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

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 76-97-430

FMC CORPORATION - CHAIN DIVISION
INDIANAPOLIS, INDIANA

SEPTEMBER 1977

I. TOXICITY DETERMINATION

The following determinations have been made based upon environmental air samples collected on March 28-31, 1977, employee interviews concerning any symptomatology which may be attributed to the work environment, and available toxicity information:

A. Employees' exposure to airborne total nuisance particulates, oil mists, iron oxide, aluminum, molybdenum, cadmium, lithium, arsenic, selenium, nitric oxide, nitrogen dioxide, petroleum distillates as aliphatic solvents--"140 flash", perchloroethylene, dichloromethane, benzene, toluene, and carbon monoxide did not pose a health hazard at the time of this environmental evaluation in Departments 119, 105, and 121.

B. Employees' (compacting machine operator and induction machine operator in Department 119 and coupling machine operator in Department 105) exposure to airborne nickel did pose a potential health hazard at the concentrations measured at the time of this environmental evaluation. It is noted that the special mix used during this evaluation is processed only a few weeks during the year. Employees' exposure to nickel during the processing of the normal mix should not pose a problem as the concentrations of nickel are lower by over an order of magnitude compared to the special mix used during the survey.

C. Employees' exposure to airborne fluorides, silver, copper, zinc, nickel, cadmium, selenium, and arsenic did not pose a health hazard at the concentrations measured at the time of this environmental evaluation during silver soldering operations in Department 108-T.

D. Employees may be occasionally exposed to smoke and fumes containing significant concentrations of oxides of nitrogen, nitrogen dioxide, carbon monoxide, and related compounds during malfunctioning of furnace operations in Departments 119 and 121. This is based on knowledge of production conditions, discussions with management and union representatives concerning operational conditions or malfunctions, medical symptomatology and similar information elicited during the survey.

Detailed information concerning the results of this evaluation are contained in the body of the report. Recommendations are also included to alleviate observed and potential hazards noted during the survey.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services; Information 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:

a) FMC Corporation-Chain Division, Indianapolis, Indiana
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region V
d) NIOSH - Regions V and VII

For the purpose of informing the approximately 165 "affected employees", the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where exposed employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of Local 1150 of the United Steel Workers of America regarding the employees' alleged complaints of "large amounts of powdered metal dust; molybdenum; powdered metal binder; continually filling air - frequent amount of smoke from adjoining heat treat, eye irritation and irritations to breathing". The initial request also specified heat and noise as a problem area. Although we did provide some initial advice and consultation on heat and noise, there were no in-depth evaluations made on heat and noise as physical agents are not covered under Section 20(a)(6) of the basic Act referenced in the previous paragraph. Therefore, heat and noise are not included as part of this report.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

The initial request covered Departments 105 and 119 and was subsequently expanded (per agreement and request from both management and union) to include Department 121. Departments 105, 119 and 121 adjoin each other and this contributes to the overall environmental conditions in these departments. Department 105 is involved with the manufacturing of various metal chains which are widely used in the automobile and related industries. These operations involve the use of several highly automated machines which automatically put the parts (e.g., links, bushings, etc.) together, couples, and strength tests the chains. The final chains are dipped in a tank containing mineral spirits and rust preventatives, and then final packaged for shipment. These parts are primarily iron metal parts. Department 119 is involved with the manufacturing of various gears, cams and sprockets which are widely used in the automobile and related industries. This involves mixing of various metallic fines and other components for compaction by large presses, heat treatment, induction heating and milling or other machine operations. Ancillary operations include wheelebrator, plastic injection molding operations, boring and machining operations, and subsequent quality control testing. Both iron and aluminum based parts are involved in these operations. Department 121 is involved primarily with the heat treatment of various small parts (e.g., links, bushings, etc; primarily iron based metals) as well as the use of quenching oils, rust preventatives and similar compounds used in such operations. It should also be noted that Departments 105 and 119 also use various cutting fluids, oils and rust preventatives.

Silver soldering operations were evaluated in Department 108-T Tool Room. This operation involves one employee (on any one day) out of three employees and is conducted in a separate area away from Departments 105, 119 and 121.

B. Evaluation Progress and Methods

1. Progress

An initial walk-through survey was conducted on August 10-11, 1976. Bulk samples and a few general area air samples were obtained during the initial survey to better identify potential exposures. Approximately 39 employees were interviewed (medical standpoint - symptomatology and work plus medical history) to more fully quantitate the complaints from employees.

Subsequent contacts were made with various manufacturers of products used in the departments covered by this evaluation and to FMC management to more fully quantitate potential exposures. A follow-up environmental survey was made during March 28-31, 1977. Several employees (approximately 20 employees in all departments) were questioned concerning any occupationally related health problems. Bulk samples on some formulations (as used) were obtained on April 1, 1977, for microbiological analysis of the samples. Appropriate entrance and exit interviews were held with representatives of management and union. The main reason for the time delay between the initial survey and the follow-up survey on this evaluation is due to the fact that there was an interim strike by the union.

In reviewing the data contained in the background information of this report, it is noted that we made several recommendations during the exit interview at the time of the initial walk-through survey. Many of these recommendations (e.g., local ventilation at mixing operations, etc.), particularly concerning silver soldering operations and mixing operations, were already implemented by management at the time of the follow-up survey. This report emphasizes the results of the follow-up evaluation.

2. Environmental Methods

Personal and general area air samples were used to evaluate employee exposures. The personal samples were obtained by attaching the pump to the worker's belt with the sampling media (e.g., filter, charcoal tube) in a holder attached to the lapel of the worker to obtain a representative sample of air in the breathing zone of the worker. Samples were obtained for a sufficient period of time so that for all practical purposes they may be considered as eight-hour time-weighted averages. General area samples were obtained at selected fixed locations in close proximity to operations.

Samples for the determination of airborne concentrations of organic vapors were collected by absorbing vapors onto charcoal or silica gel contained in glass sampling tubes at a sampling rate of 0.2 liters per minute (lpm). The sampling tubes were transmitted to the laboratory for analysis by gas chromatography.[1] Samples for the determination of total nuisance particulates were collected by capturing the particulates or mists on tared vinyl metracell filters at a sampling rate of 1.7 lpm. These samples were analyzed gravimetrically.[1] Samples for the determination of oil mists were obtained with mixed esters of cellulose membrane filters (0.8 micron average pore size) at a sampling rate of 1.7 lpm. These samples were analyzed spectrofluorometrically for oil mists.[1] Samples for the determination of iron, arsenic, selenium, nickel, aluminum and other metals were obtained in the same manner as oil mists but were analyzed via atomic absorption methods.[1] Impinger samples with various absorbing solutions (e.g., triethanolamine solution for nitrogen dioxide, etc.) were obtained by bubbling air through the solution at a sampling rate of 1 lpm. The impinger samples were analyzed by methods specified in reference one for the specific compounds. Bendix, MSA and/or Draeger detector tubes with respective pumps were also used for evaluation of potential exposures to various contaminants such as oxides of nitrogen and nitrogen dioxide. Bulk samples of the various mixtures were also obtained for analysis and use in analysis of the environmental samples.

A few general area air samples were obtained around the injection molding and compacting machines and analyzed for ethylenediamine and hexamethylenediamine. Several general area and personal samples were obtained around the injection molding operations and analyzed for methylene chloride, heptane, and Freon® 12 (1,2-dichlorodifluoromethane). Detector tube samples were obtained for triethylamine and triethanolamine around various operations (e.g., use of rust preventatives, decomposition products - compactor press, etc.) where there may be a possibility of exposure to these compounds. Detector tube samples were also obtained for formaldehyde during the purging and normal operations of the injection molding machines. The results of most of these samples were not detectable, although some samples (e.g., methylene chloride, Freon® 12, etc.) were detectable at very low levels for these compounds. Therefore, employee exposures to Freon® 12, heptane, methylene chloride, formaldehyde, ethylenediamine, hexamethylenediamine, triethanolamine, and triethylamine are not considered further in this report as they were not considered as a hazard at the time of the survey.

