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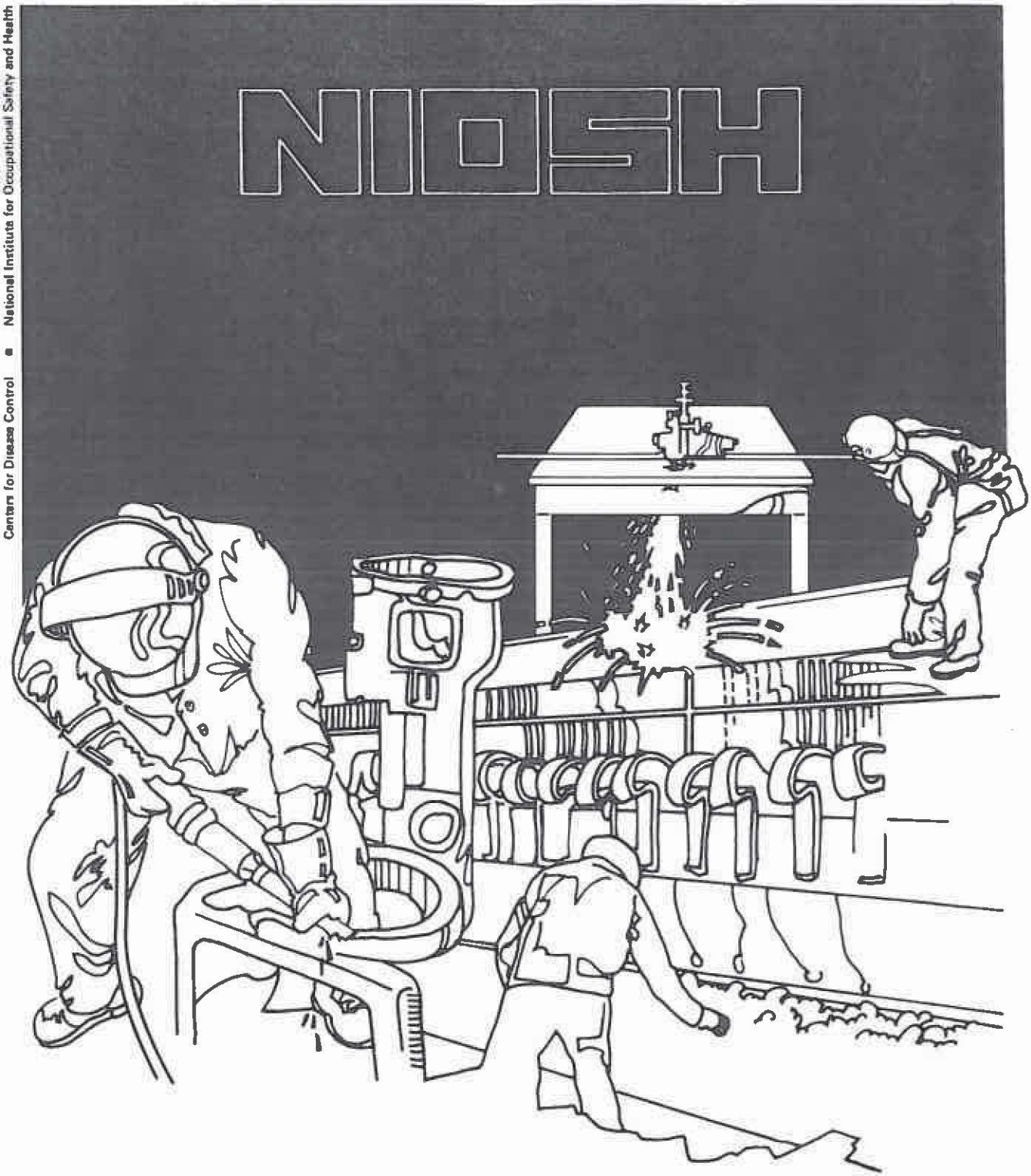

Health Hazard Evaluation Report

HETA 81-433-1452
GENERAL MOTORS CORPORATION
FRAMINGHAM, MASSACHUSETTS

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 81-433-1452
MAY 1984
GENERAL MOTORS CORPORATION
FRAMINGHAM, MASSACHUSETTS

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I. SUMMARY

In August 1981, the Harvard Occupational Health Program, under a Cooperative Agreement with the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from the Millwright and Machinery Erectors Local Union 1121. Complaints of numbness and tingling of the extremities were made by 19 of 100 millwrights working to tear down a conveyor system at the Framingham, Massachusetts, General Motors Plant.

