HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT
HETA 88-268-L1980
FEDERAL-MOGUL CORPORATION
MALDEN, MISSOURI
JULY 1989

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226

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NIOSH INVESTIGATORS:
William Daniels, CIH
Jou-Fang Deng, M.D.
Steven Lee, CIH

I. INTRODUCTION

On May 25, 1988, NIOSH received a request from a representative of the International Molders and Allied Workers Union, Local Union 43, to conduct a Health Hazard Evaluation at Federal-Mogul Corporation, Malden, Missouri. The requestor was concerned with employee exposures to metalworking fluids and emissions from a tin plating operation used in the manufacture of automobile pistons.

In response to this request, a combined medical-environmental site visit was conducted at the Federal-Mogul Corporation facility on September 14th and 15th, 1988. An opening conference was held with management and union representatives during which the basis for the request was discussed, along with the nature of the plant operations. Following this meeting, a walk-through inspection of the facility was conducted. During the course of the survey, confidential interviews were conducted with thirteen employees who worked at the plant, material safety data sheets and the plants metalworking fluid maintenance and dermatitis prevention program were reviewed, and environmental samples were collected to assess airborne concentrations of total particulate, inorganic tin, and sodium hydroxide. The results of the environmental survey were transmitted to the requestor and company by letter on January 6, 1989.

II. BACKGROUND

Federal-Mogul Corporation, Malden, Missouri, produces pistons, primarily for use in automobiles. At the time of the survey the plant had been in operation for 25 years. The area of concern in this request was the Finishing Department, where machining and tin plating of the pistons is carried out. This area employed a total of 152 workers over three shifts.

The pistons, which are composed of an aluminum alloy, are machined to their final tolerances in the Finishing Department of the plant. The machining operations are divided into two groover lines, one Excello line, and one grinder line. Approximately ten employees per shift work at each of these lines. Each groover line is supplied by a central metalworking fluid or "coolant" reservoir system. A mixture of two different "water-soluble" or water-emulsifiable coolants is used for these operations. The Excello and grinder lines are supplied by a separate central coolant system which also uses a water-emulsifiable fluid. One plant engineer is responsible for maintaining the coolant systems. A plant maintenance employee is responsible for regular monitoring of the coolant system parameters. Engineering controls on the machinery included splash guards, general ventilation, and local exhaust ventilation at individual machines.

The tin plating line is also located in the Finishing Department. This operation is used to deposit a thin layer of tin onto the pistons. The parts to be plated are loaded onto a conveyor, which automatically passes them through a series of solutions. These solutions include an alkaline spray wash, an alkaline soap cleaner, an acid deoxidizer, and stannate tin plating baths. The plating line is operated by two employees who are responsible for loading and unloading the parts, as well as maintaining the plating solutions. Engineering controls on the plating line include bath enclosures and local exhaust ventilation.

III. MATERIALS AND METHODS

A. Environmental

On September 15, 1988, an environmental survey was conducted at Federal-Mogul Corporation. During the survey, material safety data sheets and the company's coolant maintenance and dermatitis prevention programs were reviewed. In addition, environmental samples were collected to assess employee exposures to airborne contaminants from the machining and tin plating operations. During this survey, personal breathing zone (PBZ) air samples were collected near the breathing zone of the employees, and area samples were collected at locations in the general vicinity of some of the operations being conducted. Samples were collected using battery-powered pumps operating at a controlled flow rate. The pumps were attached by Tygon tubing to the appropriate collection media. A brief overview of the rationale for sample collection and the specific methodologies used is included below.

Due to their varied composition, several difficulties are encountered when attempting to quantify airborne concentrations of metalworking fluids. Traditionally, mineral oil mist has been sampled for using a methods such as fluorescence or infrared spectrophotometry.[1] However, the water-emulsifiable metalworking fluids, such as those encountered during this survey, are not readily analyzed by these methods. Therefore, in order to estimate the airborne concentration of metalworking fluid, a methodology was used which assessed the total weight of all airborne particulate. Since metallic components from the work piece can contribute to the total particulate weight on the sample, side-by-side area air samples were also collected at each of the machining lines to determine the contribution of the metallic components to the total particulate weight.

