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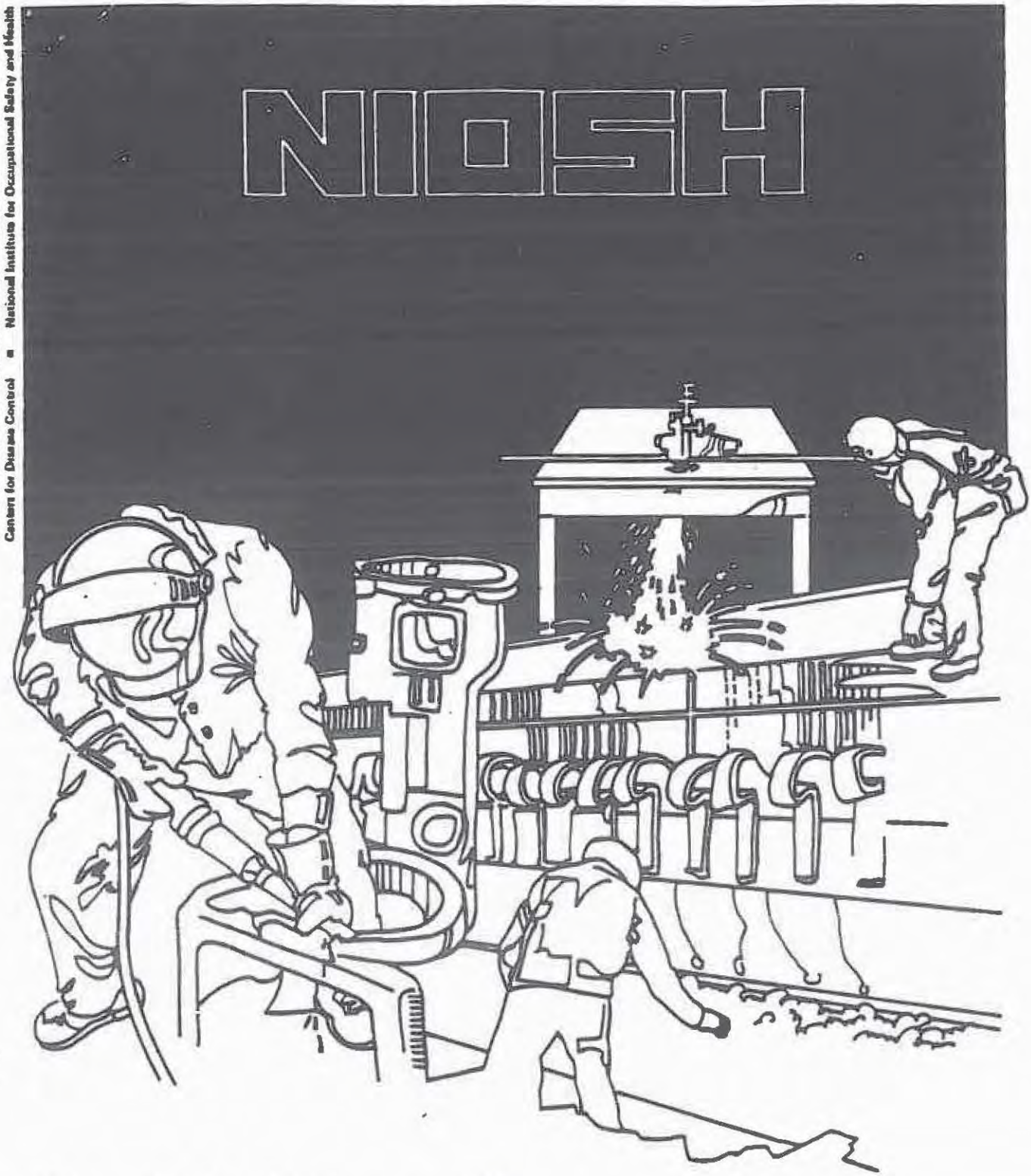

Health Hazard Evaluation Report

HETA 84-233-1663
FMC CORPORATION
POCATELLO, IDAHO

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.

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FMC CORPORATION
POCATELLO, IDAHO

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I SUMMARY

In April 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Association of Machinists, Lodge 1933, Pocatello, Idaho to determine if exposures to silica dust, sulfur dioxide, phosphorous compounds and carbon monoxide were the cause of adverse health effects among employees at FMC Corporation, Pocatello, Idaho.

An initial survey was conducted on June 20, 1984; a follow-up environmental-medical survey was conducted on September 25-27, 1984. An interim report was submitted to FMC Corporation and the union February 28, 1985, and a medical report was provided on September 18, 1985.

The environmental criteria used in the evaluation are derived from a variety of sources and are based on the most recent information available. In some cases, these criteria are less than the legal OSHA standards and are based primarily on concerns relating to prevention of occupational diseases.

The NIOSH environmental breathing zone sample results correlated very well with the past FMC data for carbon monoxide, respirable and total quartz dust, phosphorus and sulfur dioxide. The nine carbon monoxide samples ranged from 1 to 9.5 ppm which are all below the NIOSH evaluation criteria of 35 ppm and the OSHA standard of 50 ppm. The respirable quartz dust samples ranged from 0.43 to 5.71 mg/cu m. Five of the ten samples exceeded the NIOSH criteria of 50 ug of quartz per cu m and also the OSHA standard which is a variable concentration based on the percent of free silica in the sample. The total quartz dust samples ranged from 1.93 to 42 mg/cu m. Seven of the nine samples exceeded the OSHA standard which is a variable concentration based on its percent free silica in the sample. Five of the ten total dust samples exceeded the ACGIH criteria of 10 mg/cu m, but none exceeded the OSHA standard of 15 mg/cu m. The sample concentrations ranged from 1.09 to 13.21 mg/cu m. The 8 phosphorus samples ranged from <0.023 to 0.075 mg/cu m which are all less than the OSHA standard of 0.1 mg/cu m. Eight sulfur dioxide samples were 0.01 ppm or less, one was 0.39 ppm and one (1.24 ppm) exceeded the NIOSH criteria of 0.5 ppm. All were less than the 5 ppm OSHA standard.

The medical evaluation involved interviewing 187 workers out of 493 (30%) in the groups of interest; discussing the plant health and dental programs with the medical department; and reviewing the reasons for visits to the plant clinic during August 1984, pulmonary function data from the spring of 1984, and the epidemiological studies which had been done at the plant. 47.6% of the workers interviewed (89/187) reported work related health problems. Forty-one of 187 workers' (22%) reported complaints involved the respiratory tract with phosphorous, phosphine, sulfur dioxide, and dust mentioned as causes; 17 (9%) reported decreased hearing; 13 (7%) irritant skin problems;

and 10 (5%) back problems. The incidence of painful joints appeared to relate to the physical demands of the job. Thirty-four percent (61/180) of workers interviewed reported minor phosphorous burns from time to time, with the Phosphorous and Maintenance Departments having the higher incidences. The questionnaires suggest that the company's comprehensive dental program is working as planned. The laboratory and office workers had significantly more dental visits without problems (92%), and the Phosphorous Department significantly less (44%). Smoking may also have been a factor. Only 16% had dentures with no significant differences between departments as to average age (51.6 years) or of incidence. According to the plant physician the 2-3 cases of phossy jaw were well in the past and there have only been 6 cases of slow dental healing which might be due to phosphorous exposure.

The general medical program appears appropriate for the nature of the work with good utilization, although followup of respiratory complaints seen at clinic by work area might pinpoint irritant exposures. The company pulmonary function studies coupled with the company epidemiologic study suggest that most workers are not suffering long term loss of pulmonary function due to their work; however, interviews suggest some over shift loss of function from exposure to noxious fumes. The company sponsored epidemiologic studies appeared to be well done within size and time constraints with a high percentage of follow-up. In general, mortality and serious morbidity followed the experience of the U.S. as a whole. The only statistically significant or near significant deviation was an excessive number of trauma deaths not related to work. There was no increase in cancer deaths at the plant, either overall or when examined by minimum lengths of employment. Thirty-three per cent (33%) of the cancer deaths were lung cancers with a statistically insignificant clustering among maintenance workers.

On the basis of the data obtained from this investigation, it has been determined that the workers in the preparation departments and the furnace area are potentially exposed to excessive airborne concentrations of respirable and total quartz dust. In addition, the workers in the furnace area are potentially exposed to excessive airborne concentrations of sulfur dioxide.

There is no doubt that the potential for harmful exposures to phosphorous, phosphine, hot surfaces and liquids exists in this plant. However, the occupational health programs appear to be addressing these problems.

Recommendations for further reducing exposures through the use of engineering controls and respiratory protection are included in Section VIII of this report.

KEYWORDS: SIC 2819 (Industrial Inorganic Chemicals). Carbon monoxide, silica, total dust, phosphorous pentoxide, phosphorus vapor, sulfur dioxide.

II INTRODUCTION

In April 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Association of Machinists, Lodge 1933, Pocatello, Idaho to determine if exposures to silica dust, sulfur dioxide, phosphorous compounds and carbon monoxide were the cause of adverse health effects among employees at FMC Corporation, Pocatello, Idaho.

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III BACKGROUND

The FMC Corporation plant in Pocatello, Idaho, produces elemental phosphorous from the reaction, at high temperatures, of phosphate bearing shale, coke and silica. The plant produces 250 million pounds of phosphorous each year from two million tons of raw material. Figure 1 is a schematic flow sheet of the operation.

The phosphate shale is mined near Pocatello and is transported by open gondola cars to the plant. As the trainloads of phosphate shale arrive at the plant, each gondola--loaded with 100 tons of ore--is positioned on a roto-dumper. Automatic clamps lock the car in position, and the dumper rotates it far enough to release the shale. The operation can unload a 90-car train in a single eight-hour shift.

A high speed conveyor belt moves the shale from the dump hopper to a stockpile, which grows from almost nothing in early spring to a 1.2 million ton "mountain" in late summer. As Idaho's freezing weather prohibits unloading during the winter months, half a year's supply of ore must be stockpiled by the time shipping operations close down in October. Enough shale is piled onto the mountain to enable the plant to operate 24 hours a day, every day of the year.

In the first step of the refining process the shale is crushed, screened, and pressed into home barbecue-sized briquettes. The briquettes are "calcined" or heated to a temperature high enough to burn off organic impurities and moisture. Calcining also hardens the briquettes so they can withstand rough treatment without excessive breakage. The process is fueled by carbon monoxide gas produced in the plant's four main electric furnaces.