3. Medical Methods

Approximately 22 swing and 17 day shift employees were interviewed during the initial walk-through survey. A brief questionnaire was then completed containing identification data. An occupational history and a history of complaints related to work were obtained. Skin and respiratory irritation and other symptoms were elicited which may be work related. Separate discussions were held with several employees in each department to elicit any complaints or health problems related to the work environment during the evaluation conducted in March 1977.

C. Evaluation Criteria

1. Environmental Criteria

The three primary sources of environmental evaluation criteria considered in this report are: (a) NIOSH Criteria Documents with recommended standards for occupational exposure; (b) American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's) with supporting documentation; and (c) Federal Occupational Health Standards as promulgated by the Occupational Safety and Health Administration, U.S. Department of Labor (29 CFR 1910.1000). For the substances evaluated during this study, the primary environmental criteria used were:

SUBSTANCE	STANDARD OR GUIDE mg/M3*
Total Nuisance Particulates	10.0 (b)**
Oil mists, particulate (mineral)	5.0 (b,c)
Iron oxide fume	5.0 (b)
Aluminum as alundum (Al_2O_3)	10.0 (b)
Nickel, inorganic and compounds	0.015 (a)
Molybdenum - soluble compounds	5.0 (b,c)
Cadmium	0.04 (a)
Lithium as lithium hydride	0.025 (b)
Arsenic	0.002 (a) (15 minute sampling period)
Selenium compounds (as Se)	0.2 (b,c)
Copper - dusts and mists	1.0 (b)
Zinc - zinc oxide	5.0 (a,b,c)
Fluorides, inorganic	2.5 (a,b,c)
Silver, metal and soluble compounds (as Ag)	0.01 (b,c)
Carbon monoxide	38.5 (a)
Nitric oxide (NO)	30.0 (a,b)
Nitrogen dioxide (NO_2)	1.8 (a) (15 minute sampling period)
Petroleum distillates as aliphatic solvents - "140 flash"	150.0 (b)
Perchloroethylene	335.0 (a)***
Dichloromethane (methylene chloride)	108.0 (a)
Benzene	3.2 (a)****
Toluene	375.01 (a,b)

*Approximate milligrams of substance per cubic meter of air sampled.

**Reference letters in parentheses refer to the source(s) from the above discussion from which the standard or guide was obtained.

***In case of a mixture of air contaminants particularly with organic solvents, the overall effects are considered as additive. An employer shall compute the equivalent exposure as follows:

$$*E_m = \frac{C_1}{L_1} + \frac{C_2}{L_2} \cdots \frac{C_n}{L_n}$$

Where:

Em is the equivalent exposure for the mixture.
C is the concentration of a particular contaminant.
L is the exposure limit for that contaminant, from Table Z-1, Z-2, or Z-3.

*The value of EM shall not exceed unity or 1.

****The current ACGIH-TLV for benzene is 30 mg/M^3 with a reference that benzene is a chemical substance associated with industrial processes which are suspect of inducing cancer in man. However, recent studies from clinical as well as from epidemiological data are conclusive at this time that benzene is leukemogenic because it produces progressive, malignant disease of the blood-forming organs. Based on this more recent data, NIOSH recommended to OSHA that an emergency standard for benzene be 3.2 mg/M^3. OSHA has recently published an emergency standard for benzene of 3.2 mg/M^3.

Occupational health exposure limits for individual substances are generally established at levels designed to protect workers occupationally exposed on an eight-hour per day, 40-hour per week basis over a normal working lifetime.

2. Medical Criteria

a. Toxic Substances Data[2,3,4]

(1) Total Nuisance Particulate or Dusts; including Aluminum as Alundum

Nuisance dusts have few adverse effects on the lungs and do not produce significant disease or toxicity when exposures are kept under reasonable control. These dusts are presumably biologically inert so that when inhaled the architecture of the alveoli remains intact, little or no scar tissue is formed, and any reaction provoked is potentially reversible. Excessive concentrations in workroom air may reduce visibility, cause unpleasant accumulations in the eyes, ears, and nose, and secondarily cause injury to the skin due to vigorous cleansing procedures necessary for their removal.

(2) Oil Mists

The primary effects of mineral oil are upon the skin. Dermatitis remains a common problem among workers coming in contact with such oil. Oil acne and folliculitis result from mechanical blockage of the follicular openings in skin contact areas. This results in comedones (blackheads) and papular lesions (pimples or white heads) associated with varying degrees of inflammation. In occasional cases, secondary infection in the primary lesions of oil folliculitis have been observed and in such cases the individual's skin or nose is the source of the offending agent.

The health standard for oil mist (mineral) of 5 mg/M^3 refers to airborne mist of petroleum-base cutting oils or white mineral petroleum oil. Experimental findings indicate that heat-decomposed oil fumes are irritant but do not result in changes in the lungs at 5 mg/M^3. Theoretically, the inhalation of extremely high levels of oil mists could result in lipid pneumonitis. This has not been reported to be a problem in industry.

(3) Iron Oxide (Fe_2O_3)

Inhalation of iron oxide fume or dust causes an apparently benign pneumoconiosis termed siderosis. Fe_2O_3 alone does not cause fibrosis in animal's lungs and the same probably applied to humans. Six to ten years of exposure to high concentrations of Fe_2O_3 is usually required before X-ray changes occur. Numerous studies of those exposed to welding fumes who had X-ray changes had normal spirograms but lung compliance was reduced and those with the most severe reduction complained of dyspnea. Such medical problems should not occur at levels less than the environmental criteria of 5 mg/M^3.

(4) Nickel, Inorganic Compounds[5]

Many lung cancers and nasal cancers in nickel refinery workers appear to have been induced by inorganic nickel, and no single nickel-containing substance can be implicated as the causative agent. NIOSH, therefore, recommends that all forms of inorganic nickel be controlled as carcinogens. NIOSH has also found that workers can be adversely affected by skin contact with nickel, and that because nickel is often found in the non-occupational environment, some individuals may develop a sensitivity to nickel regardless of precautions taken in the workplace. It is recognized, therefore, that the recommended standard cannot completely protect these individuals from developing recurrent dermatitis when occupationally exposed to nickel. However, the recommended standard will greatly reduce the risk of unsensitized workers becoming sensitive to nickel in the course of their employment.

(5) Molybdenum (Mo)

Molybdenum compounds exhibit a low order of toxicity. Molybdenum is an essential trace element as it functions as a Mo-flavoprotein in electron transport in the body. It is reported to be selectively concentrated in the liver and kidney, with high concentrations in the endocrine glands. Signs of molybdenum poisoning are loss of appetite, listlessness, diarrhea, and reduced growth rate.

(6) Cadmium

Acute cadmium fume poisoning, with lung edema being the outstanding sign, has been reported relatively frequently. Non-fatal pneumonitis has been reported from concentrations between 0.5 and 2.5 mg/M^3 and relatively mild case have been attributed to even lower concentrations. It has been reported for chronic exposures that there is an increase in urinary protein (beta-2 microglobulin) and moderate anemia in workers exposed to cadmium fume in concentrations ranging from 0.075 to 0.24 mg/M^3.

(7) Lithium as Lithium Hydride

The inherent toxicity of the lithium ion is relatively high, a few milli-equivalents in the plasma giving rise to serious signs and symptoms referable to the nervous system. These include anorexia, nausea, tremor, muscle twitches, apathy and mental confusion. Lithium hydride is an intensely irritating and corrosive material to the skin, eyes and respiratory tract.

(8) Arsenic

The chief effects of inhalation of dusts of inorganic arsenic compounds are irritation of the skin and injury to the mucous membranes. Ulcers and performation of the nasal septum are not uncommon among arsenic workers. Chronic long-term exposure at low levels of inorganic arsenic may result in lung cancer. One of the chief effects of exposure to arsenic compounds is dermatitis.

