended to persist overnight in the case of the painters. Otherwise complaints did not show any particular relation to job category. Nor did they appreciably relate to laboratory results or pulmonary function test.

Summary -- Based on an increased average blood lead level, it appears that those working with the paint (painters and sander finishing) are absorbing lead in excess of the rest of the work force. Although measured levels suggested no clinical problems were likely, in the absence of a good lead monitoring and control program, there is a good chance that blood lead levels could gradually rise, possibly to clinically significant levels.

Pulmonary function testing suggested that the welding operations may be having an adverse effect on the welders as shown by an increased proportion of non-smoking welders showing a clincically significant decrease in function over shift and by a lesser difference in function between non-smoking welders and smoking welders than might be expected. For the study group as a whole the expected decrease in function for smokers was demonstrated at a statistically significant level.

Questioning indicated moderately widespread mucous membrane irritation in welders and painters and some chest complaints in welders and others (printers excluded). This did not relate to pulmonary function testing. Along with the pulmonary function testing, this suggests a need for improving the ventilation in general.

VII. DISCUSSION AND CONCLUSIONS

A health hazard exists at this work place. This conclusion is based on excessive exposures to lead, iron oxide, and manganese. Medical data also suggests that workers may be absorbing lead by some slightly elevated levels. Pulmonary function data suggests obstructive pulmonary changes among the welders.

VIII. RECOMMENDATIONS

1. Smoking, eating, and drinking must be prohibited in the work area.

2. Workers should wash hands thoroughly before eating, smoking, and snuff usage.

3. Workers should be given clean clothes at the beginning of each shift. These clothes should be removed and left at the facility at the end of the work tour.

4. Local and general ventilation should be improved throughout the facility especially in the welding and painting areas.

5. It would be advisable for painters to have blood leads checked annually in accordance with OSHA (29 CFR 1910.1025).

6. Individual follow-up of pulmonary function findings. (Individuals have been notified.) Consideration of a program of periodic pulmonary function testing and chest x-rays for welders and sanders, particulary if there is difficulty in improving the ventilation.

7. An industrial hygienist and industrial physician should do a comprehensive evaluation of this facility at least yearly.

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGMENTS

Report Prepared By:

Bobby J. Gunter, Ph.D.
Regional Industrial Hygienist
NIOSH - Region VIII
Denver, Colorado

Theodore W. Thoburn, M.D.
Chief, Medical Section,
Hazard Evaluation and Technical
Assistance Branch (HETAB)
Division of Surveillance, Hazard
Evaluations, and Field Studies (DSHEFS)
NIOSH - Cincinnati, Ohio

Evaluation Assistance:

G. Robert Schutte
Medical Technician
Medical Services Section
Support Services Branch, DSHEFS
NIOSH - Cincinnati, Ohio

Raymond L. Ruhe
Industrial Hygienist
HETAB, DSHEFS
NIOSH - Cincinnati, Ohio

David P. Edelbrook
HETAB, DSHEFS
NIOSH - Cincinnati, Ohio

Originating Office: Hazard Evaluation and Technical Assistance Branch (HETAB)
Division of Surveillance, Hazard Evaluation, and Field Studies (DSHEFS)
NIOSH, Cincinnati, Ohio

Report Typed By: Marilyn K. Schulenberg
NIOSH - Region VIII
Denver, Colorado

XI. DISTRIBUTION AND AVAILABILITY

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Copies of this report have been sent to:

1. Steiger Tractor, Inc.
2. International Association of Machinist's and Aerospace Workers.
3. International Association of Machinist's and Aerospace Workers Union 2525.
4. U.S. Department of Labor/OSHA - Region VIII.
5. NIOSH - Region VIII.
6. North Dakota Department of Health
7. State Designated Agency

For the purpose of informing all employees, a copy of this report shall be posted in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE 1

Breakdown of Medical Study Group by Job Category
with Smoking Habits and Age

Steiger Tractor, Inc.
Fargo, North Dakota

May 15-17, 1979

	Approximate Number on Duty	Number Studied	Smokers	Non-Smokers	Average	Age Range
Welders	60	20	12	8*	27.8	19-44
Painters	10	6	4	2	29.8	26-35
Others	100	8+@	5+@	3	29.5	23-42
Assembler		1	1			
Hot Saw Operator		1		1		
Inspectors		3+	2+	1		
Press Operator		1		1		
Sand Blaster		1	1			
Sander (Refinishing)		1@	1@			
Total		34	21	13+	28.6	19-44

* Includes one ex-smokers
+ Includes one ex-welder
@ Includes one ex-painter. Job still involves work with paint.