After calcining, the briquettes are combined with exacting proportions of silica and coke. Another conveyor feeds this mixture, or "burden," into the four giant electric furnaces which produce the elemental phosphorus.

Giant 10-foot-high, seven-ton carbon electrodes energize the furnaces, heating them to temperatures ranging from 2500 to 8000° Fahrenheit. As the burden mixture undergoes chemical reaction, waste slag and ferrophos flow like molten lava from the furnaces under controlled conditions.

The chemical reaction also produces two gases: carbon monoxide and phosphorus. After the gases pass through electrostatic precipitators which remove dust and other impurities, the phosphorus gas is cooled and condensed to liquid form by water sprays, becoming the end product of the entire operation--elemental phosphorus. It is then collected and pumped to storage. Blowers pump the remaining carbon monoxide gas to the calciners which use it as primary fuel.

The molten by-products that settle at the bottom of the furnaces during the refining operation are directed down a raceway and into a cooling pit by "tappers". The slag--mostly calcium silicate--is cooled by spraying water, and after solidifying is scooped up with front end loaders, dumped into trucks, and hauled to storage areas or crushing plants. It is used extensively in highway and railroad ballast construction. The ferrophos is crushed and sold for its vanadium, iron and chromium content.

Because elemental phosphorus ignites when exposed to air, it must be sealed from the atmosphere and kept underwater. The liquid phosphorus is pumped from the underground storage tanks through pipes into special leak-proof railroad cars.

The Pocatello plant ships nearly 1500 tank cars each year to phosphorus-burning plants around the United States and to overseas customers. These plants combine the phosphorus with other elements to produce phosphate compounds used in countless products.

There are approximately 600 employees (400 hourly) at this plant. Of these, approximately 200 workers operate the plant on a 24 hours/day, seven days/week schedule. In addition, there are 200 maintenance workers, the majority of which work the day shift.

Each operation in the process is controlled by an operator who spends most of his work shift in a control room where the operation is monitored and controlled. In addition, there are one or more workers in each area who assist in keeping the equipment running smoothly and perform various clean up duties. The maintenance crews work primarily in areas assigned to that crew.

The plant workers may be exposed to the following airborne contaminants while performing their jobs; silica bearing dusts; phosphorous pentoxide, elemental phosphorous vapors, sulfur dioxide and carbon monoxide. The firm's full-time industrial hygienist monitors each job classification for these contaminants.

FMC has a respirator program to supplement the engineering controls in use on the various processes to reduce worker exposure to the airborne contaminants. In some work areas, respirator usage is required while in other areas the individual worker uses his own judgment. At the time of the NIOSH survey, each worker performed his own respirator maintenance.

In 1977 an epidemiologic study of the employees of the FMC Corporation plant in Pocatello, Idaho, was conducted by faculty members of the Medical College of Wisconsin covering all workers who had worked at least one year at the plant from July 1, 1949 (about the time the plant was opened) through December 31, 1976. In 1982 the same investigators extended the study through December 31, 1981. Both mortality and morbidity (sufficient to require physician care) was examined. Age, sex, and race specific rates for the United States as a whole were used for comparison purposes. In the 1977 study the status of 91.4% of the 1,497 employees was determined (the lowest percentage being 81.8% in non-white males working in the preparation area other than calcining and fluid bed). In the 1981 extension the number of employees had increased to 1,734 with the status being known for 98.4%.

IV EVALUATION DESIGN

A. Environmental

Environmental breathing zone air samples were collected to determine employees' exposure to the substances listed below.

After reviewing the company's sampling results, the job classifications that had previous exposures were selected for sampling. Approximately 10 samples were collected for each contaminant.

Substance	Collection Method	Flow Rate	NIOSH Analytical Method
Carbon Monoxide	long term detector tubes	20cc/min	direct reading
Respirable Quartz Dust	PVC filter	1.7 lpm	Filters weighed on an electrobalance. Quartz determined by x-ray diffraction NIOSH Method 7500.
Total Quartz Dust	PVC filter	1.7 lpm	Filters weighed on an electrobalance. Quartz determined by x-ray diffraction NIOSH Method 7500.

Substance	Collection Method	Flow Rate	NIOSH Analytical Method
Total Dust	PVC filter	1.5 lpm	Filters weighed on an electrobalance.
Elemental Phosphorous	Tenax sample tube	50cc/min	P&CAM S-334
Phosphorous Pentoxide	PVC filter	1.5 lpm	Technicon Auto Analyzer II Method No. 376-75 W/B and 329-74 W/B.
Sulfur Dioxide	Cellulose membrane filter followed by KOH treated filter.	1 lpm	P&CAM 268

B. Medical

To evaluate current health problems at the plant, all workers on two of the four rotating shifts were interviewed by either the NIOSH physician or a senior NIOSH industrial hygienist utilizing a questionnaire which included identifying data, work history, smoking history, and a brief medical history which emphasized job related problems. Particular attention was paid to dental problems, phosphorus burns, and joint problems. All the maintenance foremen and one third of the maintenance workers (systematic random sample without replacement) were also interviewed; as were one of three of the car shaker crews; day shift operators from the phosphorous department; and every third salaried employee falling into the categories of design engineers, technical engineers or assistants, and maintenance engineers (office secretaries were excluded). The numbers interviewed by job title are shown in Table 7. The groupings used in subsequent analysis of the data are also indicated in this table. In all, 187 individuals were interviewed (this excludes one who did not give information which could be included in the analysis) out of 493 who fell in the groups being studied. There was a total of 611 current employees. Six (6) employees not included in the sample interviewed at the time of the NIOSH visit were interviewed by telephone, but to avoid bias their responses were not included in the statistical analysis.

In addition to the interviews, the NIOSH physician discussed the health and dental programs at the plant with the medical department; reviewed a printout of reasons for visits to the plant clinic for August 1984; reviewed pulmonary function data from the spring of 1984; and reviewed the epidemiological studies which had been done at the plant. The epidemiological studies were also reviewed by a NIOSH epidemiologist from the Hazard Evaluation and Technical Assistance Branch in Cincinnati, Ohio.

V EVALUATION CRITERIA

A. Environmental 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, 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 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 (TLV's); 3) the U. S. Department of Labor (OSHA) occupational health standards; and 4) the American Industrial Hygiene Association's Hygiene Guide Series. 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 primarily 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 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.

Substance	NIOSH or (ACGIH) Recommended Criteria 10 Hr TWA	OSHA Standards 8 Hour TWA	Health Effects
Carbon Monoxide	35 ppm	50 ppm	headache, dizziness, drowsiness, nausea.
Respirable Quartz Dust	50 ug/cu m	$\frac{10 \text{ mg/cu m}}{\% SiO_2 + 2}$	Silicosis--A nodular pulmonary fibrosis caused by pulmonary deposits of particles of free silica, pulmonary function impairment. Symptoms include cough, dyspena, wheezing and repeated non-specific chest illness.
Total Quartz Dust	$\frac{30 \text{ mg/cu m}}{\% SiO_2 + 3}$ (ACGIH)	$\frac{30 \text{ mg/cu m}}{\% SiO_2 + 2}$	Same as respirable quartz dust.
Total Dust (Nuisance)	10 mg/m^3 (ACGIH)	15 mg/m^3	Little adverse effect on lung or toxic effect when kept under reasonable control.
Elemental Phosphorous (P_4)	0.1 mg/cu m (ACGIH)	0.1 mg/cu m	Irritation of skin, eyes, and mucous membranes of nose, throat and respiratory tract. Contact with skin has caused severe burns. Chronic exposure may lead to cough, bronchitis and pneumonia, may cause phosphorous necrosis of the jaw ("Phossy jaw").
Phosphorous Pentoxide	1.0 mg/cu m (AIHA Hygienic Guide Series)	none	A local irritant and a very strong dehydrating agent, with moisture it forms phosphoric acid which is corrosive to the skin, membranes and the eyes.
Sulfur Dioxide	0.5 ppm	5 ppm	Irritation of nose and throat, sneezing and coughing. Low levels can cause a reflex increase in rate and diminution of the depth of respiration with reflex broncho constriction resulting in pulmonary air flow resistance. Long exposure may result in conjunctivitis and frequent respiratory infections.

VI RESULTS AND DISCUSSION

A. Environmental Results

This evaluation request included all job descriptions in the plant process. Evaluation of the occupational health exposures for each job description would entail extensive sampling. The on-site FMC industrial hygienist has performed these evaluations over the last few years and it was not practical for NIOSH to duplicate all this work.

The FMC data was reviewed and 10 job descriptions that showed the highest exposures for each contaminant were selected to be sampled. The sampling was divided between the preparation areas (unloading, screening, crushing, pelletizing, and calcining) and the furnace area.

Carbon Monoxide

The carbon monoxide sample results are shown in Table 1. The carbon monoxide concentrations ranged from 1 to 9.5 ppm. These were comparable to the FMC data. These concentrations are well below the criteria of 35 ppm and hence under normal conditions do not constitute a health risk. There is the potential for leaks or other disruptions that would produce high concentrations. The workers are trained to be cautious in these areas and spot measurements are made prior to entry.

Respirable Quartz Dust

The respirable quartz dust results are shown in Table 2. The NIOSH sample results corresponded very well with the FMC results for the same job descriptions. Five of ten samples exceeded the OSHA permissible exposure limits and the NIOSH recommended criterion. In the preparation departments, most of the areas--except the control room--are designated respirator areas. The sample results confirm that the workers need to adhere to the established respirator policy. In the furnace area the use of respirators is left up to the worker. The metal tapper's exposure exceeded the criteria for respirable quartz dust. As will be shown later, several samples for total dust and for total quartz dust also exceeded their respective criteria. This indicated that a mandatory respirator usage policy should be considered for the furnace area and/or engineering controls installed to reduce the dust concentrations.