To determine whether these symptoms were work-related, environmental and medical evaluations were conducted on August 18, 1981. Air concentrations of respirable dust and the four metal components (lead, manganese, cadmium, chromium) of the paints used on the conveyor systems were assessed; a detailed medical history was taken; and neurological examinations were performed on the 13 symptomatic workers who were present on the day of the site visit.

All general work area measurements of respirable dust (0.03 to 0.05 mg/m^3) were well below the environmental criteria of 5 mg/m^3. Immediately adjacent to a cutting torch operation, respirable dust levels ranged from 2 to 5 mg/m^3. . The six personal air sample results showed detectable exposures to lead, manganese, cadmium, and chromium, but all samples were well below the environmental criteria except for one lead sample of 67 ug/m^3 as compared to the evaluation criteria and OSHA standard of 50 ug/m^3.

The medical history and neurologic examinations confirmed the workers complaints, but showed no additional disorders caused by workplace exposures. Erythrocyte protoporphyrin levels were normal in all persons tested, indicating no increased lead absorption.

Millwrights holding heavy grinding and cutting tools could potentially suffer injury to the small nerves of their hands and arms due to vibration and direct nerve compression by tools. Also, a directly overhead posture could cause compression at the collarbone of the larger nerve trunks that carry sensation from the hands and arms.

It is concluded that toxic exposures were not responsible for the symptoms of numbness and tingling. Most of the symptoms experienced by the workers can be attributed to the tools and working postures required for their jobs. Recommendations are outlined in this report to alleviate these ergonomic problems.

KEYWORDS: SIC 3535 (Conveyors and Conveying equipment), lead, manganese, cadmium, chromium, ergonomics.

II. INTRODUCTION

On August 10, 1981, two business agents for the Millwright and Machinery Erectors of Massachusetts Local Union 1121, Allston, Massachusetts 02134, requested a health hazard evaluation at the General Motors Plant in Framingham, Massachusetts. The workers at the plant were complaining of "numbness in their hands" and "tingling in their fingers." The work being performed was principally the removal of old conveyors and installation of new conveyors which necessitated the burning, welding, and grinding of painted metal surfaces. The field portion of the health hazard evaluation study was conducted on August 18, 1981, and consisted of medical questionnaire, medical history, neurological examination, neurobehavioral testing, limited environmental sampling to reveal potential exposures, and a qualitative ergonomic assessment.

III. BACKGROUND

In 1981, the General Motors assembly plant in Framingham, Massachusetts, was undergoing remodeling designed to change over the production line from larger to smaller size cars. As part of this renovation, the conveyor system that carried vehicles during assembly, was torn down and reconstructed. About 90 percent of the old conveyor system was removed from the plant and scrapped. The specific tasks associated with the conveyor removal and reconstruction were performed under contract to the Midwest Conveyor Company of Kansas City, Missouri. This company hired local workmen to perform various tasks required for the contracted work.

The conveyor removal work was performed by the Millwright Local 1121 of Boston. Many of the workers were millwrights for 15-20 years and had been employed in similar jobs in the past. Midwest Conveyor Company began work at the plant in December 1980, with a workforce of about 15 persons. Tasks at that time included the removal of old conveyors, a job which was primarily done by another contractor, and other repair work within the plant. In mid-June 1981, the crew was increased to 100 millwrights and 20 ironworkers.

The work of the millwrights included metal cutting using oxyacetylene torches, metal grinding using hand-held electrical grinders, assembly and clamping of parts, and welding using conventional stick welding techniques. Work was usually done in teams of two workers. Conveyor sections were welded together on the floor. Since conveyor systems were located on the 30 foot high ceiling, welded pieces were installed with the use of scaffolding or a scissors lift. Approximately half of the operations were done at floor level. To meet production demands, millwrights typically worked a ten hour day, six days a week.

