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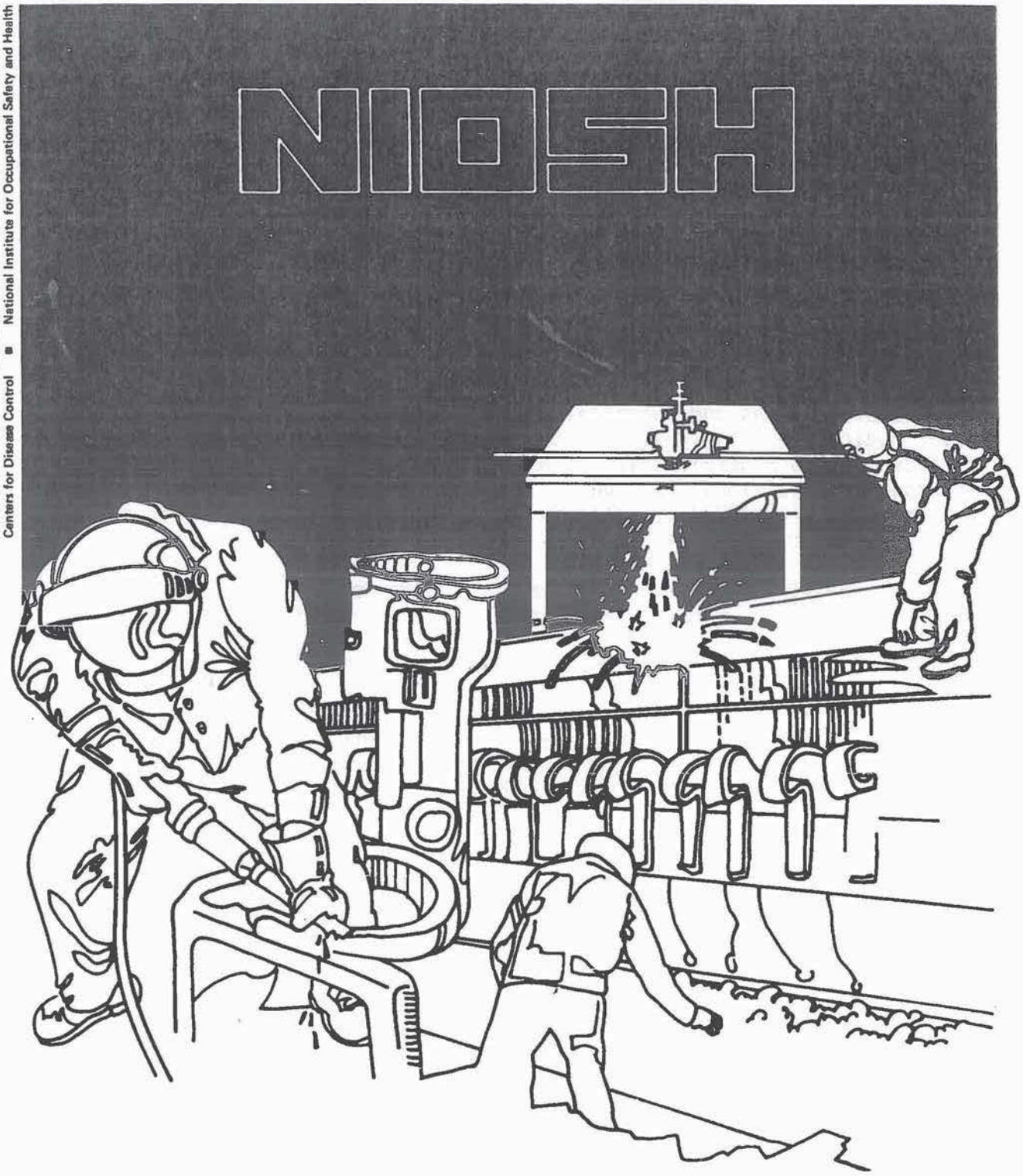

Health Hazard Evaluation Report

HETA 82-081-1294
MOLITOR INDUSTRIES, INC.
ENGLEWOOD, 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 82-081-1294
APRIL 1983
MOLITOR INDUSTRIES, INC.
ENGLEWOOD, COLORADO

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I. SUMMARY

In December 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request from Molitor Industries, Inc., Englewood, Colorado, to evaluate occupational exposures to fumes generated in lead welding and tin soldering operations during the fabrication of research environmental chambers.