Total Quartz Dust

The total quartz dust results are shown in Table 3. The percent of quartz in these samples could not be determined accurately due to the unknown particle sizes. If the particle size of the sampled dust does not match the size of the quartz particles used in the standard, errors are introduced. Hence, for the purpose of these

results, a constant 6% silica content was assumed to be present. Seven of the nine total quartz dust samples exceeded the criteria of 3.75 mg/cu m. All six of the samples collected in the preparation area were high. Four of the six exceeded 10 mg/cu m (14.5, 22.9, 23.6, and 42.0 mg/cu m). As stated above under the Respirable Quartz Dust section, respirators are required in these areas. When 8 hour dust exposures are this high and a worker only spends a portion of his work shift in the dust areas, then during the times the worker is in these dusty areas, his dust exposure is very high. The use of disposable respirators is questionable under these conditions and half face cartridge type respirators should be used. The FMC data also shows numerous dust results that are in the 10 to 20 mg/cu m range.

One of the three samples collected in the furnace area exceeded the total quartz dust criteria and again emphasizes the need for respirator usage and/or engineering controls.

Total Dust

The total dust results are shown in Table 4. These samples were collected to determine the extent of phosphorus pentoxide exposure and the total dust measurements were a secondary result. Five of the ten samples were between 10 and 14 mg/cu m. These results compare favorably with the FMC results for the same job descriptions. Again, the need for respirators and/or engineering controls is evident in the preparatory and furnace areas.

Phosphorus Pentoxide

The phosphorus pentoxide samples were analyzed by the laboratory for total phosphorus instead of phosphorus pentoxide. Total phosphorus includes phosphorus pentoxide plus other phosphorus compounds which do not exhibit the same toxic effects as phosphorus pentoxide. Due to this error, there are no phosphorus pentoxide results available.

Phosphorus

The elemental phosphorus results are shown in Table 5. The phosphorus concentrations ranged from less than 0.023 to 0.075 mg/cu m which is less than the criteria of 0.1 mg/cu m. These measurements correspond very well with the FMC results.

Sulfur Dioxide

The sulfur dioxide results are shown in Table 6. The sulfur dioxide concentrations in the preparatory areas were 0.01 ppm or less. The concentrations in the furnace area ranged from 0.01 ppm to 1.24 ppm. One sample of 1.24 ppm exceeded the NIOSH criteria of 0.50 ppm and one (0.39 ppm) was 80% of it. The FMC sampling shows many sample results between 0.50 and 1.0 ppm. The OSHA standard for sulfur dioxide is 5 ppm which is being met; however, many exposures are occurring in the furnace area which exceed the NIOSH recommended criteria of 0.5 ppm.

Phosphine

A concern of the workers that was brought to the investigators' attention was potential phosphine exposure. There were several "phosphine" areas where workers occasionally go to perform a task. Several spot measurements were taken. The phosphine concentrations were less than 0.1 ppm (the phosphine criteria is 0.3 ppm). The areas are posted with signs that state the phosphine concentrations need to be measured before performing work. The signs were not all highly visible.

General

When a worker is exposed to several airborne contaminants, the exposures to an individual contaminant cannot always be treated independently of the others present. When two or more chemicals have similar health effects, additive effects must be considered. Several substances present in the furnace area are in this category. Phosphorus, phosphorus pentoxide and sulfur dioxide all produce irritation of the eyes, nose, and respiratory system. The majority of these exposures occur during taps. Since this operation is not continuous, the worker's peak exposure to these substances during taps would be higher. Based on this, required respirator usage by the workers and/or improved engineering controls are needed in the furnace area.

There are local exhaust enclosures over the slag runways; however, during this evaluation some of the doors were being left open during taps. Many doors are warped and do not fit tightly and portions of the enclosure have been burned away. Fumes escaping during the taps tend to fill the entire furnace area. The ventilation system needs to receive better maintenance, but the workers also have to use the system properly by keeping the doors of the enclosure closed. There are rest break sheds located on the tapping floor by the furnaces. These have fresh supply air provided to them; however, all were not receiving fresh air due to disconnected duct work. These need to be kept in good working order.

In the past respirator maintenance had been left up to each individual. Since the NIOSH site visit we understand that FMC has been performing the respirator cleaning and maintenance.

A complaint expressed to the investigator was that the workers were not being informed of the FMC sample results and what they meant. As a consequence of this evaluation, FMC is preparing a method to disseminate the sample results and their meaning to the affected employees.

B. Medical

Company Medical and Dental Program. The company has a program of pre-employment, periodic, and termination physical examinations which include blood work, urinalysis, chest X-ray, pulmonary function testing, electrocardiogram, vision screening, and audiogram. Frequency of complete periodic examinations, and of the various screening tests is based on age, exposures, and medical history. In addition, there are programs of health education and blood pressure screening. Workers returning to work after serious injury or illness must be cleared through the medical department. The plant dispensary is staffed by a registered nurse from 8:00 a.m. to 4:30 p.m. Monday through Friday. A contract physician is available for a few hours three days weekly. The guards at the gatehouse are trained as Emergency Medical Technicians and have appropriate supplies to handle emergencies when the dispensary is not open. Minor off-the-job illnesses and injuries are seen at the dispensary in addition to the on-the-job problems and the examinations and screening tests.

The plant has a comprehensive dental program. Workers are evaluated by the company dentist at the time of the pre-employment examination, needed dental care is indicated, and the newly hired worker is given 30 days to get the needed work done at the worker's expense. The worker (and in more recent years, his dependents) is then covered by a comprehensive dental program with few deductibles. Although the worker's oral health is supervised by the company dentist, the actual restorative work is done by a dentist of the worker's choice. Following extractions or dental surgery, workers are excluded from phosphorous exposure until the company dentist has assured adequate healing. Routine dental examinations are done semiannually for phosphorous exposed workers and yearly for others. Dental X-rays are done every two years. Complete dentures are followed for two years before being dropped from routine follow-up. According to the company doctor there were 2 or 3 cases of phossy jaw in the 1950's, and there have been about 6 cases of slow healing of dental lesions for a total of 9 cases of dental problems which could probably be related to phosphorous exposure during the 30+ years the plant has been in operation.

NIOSH Interviews. Table 8 characterizes the workers interviewed by sex, age, years at the plant, and smoking status broken down by department and working area. The workforce was overwhelmingly male (97%); 99% in the Preparation, Phosphorous, and Maintenance Departments combined, and 92% in the Office, Laboratory and Service Departments combined. (Fisher's Exact probability = 0.016 making the difference between the two groups statistically significant, but there is probably no clinical significance for the health effects of concern.) Differences in years at the plant by department were not statistically significant. The maintenance workers were statistically significantly older than the rest of the workers studied (Analysis of variance $F_{(5,181)} = 2.475$, $p = 0.036$, difference in means and L value for Maintenance vs. the rest = + 5.38 $\pm$ 4.84 years).

The Phosphorous Department with 83% smokers and ex-smokers had the highest rate of "ever smoked", and the Service Department had the lowest rate, 22%. Both these groups were statistically significantly different from the rest of the plant's 47% (Chi^2s = 28.592 and 14.002 respectively; chance probability of either less than 0.0005). The maintenance workers showed 45% smokers and ex-smokers compared to 48% in the Preparation Department, and 44% for the Laboratory and Office combined. These differences were statistically insignificant. As the health unit at the plant actively encourages quitting smoking, the distribution of current smokers is somewhat different than for the "ever smoked". The Phosphorous Department with 56% smokers and the Preparation Department with 48% smokers have the highest rate of current smokers (combined rate 53.4%). This is statistically significantly higher than the rest of the plant (Chi^2 = 12.238, p less than 0.0005). The Service Department was lowest with 22% current smokers. Again this is statistically significantly different from the rest ($Chi^2 = 4.203$, $p = 0.042$). The Laboratory and Office together had 31% current smokers and the Maintenance Department 29%.

NIOSH Interviews - Worker Identified Health Programs. When asked if they had any health problems which might be related to their work, 98 of the 187 workers interviewed (52.4%) said they did not, 5 (2.7%) said they didn't have any work related health problem but went on to mention what could potentially be a problem, 2 (1.1%) said they didn't but then went on to describe a problem, and 82 (43.9%) felt they had a health problem which might be work related. Table 9 tabulates possibly work related illnesses mentioned by the last three groups. Tables 10 A, B and C give further detail on respiratory problems, on a group of health problems labeled "Stress, etc." whose exact relation to work is unclear, and on "Other" conditions.

The largest group of complaints involved the respiratory tract. Fourty-one (41) workers (22%) felt they had possibly work related respiratory tract problems. Phosphorous, phosphine, sulfur dioxide, and dust were mentioned as causes of the irritative problems. Specific locations mentioned were: the furnace building, particularly the tapping floor; the calciner, the sump, and the metal pits. The respiratory complaints can be roughly divided into five major problems, not necessarily exclusive of each other. 1) Acute exposure may be irritating to the upper respiratory tract. Severe irritation may lead to inflamation and/or nose bleeds. 2) Continued exposure can lead to chronic nasal stuffiness, hay fever-like symptoms, chronic sinus problems. 3) Acute exposure may be irritating to the lower respiratory tract giving a feeling of tightness in the chest, taking one's breath away, even progressing to chemical pneumonia. Such irritation will certainly aggravate asthma. 4) Chronic exposure may lead to chronic bronchitis and/or decreased pulmonary function. It may also lead to an asthma like condition. 5) Carbon monoxide exposure can lead to asphyxiation with lesser exposure causing headaches, lethargy, shortness of breath, and loss of awareness. Although carbon monoxide itself is not irritating and has no odor it is often accompanied by other fumes which can be quite irritating. Of the four gassings reported on the questionnaires, two specifically mentioned the precipitator as the place it occurred. All occurred in maintenance workers.

Acute upper respiratory irritation, if it passes quickly on getting out of the noxious atmosphere, is unlikely to be considered a health problem, just a nuisance. One worker mentioned strong odors of sulfur about the plant on almost a weekly basis. Another worker, in the Phosphorous Department, mentioned having lost his voice once after a bad exposure. Chronic upper respiratory problems and acute and chronic lower respiratory problems are detailed in Table 10 A. Nineteen (19) workers (10%) mentioned chronic upper respiratory problems. In the case of 15 of these (8% of work force interviewed) this was chronic congestion of nose or sinuses. Acute lower respiratory tract problems were only mentioned by 8 workers (4%) with most of these (5) representing chemical pneumonia or chemically burned lungs. Seventeen (17) workers (9%) had chronic lower respiratory tract problems with most of these (14) being a loss of breathing capacity at work. Often the difference between an acute and a chronic problem is that those with chronic problems are required to be exposed to the noxious atmosphere fairly regularly. The distinction between hay fever or "allergy" and effects of chronic exposure to a noxious atmosphere is often hard to make. A person can develop non-work related allergies after coming to work at FMC, although chronic irritation of the airways might contribute

to the symptoms. Hay fever due to pollens typically comes on about the same time each year - spring, summer, or fall, lasts several weeks to months, and then subsides until the next year. Onset and duration in any particular year is influenced by the weather; the onset of spring, temperature trends, and the amount of rainfall. Effects from chronic exposure to a noxious atmosphere may be worse during cold months if less outside air is used for ventilation in an effort to conserve heat. If exposure involves a volatile liquid, it may be worse in hot weather. Also weather conditions causing inversions can trap the noxious fumes leading to increased complaints.