TABLE 2

Breathing Zone Air Concentrations of
Lead (Pb), Iron Oxide (Fe_2O_3), Manganese (Mn), Chrome (Cr), and Copper (Cu)
on Welders, Painters, Flame Cutters, and Abrasive Blasters

Steiger Tractor Inc.
Fargo, North Dakota

May 15-16, 1979

Sample Number	Location	Job Classification	Time of Sampling	mg/M^3				
				Pb	Fe_2O_3	Mn	Cr	Cu
21	Sanding Booth	Grinder	7:16 AM - 1:30 PM	*	9.1	*	*	*
22	Sanding Booth	Grinder	7:18 AM - 3:03 PM	*	9.6	*	*	*
23	Sanding Booth	Grinder	7:21 AM - 2:57 PM	*	6.7	*	*	*
24	Sanding Booth	Metal Blaster	7:32 AM - 2:57 PM	*	7.3	*	*	*
15	Rework Area	Paint Touchup	7:35 AM - 3:10 PM	0.35	.16	*	*	*
16	Rework Area	Abrasive Blaster	7:30 AM - 3:07 PM	0.07	.19	*	*	*
25	Tab Welding	Welder	7:36 AM - 2:51 PM	*	10.1	.67	*	*
26	Core Welding	Welder	7:38 AM - 2:53 PM	*	7.8	.63	*	*
27	Small Parts	Welder	7:40 AM - 2:53 PM	*	4.6	.82	*	*
28	Small Parts	Welder	7:42 AM - 2:54 PM	*	27.7	1.52	*	*
17	Small Cab	Welder	7:21 AM - 2:48 PM	*	7.2	.45	*	*
1	Cat Area	Welder Inspector	6:50 AM - 2:35 PM	*	1.4	.31	*	*
2	Cat Area	Welder	6:52 AM - 2:43 PM	*	5.0	.27	*	*
3	Cat Area	Welder	6:58 AM - 2:34 PM	*	1.6	.11	*	*
4	Cat Area	Welder	6:02 AM - 2:39 PM	*	7.5	.19	*	*
5	Cat Area	Press Operator	6:03 AM - 2:36 PM	*	4.8	.08	*	*
6	Cat Area	Welder	6:08 AM - 2:35 PM	*	4.0	.29	*	*
7	Cat Area	Welder	6:12 AM - 2:37 PM	*	6.1	.37	*	*
8	Cat Area	Welder	6:17 AM - 2:40 PM	*	6.9	.34	*	*
29	Cat Area	Welder	9:12 AM - 2:40 PM	*	2.6	.09	*	*
10	Cat Area	Welder	6:23 AM - 2:52 PM	*	10.4	.64	*	*
11	220 Frame	Stud Gun Welder	6:58 AM - 2:52 PM	*	1.0	.10	*	*
12	221 Frame	Welder	6:58 AM - 2:52 PM	*	4.4	.24	*	*
13	Cab Welding	Welder	7:07 AM - 2:53 PM	*	8.1	.41	*	*
18	Fabrication	Flame Cutter Helper	7:16 AM - 3:19 PM	*	0.04	*	*	*

TABLE 2, (continued)