(9) Selenium Compounds

The chief effects of exposure to selenium are garlic odor of breath, skin rashes, indigestion, metallic taste and sore throats. Intense irritation of the eyes, nose and throat, followed by a headache has been reported in a group of workers[6] briefly exposed to high concentrations of selenium. The current TLV of 0.2 mg/M^3 should prevent systemic toxicity and minimize the irritant effects.

(10) Copper

Inhalation of copper either as a dust, fume, or mist may result in congestion of the nasal mucous membrane which can lead to ulceration and perforation of the nasal septum. In chronic exposures, the liver, kidneys, and spleen may be injured and can cause anemia. Acute exposures to copper cause gastrointestinal irritation, mainly to the nerve endings in the stomach, and immediately cause vomiting. The evaluation criteria of 1 mg/M^3 has a large safety factor, and worker exposures maintained at or below this level should eliminate any physiological damage.

(11) Zinc

The toxicity of zinc compounds by mouth is low. Metal fume fever (zinc chills, brass founders ague, etc.) may result from inhalation of zinc oxide fumes or finely divided dusts. Mild gastric disturbances or symptoms have been attributed to exposure to zinc.

(12) Fluoride

The toxic effects of fluoride have been placed in three groups by Roholm[7]: (a) acute systemic intoxication (usually by ingestion; (b) local corrosion and irritation of the mucous membranes and skin; and (c) chronic bone changes ranging from mottling of tooth enamel to crippling skeletal abnormalities. The limit of 2.5 mg F/M^3 is sufficiently low to prevent irritative effects and to protect against disabling bone changes.

(13) Silver

Argyria is a cosmetic defect which consists of an unsightly, permanent blue-gray discoloration of the skin, mucous membranes and eyes; appears to be the main pathologic effect from accumulation of silver in the body.[8] This may result from inhalation or ingestion of silver salts, such as nitrate or fulminate, while localized argyria may be caused by penetration of the skin by fine particles of metallic silver.

(14) Carbon Monoxide

Symptoms such as headache, fatigue, and dizziness appear in healthy workers engaged in light labor when approximately ten percent of the hemoglobin is combined with carbon monoxide. Such a degree of saturation could be achieved by continously breathing air containing 55 mg/M^3 of carbon monoxide for approximately six to eight hours. Carbon monoxide forms metastable chemical compounds, primarily with the hemoglobin and secondarily with other biochemical constituents, which in a complex manner reduces the availability of oxygen for the cellular systems of the body. The effect of carbon monoxide exposure on man is enhanced by many environmental factors such as heavy labor, high environmental temperatures and altitudes above 2,000 feet.

(15) Oxides of Nitrogen and Carbon Monoxide (nitric oxide - NO and nitrogen dioxide - NO_2)

The chief toxic effect of NO has been ascribed to the formation of methemoglobin and subsequent action on the central nervous system. Available information on the mechanism of NO intoxication suggests that in mixtures with carbon monoxide as well as NO_2, additive effects should be assumed. NO_2 is a strong irritant to the eyes, nose and upper respiratory tract. NO_2 has a distinct odor around 5-10 mg/M^3. The acute and usually delayed effects of higher concentrations of nitrogen dioxide on man are well-established. After the initial response of irritant cough, which is often associated with mild headaches and dyspnea, there is a characteristic remission of symptoms for up to 12 hours before the onset of acute and potential lethal pulmonary edema. If the patient recovers from the first phase of edema, there may be no further symptoms arising from the exposure incident. Relapses have been recorded in the form of a second attack (few days to several weeks) of acute dyspnea, cough and fever. The evidence suggests that, in most cases, if the patient survives this serious stage, total recovery takes place. The effects of the preceding paragraphs (14 & 15) are normally considered as additive due to the similar symptomology.

(16) Organic Solvents (toluene, petroleum distillates, dichloromethane, and perchloroethylene (tetrachloroethylene)

The acute effects resulting from excessive exposure to these agents are generally similar although there are some minor differences. The effects are narcotic in appropriate exposures. Toluene has been most extensively studied, and concentrations slightly above the TLV of 375 mg/M^3 give rise to mild fatigue, weakness and paresthesias of the skin. At higher concentrations nausea, headaches, dizziness and confusion appear which may progress (given sufficient exposure) to a loss of coordination and finally unconsciousness. Chronic effects of exposure to such agents may include weakness, dizziness, headaches, fatigue, and in the case of skin contact, dermatitis. For the most part, the effects from each of the organic solvents are considered as additive and may contribute to an additive effect. Symptoms reported concerning perchloroethylene included headache, mild eye, nose or throat irriation, sleepiness and dizziness. At high concentrations perchloroethylene has caused liver or hepatic damage or injury and will affect the central nervous system. It is believed that concentration of perchloroethylene and the other solvents covered by this paragraph, below the suggested environmental criteria will prevent serious narcotic effects, and that chronic intoxication involving hepatic or central nervous system effects is unlikely if concentrations are maintained below this level.

(17) Benzene

Dermal contact with liquid benzene may cause erythema and blistering of the skin. A dry, scaly dermatitis may develop during prolonged or repeated exposure. Acute exposure produces an initial state of euphoria followed by giddiness, headache, nausea, a staggering gait, and, if not immediately removed from exposure, a state of unconsciouness. In chronic benzene poisoning at lower levels of exposure, symptoms of headaches and sleeplessness, and shortness of breath. The unique aspect of chronic benzene poisoning is its effect on the blood-forming system. Recent studies have reported cases of benzene-related blood dyscrasias (aplastic anemia) and chromosomal aberrations. Although some investigators have observed acute forms of leukemia associated with benzene exposure, a recent connection with chronic leukemia has been alleged. NIOSH recommends that the level of benzene in air be kept as low as possible (3.2 mg/M^3).

(18) Biological Contaminants

The advent of synthetic and semi-synthetic cutting oils that employ large reservoir-holding tanks for recirculation of these fluids has created an area that is conducive to bacterial and presumably other microbiological agent overgrowth. Many species of bacteria have been isolated from these fluids. The most common isolates include pseudomonas, moraxella, alcaligenes, klebsiella, pasturella and escherchia species to name a few. The colony counts in NIOSH studies have ranged from 43,000 per/ml (from holding tank) 2 days after changing the fluid to almost 400,000 per/ml 14 days after changing the same tank[R].

The exact effects or potential harm from high level contamination with wide species variation are unknown. Infections from the bacterial or other health effects from these biological contaminants are variable but do constitute areas of potential toxicity.

D. Results and Discussion

1. Environmental Results and Discussions - Departments 119, 105 and 121.

Table I shows the results of 4 personal and 5 general area air samples for total nuisance particulates. All results were less than ten percent of the environmental criteria of 10 mg/M^3 for total particulates.

Table II shows the results of 34 personal and 7 general area air samples for iron, aluminum, molybdenum, cadmium, lithium, and nickel. With the exception of nickel, all results were less than ten percent of the environmental criteria of 5 mg/M^3 for molybdenum, 5 mg/M^3 for iron, 10 mg/M^3 for aluminum, 0.04 mg/M^3 for cadmium, and 0.025 mg/M^3 for lithium (as lithium hydroxide). Seventeen (17) of the 34 personal and 1 of the 7 general area air samples showed the presence of airborne nickel concentrations. Three of the personal (maximum concentration of 0.18 mg/M^3) and one of the general area (concentration of 0.20 mg/M^3) air samples exceeded the environmental criteria of 0.015 mg/M^3 for nickel. Samples indicate that the maximum exposures are around the mixing and compacting areas in Department 119. It is noted that about 2 weeks a year FMC runs a special mix (0002 WIGPM) containing 1 to 1.5 percent nickel and this mix was being processed during this survey. The mix normally processed in this department contains 0.16 mg of nickel per gram of mix or .016 percent nickel in the mix. Four (4) general area air samples were obtained during the initial survey in and around the mix-compacting area (processing normal mix) and no nickel was detected in these air samples. Hence, the NIOSH investigators do not feel that exposure of employees to airborne nickel should be a problem during the processing of the normal iron mix. It is noted that molybdenum disulfide was

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not being used as a lubricant in Department 105 during the survey, except on a few semi-automated machines during the second day. The four general area air samples obtained during the initial survey were also analyzed for molybdenum. Samples obtained during both surveys showed concentrations less than 5 percent of the environmental criteria of 5 mg/M^3 for molybdenum. Except for this concentration of nickel, the composition of the special mix (0002 WIGPM) and the normal mix used in Department 119 is for all practical purposes the same.