The second most common problem mentioned by 17 workers was decreased hearing. This was distributed across the production and maintenance areas which is not surprising as there are noisy operations at the plant. Of the thirteen (13) skin problems mentioned, 6 felt they were due to exposure to the irritant fumes or dust, sulfur dioxide in particular. In several cases the plant clinic had concluded that it was the sulfur dioxide exposure which was the problem. Five (5) felt that heat and/or sweat was the cause of the problem, sometimes in conjunction with exposure to the irritant fumes. Certainly moist skin is more likely to be irritated by irritant fumes or dust than dry skin. Back problems were mentioned by 10 workers (5%). Other reported problems are detailed in Tables 10 B and 10 C.

NIOSH Interviews - Dental Problems. In general, the questionnaires suggest that the dental program is working about as prescribed. Of the 187 workers interviewed only 30 (16%) had dentures. The average age of the denture wearers was 51.6 $\pm$ 7.3 years, with the lowest average age being 48.5 $\pm$ 9.5 among the maintenance workers and the highest average age being 54.8 $\pm$ 6.8 among preparation workers, followed closely by the phosporous workers with an average age of 54.2 $\pm$ 5.3. These differences in ages are not statistically significant. The average number of years worked for FMC by the denture wearers was also not statistically significantly different between departments, the overall average being 22.0 $\pm$ 10.2 years. The laboratory and office workers were high with 30.5 $\pm$ 4.9 years, and the maintenance workers low with 17.0 $\pm$ 10.5 years. The maintenance workers had the highest proportion of denture wearers (20%), and the service workers, and laboratory and office workers the lowest (13%). Again the differences between departments were not statistically significant.

Only 10 interviewees reported they had seen the dentist in the past year for dental infections such as gingivitis, pyorrhea, jaw surgery, or root canals, for an overall incidence of 6% of the 158 workers without dentures or with dentures for less than one year. The Phosphorous Department had the highest incidence with 12% (6 cases) and the laboratory and office workers the lowest with none. Although the differences between the Phosphorous Department and the rest did not quite reach statistical significance (Fisher's Exact Test $p = 0.055$) this lack of significance might relate to the small numbers. Most of the infections (8 of the 10) were in cigarette smokers. This relation was statistically significant (Fisher's Exact Test $p = 0.0098$). Since the Phosphorous Department has the highest proportion of smokers it is possible that smoking and working with phosphorous both contribute to dental infections but the numbers are too small to further explore this relationship.

Fourty-seven (47) of the 158 workers without dentures of over one year's standing had had dental restorations in the past year (cavities and/or caps) for an overall incidence of 30%. The Service (39%) and Phosphorous (42%) Departments had the highest incidence and the laboratory and office workers the lowest (7%). Although statistically significant ($Chi^2 = 10.589$, $p = 0.048$) the clinical significance of these differences is not evident. Current smoking did not significantly relate to the incidence of restorations.

Looking at 91 of 145 dental visits at which no problems were found, the laboratory and office workers had the highest percentage (92%) of no problem visits and the Phosphorous Department the lowest (44%). The other departments were: Maintenance 77%, Preparation 70%, and Service 57%. These differences were statistically significant ($Chi^2 = 15.861$, $p = 0.0041$). Further, the laboratory and office workers were statistically different from the rest as were the phophorous workers. Current smoking status may, however, be a confounding factor as 71% of the 87 non-smokers seen had no dental problems whereas only 50% of the 58 current smokers had no problems. This difference was also statistically significant ($Chi^2 = 5.854$, $p = 0.017$). Work in the Phosphorous Department seems to be the more important factor as a comparison between smokers and non-smokers within the Phosphorous Department was not statistically significant, nor was a comparison made in all the other departments combined.

NIOSH Interviews - Other Problems. Although workers were asked about phosphorous burns in particular, thermal burns were also mentioned. Thirty-four per cent (34%, 61 of 180) of the workers had minor phosphorous burns from time to time, the highest being 42% in the Phosphorous Department and the lowest 22% in the Service Department. The differences when considering all departments were not statistically significant. However, if the Phosphorous and Maintenance Departments are compared with the Service and Preparation Departments the former have statistically significantly more minor phosphorous burns (39% vs. 23%, Chi^2 = 3.983, p = 0.047). All the bad phosporous burns were sustained by workers in the Maintenance (6 of 45), Service (3 of 32), and Phosporous (4 of 59) Departments for an overall incidence of 10%. The clustering of bad phosphorous burns in the three departments is statistically significant (Fisher's Exact Test p = 0.023), but the differences in incidence between these three departments is not statistically significant. Six (6) of the 7 thermal burns reported were in Phosphorous Department workers, a statistically significant clustering (Fisher's Exact Test p = 0.0054).

There were a lot of complaints about joint pains, with tapping floor duty being mentioned in particular by many workers who had been through it. Of the ten current tappers and metal tappers, 6 complained of joint pains (60%) compared to 21 of 44 (48%) for the rest of the phosporous department. This slight difference was not significant. Looking at more than occasional joint pain not definitely related to non-job causes found 21% of the laboratory and office workers (3 of 14) so classified compared to 56.5% (91 of 161) for the production and maintenance workers. This difference was statistically significant (Chi^2 = 5.047, p = 0.025). The difference observed is probably due to the considerably greater physical demands of production and maintenance work rather than to phosphorous exposure as there were otherwise no significant differences between the various departments. Table 11 details joint pain complaints by department and joints mentioned. The Service Department with 69% with complaints had the highest proportion with joint pains and the Phosphorous Department with 50% the least. Back pains (30.8%) were the leading complaint, followed closely by knees (20.9%), shoulders (20.9%), elbows (20.9%), and arthritis (not otherwise specified) (19.8%). Of the 39 clinic visits for Arthritis, Tendonitis, Back and Joint Pain shown in Table 12, 23 (60%) were for back pain - 3 industrial first visits, 5 industrial revisits, 13 non-industrial first visits, and 2 non-industrial revisits. It would appear that not all joint pain is seen at the clinic.

Twenty (20) of the 187 workers reported they had elevated blood pressure (11%). There was no significant clustering by department either by incidence, average age, or average years at FMC. The mean age of those with elevated blood pressures was 48.5 $\pm$ 9.6 years and the mean years at the plant was 20.8 $\pm$ 10.0 years compared to 40.0 $\pm$ 10.8 years and 13.7 $\pm$ 9.9 years respectively for the rest of the workers. These differences are statistically significant ($t = 3.3660$, p less than 0.001; and $t = 3.0059$, $p = 0.0051$ respectively). Because the incidence of high blood pressure and the likelihood of longer service are both related to age, and because there were no significant differences between departments, these differences in the incidence of high blood pressure are probably related to age rather than service at the plant.

Company Clinic Data. Tables 13 and 14 present a compilation of visits to the plant dispensary for the month of August 1984 taken from a tabulation supplied by the company. As can be seen, very few medical problems were classified as industrial, most of the injury and musculoskeletal problems considered industrial were seen in hourly workers, and both hourly and salaried workers used the clinic appreciably for problems classified as "not industrial". In particular, the clinic classified all of the upper respiratory infections seen as "not industrial". This is at variance with the interview data by the NIOSH physician which indicated that 15 (8%) of workers interviewed had upper respiratory irritation and/or stuffiness they felt was related to job exposures. Some expressed the opinion that visits to the clinic because of symptoms caused by exposure to the fumes on the job usually drew a diagnosis of upper respiratory infection with symptomatic treatment only. It appears that this might be the case in some instances. If allergies, sinus problems, and respiratory irritation are lumped together 46 of 187 NIOSH interviewees (25%) reported problems with no statistically significant differences in incidence between departments. The Maintenance Department was highest with 35% and the Service Department lowest with 11%.

Company Pulmonary Function Test Data. Review of company supplied pulmonary function tests from the spring of 1984 is contained in Table 13. Included were measurements of forced vital capacity (FVC) and one-second forced expiratory volume (FEV_1). FVC measures the total amount of air one can force out of his lungs after breathing in as deeply as possible. FEV_1 measures the amount of air one can breathe out in the first second. The FVC can be impaired by restrictive lung disease, such as pulmonary fibrosis. FEV_1 can be impaired by cigarette-related lung damage or some other conditions causing obstruction to air flow. Any

condition that impairs FVC usually impairs FEV_1, but the reverse is not true. Conditions that impair FEV_1 do not necessarily impair FVC. In interpreting the results, the best test results are used. They are compared to "predicted values" which take into account age, height, sex, and race, factors which have been found to be important in determining pulmonary function. Pulmonary function is considered "normal" if the best FEV_1 and the best FVC are each 80 percent or more of their respective predicted values.

Data were given as a percentage of predicted. Analysis of variance failed to find statistically significant differences between departments or between job groupings within departments. Of the 133 persons tested, 128 were included in the analysis. Four were excluded as their job title was not specific for any one department, and another was excluded because the values so far exceeded those normally seen that the results must be considered of questionable validity without having the actual tracing available for study. The concentration of workers with low FEV_1s in Maintenance Crew #8 is not statistically significant, but this might be due to small numbers (4). As current or past cigarette smoking could be a likely cause for decreased FEV_1 values, it is unfortunate that smoking data is not available to link with the pulmonary function data. The NIOSH questionnaire data (again only based on 4 interviews) found no current smokers, but 2 ex-smokers in Maintenance Crew #8. One of them had respiratory problems which required him to be restricted from exposure to noxious fumes. The other 3 workers in the crew interviewed had no pulmonary complaints. This suggests that this crew is a place people with impaired pulmonary function can be assigned, rather than a place where they develop pulmonary problems.