In June and October 1982, NIOSH investigators conducted an environmental and medical evaluation. Personal breathing zone exposures to lead and tin compounds were determined for a portion of the employees who work in the fabrication operations (welders and solder operators).

Personal samples for lead ranged from 0.01 to 0.3 mg/M^3 and were above the NIOSH criteria and/or the Occupational Safety and Health Administration (OSHA) standard of 0.05 mg/M^3 for lead. Personal samples for tin ranged from non-detectable to 0.39 mg/M^3 and only one tin level exceeded the NIOSH criteria and the OSHA standard of 0.1 mg/M^3. Both the elevated lead and tin exposures were found while the operators were working in a confined space operation.

A medical questionnaire was administered and bloods were drawn at the beginning and end of the lead work operations for the workers involved. There were no work related health complaints and all blood lead and free erythrocyte protoporphyrin (FEP) levels were within normal limits.

On the basis of the environmental data obtained in this investigation, NIOSH determined that the employees are overexposed to lead and tin during a portion of the work that was evaluated. Therefore, based on the results of this investigation, there does appear to be a potential health hazard to the workers at various phases of the welding and soldering operations. This is particularly true if the lead or tin work is continued for extended periods of time. Recommendations to reduce and/or eliminate these exposures are included in Section VIII of this report.

KEYWORDS: SIC 3490 (Miscellaneous Fabricated Metal Products), environmental control chambers, welding, soldering, lead, and tin.

II. INTRODUCTION

In December 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) from a representative of Molitor Industries, Inc., Englewood, Colorado. The request asked NIOSH to determine if there was a health hazard resulting from exposures to lead or tin compounds during the welding and soldering operations which are part of the construction of environmental test chambers. Due to a work delay NIOSH could not perform its first environmental survey until June 1982; an additional environmental and medical survey was performed in October 1982. The results presented in this report were given to the company and employees during January 1983.

III. BACKGROUND

Molitor Industries, Inc. is a diversified operation which primarily produces chambers for control of rare environmental contaminants. The various contaminants include chemical, biological, and radiological materials and, therefore, the construction of these chambers requires a variety of skills and processes in order to meet the stringent specifications of the requestor. Included in the development of these chambers is a variety of fabricating steps, e.g., welding, grinding, and buffing, as well as dye testing the chambers (quality control) to assure that each chamber meets the specifications of the requestor. There are normally between 8-12 employees involved in this phase of the welding, grinding, and buffing of the chambers and 1-2 workers involved in the dye testing/quality control process.

Once a stainless steel chamber is structurally intact a large percentage of these chambers require lead linings. The thickness of the lining depends on the requestor's order but normally it will be either 1/4, 1/2, 1 inch or any of these combinations. The lead comes in 24" x 24" plates which are cut and welded together as required.

The soldering operation is a continuous activity which is performed at the final phases of the chamber's development. The type of solder varies and can contain a variety of elements, such as 60-70% lead, 30-40% tin or vice versa depending on the requirements of the job.

During the final phases of the chamber's development both the welding and the soldering operators are frequently working inside the chamber and thus confined space exposures become a major concern.

The personal protective equipment offered the workers during these operations include welding helmets and gloves. Normally there are between 3-4 employees working at one time and 2-3 workers involved in the soldering operation.

IV. METHODS AND DESIGN

A variety of techniques were used to evaluate the suspected contaminants in the various departments surveyed. Personal samples were taken on all of the welders involved in the lead plate welding processes and on a portion of the solderers. The following is a description of the environmental and medical techniques used:

A. Environmental

Six personal air samples were collected for lead and two personal air samples for tin during the survey periods. These contaminants were sampled using 37 millimeter AA 0.8u pore density cellulose membrane filters and air drawn at a flow rate of 1.5 liters per minute with a vacuum pump. The samples were analyzed using NIOSH Methods S-341 and S-183.