Table III shows the results of 5 personal and 1 general area air samples for arsenic and selenium. No arsenic or selenium was detected on these samples and therefore, are not considered as toxic.

Table IV shows the results of 17 personal and 1 general area air samples obtained for analysis of oil mists. The maximum result was 0.8 mg/M^3 which is well below the environmental criteria of 5.0 mg/M^3 for oil mists.

Table V shows the results of 9 general area air samples obtained for analysis of nitrogen dioxide. The maximum result was 0.06 mg/M^3 which is well below the environmental criteria of 1.8 mg/M^3. In addition, several detector tube samples were obtained of the general breathing zone in all departments for oxides of nitrogen (e.g., NO), nitrogen dioxide (NO_2) and carbon monoxide. A few detector tube samples for nitric oxide were barely positive (around 1 mg/M^3) which is well below the environmental criteria of 30 mg/M^3. All detector tube samples for nitrogen dioxide were less than detectable levels of 1 mg/M^3. Samples for carbon monoxide showed maximum levels of around 10 mg/M^3 which is less than thirty percent of the environmental criteria of 38.5 mg/M^3 for carbon monoxide. A sufficient number of samples were obtained to conclude that exposure of employees to these contaminants (e.g., NO, NO_2 and CO), either separately or when considering the combined effects of these contaminants as additive, did not constitute a health hazard and are not toxic. The exhaust air at a tail pipe (note: not exposure level) from one fork lift truck showed levels of carbon monoxide of around 750 mg/M^3 which along with the various furnaces (burn-off flames, etc.) give rise to the exposure levels of 10 mg/M^3 for carbon monoxide. The furnaces in Departments 121 and 119, particularly when there are operational problems giving rise to visible smoke and fumes, are a source of carbon monoxide and various oxides of nitrogen. Under a different set of environmental conditions such as closed doors, the concentrations of these contaminants may be higher. The concentrations of these contaminants may well be toxic when there are visible smoke and fumes accompanied with appropriate medical symptomatology (e.g., headaches, sore throats, etc.). No such potential toxic conditions were noted during the initial or environmental survey.

Table VI shows the results of 8 personal and 3 personal general area air samples obtained for analysis of aliphatic solvents, perchloroethylene, dichloromethene, and toluene and all samples were less than four percent of the environmental criteria of 150 mg/M^3, 335 mg/M^3, 720 mg/M^3 and 375 mg/M^3 respectively. Ten of the 11 air samples were positive for benzene (maximum concentration of 0.7 mg/M^3) and all samples were less than twenty-five percent of the environmental criteria of 3.2 mg/M^3 for benzene. Even when considering the combined effects ($Em = \frac{C_1}{L_1} + \frac{C_2}{L_2} \, . \, . \, \frac{C_n}{L_n} = 1$) of all the organic compounds covered by this evaluation, employee exposure would be a maximum Em of less than 0.30 or thirty percent of the environmental criteria Em = 1.

Table VII presents the results of microbiology analysis of bulk samples of various oils and cutting oils. Products A and B (product B discontinued after survey) as used showed the colony count of bacteria (>100,000 per cc) in these samples to be excessive and indicates a need to change the solutions on a more frequent basis. In addition one sample (product B) showed the presence of the fusarium species of fungus which is also indicative of a need to replace the old solution with a new solution.

2. Environmental and Medical Results with Discussions on Silver Soldering Operations - Department 108-T

Table VIII showed the results of four personal (only one person at time of survey) and two area samples for fluorides, silver, copper, zinc, nickel, cadmium, arsenic and selenium and none of these contaminants were detected during the survey. Discussions with the few employees involved in silver soldering operations did not indicate any symptoms which might be attributed to these contaminants since the installation of the ventilation system for the silver soldering operations. Therefore, exposures of workers to the contaminants involved in the silver soldering operations are not toxic and did not present a health hazard at the time of this evaluation. Although the medical history of previous exposures might be indicative of toxic exposures, no definitive statements can be made without additional medical information or environmental samples obtained during previous operations (e.g., no ventilation, different product, etc.) which are not covered by this evaluation.

3. Medical Results and Discussion - Departments 119, 105 and 121

Thirty-nine (39) workers were evaluated using a non-directed medical questionnaire. 20 were males, 19 were females. The mean age of the group was 43 years with a range of 24 to 55. The mean length of employment with FMC was 13.7 years with a range of 3 to 32 years. In the group there were 23 smokers and 16 who did not smoke or who had quit for at least 1 year.

Twenty-nine (29) of 39 had complaints that they attributed to their work environment. The most common complaint (24 of 39) was eye, nose and throat irritation. Difficulty breathing (8 of 39), headaches (4 of 39), skin rash (2 of 39), nausea (2 of 39) and skin burns (1 of 39) were other symptoms reported by these workers.

The symptoms experienced by the workers relating to upper respiratory irritation were attributed to dust, smoke, and fumes as the offending agents. These were occasional complaints (one every week or so) and did not occur on a daily basis. On a very infrequent basis (approximately twice a year) some employees went outside of the building to get a breath of fresh air. Many employees attributed the fumes to malfunctions in the furnace operations. General discussions with employees during the environmental survey indicated a significantly reduced number of subjective worker complaints as noted during the initial survey.

The bacterial counts and species variety in the cutting oil solutions is significant. The present and long term health effects are unknown but further information needs to be collected. Suggested tank changing schedules and a bacterial monitoring protocol are included in the recommendations.

4. Findings and Conclusions

Based on the above medical and environmental information, it is determined that with the exception of nickel, employees were not exposed to the various contaminants (e.g., metals, organic solvents, etc.) covered by this evaluation in concentrations which could be considered as potentially toxic at the time of the survey.

Based on information presented, it is determined that employees are exposed to concentrations of nickel which are considered as potentially toxic. However, no conclusions are made concerning the long term effects due to the short term exposures (a few weeks per year) of employees in the processing of the mix product containing 1-2 percent nickel. It is felt that nickel should not be a problem during processing of the normal mix.

In reviewing the medical symptomatology and the environmental results, it is felt that the primary problems have occurred upon occasion during other environmental conditions (e.g., closed doors and windows, etc.) and/or different operational conditions (e.g., furnace operation malfunction, fork lifts, etc.). These conditions may have or have resulted in concentrations of various ocntaminants (probably oxides of nitrogen, CO, NO_2, etc.) which would be considered as toxic or acute exposures of employees to the contaminants covered by this evaluation. Such symptoms when reported by employees should indicate the need to evaluate various polluting operations such as the malfunction of furnace operations.

Bulk sample analysis of Product B as received and as used showed the positive indication of nitrosamines in these samples. This information along with available toxicology information and appropriate recommendations to obviate the potential hazards were summarized in a letter dated June 15, 1977 (attached as Appendix A), to appropriate management and union representatives and to the manufacturers of Product B. The products as denoted by letters of the alphabet are proprietary, and therefore, as we have discharged our responsibilities under the Act on informing appropriate persons (all union and management) on the toxicity and recommendations on nitrosamines, no further discussions on this matter are relevant to this evaluation.

