HETA 77-099-064
Region-7

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

HAZARD EVALUATION AND TECHNICAL ASSISTANCE
REPORT NO. TA 77-66

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA

JULY 1978

Study Requested By: Operations Manager
Platte Chemical Company

Report Prepared By: Raymond L. Hervin
Regional Industrial Hygienist
National Institute for Occupational
Safety and Health
Kansas City, Missouri

Dr. Susan Daum, M.D.
Dr. Marion Moses, M.D.
Mt. Sinai School of Medicine
New York, New York

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3. PB89-152920

4. Title and Subtitle: Hazard Evaluation and Technical Assistance Report Report No. TA-77-66, Platte Chemical Company, Fremont, Nebraska

5. Report Date: 78/07/00

6.

7. Author(s): Hervin, R. L., S. Daum, and M. Moses

8. Performing Organization Rept. No.: TA-77-66

9. Performing Organization Name and Address: Hazard Evaluation and Technical Assistance Branch, NIOSH, U.S. Department of Health and Human Services, Cincinnati, Ohio

10. Project/Task/Work Unit No.

11. Contract (C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words) In response to a request from the Platte Chemical Company, Fremont, Nebraska, an evaluation was made of possible hazardous working conditions at the site. At the time of the survey the company employed about ten persons. There was one large production line which processed several tons of granular product or pesticide per day. Four or five workers were employed in the production of a liquid product identified as a seed protectant and nutrient mixture. Employees in the granular facility were exposed to concentrations of S-(((1,1-dimethylethyl)thio)methyl)-0,0-diethyl-phosphorodithioate in excess of the environmental criteria. Heptachlor (76448) exposures in the seed protectant area were also in excess of environmental criteria. Employees were exposed to excessive levels of aliphatic solvents, benzene (71432), captan (133062), diazinon (333415), and organophosphates. There was a potential exposure to free silica (7631869) in the granular facility. A significant number of workers reported acute symptoms probably due to excessive pesticide and dust exposures. The authors recommend that immediate action be taken to lower potential exposures by providing improved engineering controls and practices at this site. More frequent cleanup of the screening pit and other areas should be implemented until improved engineering controls can be tried. Strict contamination and decontamination control procedures, a program of employee and management education, a respiratory protection program, improvements in personal protective equipment use and care, improved medical and training practices, and discontinuance of the use of solvents containing benzene are also recommended.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms: NIOSH-Publication, NIOSH-Author, Region-7, TA-77-66, Hazards-Confirmed, NIOSH-Technical-Assistance-Report, Chemical-manufacturing-industry, Pesticides, Agricultural-chemicals, Organo-phosphorus-compounds, Organo-phosphorus-pesticides

c. COSATI Field/Group

18. Availability Statement

19. Security Class (This Report)

21. No. of Pages: 45

22. Security Class (This Page)

22. Price

(See ANSI-Z39.18) *See Instructions on Reverse*

OPTIONAL FORM 272(4-77)
(Formerly NTIS-35)
Department of Commerce

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

HAZARD EVALUATION AND TECHNICAL ASSISTANCE
REPORT NO. TA 77-66

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA

JUNE 1978

I. SUMMARY

The Platte Chemical Company in Fremont, Nebraska, requested assistance from NIOSH in evaluating employees' exposure to various compounds used in the formulation of pesticide products processed at their facility. The medical-environmental survey of formulation operations in the liquid and granular facilities conducted on November 15-17, 1977, included medical interviews, limited physical examinations, and blood sample analyses; environmental measurements for potential airborne contaminants; and a review of available literature on the chemicals used at the time of the survey. Based on data collected during this survey, the following determinations have been made:

A. Employees' exposure to S-[[(1,1-dimethylethyl)thio]methyl]O,O-diethyl phosphorodithioate (hereinafter referred to as Product A) exceeded the environmental criteria for Product A and may pose a health hazard during routine processing operations and pit cleanup operations in the granular facility at the time of the survey.