B. Medical

Because use of lead in this shop is only an intermittent activity, blood lead and free erythrocyte protoporphyrin (FEP) levels were determined on the three workers who would be working with lead at the beginning of the lead fabricating activity and again at the end of the activity two weeks later. On the first blood drawing one in-plant control and one other control were obtained. At the second drawing one out-of-plant control was used. The in-plant workers were also individually interviewed regarding any medical problems they might have.

Blood leads were determined by the Clinical and Biochemical Support Section, NIOSH, Cincinnati, Ohio, utilizing anodic stripping voltammetry. FEPs were determined by Environmental Sciences Associates, Inc., Bedford, Massachusetts.

C. Other

An evaluation of the work practices, personal protective equipment, and techniques used to exhaust and/or dilute the contaminant was also assessed in the plant during the survey periods.

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.

The environmental criterion for lead and tin are described below:

	Permissible Exposure Limits 8-Hour Time-Weighted Exposure Basis
Lead.....	0.05 mg/M^3 (OSHA) 0.03 mg/M^3 (OSHA Action Level)
Tin.....	0.1 mg/M^3 (OSHA, NIOSH)

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

NOTE: Action Level means employee exposure without regard to the use of respirators to an airborne concentration of lead of 30 ug/M^3 (0.03 mg/M^3) 8-hour TWA.

B. Medical/Toxicology

1. Lead

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.

Blood lead levels below 40 ug/deciliter* 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/deciliter. Lead levels between 40-60 ug/deciliter represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/deciliter are considered dangerous and often require hospitalization and medical treatment.

The Occupational Safety and Health Administration (OSHA) standard 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* must be immediately removed from further lead exposure if confirmed by a follow-up test and, starting from March 1, 1983, workers with average lead levels of 50 ug/100 g 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) can be used to measure the degree of interference with hemoglobin production at the time the red cells are made. Although some diseases and iron deficiency anemia can cause a rise in FEP, in a healthy man working with lead, lead absorption is the most likely cause for such an increase. Further the FEP levels can be related to the average blood lead concentration over the past 3-4 months (the average life span of a red cell). Normal values are below 50 ug/dl. The relationship between lead exposure and FEP is not particularly evident until elevated FEP levels are found.

2. Tin

Tin exposures are acute and are primarily irritants of the eyes and skin. No systemic effects have been reported from industrial exposures. Inhalation of fumes can also produce headaches, sore throat, and cough.

VI. RESULTS AND DISCUSSION

Employee exposure to suspected airborne concentrations of lead and tin were evaluated. The following are the results and conclusions of NIOSH's evaluation:

* 1 ug/deciliter whole blood is roughly equivalent to 1 ug/100 g whole blood.

A. Environmental

A total of six personal airborne time-weighted average (TWA) samples were taken for lead. Two of these samples were taken during for the June study and four during the December study. The lead levels ranged from 0.01-0.3 mg/M^3 which exceeded either the OSHA TWA of 0.05 mg/M^3 or the OSHA Action Level of 0.03 mg/M^3. An additional two samples were taken on the solderers during the June survey. The tin levels ranged from Non-detectable (ND) to 0.39 mg/M^3 which exceeded both the OSHA standard and NIOSH criteria levels of 0.1 mg/M^3 (refer to Table 1).

B. Medical

There were no work related health complaints. All blood lead and FEP levels were within normal limits. The control blood leads (4-5 ug/dl) were appreciably lower than the worker blood leads (15-22 ug/dl), but FEPs were comparable for the two groups (22-46 ug/dl). The one worker who did most of the lead work showed a slight rise in blood lead from 20 to 24 ug/dl. This is well within the margin of laboratory variation and is, therefore, probably not significant. His FEP showed a slight drop (28 to 22 ug/dl) which is also probably not significant. The other two workers showed slight drops in blood lead levels, but one did show a drop in FEP from 46 to 27 ug/dl, suggesting the possibility of greater lead exposure in the past.