Several of the recommendations (particularly concerning the silver soldering and mix operations) made at the time of the initial survey were implemented by the time of the environmental survey. In addition, good progress (e.g. purchase of equipment, etc.) has been made on improving the general ventilation in Departments 105, 119 and 121.

V. RECOMMENDATIONS

In view of the above information, the following recommendations are submitted to management to alleviate observed and potential hazards and to provide a more desirable working environment for all personnel:

A. Future reports of employees suffering irritation should be taken seriously and operations should be investigated for any sources of operational malfunctions or emissions.

B. Personal hygiene of employees (e.g. washing hands, changing clothes,etc.) should be stressed as doing their part in making the workplace a more healthy and comfortable environment.

C. The company should compile as many "Material Safety Data Sheets", or their equivalent, as possible. By understanding the toxicity of and hazards associated with materials handled, the company will be able to provide useful instructions to employees on good work practices. Employees should be instructed or trained concerning the hazards and precautions to be taken in processing the materials handled. The end result would be the development of respect for all materials, leading to a more healthful and a safer work environment.

D. The data contained in this report, although indicative of some exposure to benzene (probably as a minor impurity in "Flash 140" solvent) at levels less than the health standard or guide, is not sufficient to provide assurance that employees' exposure to benzene is or is not toxic for operations not covered by the survey. Therefore, it is recommended that a more indepth environmental study be performed by the company concerning any operation where benzene may be an impurity in the solvent. It is suggested that solvents with benzene be replaced with those found to be benzene free.

E. The medical and environmental (monitoring, protective clothing, etc.) recommendations contained in the "Criteria for a Recommended Standard, Occupational Exposure to Inorganic Nickel" for those employees considered occupationally exposed to nickel should be implemented as soon as possible, or the company may consider processing only those mixes which do not produce detectable amounts of airborne nickel. If the latter action is implemented, monitoring (personal air samples) of the airborne dusts by the company will be necessary to show that processing of such mixes does not generate excessive amounts of nickel compounds. The processing of the special mix (0002 WIGPM) did generate excessive amounts of nickel during this evaluation.

F. The filters were clogged with dust in the local ventilation system provided for the grinders in Department 105. A periodic inspecting and maintenance program should be established for all ventilation systems. Continued emphasis should also be made on improving the general ventilation in Departments 105, 119 and 121.

G. A more formal respirator program (e.g. medical, etc) should be established by the company where respiratory protection is used. Minimum procedures such as those outlined in the Occupational Safety and Health Standards, 29 CFR 1910.134 (b) (1)-(11), should be followed. All respirators used must be of the NIOSH-Certified type.

H. Open vessels containing volatile substances constitute both a fire and health hazard and should therefore be kept covered when not in use.

I. Infrequent operations (e.g. nitric acid hood, crock pot, etc.) were not conducted or evaluated during this survey. These operations should be evaluated by the company if there is a possibility of employees' exposures to toxic concentrations of fumes (e.g. NO, NO_2, etc.) and oil mists.

J. Change cutting fluids in holding tanks every 7-10 days, or as appropriate.

K. Submit tank specimens for bacterial culture to a reputable laboratory asking for species identification and exact colony count. This should be done once a month just prior to changing the tank fluid.

L. A periodic inspection and maintenance program should be established for any inside vehicles such as fork lift trucks to preclude excessive discharges of carbon monoxide from these vehicles and subsequent build-up of carbon monoxide concentrations in confined spaces.

VI. REFERENCES

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8. Pillsbury, D.M.; Nile, W.R.: Argyria, The Pharmacology of Silver Williams and Wilkins, Baltimore (1939).

VII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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TABLE I

RESULTS OF PERSONAL (DENOTED BY P) AND GENERAL AREA (DENOTED BY GA) AIR SAMPLES (VM FILTERS) FOR TOTAL PARTICULATES OBTAINED DURING THE ENVIRONMENTAL SURVEY CONDUCTED ON MARCH 29 (DENOTED BY SAMPLE A-NO.) AND MARCH 30 (DENOTED BY SAMPLE B-NO.), 1977, AT FMC CORPORATION-CHAIN DIVISION; INDIANAPOLIS, INDIANA; REPORT NO. 76-97. (RESULTS EXPRESSED AS mg/M^3 - MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR SAMPLED).

DEPARTMENT-OPERATION	SAMPLE NUMBER	SAMPLING PERIOD AM PM	TOTAL NUISANCE PARTICULATES-mg/M^3
D-119 Comp. Press Operator P	A-2254	7:27--2:15	0.8
D-119 Al Boramatic Operator P	A-2273	7:54--2:11	0.5
D-119 Mix Hander Operator P	A-2266	8:05--2:40	0.4
D-119 Alum Boramatic Operator P	B-2958	9:36--2:25	0.3
Area Aisle Between D-119 and D-105 GA	A-402	8:26--2:29	0.4
D-119 Area Compactor GA	B-2985	9:33--2:22	0.7
Area Aisle Between D-119 and D-105 GA	B-2927	9:34--2:10	0.4
D-119 Mix Area GA	B-2296	8:53--4:00	0.3
D-119 Press Area GA	B-2294	8:56--4:00	0.7

Environmental Criteria for Total Nuisance Particulates is ------- 10 mg/M^3.

Minimum detectable level -- 0.01 mg per sample

TABLE I

RESULTS OF PERSONAL (DENOTED BY P) AND GENERAL AREA (DENOTED BY GA) AIR SAMPLES (AA FILTERS) FOR VARIOUS METALS OBTAINED DURING THE ENVIRONMENTAL SURVEY CONDUCTED ON MARCH 29 (DENOTED BY SAMPLE A-NO.), MARCH 30 (DENOTED BY SAMPLE B-NO.), AND MARCH 31 (DENOTED BY SAMPLE C-NO.), 1977, AT FMC CORPORATION-CHAIN DIVISION; INDIANAPOLIS, INDIANA; REPORT NO. 76-97. (RESULTS EXPRESSED AS mg/M^3 - MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR SAMPLED).

DEPARTMENT-OPERATION	SAMPLE NUMBER	SAMPLING PERIOD AM PM	IRON mg/M^3	ALUMINUM mg/M^3	NICKEL mg/M^3
D-121 Furnace Operator P	A-42	9:41--3:01	0.02	0.02	ND
D-121 Furnace Operator P	B-86	8:07--2:03	0.01	0.01	ND
D-119 Compacting Machine Operator P	A-40	7:27--3:17	0.04	ND	0.183
D-119 Induction Hardener Machine Operator P	A-43	7:32--3:00	0.03	0.01	0.019
D-119 Bow Dine Drill P	A-45	7:40--3:13	0.03	0.01	0.011
D-119 Group Leader P	A-31	7:44--3:15	0.03	0.02	0.006
D-119 Boramatic & Vibrator Operator P	A-36	7:50--3:03	0.24	0.02	ND
D-119 Al Boramatic Operator P	A-37	7:54--3:15	0.03	0.01	0.007
D-119 Boramatic Vibrator Operator P	B-87	11:12--2:29	0.60	0.03	ND
D-119 Aluminum Boramatic Operator P	B-98	7:38--1:50	0.03	0.04	ND
D-119 Boramatic Iron Casting Operator P	B-96	7:43--1:54	0.08	0.02	0.011
D-119 Relief Operator Mold P	B-54	7:50--1:31	0.01	ND	ND
D-119 Compactor Operator P	B-78	7:58--4:21	ND	ND	ND
D-119 Compactor Operator P	B-85	8:05--2:04	0.01	ND	ND
Area Sample Between D-119 and D-105 GA	A-47	8:26--2:29	0.04	ND	0.010
Area Aisle Between D-119 and D-105 GA	B-95	8:19--2:10	0.01	0.02	ND
D-119 Area Mixing GA	C-55	8:53--4:00	0.03	ND	ND
D-119 Area Compactor GA	C-79	8:56--4:00	0.03	ND	0.208
Area Between D-119 and D-105 GA	C-52	9:00--4:00	0.02	ND	ND
D-105 Run-In Operator P	A-8	7:26--2:58	0.03	0.02	ND
D-105 Run-In Operator P	A-15	7:38--3:19	0.02	0.01	0.007