In early August 1981, several workers were repairing a conveyor system inside the first color ovens which are used during normal plant operations to heat the first coat of paint. All of this work was done on scaffolding. During this week-long operation, several workers complained of numbness and tingling of the extremities. Another operation performed in early August was the repair of car carriers. This operation included sawing of steel parts and reconstruction of the car carriers to fit a new design. This job involved extensive grinding, cutting, and welding. Additionally, the more routine activities of cutting, grinding and welding on the conveyors were continuing in other areas of the plant.

Four millwrights were seen at a local hospital on August 10, 1981, with complaints of numbness and tingling in their extremities. They were evaluated in the emergency room and ultimately referred to an occupational health clinic. In view of the unusual number of complaints which occurred among the workforce over a short time period, the Millwright Local 1121 requested a health hazard evaluation.

Discussions with plant and union personnel revealed that about 19 of 100 then-employed millwrights had experienced symptoms of numbness and tingling over the previous few weeks. Reports were also received that methylene chloride was being used to remove paint from the conveyor system and workers were concerned that they might be grinding or cutting through lead-based paints.

IV. EVALUATION METHODS

A. Environmental

Air concentrations of respirable dust were determined at a number of locations using a TSI Respirable Dust Monitor.

Six workers were sampled for lead, cadmium, chromium, and manganese, using calibrated personal sampling pumps and membrane filters at airflows of 1.7 liters per minute (lpm). Work conducted during the sampling included welding, cutting, and grinding. The sample durations were about two hours. The sampling strategy was intended to reveal potential exposures rather than time weighted average daily exposures.

Six paint chip samples were obtained at random points on the conveyor. Both the paint chips and the filter samples were analyzed for lead, cadmium, chromium, and manganese following NIOSH procedures using graphite furnace atomic absorption spectroscopy. (NIOSH Method P&CAM 298 with modifications.)

B. Medical

On Tuesday, August 18, 1981, a visit was made to the plant and medical evaluations were performed on 19 millwrights. The list of 19 persons with extremity paresthesiae was provided by the union and 13 who were present at work on the day of our visit were tested. Six employees without extremity symptoms were evaluated for comparison.

A detailed medical questionnaire was administered to each individual along with questions regarding job duties. A detailed medical history and neurological examination was performed on all 13 symptomatic workers. All of the workers received neurobehavioral testing which included the administration of the Santa Ana Dexterity Test and the Continuous Performance Test (1). The Profile of Mood States (2) was also administered to assess affective disorders. The medical questionnaire included questions modified from a Swedish questionnaire (3) which has been found to be particularly useful in evaluating nervous system disorders. All examinations were performed on the plant property in trailers parked adjacent to the plant.

C. Ergonomic

An ergonomist conducted a qualitative survey by observing work practices in each job category.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, occupational health professionals employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria 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. However, 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 Government 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.

The environmental criteria used for this study are presented in Table 1. Listed in Table 1 for each substance, are the recommended evaluation criteria for this study, the source of the recommended limit, the principal or primary health effects underlying each recommended limit, and the current OSHA standard.

VI. EVALUATION FINDINGS

A. Environmental

The results of the respirable dust monitoring ranged from 30 to 50 micrograms per cubic meter (ug/m^3) in general work areas and from 2 to 5 milligrams per cubic meter (mg/m^3) near torch cutting operations. All measurements except one immediately adjacent to a torch cutting operation were well below the environmental criteria for respirable dust (5 mg/m^3). Respirable dust levels approximately four feet from a torch cutting operation dropped to 0.5 mg/m^3.

The results for the bulk paint chip samples are given in Table 2. The metal contents of the bulk paint chip samples are given as percentages. The results for the air sample filters are given in Table 3.

The personal air sample results show detectable exposures to lead, manganese, and chromium but all measured samples were well below the evaluation criteria except for one lead sample. This two-hour lead sample showed an air concentration of 67 ug/m^3 as compared to the evaluation cirteria (OSHA standard) of 50 ug/m^3 and indicates the possibility of an over-exposure to lead fume.