B. Employees' exposure to "free silica" (e.g., cristobalite and/or quartz) exceeded the environmental criteria for total dust containing "free silica" during routine processing operations and pit cleanup operations in the granular facility.

C. Employees' exposure to the combined effects of butyl alcohol, mineral spirits, benzene and toluene may pose a potential health hazard at the concentrations measured during routine operations in the liquid packaging area of the liquid facility.

D. Employees' exposure to heptachlor was in excess of the environmental criteria and may pose a health hazard at the concentrations measured during routine processing operations in the seed protectant area of the liquid facility.

Detailed information concerning the results of this survey are contained in the body of this report. Recommendations are included in this report which are designed to reduce employees' exposure to a minimum.

II. PROGRESS AND BACKGROUND INFORMATION ON POTENTIAL EXPOSURES

A walk-through survey was conducted by a NIOSH industrial hygienist on August 22-23, 1977, to observe various operations and ascertain what chemicals are used in the granular facility and in the liquid facility.

It was necessary to postpone the follow-up medical-environmental evaluation for two months to enable NIOSH to confirm appropriate sampling/analytical techniques for Product A. The medical-environmental evaluation was conducted on November 15-17, 1977. Initial results, observations, and recommendations were made to management in an exit interview on November 17, 1977. Laboratory results from analysis of environmental samples and the initial draft of the medical report were available in mid-March 1978. A discussion with management on March 14, 1978, concerned the preliminary environmental and medical data and findings as well as a summary review of recommendations which were essentially the same as those covered during the exit interview. Management and employees were cooperative during the investigation, and the investigator feels that management is genuinely interested in minimizing the exposure of employees. The following is a summary of the potential exposure of employees to various contaminants in the granular and liquid facilities.

A. Granular Facility

The number of employees in this facility varies depending upon the season and the number of shifts. At the time of the survey there were approximately 10 employees on day shift and 10 employees on swing shift. The facility has been operational for four years, and there has been an inordinate amount of employee turnover.

The facility has one large production line which processes several tons of granular product or pesticide per day. The main production item is Product A, although other granular organophosphate pesticides are also processed at this facility. The process involves adding a mixture of liquid pesticide and glycol to a granular clay, mixing, screening for appropriate granular size, bagging, sealing, and weighing and packaging of bags in cartons for shipment. The equipment has a ventilation system with the air passing through a bag filter and a roughing and charcoal bed filter plus a hypochlorite scrubber prior to discharge. The mechanical screening apparatus is in an enclosed pit (approximately 12 feet x 8 feet x 6 feet) which is below the floor area. Cleanup of the filters and screening pit increases the potential exposure of employees to the product being processed. Cleaning the pit involves two men entering the pit and manually shoveling the granular pesticide into a 55 gallon drum. The drum is lifted from the pit, manually dumped on a large sheet of plastic, and covered with a sheet of plastic for packaging.

The company has some general administrative operational procedures, and there is some training of employees in health and safety matters. Employees are provided protective clothing including boots, coveralls, rubber gloves, hats, and approved half-mask respirators with appropriate filters. It is mandatory that employees wear protective clothing. The principal exposure would be to the dust containing the pesticide or primarily Product A with secondary consideration to "free silica" (e.g., cristobalite and/or quartz) contained in the granular clay and to tertiary butyl mercaptan which is a contaminant in Product A. A change room, showers, and laundry facilities are available for employees. It is mandatory that employees shower at the end of their shift.

B. Liquid Facility

This facility has 4 to 5 employees and is normally operational on the day shift only. The liquid facility consists of a production building (consisting of two main processing areas identified as a seed protectant area and nutrient mixing/packaging area), a tank farm, and a warehouse with a liquid filling area.