Company Sponsored Epidemiologic Studies. The 1977 epidemiologic study covered all workers who had worked at least one year at the plant from July 1, 1949 (about the time the plant was opened) through December 31, 1976. In 1982 the same investigators extended the study through December 31, 1981. Both mortality and morbidity (sufficient to require physician care) was examined. Age, sex, and race specific rates for the United States as a whole were used for comparison purposes. In the 1977 study the status of 91.4% of the 1,497 employees was determined (the lowest percentage being 81.8% in non-white males working in the preparation area other than calcining and fluid bed). In the 1981 extension the number of employees had increased to 1,734 with the

status being known for 98.4%. It is not explained why the number of non-white males are less (82) in the expanded study than in the initial study (96).

In general mortality among the FMC workers followed the expected pattern with only minor, statistically insignificant variation. The only statistically significant increase was in the number of trauma deaths among white males. White male maintenance workers did show a statistically insignificant increase in cancer deaths, and white male workers in general also showed some increase in deaths due to stroke. Non-white males showed statistically insignificant increases in cancer deaths and trauma deaths. Females showed a statistically insignificant increase in overall deaths, felt primarily due to trauma deaths. Of the 51 trauma deaths among FMC workers over the 30 years of the study, only 6 were due to accidents at FMC with no more than 2 in any one department. Eleven (11) deaths were due to motor vehicle accidents, 9 to suicide (no more than 3 in any particular department), 8 to homicide, and 6 to hunting and fishing accidents. Thus it was concluded that although there may be a relation between traumatic deaths and living in the general area of the FMC plant, the increase in traumatic deaths was not primarily due to in-plant activity.

Of the 45 cancer deaths 16 (33%) were lung cancers, 4 were stomach cancers, 3 each were kidney cancer and "unknown", with the rest having only 1 or 2 deaths for any particular cancer site. Half (8) of the lung cancers were in maintenance workers, otherwise there was no clustering. In the report it was speculated that factors of importance might be that maintenance workers on the average started working for FMC 5 years later in life than the rest of the workers allowing more exposure elsewhere, and that perhaps maintenance workers had greater opportunity to smoke on the job. Although this may have been true in the past, the NIOSH interviews found 55% of the maintenance workers had never smoked (compared to 46% for the plant as a whole) and only 29% still smoked (compared to 40%). Because there is usually a long period of time between first exposure to a substance which causes cancer and the time cancer can first be diagnosed (the latent period), the study did compare the ratio of observed number of cancer deaths for white males to expected numbers (Standard Mortality Ratio) for several minimum lengths of employment. There was no trend of increasing cancers with increasing length of employment, with there always being slightly fewer cancers observed than expected. They interpreted this as showing no increased risk due to work at FMC. As the longest period covered was 20 or more years of employment this is a reasonable interpretation.

Considering that lung cancer was the major form of cancer found, the NIOSH epidemiologist suggested that it might be more appropriate to compare the FMC experience with rates specific for Bannock County which have now become available.[A] For lung cancer, rates for white males were 35% lower than for the U.S. as a whole, and 10% lower for non-white males. On the other hand, lung cancer rates are greatly influenced by smoking habits so it is reasonable to question whether the smoking habits of the FMC workers more closely follow those of the U.S. as a whole, or those of Bannock County. It was the NIOSH investigators' opinion that, except for somewhat higher numbers of ex-smokers, the smoking habits of workers in the Preparation, Phosphorous, and Maintenance Departments were not particularly different than those seen in other areas of the country. Also, according to a map giving religious preference by county for the U.S. in 1950[B], over 50% of those giving a religious preference in Bannock County preferred the Church of Jesus Christ of the Latter Day Saints (Mormon). That church has a strong anti-smoking stand. It is quite possible that the low rate of lung cancer in the county relates to this religious affiliation. Thus comparison of lung cancer rates with the U.S. as a whole is probably not particularly misleading.

In examining stroke deaths it appeared that in most cases FMC employment represented only a small part of the individual's life often with considerable time elapsing after employment at FMC ceased. A review of 15 strokes included in the epidemiological report showed:

	FMC Employment Time Exceeds Time After FMC	FMC Employment Time Is Less than Time After FMC	t	p
Number	5	10		
Age at Hire	50.0 ± 4.2	37.9 ± 11.2	2.3023	0.041
Years at FMC	11.4 ± 5.0	3.4 ± 2.3	4.3347	#
Years since FMC	3.6 ± 3.8	18.1 ± 8.7	3.4992	0.0064
Age at Death	65.0 ± 6.9	59.5 ± 12.6	0.9011	N.S.

= less than 0.001 N.S. = not significant

As can be seen from the above table the only thing not statistically different between the two groups is the age at death. This suggests that the length of time at FMC, and hence exposures at FMC, have little to do with the strokes. Of the two stroke deaths under age 50 one worked 2 years at FMC and lived 5 years after that and the other worked only 1 year at FMC and lived 23 years thereafter.

In following up living workers and ex-workers for current health problems sufficiently serious to require medical attention the morbidity study was able to determine the health status on 1,353 of the 1,487 known to be alive. Of these, 911 (67.3%) reported no significant health problems; 10.3% had high blood pressure; 6.2% had heart problems. Considering the age of persons this pattern of illness is expected. Emphysema only accounted for 2% of illness, not particularly high considering there are smokers in the group and workers identified exposure to noxious fumes at work as a problem. There were no particular relationships to specific work areas.

Medical Summary. The company has a comprehensive dental care program which appears to be well followed. NIOSH interview data suggests that the phosphorous exposed workers have more dental problems than do other workers (possibly aggravated by smoking in the case of dental infection), but that in recent years this has not lead to serious dental problems because of the rigorous dental program. The end result of dental problems - dentures - is not increased in any particular part of the plant and does not appear to be occurring at an abnormally young age. The general medical program appears appropriate for the nature of the work with good utilization. Judging from the NIOSH interviews, it is possible that a more rigorous analysis of respiratory complaints seen at clinic by work area might suggest that some of the complaints labeled as "not-industrial" may actually be "industrial". The company pulmonary function studies coupled with the company epidemiologic study suggest that most workers are not suffering long term loss of pulmonary function due to their work, however interviews suggest that some workers do suffer some loss of function while on the job from exposure to noxious fumes. The data available did not indicate that this possibility has been tested for.

The company sponsored epidemiologic studies appeared to be well done. They did suffer some from small cohort size and limited length of follow-up, but this could not be helped. They did get a high percentage of follow-up. In general, mortality and serious morbidity followed the experience of the U.S. as a whole. The only statistically significant deviation was an excessive number of trauma deaths among white males, with similar trends among non-white males and among females. This appeared to be related to living in the area rather than working at FMC as there had been only 6 on the job fatalities at the plant in the 30 years of study. There was no statistically significant increase in cancer deaths at the plant, and when cancer deaths were examined by minimum lengths of employment there were always slightly fewer

cancer deaths than expected. Thirty-three per cent (33%) of the cancer deaths were lung cancers with a statistically insignificant clustering among maintenance workers. The investigators doing the epidemiologic study felt this might relate to smoking. The NIOSH epidemiologist suggested that comparison with lung cancer mortality figures for Bannock County (now available) might show an excessive lung cancer rate among FMC workers as Bannock County has a lower lung cancer rate than the U.S. as a whole (the comparison used by the company sponsored study). The NIOSH investigators, however, feel comparison to the U.S. as a whole is not that misleading as past smoking patterns in production and maintenance workers did not seem particularly different than other plants the investigators have studied, and Bannock County residents could be expected to smoke less than U.S. residents in general because of local religious preferences.

Complaints of joint pains appeared to relate more to hard labor than to any particular department. Both the NIOSH interviews and the company clinic tabulations identified back problems as the leading complaint of this nature. Minor phosphorous burns were fairly common, reported by 34% of the interviewees, with more in the Phosphorous and Maintenance Departments than in the other production departments. Bad phosphorous burns were considerably less frequent and confined to Phosphorous, Maintenance, and Service Departments. The few thermal burns were almost completely confined to the Phosporous Department. Blood pressure and cardiac problems seemed to be age related rather than work related.

VII CONCLUSIONS

The NIOSH breathing zone sample results correlated very well with the FMC data for carbon monoxide, respirable and total quartz dust, phosphorus, and sulfur dioxide. The NIOSH samples for phosphorus pentoxide were not analyzed properly and therefore could not be compared.

The workers in the preparation departments and the furnace area are potentially exposed to excessive airborne concentrations of respirable and total quartz dust. In addition, the workers in the furnace area are potentially exposed to excessive airborne concentrations of sulfur dioxide. FMC requires the use of respirators in portions of the preparation area and these areas have signs posted stating this. Respirators are not required in the furnace area, but are left up to the discretion of the individual. Respirators should be required in the furnace area when certain tasks are performed and/or engineering controls installed to reduce the airborne concentrations of the

contaminants. This decision should be based on the sampling data available. The combined additive effects of phosphorus, phosphorus pentoxide and sulfur dioxide need to be taken into consideration in making this decision.

There is no doubt that the potential for harmful exposures to phosphorous, phosphine, hot surfaces and liquids, and noise exists in this plant. However, the medical, dental, and environmental programs appear to be addressing the problems fairly well so that most workers should not experience serious health problems from their work.

The company has a comprehensive dental program which appears to be functioning well. Although phosphorous exposure still appears to carry a slight risk of increased dental problems, the dental program is adequate to keep these from becoming severe problems.

The medical program appears to be generally accepted and to be reasonable. More effort could be made to characterize the effects of exposure to noxious fumes on chronic upper respiratory complaints and on pulmonary function over shift. The company's pulmonary function testing and the company sponsored epidemiologic study indicate that long term effects from these exposures do not seem to be a problem.

Joint pain, particularly back problems, seem to be a function of hard labor. Accidents and injuries on the job, although undesirable, do not seem to be taking an excessive toll. There may still be room for improvement in hearing protection as 9% of the workers interviewed felt they had work related hearing loss. Certainly as long as there are noisy operations, there will be a need for a hearing conservation program.

VIII RECOMMENDATIONS

1. FMC should clean and maintain all respirators rather than have each employee responsible for his own respirator.

2. Because of the high peak dust exposures, half face cartridge respirators should be used in some areas in lieu of single use respirators.

3. Each job description and task should be re-evaluated and those with exposures that can exceed the criteria for the respective substance should be reduced through the use of engineering controls and/or respiratory protection.