The observed welding consisted of standard arc welding using Hobart 7018 welding rods (1/8 inch). Typical amounts of smoke and fume were coming from the weld point. The welders were protected from UV radiation by using face shields with dark glasses.

B. Medical

The symptoms reported by workers varied considerably in nature, distribution, and location. Most of the millwrights had symptoms that were rather short-lived (lasting less than two weeks in 60 percent of the cases) and varied in intensity at different times of the day. Some individuals reported that the symptoms were worse in the morning, some while driving to work, and some in the evening.

Five individuals reported bilateral upper extremity numbness beginning since coming to work in their job as a millwright at the General Motors Plant; of these, three had symptoms present on the day of our evaluations. Seven complained of having a unilateral upper extremity numbness with four having symptoms present on the day of our evaluation. Despite prior reports of an apparent explosive outbreak of these complaints, onset dates of symptoms varied considerably (Figure 1). Furthermore, latency of the onset of symptoms from beginning of employment varied from one week to 17 weeks (median: five weeks).

The results of the questionnaire analyses, behavioral test performance, and mood survey, confirm the reports of symptoms seen in these workers but show no evidence of additional disorders which can be construed to be caused by workplace factors.

Erythrocyte protoporphyrin levels showed normal concentrations in all persons tested thus indicating no evidence of increased lead absorption in these individuals.

C. Ergonomic

Several millwrights were observed performing grinding tasks, two major categories of which were noted. The first category involved situations where the conveyor sections were located on

the plant floor. In this instance, the surfaces to be grinded were located at about waist height, and the work was performed while assuming a stooping, squatting, or kneeling posture. The second category involved situations where the conveyor sections were suspended from overhead structural steel. In this instance, the millwright stood on an adjustable lift while working. Depending on overhead clearances, the surfaces under preparation were located from mid-chest height to overhead. Generally, the work was performed from a standing posture. If necessary, the grinding tool was held overhead to perform the operation.

VII. DISCUSSION

The medical symptoms reported by these workers during July and August of 1981 can, in most part, be attributed to traumatic injuries to peripheral nerves. In some instances, job-related factors may have contributed to the development of these conditions. Specific work postures which appeared to be significant in terms of the development of the traumatic injuries include wrist flexion and extension and radial and ulnar deviations to weld, grind, and cut metal. These positions resulted in repetitive trauma to upper extremities. Furthermore, repetitive local vibration stress occurred as a result of a hand held grinding machine. This factor was responsible for some of the conditions seen in these workers.

We saw no evidence of significant, permanent neurological damage occurring as a result of workplace factors. Most of the conditions seen were transient disturbances which were not associated with any permanent residual effect. A possible exception to this statement was one individual with symptoms consistent with Raynaud's syndrome whose disease may have resulted from his prolonged use of grinding tools.

Both burning (cutting) and welding produced considerable amounts of metal fume, most of which would originate from the structural steel. Some fume and gases would also be produced by the welding rod which contains manganese (0.65%) and other metals.

Burning and aerosolization of the paint during welding, cutting and grinding is also of concern. Metal pigments, especially lead, may be present in one or more of the paints that had been used on the conveyors. Several different paints were observed including white, grey, deep red, yellow and orange.

Since work was conducted simultaneously in many different parts of the plant, emission sources were diffuse. However, workers noted the presence of particularly noxious air when working in confined spaces such as the "pit" beneath the floor level conveyor.

From an ergonomic standpoint, several problems could be expected to arise from the grinding activities since workers' hands were subjected to sustained vibrations transmitted from the grinding tool. Although measurements of vibration frequency and amplitude were not taken, it is reasonable to predict that this exposure could be associated with vibration induced Raynaud's Syndrome, and finger paresthesia.

In operating the grinding tool, the millwrights were observed to use extreme wrist positions (flexion, extension, ulnar and radial deviation) on a highly repetitive basis. These postures could cause tendonitis and/or tenosynovitis in the upper extremities. In addition, these bad postures could cause median nerve entrapment in the carpal tunnel. At least two workers mentioned that they suffered nocturnal paresthias. Such complaints are common in cases of carpal tunnel syndrome.