The seed protectant area has a production line which processes a few thousand pounds per day of a variety of particulate pesticides (e.g., heptachlor, diazinon®, captans, carbamates, etc.) for use as a seed protectant. The process includes a brush sifter, pre-blender, hammer mill, blender, powder filler, and packaging operations which are on a batch basis similar to the granular facility. Parts of the equipment (e.g., loading, bagging, etc.) had ventilation with a bag filter. The facility processed heptachlor for one day during the follow-up survey discussed below.

The nutrient mixing/packaging area has two large mixing tanks, liquid packaging equipment and local ventilation. Several different types of nutrients (e.g., magnesium chloride, calcium, ammonia, copper sulfate, ferrous sulfate, sulfur, zinc, copper, manganese, etc.) are mixed with other ingredients such as complexing and/or chelating agents (e.g., lignins, pentasodium salt of diethylenetriaminepentoacetate). This facility was not operating at the time of the follow-up survey.

Tha tank farm consists of several large tanks for storage and/or dilution of various chemicals which may be used in the nutrient facility or in the liquid packaging area in the warehouse. Examples of various chemicals in the tank farm are 2,4-dichlorophenoxyacetic acid (2,4-D), esters of 2,4-D, dimethylamine salt of 2,4-D, propionic acid, kerosene, various alcohols, naphtha, and similar compounds. Esters of 2,4-D and 2,4-D as well as Product B (mixture of oil, alcohol, etc.) are two of the main chemicals packaged.

The liquid packaging area of the warehouse consists of a typical liquid packaging machine (with no ventilation) for filling of metal containers of various sizes with the mixture of liquid pesticide. The main problem during the packaging of Product B processed at the time of the follow-up survey appeared to be due to the organic solvents or their contaminants which included potential exposure to butyl alcohol, mineral spirits, benzene, toluene, and xylene. Protective clothing is provided but not mandatory for workers in the liquid facility. Showers are also available for the employees.

III. EVALUATION METHODS, CRITERIA AND TOXICOLOGY

A. Evaluation Methods

Breathing zone samples (plus general area samples) were obtained on workers who were considered to have the highest potential exposure. The following is a summary of the sampling and analytical methods used during the survey. Unless indicated otherwise, samples were analyzed in accordance with appropriate procedures contained in the NIOSH Manual of Analytical Methods, HEW Publication No. (NIOSH) 77-157; Cincinnati, Ohio 1977.

1. AA filter samples in three-piece cassettes were obtained at 1.5 liters per minute (lpm) using MSA Model G pumps. Some smear samples were also obtained by wiping approximately 100 square centimeters of area with a coarse type AA filter. These samples were extracted with 2 milliliters (ml) of benzene and analyzed using a Tracor 222 gas chromatograph equipped with a flame photometric detector employing a phosphorus filter for analysis of Product A (granular facility) with a detection limit of 0.2 micrograms (µg).

2. Pre-weighed FWSB filter samples in three-piece cassettes for total dust and two-piece cassettes in a 10 millimeter (mm) cyclone for respirable dust were obtained at 1.7 lpm in the granular facility. These samples were analyzed for total weight and "free silica" defined as quartz and/or cristobalite with a detection limit of 0.03 milligrams (mg) per sample.

3. Chromosorb 104 contained in glass tube samples were obtained in the granular facility at a flow rate of 0.2 lpm using a Sipin pump. These samples were analyzed by gas chromatographic procedures for tertiary butyl mercaptan with a detection limit of 0.01 mg per sample.

4. Charcoal tube samples were obtained during liquid packaging operations at a flow rate of 0.2 lpm using a Sipin pump. These samples were obtained for analysis of butyl alcohol, mineral spirits-aliphatic solvent "140 flash", benzene, toluene, and xylene with a detection limit of 0.01 mg per sample.

5. GF filter samples in three-piece cassettes were obtained during seed protectant operations in the liquid facility using an MSA Model G pump at 1.5 lpm for analysis of heptachlor and lindane. These samples were extracted with 5 ml of trimethylpentane, diluted 1 to 100, and analyzed by gas chromatography using an electron capture detector and a 4 foot OV-101 glass column at 170°C with a detection limit of 0.001 mg per sample for heptachlor and lindane.