Samples for total airborne particulate were obtained using battery-powered sampling pumps operating at 2.0 liters of air per minute (lpm). The pumps were attached with Tygon tubing to the collection media which consisted of pre-weighed polyvinylchloride (PVC) filters contained in 2-piece plastic cassettes. The samples were analyzed for total weight using NIOSH Method 7300.[1]

Samples for trace metal content were obtained in the same manner except that the collection media consisted of 37-millimeter (mm), 0.8

micron pore size, mixed-cellulose ester membrane filters contained in 3-piece plastic cassettes. The samples were analyzed for 30 trace metals using inductively coupled plasma - atomic emission spectroscopy in accordance with NIOSH Method 7300.[1]

Among the contaminants which would be expected to be released from the tin plating operation would be sodium and potassium hydroxide from the alkaline cleaning solutions, as well as tin salts from the mists created at the tin plating baths. In order to assess exposures to sodium hydroxide, general area air samples were collected using battery-powered sampling pumps operating at 1.5 lpm attached with Tygon tubing to a collection media consisting of 37-mm diameter, 1.0 micron pore size, polytetrafluoroethylene (PTFE) filters contained in two-piece plastic cassettes. The samples were analyzed for alkaline dusts, as sodium hydroxide, using an acid-base titration in accordance with NIOSH method 7401.[1]

PBZ samples for tin were collected in a similar manner at a flow rate of 2.0 lpm using a collection media consisting of 37-millimeter, 0.8 micron pore size, mixed-cellulose ester membrane filters contained in 3-piece plastic cassettes. The samples were analyzed for inorganic tin using atomic absorption spectroscopy.

B. Medical

During the survey on September 14 and 15, 1988, confidential medical interviews were conducted with thirteen of the employees working on the various shifts. In addition, the employees were examined for the presence of dermatitis.

IV. EVALUATION CRITERIA

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 important; however, 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 preexisting 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 often are 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 becomes 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 (TLVs), 3) the U.S. Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards [Permissible Exposure Limits (PELs)]. Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more recent information than are the OSHA standards. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that the company is required by the Occupational Safety and Health Administration to meet those levels specified in 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. A short-term exposure limit (STEL) is a 15-minute time weighted average. A ceiling (C) value is the employees instantaneous exposure exposure which should not be exceeded at any time during the work-shift unless a time period is specified.

Following is a brief discussion of the major contaminants evaluated during this survey, as well as their evaluation criteria.

A. Cutting and Grinding Fluids

As previously discussed, the composition of metalworking fluids varies greatly. The fluids evaluated in this survey would be classified as "emulsions", which are often referred to as water soluble fluids. These fluids are composed of severely hydrotreated and/or severely solvent-refined petroleum oils to which emulsifiers and other substances have been added. The majority of the health effects studies of metalworking fluids have centered on exposure to mineral oil mist of petroleum-based fluids. A 1962 review of literature associated with the use of several types of oils found a "striking lack of illness related to oil mist inhalation."[2] Experimental animal studies of exposures to mineral oil mist and solvent-extracted naphthenic-base oils did not reveal any significant histologic changes or health effects to the animals exposed.[3] Based on this information, the ACGIH recommends a TLV of 5 milligrams per cubic meter of air (mg/M^3) as an 8-hour TWA for mineral oil mist, with a short-term exposure limit of 10 mg/M^3 as a 15-minute TWA.[4] The documentation notes that this TLV may not provide any margin of safety for mineral oils which have been altered by partial heat-decomposition, oxidation, or that may contain certain toxic or carcinogenic components.[3] The OSHA PEL for mineral oil mist is also 5 mg/M^3 as an 8-hr TWA.[5] No environmental criteria were found to exist for any of the coolant additives.

The chief problem which results from exposure to metalworking fluids is contact dermatitis caused by the fluids themselves or certain additives in them. The fluids can act very much like soap upon the skin, removing surface oils and fats and causing the skin to become dry, cracked, and susceptible to infections. In addition, some of the additives occasionally used in these fluids can make matters worse in that they may be primary irritants or sensitizers. Suspended metal particles or shavings in the fluids may have an abrasive action on the skin causing cuts and scratches, which can become infected and further contribute to dermatologic problems.[6]

B. Sodium Hydroxide

Sodium hydroxide is a strong alkali and is corrosive to any tissue with which it comes into contact. Effects of inhalation of the dusts and mists will vary from mild irritation to destructive burns of the respiratory tract depending on the severity of exposure. Effects of skin or eye contact with sodium hydroxide can range from irritation to burns, depending on concentration.[7] The NIOSH REL, OSHA PEL and ACGIH TLV for sodium hydroxide is a ceiling value 2 mg/M^3.[7,5,4]

C. Inorganic Tin Compounds

In general, the toxicity of inorganic tin and its salts is relatively low. With the exception of the oxides, these compounds can cause irritation of the eyes, nose, throat, and skin.[7] The OSHA PEL and ACGIH TLV for inorganic tin compounds are 2 mg/M^3 as an 8-hour TWA.[5,4]