4. All engineering controls need to be utilized as designed, e.g., the doors on the slag runner ventilation enclosure need to be closed during taps. The controls also need to be maintained as designed. The repair of these systems should be a high priority item.

5. Conditioned air should be provided to the crane cab in the furnace area. The system should remove the dust, phosphorus, phosphorus pentoxide and sulfur dioxide from the air entering the crane cab. The crane cab doors and windows must be closed at all times. The cab has a filter and an ESI unit to remove particulates. Based on the total dust results, they are either not working properly or the doors and windows were open during the sample period.

6. The tapper rest sheds need to have filtered air provided to them at all times.

7. The workers should be provided with the sample results for their job description, the health effects of the exposure and the various methods to reduce their exposure.

8. All areas where phosphine can be present need to have highly visible signs warning them of the potential exposure. The workers need to be trained in the recognition of phosphine.

9. The company clinic should consider monitoring respiratory complaints by work area as an aid in identifying locations requiring additional environmental attention. Pre- and post-shift pulmonary function testing might also be of value in some areas.

10. The dental program should continue to be emphasized, as the potential for severe dental problems still seems to be present.

11. It is desirable that the company's mortality-morbidity study be updated periodically.

IX REFERENCES

A. Environmental Protection Agency, U. S. Cancer Mortality Rates and Trends 1950-1979.

B. Gaustad, E.X., Historical Atlas of Religion in America. Harper & Row, New York, 1962.

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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. FMC Corporation Pocatello, Idaho
2. International Association of Machinists, Lodge 1933 Pocatello, Idaho
3. U. S. Department of Labor/OSHA - Region X
4. NIOSH - Region X

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

Carbon Monoxide Air Concentrations

FMC Corporation
Pocatello, Idaho
HETA 84-233

Job Description	Date	Sample Number	Sample Time Minutes	Carbon Monoxide PPM
Scrubber Operator	9-26-84	5	375	1
Operator D Pelletizer	9-27-84	8	389	1
Maintenance Crew #5	9-25-84	2	380	3
Tapper #1 Furnace	9-26-84	4	406	4.5
2nd Helper #1 & 2 Furnace	9-26-84	3	383	3
Maintenance Crew #6	9-27-84	11	439	2
Chief Operator #3 & 4 Furnace	9-27-84	9	407	1.5
Tapper West	9-27-84	10	417	2.5
Crane Operator	9-25-84	1	282	9.5

Table 2

Respirable Quartz Dust Air Concentrations

FMC Corporation
Pocatello, Idaho
HETA 84-233

Job Description	Date	Sample Number	Sample Time Minutes	Sample Volume Liters	Respirable Quartz Dusk mg/cu m	OSHA* PEL mg/cu m	Free Silica in respirable Quartz Dusk ug/cu m	NIOSH ** Criteria ug/cu m
Maintenance Crew #1	9-25-84	1793	422	717	1.60	1.11	112	50
Maintenance Crew #7	9-27-84	1791	373	634	2.19	2.38	47	50
Shale Feed Operator	9-25-84	1777	431	733	0.49	1.33	27	50
Scrubber Operator	9-25-84	1796	436	741	1.12	0.78	121	50
Shovel Operator	9-26-84	1790	442	751	0.43	1.49	< 20	50
Coke Operator	9-26-84	1788	406	690	3.07	2.08	87	50
Tripper Operator	9-27-84	1764	380	646	2.06	0.68	263	50
Front End Loader	9-25-84	1783	396	673	0.28	1.05	< 22	50
Metal Tapper East	9-26-84	1771 + 1811	408	693	5.71	2.00	171	50
1st Helper #3 & 4 Furnace	9-27-84	1815	401	682	1.07	2.50	< 22	50

* OSHA Pel is calculated for each sample as follows:

$$\text{PEL Respirator Quartz Dust mg/cu m} = \frac{10\text{mg/cu m}}{\%\ \text{Silica} + 2}$$

** NIOSH criteria is 50 ug of Respirable Free Silica per cubic meter of air.

Table 3

Quartz Total Dust Air Concentrations

FMC Corporation
Pocatello, Idaho
HETA 84-233

Job Description	Date	Sample Number	Sample Time Minutes	Sample Volume Liters	Quartz Total Dust mg/cu m	OSHA* PEL mg/cu m
Conveyor Operator	9-25-84	1785	384	576	23.6	3.75
Operator D Pelletizer	9-26-84	1813	393	668	22.9	3.75
Recovery Helper	9-26-84	1803	383	651	4.99	3.75
Press Operator	9-26-84	1787	399	678	14.5	3.75
Maintenance Crew #1	9-27-84	1772	435	739	5.41	3.75
Operator D Calciner	9-27-84	1361	400	680	42.0	3.75
1st Helper #3 & 4 Furnace	9-25-84	1814	426	724	2.49	3.75
Slag Tapper #4 Furnace	9-26-84	1771	423	719	1.93	3.75
Slag Tapper #3 Furnace	9-27-84	1812	416	707	6.66	3.75

* OSHA PEL is calculated for each sample as follows:

$$\text{PEL Quartz Total Dust mg/cu m} = \frac{30 \text{ mg/cu m}}{\% \text{ Silica} + 2}$$

NOTE: The % quartz measured in these samples was questionable. The particle size of the quartz standard has to match that in the sample to get accurate analysis. This was not accomplished. Hence, based on the percentage of silica in the respirable dust samples, an average of 6% silica was used for these calculations.

Table 4

Total Dust Air Concentrations

FMC Corporation
Pocatello, Idaho
HETA 84-233

Job Description	Date	Sample Number	Sample Time Minutes	Sample Volume Liters	Total Dust mg/cu m
Maintenance Crew #3	9-25-84	8327	374	636	12.91
Maintenance Crew #7	9-27-84	8314	391	586	13.19
Tripper Operator	9-26-84	8325	387	580	13.28
Phosphorus Operator Loader	9-25-84	8326	214	321	1.09
1st Helper #1 & 2 Furnace	9-27-84	8320	399	598	3.93
2nd Helper #1 & 2 Furnace	9-25-84	8322	427	640	12.94
Tapper #2 Furnace	9-25-84	8321	418	627	10.06
Tapper #4 Furnace	9-27-84	8333	415	622	6.51
Phosphorus Loader	9-26-84	8336	285	427	2.58
Crane Operator	9-26-84	8319	380	570	3.47

Table 5

Phosphorus Vapor (P_4) Air Concentrations

FMC Corporation
Pocatello, Idaho
HETA 84-233

Job Description	Date	Sample Number	Sample Time Minutes	Sample Volume Liters	Phosporous (P_4) mg/cu m
Recovery Chief Operator	9-26-84	24	382	19.4	< 0.025
Shovel Operator	9-27-84	30	351	18.2	< 0.027
Phosphorus Operator Centrifuge	9-25-84	23	421	21.9	0.064
Maintenance Crew #5	9-25-84	22	390	19.9	0.075
1st Helper #3 & 4 Furnace	9-26-85	26	311	16.9	< 0.030
Tapper West	9-26-84	25	419	21.5	< 0.023
Phosphorus Operator Pumper	9-26-84	27	387	20.1	0.070
Maintenance Crew #6	9-27-84	31	435	23.0	0.035

Table 6

Sulfur Dioxide Air Concentrations

FMC Corporation
Pocatello, Idaho
HETA 84-233

Job Description	Date	Sample Number	Sample Time Minutes	Sample Volume Liters	Sulfur Dioxide PPM
Maintenance Crew #1	9-25-84	1	419	419	< 0.01
Maintenance Crew #3	9-27-84	11	413	413	0.01
Coke Operator	9-25-84	3	412	412	< 0.01
Calciner D Operator	9-26-84	8	370	370	< 0.01
Calciner Operator	9-27-84	12	401	401	< 0.01
Tapper #3 Furnace	9-25-84	2	420	420	0.01
Tapper #2 Furnace	9-26-84	5	399	399	1.24
2nd Helper #3 & 4 Furnace	9-26-84	7	415	415	0.01
Crane Operator	9-27-84	10	412	412	0.01
Metal Tapper East	9-27-84	9	394	394	0.39

Table 7

FMC Workers Interviewed by Job Groupings

HETA 84-233

Department	Jobs	Department Number	Jobs	Department Number	Jobs	Department Number
LABORATORY	4	Preparation (cont.)		Phosphorous (cont.)		
Foreman	1	Pelletizer	4	Other Phosphorous	3	
Technicians	3	Press Operator	2	Outlying Forman		1
		Operators D	2	Boiler Operator		2
OFFICE	12	Calciner	7			
Operating Supervisor	1	Foreman	1	MAINTENANCE	51	
Engineering Supervisor	1	Chief Operators	3	General Maintenance	6	
Technical Supervisor	1	Calciner Operator	1	Area Supervisors		2
Process Engineers	2	Calciner Feeder Op.	2	Maintenance Engineer		2
Engineering Aid	1	Recovery	6	Maint. Engine. Tech.		1
Design Engineers	4	Chief Operators	3	Maintenance Foreman		1
Assoc. Elec. Engineer	1	Recovery Operator	1	Crew 1	7	
Computer Operations	1	AA Operator	1	Foreman		1
		Recovery Helper A	1	Calcine Mechanic		1
SERVICE	32	Other Preparation	5	Millwrights		2
General	8	Shale Feeder Op.	2	Other		3
Area Supervisor	1	Coke Operator	1	Crew 2	4	
Foremen	2	Sample Operator	1	Foreman		1
Training Foreman	1	Scrubber Operator	1	Crew Members		3
Operators D	2			Crew 3 - Shale	6	
Janitor	1	PHOSPHOROUS	59	Foreman		1
Utility	1	General Phos.	15	Crew Members		5
Rail Car Operations	6	Foremen	3	Crew 4 - Electrical	5	
Car Movers	2	Chief Operators	6	Foreman		1
Dumper Operators	3	1st Helper	3	Instrumentation		1
Operator D	1	Relief Operator	1	Crew Members		3
Slag Pit Operations	5	A Relief	2	Crew 5	5	
Chief Operator	1	Phos. Loading Dock	6	Foreman		1
Shovel Operator	1	Dock Supervisor	1	Crew Members		4
Front End Loader Op.	1	Phosphorous Loaders	2	Crew 6	4	
Dozer Operator	1	Phos. Operators	3	Foreman		1
Relief Operator	1	Furnace Area	31	Crew Members		3
Heavy Equipment	13	Furnace Supervisor	1	Crew 7,Elec.,Inst.	6	
Mobile Equip. Super.	1	Regulator Operator	3	Foreman		1
Chief Operator	1	Burden Operator	2	Instrument Man		1
Dozer Operators	5	Burden Controller	2	Electrical Foreman		1
Front End Loader Op.	2	Phos. Pump Operator	2	Electricians		3
Truck Driver	1	Centrifuge Operator	1	Crew 8, Mob. Main.	4	
Crusher Operator	1	Crane Operator	2	Foreman		1
General Operator	1	2nd Helpers	2	Diesel Mechanics		2
Belt Chaser	1	B Relief Operator	1	Mechanic		1
		Tappers	11	Crew 10	4	
		Metal Tappers	3	Foreman		1
PREPARATION	29	Operator D Clean-up	1	Crew Members		3
General Preparation	7	Reclaim	4			
Foremen	2	Chief Operator	1	TOTAL PLANT	187	
B Relief Operator	1	8S Reclaim Ops.	2			
Operators D	4	Dredge Operator	1			