The current blood lead results show that under current work loads lead exposure should pose no health problems. However, if the amount of lead work is increased there could be a lead problem.

VII. CONCLUSIONS

During this evaluation it was determined that a health hazard existed to those employees who performed the welding and soldering operation during a portion of their work period. This conclusion is based on the various air samples taken, evaluation of the work processes, and review of the toxicological information on those contaminants sampled. It was determined that these exposures occurred only during welding/fusing lead plates and soldering operations where tin is the primary component. Finally, it is believed that the majority of both these exposures occur during confined space operations. The welders wore only goggles and the solderers wore work coveralls.

Although the medical results did not show a health problem during the survey period the environmental results suggest that if lead use is increased there could be a problem. Permitting smoking on a lead job and carrying cigarettes into an area where they can become contaminated with lead dust are poor practices leading to unnecessary lead exposures.

VIII. RECOMMENDATIONS

In view of the findings of NIOSH's environmental and medical study, as well as personal communication with individuals at Molitor, the following recommendations are made to provide a better work environment for the concerned employees.

1. Engineering controls are the perferred method for reducing or eliminating exposures. In this case both lead and tin exposures could best be controlled by exhausting or blowing the contaminant away from the operator's breathing zone. This could be accomplished by providing a continuous current of air across the area of exposure or a portable exhaust system which would remove the contaminant as the worker performs his job. It is NIOSH's opinion that the most efficient and cost effective method would be an industrial type fan which would dilute the contaminant in the breathing zone.

2. All of the employees in the welding of lead plates and soldering operations where tin is involved should wear all of the protective equipment provided. This would include face shields when necessary and NIOSH/MSHA approved respirators. Also, eye protection for the welders and their assistants should be mandatory.

   Special concern must be taken when the welding/fusing of the lead plates in CONFINED SPACES occurs. This is also true when soldering with predominantly high concentrations of tin compounds in confined areas. The use of the engineering controls described above should reduce this problem considerably.

3. Smoking should not be permitted on lead jobs. Further, smoking materials should not be allowed in this work area.

4. Consideration should be given to a lead monitoring program utilizing FEPs (or ZPPs). Blood lead determinations would only be necessary if the FEP is elevated. ZPPs have the advantage that they can be done on a drop of blood from a finger-stick; they could be done quarterly on workers intermittently exposed to lead work. If a worker should be exposed in the future for greater than 30 days per year, they should have blood lead determinations every six months, and more frequently if they are over 40 ug/deciliter.

IX. 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, 4676 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.

Copies of this report have been sent to:

1. Molitor Industries, Inc.
2. U.S. Department of Labor/OSHA - Region VIII.
3. NIOSH - Region VIII.
4. Colorado State Department of Health.
5. State Designated Agency.

For the purpose of informing affected 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

PERSONAL AIR SAMPLES FOR LEAD AND TIN

Molitor Industries, Inc.
Englewood, Colorado

Job Description	Sampling Time (minutes)	mg/M^3 Lead	mg/M^3 Tin
June 1982			
Welder	420	0.3*	NA
Welder Assistant	540	0.03	NA
Solderer	540	NA	0.39*
Solderer	540	NA	ND
December 1982			
Welder	420	0.03	NA
Welder Assistant	420	0.01	NA
Welder	420	0.01	NA
Welder Assistant	420	0.01	NA
EVALUATION CRITERIA	OSHA	0.05	0.1
	OSHA Action Level	0.03	---
	NIOSH	0.05	0.1
LABORATORY LIMIT OF DETECTION		3 ug	5 ug

mg/M^3 = milligrams of substance per cubic meter of air
NA = Non-applicable
ND = nondetectable
ug = micrograms
* = refers to levels which exceeded NIOSH criteria or OSHA standard