V. RESULTS

A. Environmental

The results of the environmental samples collected to assess airborne exposure to the metalworking fluid are presented in Table 1. TWA concentrations of oil mist (measured as total particulate) in the seven PBZ samples collected ranged from 0.14 mg/M^3 to 1.08 mg/M^3, with a mean concentration of 0.43 mg/M^3. These concentrations are below the OSHA PEL and ACGIH TLV of 5 mg/M^3 (as an 8-hour TWA) for mineral oil mist. TWA concentrations of oil mist in the three area samples collected ranged from 0.18 mg/M^3 to 0.95 mg/M^3, with a mean concentration of 0.50 mg/M^3. The analysis for 30 trace metals which was conducted on the side-by-side samples collected at these same sample locations revealed that, with the exception of trace amounts of iron and magnesium found in the area sample collected at the groover, no other metals were detected above their respective limits of detection (Table 1). It should be noted that the analytical method used would also measure ambient "dust" concentrations in the air. While visual observations did not indicate that the environment contained excessive airborne dust, the actual concentrations of oil mist would be expected to be somewhat lower than the reported values due to the background dust which would normally be present.

The results of the air samples collected at the tin plating operation are contained in Tables 2 and 3. As evidenced by these data, no tin was found above the limit of detection of 4 micrograms (ug) per sample in the two PBZ samples collected. Sodium hydroxide was not found above limit of detection of 30 ug per sample in the two area samples collected.

B. Medical

During our site-visit on September 14-15, 1988, 13 workers were interviewed and examined from both the morning and afternoon work shifts. The workers interviewed included tin platers and grinder, groover, and Excello operators. They had been employed at the facility an average of 9.5 years (range: 1 to 20 years). Among the workers interviewed, 10 complained of recurrent skin rash. Two of these workers were found to have eczema with lichenification on their hands. The workers who reported a skin rash all felt that their rash was related to contact with metalworking fluids. Other symptoms, such as cough, chest pain, breathing difficulty, and mucous membrane irritation, were also reported. The workers related their irritant symptoms to exposure to fumes or vapors generated during the metal machining and and tin plating operations.

C. Review of Fluid Maintenance and Dermatitis Prevention Programs

The company had in place an aggressive program to maintain the coolant systems. Daily monitoring of the coolant is conducted, along with weekly laboratory analysis of coolant characteristics. Several engineering changes had been implemented to help maintain the coolant and prevent worker exposure. Proportionate pumps had been installed in each of the central coolant systems to help maintain the proper coolant concentrations. New flexible lines had been installed at the steel groovers to help better direct the fluid onto the work area. Improvements had recently been made to the splash guards on the machines. This included the installation of new pneumatic cylinders to lift the guards so that the coolant would not drip on the operators' arms, as well as new plastic fasteners which would be more resistant to the fluid.

Attempts had also been made to better control coolant odors by implementing new cleaning procedures for individual machines and the central coolant systems. Electrical switches were also installed to allow the coolant to circulate in the machines during down time and on weekends when the machines are not in use. A maintenance log had been established to monitor the oil use from each of the machines. This helped to identify and quickly repair those machines releasing tramp oil (internal machine oil) into the coolant system. A centrifuge was used to remove the tramp oil, and attempts were made to maintain tramp oil levels below two percent.

Employee training regarding dermatitis prevention was conducted on a regular basis in accordance with the company's Hazard Communication Training Program. Washrooms with lotion soaps and barrier creams were also provided for the workers use. Gloves and other protective equipment were also available as needed. Employees developing dermatitis were referred to a local physician for treatment.

VI. CONCLUSIONS AND RECOMMENDATIONS

During the environmental survey, airborne concentrations of the metalworking fluids were found to be well below the environmental evaluation criterion for oil mist. However, since there is not conclusive evidence regarding the safety of all of the various coolant additives which are in use, the company should continue to maintain the local exhaust ventilation systems to keep coolant exposure as low as possible. Periodic testing and maintenance of these units should also help to minimize upper respiratory irritation associated with the machining operations.

Employee exposures to tin and sodium hydroxide at the tin plating operation were also found to be well below the evaluation criteria. In general, the health hazards associated with tin plating operations are minimal due, in part, to the high current efficiency (and hence, low rate of misting) associated with tin plating and the relatively low toxicity of the components.[8] The presence of enclosures and local exhaust ventilation helps to further minimize the exposures. The use of the air-moving fans in the immediate vicinity of this operation should be discouraged since it can detract from the effectiveness of the local exhaust ventilation. In addition, continued emphasis should be placed on use of the proper personal protective equipment when maintaining the solutions, since many of these substances can cause severe irritation and burns in their concentrated form.