TABLE I- (continued)

DEPARTMENT-OPERATION	SAMPLE NUMBER	SAMPLING PERIOD AM PM	IRON mg/M^3	ALUMINUM mg/M^3	NICKEL mg/M^3
D-105 Coupling Operator P	A-18	7:48--3:00	0.03	0.02	0.019
D-105 Coupling Operator P	A-6	7:52--3:17	0.02	ND	ND
D-105 Assembly Operator P	A-19	8:30--3:10	0.03	0.01	0.007
D-105 Assembly Operator P	A-17	8:34--3:07	0.04	ND	ND
D-105 Assembly Operator P	A-12	8:38-11:55 12:43--3:07	0.08	ND	ND
D-105 Assembly Operator P	A-1	8:40--3:06	0.03	ND	ND
D-105 Assembly Operator P	A-11	8:43--2:50	0.04	ND	ND
D-105 Assembly Operator P	A-4	8:46--3:05	0.03	0.02	ND
D-105 Set Up Man P	A-20	8:50--2:05	0.03	0.02	0.005
D-105 Set Up Man P	A-21	9:05--2:16	0.04	0.02	0.009
D-105 Trucker & Oiler Operator P	A-23	9:10--3:13	0.04	0.02	0.006
D-105 Hand Assembly Operator P	B-63	8:06--2:25	0.04	ND	ND
D-105 Regular Assembly Operator P	B-69	7:52--2:24	0.05	ND	ND
D-105 Run-In Operator P	B-66	8:01--2:23	0.05	0.02	ND
D-105 Run-In Operator P	B-71	7:24--2:05	0.02	0.01	0.004
D-105 Coupler Operator P	B-70	7:26--2:09	0.02	0.01	0.007
D-105 Coupler Operator P	B-74	7:29--2:12	0.03	0.01	0.007
D-105 Automatic Assembler Operator P	B-64	7:32--2:14	0.05	0.01	ND
D-105 Area Coupler GA	C-91	9:02--4:00	0.04	ND	ND
D-105 Area Molybdenum Mix GA	C-76*	9:02--4:00	0.02	0.21	0.007
Detection Limits			0.005 mg/ sample	0.010 mg/ sample	0.002 mg/ sample
Environmental Criteria			5.0 mg/M^3	10.0 mg/M^3	0.015 mg/M^3

*Samples also analyzed for molybdenum and the highest sample result for molybdenum was found to be at a concentration of 0.21 mg/M^3 which is less than 5% of the American Conference of Governmental Industrial Hygienists recommended Threshold Limit Value of 5 mg/M^3 for soluble molybdenum.

NOTE: All of the above samples were also analyzed for molybdenum, cadmium and lithium and these compounds (except sample C-76 noted above for molybdenum) were not detected in the sample with detection levels of 0.005 mg/sample, .010 mg/sample and .002 mg/sample, respectively.

TABLE III

RESULTS OF PERSONAL AND GENERAL AREA AIR SAMPLES (AA FILTERS) FOR ARSENIC AND SELENIUM OBTAINED DURING THE ENVIRONMENTAL SURVEY CONDUCTED ON MARCH 29 (DENOTED BY SAMPLE A-NO.) AND MARCH 30 (DENOTED BY SAMPLE B-NO.), 1977, AT FMC CORPORATION-CHAIN DIVISION; INDIANAPOLIS, INDIANA; REPORT NO. 76-97. (RESULTS EXPRESSED AS mg/M^3 - MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR SAMPLED).

DEPARTMENT-OPERATION	TYPE OF SAMPLE	SAMPLE NUMBER	SAMPLING PERIOD AM PM
D-119 Mix Hander Operator	Personal	A-26	8:05--3:20
Aisle Between D-119 and D-105	General Area	A-32	8:31--2:29
D-119 Compactor	General Area	B-89	7:59--2:22
D-119 Mixing	General Area	B-82	8:53--4:00
D-119 Compactor Press	General Area	B-53	8:56--4:00
D-105 Coupling Machine Operator	Personal	A-2	7:55--3:01
D-105 Assembly Operator	Personal	A-9	8:25-11:53
D-105 Set Up Man	Personal	A-7	8:52--2:13
D-105 Assembly Operator	Personal	B-61	7:50--2:21

ALL SAMPLE RESULTS WERE LESS THAN THE MINIMUM DETECTABLE LEVEL OF 0.0001 MILLIGRAMS OF COMPOUND PER SAMPLE (0.0005 mg/M^3) FOR ARSENIC AND SELENIUM, RESPECTIVELY. ENVIRONMENTAL CRITIERA FOR ARSENIC AND SELENIUM ARE 0.002 mg/M^3 AND 0.2 mg/M^3, RESPECTIVELY.

TABLE IV

RESULTS OF PERSONAL (DENOTED BY P) AND GENERAL AREA (DENOTED BY GA) AIR SAMPLES (AA FILTERS) FOR OIL MISTS OBTAINED DURING THE ENVIRONMENTAL SURVEY CONDUCTED ON MARCH 29 (DENOTED BY SAMPLE A-NO.) AND MARCH 30 (DENOTED BY SAMPLE B-NO.), 1977, AT FMC CORPORATION-CHAIN DIVISION; INDIANAPOLIS, INDIANA; REPORT NO. 76-97; (RESULTS EXPRESSED AS mg/M^3 - MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR SAMPLED).

DEPARTMENT-OPERATION	SAMPLE NUMBER	SAMPLING PERIOD AM PM	OIL MISTS mg/M^3
D-119 Bow Dine Drill Operator P	A-46	7:40--3:13	0.8
D-119 Boramatic Hannicut Operator P	B-75	7:33--2:12	0.1
D-119 Leadman P	B-93	7:36--1:44	0.2
Area Between D-119 and D-105 GA	B-77	8:19--2:10	0.2
D-105 Repair Set Up Grant Operator P	A-28	9:57--3:16	0.2
D-105 Repair Set Up Grant Operator P	A-33	10:50--3:16	0.2
D-105 Run-In Operator P	A-22	7:26--2:58	0.4
D-105 Run-In Operator P	A-14	7:30--3:03	0.2
D-105 Run-In Operator P	A-10	7:30--3:03	0.5
D-105 Run-In Operator P	A-13	7:38--3:19	0.2
D-105 Coupling Operator P	A-18	7:48--3:00	0.2
D-105 Inspector Operator P	B-58	8:52--2:19	0.1
D-105 Assembler Operator P	B-59	7:55--2:20	0.1
D-105 Grant Spinner Operator P	B-57	7:57--2:27	0.1
D-105 Grant Spinner Operator P	B-60	8:03--2:23	0.1
D-105 Grant Spinner Operator P	B-56	7:22-12:54	0.2
D-105 Hand Assembly Operator P	B-72	8:08--2:16	ND
D-105 Assembler Operator P	B-51	7:33--2:17	0.1

Environmental Criteria for Oil Mists is ---------------------- 5.0 mg/M^3.

Limit of Detection -- 0.05 mg per sample

TABLE V

RESULTS OF GENERAL AREA AIR SAMPLES (IMPINGER) FOR NITROGEN DIOXIDE OBTAINED DURING THE ENVIRONMENTAL SURVEY CONDUCTED ON MARCH 29 (DENOTED BY SAMPLE A-NO.), AND MARCH 30 (DENOTED BY SAMPLE B-NO.), 1977, AT FMC CORPORATION-CHAIN DIVISION, INDIANAPOLIS, INDIANA; REPORT NO. 76-97. (RESULTS EXPRESSED AS mg/M^3 - MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR SAMPLED).