Sample Number	Location	Job Classification	Time of Sampling	mg/M^3 Pb	Fe_2O_3	Mn	Cr	Cu
19	Fabrication	Flame Cutter	7:15 AM - 3:20 PM	*	8.9	*	*	*
20	Fabrication	Flame Cutter	7:14 AM - 2:32 PM	*	4.9	*	*	*
14	Rework Area	Sander	7:30 AM - 3:10 PM	*	0.2	*	*	*
50	Rim Shop	Lead Man Welder	7:22 AM - 2:12 PM	*	2.4	*	*	*
52	Rim Shop	Welder	7:24 AM - 2:11 PM	*	1.3	*	*	*
51	Rim Shop	Automatic Welder	7:25 AM - 2:14 PM	*	1.2.	*	*	*
48	Rim Shop	Automatic Welder	7:27 AM - 2:14 PM	*	0.4	*	*	*
47	Rim Shop	Submerged Arc Welder	7:30 AM - 2:15 PM	*	5.1	*	*	*
53	Rim Shop	Welder	7:31 AM - 2:15 PM	*	2.8	*	*	*
46	Front Frames	Welder	7:42 AM - 2:29 PM	*	2.8	*	*	*
49	Rear Frames	Welder	7:48 AM - 2:33 PM	*	3.1	*	*	*
36	Rear Frame Welding	Welder	6:35 AM - 2:33 PM	*	4.3	*	*	*
39	Front Frames	Welder	6:53 AM - 2:33 PM	*	6.4	*	*	*
41	Frame Tack	Welder	7:00 AM - 2:31 PM	*	6.7	*	*	*
43	Rim Welding	Welder	7:14 AM - 2:13 PM	*	1.8	*	*	*
44	Wheel Welding	Painter	7:13 AM - 2:13 PM	*	.3	*	*	*
45	Wheel Welding	Welder	7:20 AM - 2:11 PM	*	1.8	*	*	*
55	Front End	Welder	7:43 AM - 2:30 PM	*	4.9	*	*	*
56	Front End	Welder	7:45 AM - 2:38 PM	*	4.7	*	*	*
57	Rear Frame	Welder	7:45 AM - 2:34 PM	*	6.0	*	*	*
54	Abrasive Blasting	Operator	7:43 AM - 3:54 PM	*	6.1	*	*	*
30	Small Parts	Welder	5:57 AM - 2:45 PM	*	6.9	*	*	*
31	Small Parts	Welder	5:57 AM - 2:45 PM	*	6.1	*	*	*
32	Small Parts	Welder	6:00 AM - 2:44 PM	*	2.9	*	*	*
40	Area 220	Welder	6:59 AM - 4:32 PM	*	1.8	*	*	.01
33	Cat Area	Painter	6:05 AM - 3:00 PM	*	*	*	.004	*
34	Large Paint Booth	Painter	6:18 AM - 2:40 PM	0.66	*	*	.201	*
35	Cab Rework	Painter	6:35 AM - 2:50 PM	1.75	*	*	.32	*
37	Large Paint Booth	Painter	6:50 AM - 2:38 PM	1.90	*	*	.34	*
38	Rework	Painter	6:55 AM - 2:50 PM	0.08	*	*	.01	*
42	Rework	Painter	7:07 AM - 12:48 PM	0.07	*	*	.15	*
		EVALUATION CRITERIA		0.05	5.0	1.0	0.025	1.0
		LABORATORY LIMIT OF DETECTION mg/sample		0.006	0.004	0.002	0.003	0.002

* = below laboratory limit of detection

TABLE 3

Breathing Zone Air Concentrations of
Xylene, Toluene, Methyl Ethyl Ketone (MEK), and 1,1,1-Trichloroethane
on Painters and Vinyl Installer