As evidenced by the employee interviews and medical examinations, dermatitis continues to be a problem among some employees working at the machining operations. Contact dermatitis (irritant and allergic) is a well recognized problem in the metalworking industry. Duration of skin exposure, bacterial contamination of the metalworking fluids, and suboptimal personal hygiene (e.g. inadequate handwashing) are also risk factors for development of contact dermatitis. The company should continue with their present coolant maintenance and employee education efforts to help reduce the incidence of dermatitis. Increased emphasis should be placed on a medical surveillance program for the early detection of metalworking fluid-related skin problems and complications. Once a workers develops dermatitis or another complication related to his/her use of the fluids, further exposure should be avoided. Workers developing dermatitis, should be seen by a dermatologist. Patch testing may be appropriate if the dermatitis is suspected to be allergic in nature and sensitizing chemicals are present in the work environment. Once the allergic material is identified, the worker should avoid further exposure to this substance, but he/she may be able to work with other substances.

VII. REFERENCES

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Table 1

Results of Environmental Samples for Oil Mist* and Trace Metals**
Federal Mogul Components Group
Malden Industrial Park, Malden, Missouri
September 15, 1988

Sample Type	Sample Description	Sample Time (minutes)	Sample Volume (liters)	TWA Concentration Oil Mist* (mg/m3)
Personal	Excello #2 Operator	426	852	0.14
Personal	Groover #12 Operator	423	846	1.08
Personal	Groover #5 Operator	429	858	0.61
Personal	Groover #16 Operator	415	830	0.39
Personal	Excello #5 Operator	417	834	0.25
Personal	Grinder #8 Operator	372	744	0.26
Personal	Grinder #1 Operator	406	812	0.30
Area**	Grinder #8	152	304	0.36
Area**	Groover #15	373	746	0.95
Area**	Excello #5	373	560	0.18

Evaluation Criteria: Oil Mist*
OSHA PEL 5 mg/m^3 as an 8-hour TWA
ACGIH TLV 5 mg/m^3 as an 8-hour TWA, 10 mg/M^3 STEL

Abbreviations and Key
TWA - Time-weighted average
* Measured as total particulate weight
mg/m^3 - milligrams per cubic meter of air
** An analysis for 30 metals was also conducted on side-by-side samples collected at these sample locations. With the exceptions of trace amounts of iron and magnesium found in the area sample collected at the groover, no other metals were detected. The following indicates the metals that were examined followed by their respective detection limit in micrograms. Aluminum (10), Arsenic (5), Barium (1), Beryllium (1), Calcium (5), Cadmium (1), Cobalt (1), Chromium (1), Copper (1), Iron (1), Lithium (5), Magnesium (1), Manganese (1), Molybdenum (1), Nickel (1), Lead (2), Phosphorus (10), Platinum (10), Selenium (10), Silver (2), Sodium (50), Tin (10), Tellurium (10), Thallium (10), Titanium (10), Tungsten (10), Vanadium (1), Yttrium (1), Zinc (1), Zirconium (10)

Table 2

Results of Environmental Samples for Tin
Federal Mogul Components Group
Malden Industrial Park, Malden, Missouri
September 15, 1988

Sample Type	Sample Description	Sample Time (minutes)	Sample Volume (liters)	TWA Concentration Tin (mg/m3)
Personal	Plater Specialist	416	832	< LOD
Personal	Plater Helper	413	826	< LOD

Evaluation Criteria - Inorganic Tin Compounds (as Tin)
OSHA PEL: 2 mg/m^3 as an 8-hour TWA
ACGIH TLV: 2 mg/m^3 as an 8-hour TWA

Table 3

Results of Environmental Samples for Sodium Hydroxide
Federal Mogul Components Group
Malden Industrial Park, Malden, Missouri
September 15, 1988

Sample Type	Sample Description	Sample Time (minutes)	Sample Volume (liters)	TWA Concentration Sodium Hydroxide (mg/m3)
Area	On Tin Plater Control Console	378	852	< LOD
Area	Above Tin Bath at Center of Plating Line	376	846	< LOD

Evaluation Criteria - Sodium Hydroxide
NIOSH REL: 2 mg/M^3 Ceiling (15--minute)
OSHA PEL: 2 mg/m^3 Ceiling
ACGIH TLV: 2 mg/m^3 Ceiling

Abbreviations and Key
TWA - Time-weighted average
mg/m^3 - milligrams per cubic meter of air
< LOD - Less than the limit of detection of 4 micrograms per sample for tin, and 30 micrograms per sample for sodium hydroxide.