Table 8

FMC Workers Interviewed by Sex, Age, Years with FMC and Smoking Status

FMC Phosphorus Chemicals Division
Pocatello, Idaho

HETA 84-233
September 25-27, 1984

Department Job Group	Number	% Male	Age Mean	Age S.D.	Years with FMC Mean	Years with FMC S.D.	Smoking Status (%) Smokers	Ex-Smk.	Non-Smk.
Laboratory									
Total	4	75	43.5	± 11.1	14.3	± 13.2	25	50	25
Office									
Total	12	92	36.5	± 12.0	11.3	± 12.4	33	0	67
Service									
General Service	8	75	38.5	± 12.7	16.3	± 14.0	38	0	62
Rail Car	6	100	35.0	± 6.9	11.9	± 7.4	50	0	50
Slag Pit	5	100	46.4	± 8.4	18.0	± 7.2	0	0	100
Heavy Equipment	13	100	38.7	± 10.9	14.1	± 9.3	8	0	92
Total	32	94	39.2	± 10.5	14.8	± 9.9	22	0	78
Preparation									
General Prep.	7	100	37.6	± 10.8	14.0	± 11.9	71	0	29
Pelletizer	4	100	35.3	± 5.9	6.5	± 5.2	25	0	75
Calciner	7	100	43.9	± 13.7	18.9	± 11.8	43	0	57
Recovery	6	100	43.2	± 10.8	19.4	± 8.7	67	0	33
Other Prep.	5	100	37.8	± 9.7	6.9	± 1.6	20	0	80
Total	29	100	40.0	± 10.7	14.1	± 10.3	48	0	52
Phosphorous									
General Phos.	15	100	42.3	± 10.3	17.8	± 11.9	60	20	20
Loading Dock	6	100	42.0	± 12.4	17.1	± 11.3	50	33	17
Furnace Area	31	97	36.7	± 13.0	10.5	± 9.7	52	29	19
Reclaim	4	100	37.8	± 12.4	14.3	± 10.0	75	25	0
Other Phos.	3	100	50.3	± 5.5	23.7	± 6.7	67	33	0
Total	59	98	39.4	± 12.2	14.0	± 10.8	56	27	17
Maintenance									
General Maint.	6	100	47.3	± 10.6	19.9	± 12.9	33	17	50
Crew 1	7	100	46.7	± 8.0	17.2	± 10.0	29	0	71
Crew 2	4	100	42.0	± 6.0	19.3	± 6.3	25	0	75
Crew 3 - Shale	6	100	42.7	± 4.3	14.8	± 7.7	33	0	67
Crew 4 - Elec.	5	100	48.5	± 12.0	17.5	± 9.9	20	0	80
Crew 5	5	100	50.4	± 7.1	11.5	± 3.8	20	60	20
Crew 6	4	100	45.8	± 6.6	15.4	± 3.9	50	25	25
Crew 7, Elec., Ins.	6	100	42.0	± 7.9	9.3	± 5.4	50	17	33
Crew 8 - Mobile	4	100	48.0	± 10.8	20.1	± 10.8	0	50	50
Crew 10	4	100	36.5	± 9.0	8.5	± 5.8	25	0	75
Total	51	100	45.1	± 8.6	15.3	± 8.7	29	16	55
TOTAL PLANT	187	97	40.9	± 11.0	14.3	± 10.1	40	14	46

Table 9

FMC Workers Reporting Possibly Work Related Health Problems on Questionnaires

FMC Phosphorus Chemicals Division
Pocatello, Idaho

HETA 84-233
September 25-27, 1984

Department Job Group	Number	None #	None %	Resp. #	Resp. %	Hearing #	Hearing %	Skin #	Skin %	Back #	Back %	Stress, etc. #	Stress, etc. %	Other #	Other %
Laboratory	4	3	75	1	25	0	0	0	0	0	0	0	0	0	0
Office	12	9	75	3	25	0	0	0	0	0	0	0	0	0	0
Service															
General	8	6	75	0	0	1	13	1	13	0	0	0	0	1	13
Rail Car	6	5	83	0	0	0	0	0	0	0	0	0	0	1	17
Slag Pit	5	2	40	0	0	2	40	1	20	0	0	0	0	0	0
Heavy Eq.	13	5	39	1	8	1	8	1	8	0	0	2	15	4	31
Total	32	18	56	1	3	4	13	3	9	0	0	2	6	6	19
Preparation															
General	7	6	86	0	0	0	0	1	14	0	0	0	0	0	0
Pelletizer	4	2	50	0	0	1	25	0	0	1	25	0	0	0	0
Calciner	7	4	57	0	0	1	14	0	0	0	0	2	29	1	14
Recovery	6	0	0	3	50	1	17	1	17	2	33	0	0	1	17
Other Prep.	5	0	0	2	40	0	0	2	40	1	20	1	20	0	0
Total	29	12	41	5	17	3	10	4	14	4	14	3	10	2	7
Phosphorous															
General Phos.	15	10	67	2	13	2	13	0	0	0	0	0	0	3	20
Loading Dock	6	4	67	1	17	1	17	0	0	0	0	1	17	0	0
Furnace	31	17	55	8	26	2	6	2	6	1	3	2	6	3	10
Tappers	14	8	57	4	29										
Other	17	9	53	4	24										
Reclaim	4	3	75	0	0	0	0	0	0	0	0	1	25	0	0
Other Phos.	3	1	33	1	33	1	33	0	0	1	33	0	0	0	0
Total	59	35	59	12	20	6	10	2	3	2	3	4	7	6	10
Maintenance															
General	6	4	67	2	33	0	0	1	17	0	0	0	0	0	0
Crew 1	7	1	14	4	57	0	0	1	14	1	14	3	43	0	0
Crew 2	4	1	25	2	50	0	0	1	25	0	0	0	0	0	0
Crew 3, Shale	6	2	33	2	33	1	17	0	0	1	17	0	0	2	33
Crew 4, Elec.	5	3	60	1	20	0	0	0	0	0	0	1	20	0	0
Crew 5	5	2	40	1	20	1	20	0	0	1	20	0	0	1	20
Crew 6	4	1	25	2	50	1	25	0	0	1	17	0	0	0	0
Crew 7, Elec.	6	2	33	2	33	1	17	0	0	0	0	1	17	0	0
Crew 8, Mob.	4	2	50	2	50	0	0	1	25	0	0	0	0	1	25
Crew 10	4	3	75	1	25	0	0	0	0	0	0	0	0	0	0
Total	51	21	41	19	37	4	8	4	8	4	8	5	10	4	8
TOTAL PLANT	187	98	52.4	41	21.9	17	9.1	13	7.0	10	5.3	14	7.5	18	9.6

Table 10A

FMC Workers Reporting Possibly Work Related Health Problems on Questionnaires
Breakdown of Chronic Upper Respiratory, and Lower Respiratory Problems

FMC Phosphorus Chemicals Division
Pocatello, Idaho

HETA 84-233
September 25-27, 1984

Condition	Department					
	Office	Service	Prepare-tion	Phosphor-ous	Mainten-ance	Total
Chronic Upper Respiratory Problems						
Congestion of nose and/or sinuses	1	0	2	5	7	15
Allergy, Hay fever	0	0	1	1	2	4
Sore throat, Tonsillitis	0	0	0	1	1	2
Constant flu	0	0	1	0	0	1
Total Chronic Upper Respiratory Tract Problems	1	0	3	7	8	19
Acute Lower Respiratory Tract Problems						
Persisting cough	1	0	0	0	0	1
Aggravation of asthma	1	1	0	0	0	2
Chemical pneumonia, Burned lungs	0	0	0	3	2	5
Total Acute Lower Respiratory Tract Problems	2	1	0	3	2	8
Chronic Lower Respiratory Tract Problems						
Difficulty breathing, Shortness of breath	0	0	3	6	5	14
Aggravation of asthma, Lung congestion	0	0	0	1	2	3
Chest tightness, Lungs hurt	0	0	0	0	2	2
Cough	0	0	0	0	2	2
Total Chronic Lower Respiratory Tract Problems	0	0	3	6	8	17

Table 10 B

FMC Workers Reporting Possibly Work Related Health Problems on Questionnaires
Breakdown of Stress, etc. Problems

FMC Phosphorus Chemicals Division
Pocatello, Idaho
HETA 84-233
September 25-27, 1984

Condition	Department				
	Service	Prepare-tion	Phosphor-ous	Mainten-ance	Total
Stress	0	0	1	2	3
Arteriosclerotic Heart Disease, Heart Attacks	0	1	1	2	4
High Blood Pressure	0	1	0	2	3
Diabetes	0	0	1	2	3
Stomach Problems	1	0	1	1	3
Difficulties with Shift Work	2	1	2	1	6
Total with Stress, etc. Problems	2	3	4	5	14

Table 10 C
FMC Workers Reporting Possibly Work Related Health Problems on Questionnaires
Breakdown of Other Problems

Condition	Department				
	Service	Prepare-tion	Phosphor-ous	Mainten-ance	Total
No Specifics Given	3	0	0	1	4
Tendonitis, Pain in Specific Joints, Joint Limitations	1	0	3	2	6
Generalized Arthritis	1	1	1	0	3
Sore Muscles	0	0	1	0	1
Vibration	1	0	0	0	1
Dental Problems	0	0	1	1	2
Residual from Bad Phosphorous Burn	0	0	1	0	1
Total with Other Problems	6	2	3	4	18

Table 11

Joint Pain by Involved Joints of Workers with Joint Pains Based on Interviews:
Laboratory and Office Workers, Non-Work Related and Occasional Pain Excluded

FMC Phosphorus Chemicals Division
Pocatello, Idaho
HETA 84-233

September 25-27, 1984

Joint(s)	Service Number	%	Preparation Number	%	Phosphorous Number	%	Maintenance Number	%	Total Number	%
Total Workers with Joint Pains	20		16		27		28		91	
% of total workers excluding those with non-work related or occasional pain		(69.0)		(57.1)		(50.0)		(56.0)		(56.5)
Back	5	25	4	25	11	41	8	29	28	30.8
Knees	6	30	4	25	1	4	8	29	19	20.9
Shoulders	3	15	4	25	4	15	8	29	19	20.9
Elbows	4	20	3	19	7	26	5	18	19	20.9
Arthritis, not otherwise specified	2	10	3	19	6	23	7	25	18	19.8
Hands, Thumb, Fingers	6	30	3	19	1	4	5	18	15	16.5
Hips	3	15	1	6	3	11	2	7	10	11.0
Ankle	1	5	2	13	1	4	3	11	7	7.7

Also mentioned - Wrist, 2 times; Arm, 2; Neck, 1; Legs, 1; Toes, 1.