Steiger Tractor Inc.
Fargo, North Dakota

May 15, 1979

Sample Number	Location	Job Classification	Time of Sampling	mg/M^3 Xylene	Toluene	MEK	1,1,1-Trichloroethane
CT-1	Cat Area	Painter	6:11 AM - 12:07 PM	2.2	*	*	*
CT-2	Large Cab Booth	Painter	6:43 AM - 11:47 AM	63.6	50	*	*
CT-3	Large Cab Booth	Painter	6:48 AM - 11:52 AM	27	27	*	*
CT-4	Rework Area	Painter	6:30 AM - 11:45 AM	61	88	*	*
CT-5	Rework Area	Painter	7:28 AM - 11:41 AM	72	103	*	*
CT-6	Rim Paint Booth	Painter	7:06 AM - 11:26 AM	44	52	*	*
CT-7	Rim Paint Booth	Painter	11:26 AM - 2:30 PM	46	46	*	*
CT-8	Rework Area	Painter	11:43 AM - 3:08 PM	39	68	*	*
CT-9	Rework Area	Painter	11:45 AM - 3:08 PM	46	71	*	*
CT-10	Large Cab Paint	Painter	11:53 AM - 2:34 PM	47	29	*	*
CT-11	Large Cab Paint	Painter	11:48 AM - 3:00 PM	69	53	*	*
CT-12	Cat Area	Painter	12:07 PM - 2:38 PM	*	47	*	*
CT-13	Cab Assembly	Vinyl Installer	6:58 AM - 1:17 PM	5	*	*	342
CT-14	Small Parts	Painter	7:10 AM - 1:18 PM	11	*	*	2
CT-15	Small Parts	Painter	7:02 AM - 1:24 PM	4	*	*	27
CT-16	Small Parts	Painter	7:05 AM - 1:28 PM	7	*	*	4
CT-17	Small Parts	Painter	7:07 AM - 1:14 PM	12	*	*	*
CT-18	Cab Assembly	Painter	7:11 AM - 1:17 PM	7	*	*	2
		EVALUATION CRITERIA		435	375	590	1900
		LABORATORY LIMIT OF DETECTION mg/sample		0.02	0.04	0.3	0.02

* = below laboratory limit of detection

TABLE 4

Breathing Zone and General Area Air Concentrations of
Iron Oxide (Fe_2O_3), Manganese (Mn), and Lead (Pb)

Steiger Tractor Inc.
Fargo, North Dakota

May 17, 1979

Sample Number	Location	Job Classification	Time of Sampling	mg/M^3		
				Fe_2O_3	Mn	Pb
85	Fabrication Area	Grinder	7:03 AM - 1:30 PM	53.4	0.08	*
86	Fabrication Area	General Area	7:10 AM - 1:25 PM	5.5	.17	*
87	Fabrication Area	Grinding	7:02 AM - 1:25 PM	6.6	0.03	*
88	Front Frame	Welder	7:07 AM - 1:30 PM	13.7	0.97	*
75	Cat Area	Welder	5:55 AM - 1:32 PM	20.4	0.44	*
80	Cat Area	Painter	6:20 AM - 1:25 PM	0.87	0.04	*
81	Cat Area	Welder	6:17 AM - 1:30 PM	11.7	0.12	*
82	Cat Area	Welder	6:16 AM - 1:30 PM	35.3	0.48	*
83	Cat Area	Welder	6:15 AM - 1:30 PM	14.9	0.26	*
84	Cat Area	Welder	6:12 AM - 1:27 PM	14.7	0.28	*
		EVALUATION CRITERIA		5.0	1.0	.05
		LABORATORY LIMIT OF DETECTION mg/sample		.004	.002	.003

* = below laboratory limit of detection

TABLE 5

Average Blood Lead Levels

Steiger Tractor, Inc.
Fargo, North Dakota

May 15-17, 1979

Job Grouping	Number	Average Blood Lead ug/dl	Standard Deviation
Welders	20	11.2	2.32
Painters	7*	24.1@	10.12
Others	7	13.1	2.79
Total	36**	14.9	7.70

* Includes 1 sander (finisher) who works with paint and is an ex-painter.
** Includes 2 "control" blood lead determination on workers for which no questionnaires were obtained.
@ Statistically significant difference (t=2.412; d.f.=32; p=0.02)

Table 6

Average Pulmonary Function Tests by Job Grouping and Smoking Habits
Steiger Tractor, Inc.
Fargo, North Dakota