Area	Sample Number	Time	Nitrogen Dioxide (NO_2) mg/M^3
By vibrator - D119	A-1	9:20-11:06	0.06
Vibrator furnace #3 - D121	A-2	9:45-11:03	ND
Aisleway D119-105	A-3	9:26-11:05	0.05
Vibrator furnace - D121	A-4	9:45-11:02	0.05
Back of furnace - D119	A-5	9:25-11:06	0.04
End furnace - D119	B-11	11:07-11:31	ND
Aisleway between D119 and D105	B-12	11:06-11:30	ND
Dept. 121 furnace #3	B-14	11:03-11:27	ND
Vibrator D119	B-13	11:08-11:32	ND

Environmental criteria --1.8 mg/M^3

Sample detection 0.04 micrograms per milliliter of impinger solution

TABLE VI

RESULTS OF PERSONAL (DENOTED BY P) AND GENERAL AREA (DENOTED BY GA) AIR SAMPLES (CHARCOAL TUBES) FOR ORGANIC SOLVENTS OBTAINED DURING THE ENVIRONMENTAL SURVEY CONDUCTED ON MARCH 29 (DENOTED BY SAMPLE A-NO.) AND MARCH 30 (DENOTED BY SAMPLE B-NO.), 1977, AT FMC CORPORATION-CHAIN DIVISION; INDIANAPOLIS, INDIANA; REPORT NO. 76-97. (RESULTS EXPRESSED AS mg/M^3 - MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR SAMPLED).

DEPARTMENT-OPERATION	SAMPLE NUMBER	SAMPLING PERIOD AM PM	ALIPHATIC SOLVENTS "140 FLASH POINT" mg/M^3	PERCHLORO-ETHYLENE mg/M^3	DICHLORO-METHANE mg/M^3	BENZENE mg/M^3	TOLUENE mg/M^3
D-119 Vibrator Boramatic Operator P	B-21	7:32--2:32	3.3	12.4	1.3	0.3	0.5
Aisleway Between D-119 and D-105 GA	B-22	8:19--2:10	0.3	ND	ND	0.3	ND
D-105 Trucker-Oiler Operator P	A-1	9:11--3:13	3.68	ND	ND	ND	ND
D-105 Automatic Assembler P	B-9	7:50--2:30	0.46	2.5	ND	.2	ND
D-105 Automatic Assembler P	B-8	7:52-12:42	0.54	1.4	ND	0.4	ND
D-105 Trucker-Oiler P	B-7	7:50--2:21	1.58	1.2	ND	0.6	ND
D-105 Automatic Assembler P	B-5	7:33--2:20	0.98	5.4	ND	0.5	ND
D-105 Automatic Assembler P	B-3	7:33--2:40	1.15	5.8	ND	0.7	0.2
D-105 Automatic Assembler P	B-4	7:32--2:25	0.45	3.4	ND	0.5	ND
D-105 Degreasing Tank GA	A-2	9:15--3:20	2.89	8.6	ND	0.3	0.3
D-105 Degreasing Tank GA	B-6	7:55--2:30	0.69	1.7	ND	0.4	ND
Environmental Criteria are----------			150.0	335.0	720.0	3.2	375.0

Minimum detectable levels for all of the above compounds are 0.01 mg of each compound per sample.

TABLE

RESULTS FROM MICROBIOLOGY OF BULK SAMPLES OF OILS AND CUTTING OILS USED IN VARIOUS OPERATIONS AT FMC CORPORATION-CHAIN DIVISION, INDIANAPOLIS, INDIANA; REPORT NO. 76-97 (RESULTS EXPRESSED AS NUMBER OF COLONIES OF SPECIES PER CUBIC CENTIMETER OF SOLUTION OR PER CC.)

Description of Fluid	Sample Number	Test	Bacteria Isolated	Colony Count
Product A, D-105 as used	1	Bacterial count	Escherechea coli Klebsiella pneumoniae Morapella species	>100,000 per cc
Product A, D-105 as used	2	Bacterial count	Klebsiella pneumoniae pseudomonas species	>100,000 per cc
Product A, D-119 as used	3	Bacterial count	Klebsiella pneumoniae pasteurella species	>100,000 per cc
Product B, D-119 as used	4	Bacterial count	Alealegenes Species (2 species) morapella species pseudononas species	>100,000 per cc
Product B, D-121 as used	5	Bacterial count	Pseudomonas Species	30,000 per cc
Product C, D-105 as used	6	Bacterial count	Negative	-------
Product D, D-105 as used	7	Bacterial count	Negative	-------
Product E, D-105 as used	8	Bacterial count	Negative	--------

NOTE:
All of the above samples were also cultured for fungus. Sample numbers 1, 2, 3, 5, 6, and 7 and 8 were negative. Sample No. 4 (Product B, D-119, as used) was positive for the fusarium species of fungus. No quantitative measurements were made concerning the fungus growth. Product A & B are mixed with water in a 5-10% solution and used as a cutting fluid and rust preventative, respectively. Product B is used in Departments 119 & 121 only. Products C & D are paraffin oils of various weights and are used as received as they do not mix or form emulsions with water. Product E is a mixture of various solvents and rust preventatives with no water added. No positive results were expected on Samples C, D, & E as no dilution with water.

TABLE VIII

.SULTS OF PERSONAL AND GENERAL AREA AIR SAMPLES OBTAINED DURING SILVER SOLDERING OPERATIONS AT FMC CORPORATION-CHAIN DIVISION, INDIANAPOLIS, INDIANA; REPORT NO. 76-97 (RESULTS EXPRESSED AS mg/M^3 - MICROGRAMS OR MILLIGRAMS OF COMPOUND PER CUBIC METER OF AIR SAMPLED).

Date	Job or Location	Sample Number	Type of Sample	Time	Results mg/M^3
Results for Fluorides					
3/29/77	Tool Room	1A-Impinger	Personal	9:47--3:27	<0.003 mg/M^3 or ND
3/30/77	Tool Room	2A-Impinger	Area	9:48--3:27	0.003 mg/M^3 or ND
3/30/77	Tool Room	3-Impinger	Personal	8:37--2:37	0.003 mg/M^3 or ND
			Environmental criteria		2.5 mg/M^3
Results for silver, copper, zinc, nickel, and cadmium					
3/30/77	Tool Room	AA-68-AA Filter	Personal	8:38--2:37	<0.005 mg/M^3 or ND
3/29/77	Tool Room	AA-3-AA Filter	Personal	9:47--3:27	<0.005 mg/M^3 or ND
	Environmental criteria: copper - 1.0 mg/M^3; zinc - 5.0 mg/M^3; nickel - .015 mg/M^3; cadmium - .04 mg/M^3				
Results for Arsenic--Selenium					
3/29/77	Tool Room	AA-16-AA Filter	Area	9:48--3:27	<0.002 mg/M^3 or ND
	Environmental criteria: arsenic-0.002 mg/M^3; selenium--0.2 mg/M^3				

N.D.-None Detected

APPENDIX A
(Letter is not an exact duplicate)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGION VII
FEDERAL BUILDING
601 EAST 12TH STREET
KANSAS CITY, MISSOURI 64106

PUBLIC HEALTH SERVICE
National Institute for Occupational Safety and Health

June 15, 1977

Health and Safety Manager
FMC Corporation - Chain Division
220 South Belmont
Indianapolis, Indiana 46206

SUBJECT: Product Specification No. CM-1000

Dear

As you know, we obtained bulk samples of the subject compound for analysis of nitrosamine content while conducting a survey at FMC Corporation in Indianapolis, Indiana. The following are the analytical results:

a. Results of CM-1000 (as received) bulk sample were reported as 2.25 milligrams of nitrosamine per milliliter of solution; and

b. Results of CM-1000 (as used in process - diluted) bulk sample were reported as 0.26 milligrams of nitrosamine per milliliter of solution.