Overhead grinding operations could cause local muscle fatigue due to sustained abduction at the shoulders. Non-specific complaints of pain, tinging and/or numbness could be expected in the muscles of the upper extremities.

VIII. CONCLUSIONS

We conclude that toxic chemicals are not responsible for the symptoms of numbness and tingling. This conclusion is based on the following findings: (1) Zinc protoporphyrin levels were all within the normal range. (2) Numbness and tingling were experienced in both arms in only five of the thirteen millwrights with numbness and tingling. These findings are at odds with the fact that toxic nerve damage almost always is symmetrical affecting both right and left extremities. (3) The timing was not suggestive of a toxic chemical exposure in that there was no consistency among workers in how long the symptoms lasted, in how long they took to develop after a millwright had been working at GM, and on what date the symptoms began. (4) There were no chemical substances in the work area, except lead, known to cause, or suspected of being able to cause nerve damage that might produce the symptoms of numbness and tingling. (5) There were no abnormal results on the tests evaluating brain function. Most often, industrial toxins causing numbness and tingling also affect brain function.

We believe that most of the numbness and tingling experienced can be attributed to the machinery used and the working postures required on the job. Millwrights holding heavy grinding and cutting tools could potentially suffer injury to the small nerves of their hands and arms due to vibration and direct nerve compression by tools. Also, a directly overhead posture could cause compression at the collarbone of the larger nerve trunks that carry sensation from the hands and arms.

IX. RECOMMENDATIONS

1. Use tools with reduced vibrational characteristics and wear antivibration gloves to attentuate vibration exposure (Note: Almost all millwrights wore cloth work gloves while grinding).

2. Use grinding tools which allow neutral wrist postures.

3. Workers should hold the tools as lightly as possible in order to do the job, since an increased grip strength results in an increased vibration dose.

4. The current use of lift platforms reduced the number of situations where overhead work is required. In cases where grinding must be done overhead, workers should be encouraged to lower their arms at frequent intervals for short rests.

5. Evaluation of job stresses should be performed to assess the contribution of work positions and repetitive trauma to the development of these complaints.

X. REFERENCES

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XI. ACKNOWLEDGEMENTS

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XII. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH at the Cincinnati address. Copies of this report have been sent to:

1. Midwest Conveyor Co., Kansas City, Missouri.
2. Millwright and Machinery Erectors Local Union 1121, Allston, Massachusetts
3. NIOSH, Region I
4. OSHA, Region I
5. Massachusetts Department of Labor and Industries

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

Table 1

Environmental Criteria

Substance	Recommended Evaluation Criteria 8-Hr TWA Limit	Source	Primary Health Effects	OSHA Standard
Lead	50 ug/m^3	OSHA	Kidney, blood, and nervous system effects	50 ug/m^3
Chromium	500 ug/m^3	ACGIH	Pulmonary effects	1000 ug/m^3
Cadmium	40 ug/m^3	NIOSH	Lung and Kidney effects	100 ug/m^3
Manganese Fume	1000 ug/m^3	ACGIH	Central nervous system effects, metal fume fever	5000 ug/m^3 (ceiling)
Respirable Dust	5 mg/m^3	ACGIH	Pulmonary effects	5 mg/m^3

All air concentrations are time-weighted-average (TWA) exposures for a normal (8 to 10 hours) workday of a 40-hour work week. A ceiling value is one which is not to be exceeded.