May 15-17, 1979

Job Grouping	Best FEV^1 % Predicted	Best FVC % Predicted	FEV_1/FVC %
WELDERS			
Smokers*			
Number	14	14	14
Mean	87.85	96.87	72.04
Standard Deviation	11.61	9.23	9.19
Non-Smokers			
Number	7	7	7
Mean	96.1	102.0	
Standard Deviation	13.81	11.78	5.43
Total*			
Number	21	21	21
Mean	90.60	92.95	72.77
Standard Deviation	12.67	9.81	8.05
PAINTERS			
Smokers			
Number	4	4	4
Mean	83.5#	93.7	71.4
Standard Deviation	5.56	12.06	4.06
Non-Smokers			
Number	2	2	2
Mean	99.5#	96.9	79.6
Standard Deviation	5.09	1.13	4.67
Total			
Number	6	6	6
Mean	88.8	94.8	74.2
Standard Deviation	9.58	9.51	5.66

TABLE 6 (continued)

Job Grouping	Best FEV[1] % Predicted	Best FVC % Predicted	FEV_1/FVC %
OTHERS			
Smokers			
Number	4	4	4
Mean	93.2	95.0	77.0
Standard Deviation	10.99	12.08	3.69
Non-Smokers			
Number	3	3	3
Mean	102.9	103.0	78.5
Standard Deviation	5.00	7.52	5.75
Total			
Number	7	7	7
Mean	97.3	98.4	77.6
Standard Deviation	9.77	10.50	4.30
TOTAL STUDY GROUP			
Smokers			
Number	22	22	22
Mean	88.04##	95.95	72.84
Standard Deviation	10.68	9.81	7.79
Non-Smokers			
Number	12	12	12
Mean	98.35##	101.42	76.18
Standard Deviation	10.95	9.53	5.48
Total			
Number	34	34	34
Mean	91.68	97.88	73.46
Standard Deviation	11.73	10.31	7.12

* Includes 1 smoking ex-welder and 1 ex-smoking welder (Table 6 only)

\# Statistically significant difference (t=3.393; d.f.=4; p=0.02)

Statistically significant difference from rest of study group (t=3.973; d.f.=32; p less than 0.001)

TABLE 7

Pulmonary Function Tests - Changes Over Shift by Job Grouping and Smoking Habits

Steiger Tractor, Inc.
Fargo, North Dakota

May 15-17, 1979

Job Grouping	% Change Over Shift		
	FEV^1 %	FVC %	FEV^1FVC %
WELDERS			
Smokers			
Number	12	12	8
Mean	-0.93	+5.31	-1.85
Standard Deviation	8.35	10.58	6.25
Non-Smokers			
Number	8	8	6
Mean	-4.68	-5.08	-3.12
Standard Deviation	8.74	7.07	6.00
Total			
Number	20	20	14
Mean	-2.43	1.16	-2.39
Standard Deviation	8.49	10.51	5.94
PAINTERS			
Smokers			
Number	4	4	3
Mean	+3.72	-7.70	-1.83
Standard Deviation	3.81	7.50	1.27
Non-Smokers			
Number	1	2	1
Mean	+4.2	+3.4	+2.1
Standard Deviation	----	1.91	----
Total			
Number	5	6	4
Mean	+3.82	+6.28	-0.85
Standard Deviation	3.30	6.27	2.22

TABLE 7 (continued)

Job Grouping	% Change Over Shift		
	FEV^1 %	FVC %	FEV^1/FVC %
OTHERS			
Smokers			
Number	5	5	5
Mean	-3.92	-2.00	-2.73
Standard Deviation	8.46	13.90	4.79
Non-Smokers			
Number	3	3	3
Mean	+2.93	-4.63	-2.00
Standard Deviation	4.59	7.97	1.56
Total			
Number	8	8	5
Mean	-3.55	-2.99	-2.44
Standard Deviation	6.87	11.42	3.50
TOTAL STUDY GROUP			
Smokers			
Number	21	21	14
Mean	-0.15	+4.01	-2.04
Standard Deviation	7.87	11.02	5.00
Non-Smokers			
Number	12	13	9
Mean	-3.50	-3.66	-2.29
Standard Deviation	7.68	7.07	5.07
Total			
Number	33	34	23
Mean	-1.37	2.18	-2.13
Standard Deviation	7.85	10.75	4.91