Nitrosamines have been regarded as one of the most potent families of animal carcinogens. Although nitrosamines are suspected to be human carcinogens, their carcinogenic potential in man has not been proven. For your information we have enclosed a copy of "Current Intelligence Bulletin: Nitrosamines in Cutting Fluids" dated October 6, 1976, which was previously provided to you on this matter. The concentrations of nitrosamines found in the subject product is of the same order of magnitude as found in several other products from different manufacturers.

In view of the above and enclosed information, would recommend that the "Material Safety Data Sheet" on this product be modified to show that this product has been shown to contain nitrosamines and other pertinent information which may be useful to you in using this product in a safe manner. We have, of course, notified Chemical Methods, Inc., concerning this subject product specification and the current bulletin on nitrosamines.

Thank you again for your cooperation on this matter. Please feel free to contact me by letter or telephone (816/374-5928) if you have any questions on this matter or other matters of mutual concern.

Sincerely,

Raymond L. Hervin

Raymond L. Hervin
Regional Industrial Hygienist
Occupational Safety and Health

Enclosure

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
5600 FISHERS LANE
ROCKVILLE, MARYLAND 20852

CURRENT INTELLIGENCE BULLETIN: NITROSAMINES IN CUTTING FLUIDS

October 6, 1976

On September 17, 1976, the National Institute for Occupational Safety and Health (NIOSH) was informed by the National Science Foundation (NSF) that Dr. David H. Fine (Thermo Electron Corporation, Waltham, Massachusetts), one of its grantees, confirmed the presence of a nitrosamine, diethanolnitrosamine, in commercial cutting fluids produced by four randomly selected companies.

Historically, nitrosamines have been regarded as one of the most potent families of animal carcinogens. Although nitrosamines are suspected to be human carcinogens, their carcinogenic potential in man has not been proven.

In the past year, two developments have drawn attention to the issue of nitrosamines as an occupational health hazard. The first is the introduction of a new analytical method, thermal energy analysis (TEA), with a sensitivity for nitrosamines in the part per billion (ppb) range. The other development is the recognition of the potential for formation of nitrosamines in air and other non-acidic media by reaction of secondary and tertiary amines with nitrites or other oxides of nitrogen.

The formation of diethanolnitrosamine in cutting fluids was first postulated and reported by Zingmark and Rappe in Sweden (AMBIO, Vol. 5 No. 2, 80-81, 1976). They measured diethanolnitrosamine in a specifically formulated "grinding fluid" containing nitrite and triethanolamine. They concluded that the potential hazard of working with these types of products should not be underestimated. Dr. Fine's results of September 17, 1976 underscore the concern raised by Zingmark and Rappe. Dr. Fine initially reported finding from 400 to over 1,000 ppm diethanolnitrosamine in eight commercial cutting fluids produced by four different manufacturers. He has also provided NIOSH with results which indicate up to 3% diethanolnitrosamine in certain cutting fluids. In addition, Dr. Fine has reported a study conducted during an actual machining operation showing the presence of 1000 ppm diethanolnitrosamine in the diluted cutting fluid prior to use, and 384 ppm after use. This finding strongly suggests that machine operators may be continuously exposed to nitrosamines.

Occupational exposure to cutting fluids, primarily among machine operators, has been studied for possible health effects. A recent published account by Decoufle (Ann. N.Y. Acad. Sci., 271:94-101, 1976) relates that a slight excess mortality (not statistically significant) from respiratory and digestive cancers was observed among male workers exposed to cutting fluids in metal machining jobs.

Nomenclature for cutting fluid is not standardized. The term generally applies to substances used in drilling, gear cutting, grinding, lathing, milling, and other machining operations, for the purpose of cooling, lubricating, and removing metal or plastic chips, filings, and cuttings from the contact area. These substances are variously referred to as cutting, cooling, grinding, industrial, lubricating, and synthetic oils or fluids.

Commercial cutting fluids can be divided into four categories: -

- Cutting Oils or Straight Oils --- contain mineral oil, fat, and additives. These oils are water insoluble.
- Soluble Cutting Oils --- contain mineral oil, fat, emulsifiers (may include amines), additives (rarely nitrite*), and water.
- Semi-Synthetic Cutting Oils --- contain mineral oil, water, fat, a soluble base (usually including amines), emulsifiers (may include amines), and additives (usually including nitrite).
- Synthetic Cutting Fluids --- a soluble base (usually including amines), additives (usually including nitrite) and water.

Various proprietary cutting fluids are produced by over one thousand companies in the United States. NIOSH estimates that 780,000 persons are occupationally exposed in the manufacture and use of cutting fluids.

Synthetic cutting fluids, semi-synthetic cutting oils, and soluble cutting oils may contain nitrosamines, as found by Dr. Fine, either as contaminants in amines, or as products from the reaction of amines (e.g., triethanolamine) with nitrite. Straight oils do not contain

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*Some consumers may incorporate additives containing nitrite into the soluble cutting oil while preparing it for use.

nitrites or amines but may contain polynuclear aromatic compounds (recognized as having carcinogenic potential).

Since many of the proprietary ingredients of cutting fluids have not undergone complete toxicological evaluation, NIOSH would caution any user contemplating changing from one cutting fluid formulation to another to give full consideration to the potential hazards of the substitute.

Enclosed are some industrial hygiene practices which can help minimize dermal and respiratory exposures to cutting fluids.

The potential for nitrosamine exposure during the use of cutting fluids will be further assessed as part of a proposed NIOSH project to determine the levels of nitrosamines in a number of factory environments. Follow-up epidemiologic studies are also anticipated. Studies of cancer induction in laboratory animals exposed to cutting fluids or cutting fluid components are also planned. In addition, a Criteria for a Recommended Standard which will address the problem of cutting fluids is scheduled to be completed in 1977.

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INDUSTRIAL HYGIENE PRACTICES TO MINIMIZE DERMAL AND RESPIRATORY EXPOSURE TO CUTTING FLUIDS

The following are suggested good industrial hygiene practices that can help in minimizing exposure to cutting fluids. The recent detection of nitrosamines in certain cutting fluids has compounded the recognized problem of cutting oil control.

1. Engineering Control. The most effective control of any contaminant is control at the source of generation. Effective engineering measures include the use of local exhaust ventilation, with a suitable collector, or the use of electrostatic precipitator.

2. Substitution. The substitution of a cutting fluid that does not contain either nitrosamine contaminated amines, or the necessary ingredients (amines and nitrites) for nitrosamine formation, is another possible control measure. Since many of the proprietary ingredients of cutting fluids have not undergone complete toxicological evaluation, caution should be used when contemplating any change from one cutting fluid formulation to another, giving full consideration to the potential hazards of the substitute.

3. Respirators. Personal respiratory protective devices should only be used as an interim measure while engineering controls are being installed, for non-routine use and during emergencies. Considering the carcinogenic potential and the lack of a standard for nitrosamines as a group, the only available personal respiratory protective measure is the use of a positive pressure supplied air respirator or a positive pressure self-contained breathing apparatus.

4. Protective clothing. Impervious clothing should be provided and should be replaced or repaired as necessary. Non-impervious clothing is not suggested, but if used, it should be removed and laundered frequently to remove all traces of cutting fluids before being reworn. (Laundry personnel should be made aware of the potential hazard from handling contaminated clothing.)

5. Personal cleanliness. All exposed areas of the body and any area that becomes wet with cutting fluids should be washed with soap or mild detergent. Frequent showering is recommended.

6. Isolation. Where possible, any operations involved with cutting fluids should be placed in an isolated area to reduce exposure to employees not directly concerned with the operations.

7. Barrier creams. Barrier creams may provide protection against dermal irritation and skin absorption, however, the barrier cream should not contain secondary or tertiary amines (which may react to form nitrosamines in the presence of nitrites).