Table 12

Dispensary Visits by Medical Problem and whether Initial or Revisit, Industrial or Not, Hourly or Salaried Employee

FMC Phosphorus Chemicals Division
Pocatello, Idaho
HETA 84-233

August 1984

Medical Problem	Industrial Problems			Non-Industrial Problems			Total Problems		
	New	Revisits	Total	New	Revisits	Total	New	Revisits	Total
Upper Respiratory Infections	0	0	0	22	5	27	22	5	27
Hourly	0	0	0	13	3	16	13	3	16
Salaried	0	0	0	9	2	11	9	2	11
Allergies	0	0	0	30	0	30	30	0	30
Hourly	0	0	0	11	0	11	11	0	11
Salaried	0	0	0	19	0	19	19	0	19
Gastrointestinal Disorders and Abdominal Pain	0	0	0	9	5	14	9	5	14
Hourly	0	0	0	7	5	12	7	5	12
Salaried	0	0	0	2	0	2	2	0	2
Headache, Vertigo	0	1	1	9	1	10	9	2	11
Hourly	0	1	1	6	1	7	6	2	8
Salaried	0	0	0	3	0	3	3	0	3
Dermatitis, Other Skin Disorders	1	1	2	7	3	10	8	4	12
Hourly	1	1	2	5	3	8	6	4	10
Salaried	0	0	0	2	0	2	2	0	2
Dental, Other Oral	0	0	0	1	0	1	1	0	1
Hourly	0	0	0	1	0	1	1	0	1
Eye Problems	1	0	1	4	1	5	5	1	6
Hourly	1	0	1	3	1	4	4	1	5
Salaried	0	0	0	1	0	1	1	0	1
Other Infections	0	0	0	0	4	4	0	4	4
Hourly	0	0	0	0	1	1	0	1	1
Salaried	0	0	0	0	3	3	0	3	3
Other Conditions	0	0	0	3	5	8	3	5	8
Hourly	0	0	0	1	4	5	1	4	5
Salaried	0	0	0	2	1	3	2	1	3
Total Medical Problems other than Musculoskeletal									
Hourly	2	2	4	47	18	65	49	20	69
Salaried	0	0	0	38	6	44	38	6	44
Total	2	2	4	85	24	109	87	26	113
Arthritis, Tendonitis, Back & Joint Pain	4	10	14	21	4	25	25	14	39
Hourly	4	10	14	14	4	18	18	14	32
Salaried	0	0	0	7	0	7	7	0	7
Thermal Burns	3	1	4	4	5	9	7	6	13
Hourly	3	1	4	3	5	8	6	6	12
Salaried	0	0	0	1	0	1	1	0	1

TABLE 12 (cont.)

Medical Problem	Industrial Problems			Non-Industrial Problems			Total Problems		
	New	Revisits	Total	New	Revisits	Total	New	Revisits	Total
Phosphorus Burns	1	1	2	0	0	0	1	1	2
Hourly	1	1	2	0	0	0	1	1	2
Heat Prostration	1	0	1	0	0	0	1	0	1
Hourly	1	0	1	0	0	0	1	0	1
Contusions, Lacerations, Abrasions	6	2	8	5	5	10	11	7	18
Hourly	4	2	6	3	3	6	7	5	12
Salaried	2	0	2	2	2	4	4	2	6
Sprains, Strains	6	8	14	2	2	4	8	10	18
Hourly	6	8	14	0	2	2	6	10	16
Salaried	0	0	0	2	0	2	2	0	2
Fractures	0	0	0	0	6	6	0	6	6
Hourly	0	0	0	0	1	1	0	1	1
Salaried	0	0	0	0	5	5	0	5	5
Foreign Bodies in Eye	7	1	8	1	0	1	8	1	9
Hourly	5	0	5	1	0	1	6	0	6
Salaried	2	1	3	0	0	0	2	1	3
Total Injuries and Musculoskeletal Problems									
Hourly	24	22	46	21	15	36	45	37	82
Salaried	4	1	5	12	7	19	16	8	24
Total	28	23	51	33	22	55	61	45	106
Physical Examinations							23	3	26
Hourly							14	2	16
Salaried							9	1	10
Vision Screening and Eye Forms							15	1	16
Hourly							10	0	10
Salaried							5	1	6
Hearing Assessments							2	0	2
Hourly							1	0	1
Salaried							1	0	1
Spirometry Assessments							57	0	57
Hourly							51	0	51
Salaried							6	0	6
Blood Pressure and Weight							51	1	52
Hourly							27	0	27
Salaried							24	1	25
Dental Assessment							23	0	23
Hourly							17	0	17
Salaried							6	0	6
Counseling							2	0	2
Hourly							2	0	2
Total Screening Examinations									
Hourly							122	2	124
Salaried							51	3	54
Total							173	5	178
Total Reasons for Visits									
Hourly	26	24	50	68	33	101	216	59	275
Salaried	4	1	5	50	13	63	105	17	122
Total	30	25	55	118	46	164	321	76	397

Table 13

Dispensary Visits by Category of Problem
By Hourly or Salaried, and by Industrial or Non-industrial

FMC Phosphorus Chemicals Division
Pocatello, Idaho
HETA 84-233

August 1984

Category of Problem	Industrial Number	Industrial %	Not Industrial Number	Not Industrial %	Screening Number	Screening %	Total	
Injuries and Musculoskeletal Problems								
Hourly	46	56.1	36	43.9			82	
Salaried	5	20.8	19	79.2			24	
Total	51	48.1	55	51.9			106	
% of Total Problems	92.7		33.5					26.7
Medical								
Hourly	4	5.8	65	94.2			69	
Salaried	0	0.0	44	100.0			44	
Total	4	3.5	109	96.5			113	
% of Total Problems	7.2		66.5					28.5
Screening Examinations								
Hourly					124		124	
Salaried					54		54	
Total					178		178	
% of Total Problems					44.8			44.8
Total Problems								
Hourly	50	18.2	101	36.7	124	45.1	275	
Salaried	5	4.1	63	51.6	54	44.3	122	
Total Problems	55	13.9	164	41.3	178	44.8	397	
Total Visits	55	15.7	NA		NA		351	
Problems as % of Total Visits	100.0							113.1
% Hourly or Salaries								
% of Hourly	90.9		61.6		69.7			69.3
% of Salaries	9.1		38.4		30.3			30.7

NA = Not Available

Table 14

Company Sponsored Pulmonary Function Tests as Per Cent of Predicted by Department

FMC Phosphorus Chemicals Division
Pocatello, Idaho
HETA 84-233

Spring, 1984

Department Job Group		Number	FEV_1 Mean ± S.D.	# below 80%	FVC Mean ± S.D.	# below 80%
Laboratory	Total	4	100.3 ± 4.6	0	99.2 ± 8.3	0
Office	Total	16	101.1 ± 13.6	0	104.3 ± 10.3	0
Service						
Slag Shovel Oper.		4	94.2 ± 11.2	0	97.5 ± 5.4	0
Utility		13	99.0 ± 18.5	2	98.7 ± 10.8	1
Other		13	101.5 ± 9.3	0	103.9 ± 10.9	0
	Total	30	99.5 ± 14.0	2	100.8 ± 10.4	1
Preparation	Total	9	87.9 ± 16.0	2	92.1 ± 15.2	1
Phosphorous						
Furnace Oper. & Helpers		18	96.8 ± 12.7	1	99.6 ± 15.3	2
Tappers *		8	95.8 ± 16.1	2	102.9 ± 11.1	0
Other		4	95.7 ± 9.3	0	100.1 ± 11.5	0
	Total	30	96.4 ± 12.9	3	100.5 ± 13.5	2
Maintenance						
General Maintanance		3	106.2 ± 22.6	0	110.0 ± 26.5	0
Crew 1		8	99.5 ± 16.2	0	101.3 ± 11.1	0
Crew 2		3	97.5 ± 7.2	0	104.8 ± 9.0	0
Crew 3		6	91.9 ± 10.5	1	97.5 ± 11.0	0
Crew 4 - Electrical		5	99.4 ± 9.7	0	102.9 ± 10.2	0
Crew 5		2	98.0 ± 17.1	0	98.2 ± 5.0	0
Crew 6		5	99.8 ± 19.0	1	110.7 ± 16.5	0
Crew 7 - Elec., Instr.		3	101.3 ± 18.9	0	98.5 ± 9.1	0
Crew 8 - Mobile		4	82.3 ± 18.0	3	107.6 ± 7.4	0
	Total	39	97.0 ± 15.2	5	103.3 ± 12.3	0
Total Plant+		128	97.4 ± 14.1	12	101.3 ± 12.2	4

* One outlying value omitted from analysis (FEV, 192.4, FVC 180.1).
\+ Four workers omitted as job title not specific for a specific department. (mean FEV, 103.8 ± 3.6, mean FVC 102.2 ± 5.0)

Figure 1

Schematic Flow Chart of FMC Site

FMC Corporation

Pocatello, Idaho

HETA 84-233