Table 2

Results of Paint Chip Analyses

Sample Description	% Lead	% Chromium	% Cadium	% Manganese
Red Grinding Table	0.004	0.073	8×10^{-6}	0.17
Yellow & Orange Conveyor Basket	19.4	5.0	2×10^{-4}	0.03
Red New Steel	0.24	0.64	1×10^{-3}	0.07
White Inside Conveyor	0.08	0.36	5×10^{-4}	0.02
Grinding Filings from Conveyor	0.02	0.53	8×10^{-5}	0.28
White Stockpile	0.23	0.31	2×10^{-4}	0.08

Table 3

Results of Personal Air Samples for Lead, Chromium, Cadmium, and Manganese

Filter Number	Sample Duration (Min)	Job	Air Concentrations*			
			Lead	Chromium	Cadmium	Manganese
1	134	Welding	10	5.4	0.05	10
2	142	Cutting	67	6.1	0.09	8.6
3	164	Grinding	9.3	19	0.08	0.3
4	141	Welding, Grinding, Cutting	22	5.9	0.14	10
5	125	Cutting, Welding	23	5.7	0.68	94
6	74	Welding	36	7.9	0.35	73
Evaluation Criteria			50	500	40	1000

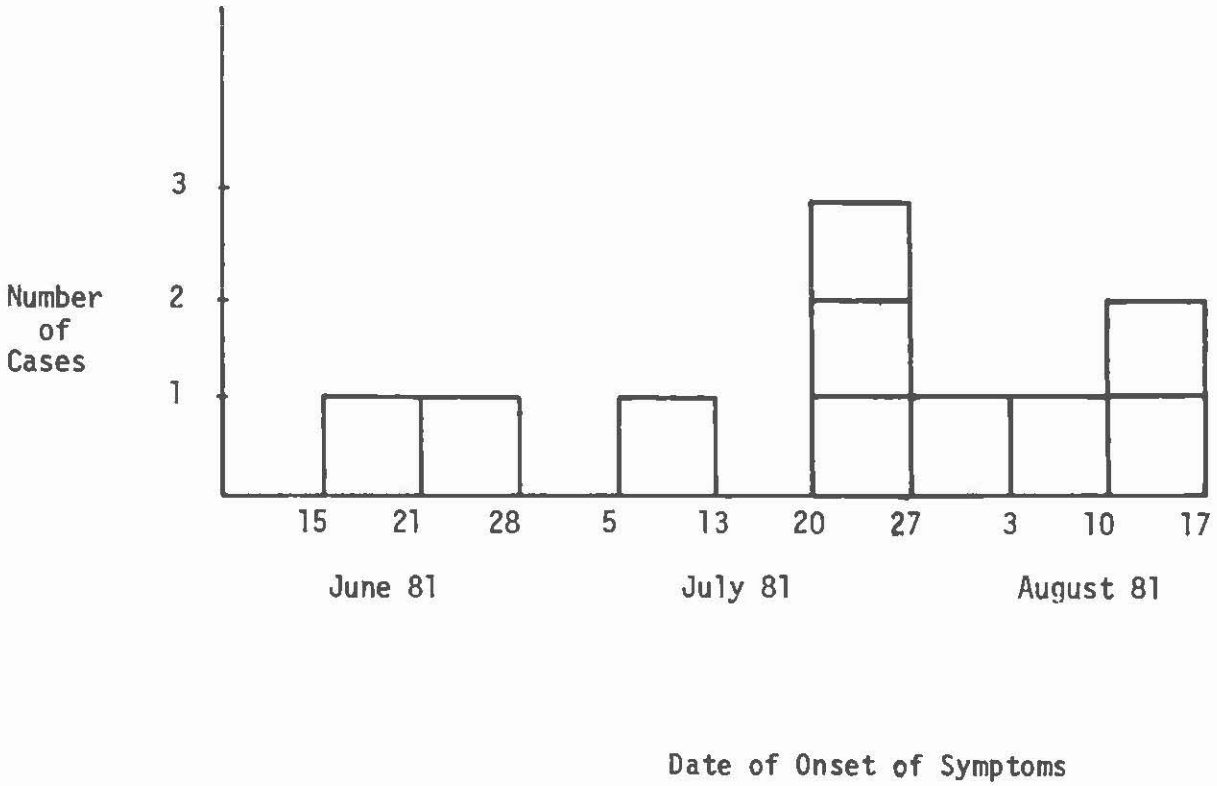
*Air concentrations are in micrograms per cubic meter (ug/m^3).

Figure 1

Date of Onset of Symptoms

vs.

Number of Cases



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