There were no statistically significant differences

TABLE 8

Symptoms and Pulmonary Findings by Job Group and Smoking Habits*

Steiger Tractor, Inc.
Fargo, North Dakota

May 15-17, 1979

	Welders			Painters			Other			Total		
	Smokers	Nonsmokers	Total	Smokers	Nonsmokers	Total	Smokers	Nonsmokers	Total	Smokers	Nonsmokers	Total
Number	12	8	20	4	2	6	5	3	8	21	13	34
Pulmonary Findings												
Restrictive	0	0	0	0	0	0	1	0	1	1	0	1
Obstructive	6+	2	8+	2@	0	2@	0	0	0	8#	2	10#
Decrease over shift	1	4	5	0	0	0	2	1	3	3	5	8
Normal	6+	4	10+	2	2	4	3@	2	5@	11#	8	19#
Sympotomatology Developing Over Shift (See Table 8A)												
Mucous Membrane Irritation	8	3	11	3	2	5	2	0	2	13	5	18
Headache or Dizziness	3	0	3	1	2	3	2	2	4	6	4	10
Chest Complaints	5	2	7	0	1	1	3	2	5	8	5	13
Stomach Complaints	1	0	1	1	0	1	1	1	2	3	1	4
Urinary Complaints	0	0	0	0	0	0	1	0	1	1	0	1
Skin Complaints	0	0	0	0	0	0	1	0	1	1	0	1
No Complaints	2	4	6	0	0	0	1	1	2	3	5	8
Symptoms Developing Overnight or Persisting Overnight after Shift (See Table 8A)												
Mucous Membrane Irritation				3	1	4						
Headache or Dizziness				1	1	2						
Chest Complaints				1		1						
Stomach Complaints				1	0	1						
No Complaints				1	0	1						
Spontaneous Complaints (See Table 8B)												
Complaints	5	5	10	1	0	1	4	2	6	10	7	17
No Complaints	7	3	10	3	2	5	1	1	2	11	6	17

* Based on current job and smoking habits.
\+ In two instances the change in FEV_1/FVC was uninterpretable.
@ In one instance the change in FEV_1/FVC was uninterpretable.
\# In three instances the change in FEV_1/FVC was uninterpretable.

TABLE 8A

Symptom List from Pre- and Post-Shift Questionnaire

Steiger Tractor, Inc.
Fargo, North Dakota

May 15-17, 1979

	Developing Overshift		Developing Overnight	
Mucous Membrane Irritation		18		4
Dry throat or sore throat	9		0	
Burning or itching eyes	7		1	
Tearing of the eyes	6		1	
Stuffy nose	3		1	
Runny nose	5		1	
Cough (if unaccompanied by chest complaints	2		1	
Headache or Dizziness (or lightheadedness)		10		2
Chest Complaints		13		1
Chest tightness, soreness, or heaviness	8		0	
Wheezing or whistling in the chest	2		0	
Shortness of breath	6		1	
Cough (if accompanied by chest complaints)	4		0	
Stomach Complaints		4		1
Stomach pains	3		1	
Nausea or upset stomach	1		1	
Urinary Complaints		1		0
Painful or burning urination	0		0	
Frequent urination	1		0	
Skin Complaints (irritation or rash)		1		0
None		8		2
Total questioned	34		6	

TABLE 8B

Spontaneously Mentioned Health Complaints

Steiger Tractor, Inc.
Fargo, North Dakota

May 15-17, 1979

Mucous Membrane Irritation
- Irritation of nose and throat
- Congestion
- On eye drops

Allergies
- Hay Fever
- Dust
- Cats and dogs

Headache from Noise

Loss of Hearing

Ear Infection

Loss of Smell

Chest Complaints
- Shortness of breath (2)
- Chest pains (2)
- Chest tightness

Stomach Complaints
- Ulcer (2)
- Nausea

Skin Complaint
- Itch from dust

Musculoskeletal Problems
- Back complaints (2)
- Tendon problem

None (17)

Except where indicated there was only one instance of each complaint.