Each employee was seen in private by one of the two physicians on the evaluation team. After an explanation of the purpose and content of our examination, each participant gave his or her informed consent for an interview and physical examination. A formal questionnaire was administered during the interview. The information elicited included past and present occupational history, past medical history, smoking and alcohol habits, reproductive history, current or past respiratory symptoms including asthma and chronic bronchitis, and current or past skin problems including acne. It also elicited acute symptoms which might be associated with the chemicals processed in the granular and liquid facilities. For each symptom elicited, the examining physician made a judgement at the time of the interview whether or not the symptom seemed to be related to the occupational environment. A physical examination was undertaken and included examination of the chest, heart, pulse, blood pressure, pupillary reaction, extra ocular motions, examination for involuntary motions or tremor, and test of peripheral muscle strength and deep tendon reflexes.

We had requested that the company's physician draw blood and supply us with laboratory data on each of the employees, including cholinesterase levels in red blood cells and plasma, complete blood count, blood urea nitrogen (BUN) creatinine, bilirubin, alkaline phosphatase, serum glutamic oxalycetic transaminase (SGOT), and gamma glutamyl transpeptidase (γ-GTP). These tests were requested in order to detect abnormalities in the group of workers examined which might be related to occupational (or other) disease. The majority of these tests were obtained on December 14 and 21, 1977. A few employees who did not participate in the original tests, as well as a few employees with abnormal test results in the initial tests, were tested on March 21, 1978.

B. Evaluation 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/M^3*
"Free silica" (as quartz and/or cristobalite) - respirable	0.05 (a)**
Total dust (nuisance)	10.0 (b)
Respirable dust (nuisance)	5.0 (b)
Total dust (containing "free silica")	$\frac{30.0}{\% \text{ quartz} + 3}$ (b)
S-[[(1,1-dimethylethyl)thio]methyl] O,O-diethyl phosphorodiethioate (Product A)	0.050 (--)***
Tertiary butyl mercaptan	1.5 (--)****
Butyl alcohol	150.0 (b)*****
Aliphatic solvent "140 Flash"	150.0 (b)
Toluene	375.0 (a,b)
Benzene	3.2 (a)******
Xylene	434.0 (a,b)
Heptachlor	0.5 (b)*******
Lindane	0.5 (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.

***Neither the ACGIH or any Federal agencies have any established criteria for Product A. Therefore, for purposes of this report only, the authors used the level of 0.05 mg/M^3 for Product A as recommended by the manufacturer and based upon the acute toxicity of Product A as discussed in Section III-C of this report.

****No limits have been established for this product. Therefore, the authors used 1.0 mg/M^3 as the criteria which was established by the ACGIH for n-butyl mercaptan.

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

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

Where:

Em is the equivalent exposure for the mixture.
C is the concentration of a particular contaminant.
L is the exposure limit or criteria for that contaminant, from the above table.

*The value of Em shall not exceed the value of 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 data from clinical as well as from epidemiological data are conclusive at this time that benzene is leukemogenic because it produces progress, malignant disease of the blood-forming organs. Based on this more recent data, NIOSH recommended to OSHA that a standard for benzene be 3.2 mg/M^3. OSHA has recently published a standard for benzene of 3.2 mg/M^3.

*******The current ACGIH-TLV for heptachlor is 0.5 mg/M^3 as noted above. Recent studies by the National Cancer Institute (NCI) indicated that heptachlor causes liver cancer in laboratory mice. Therefore, this level may not provide adequate protection from potential carcinogenic effects because the limit of 0.5 mg/M^3 was selected to prevent toxic effects other than cancer. Therefore, it is prudent to consider the potential carcinogenicity of heptachlor when handling it in the workplace.

Occupational health exposure limits or criteria 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.

C. Medical Toxicology

1. Granular Facility

There are several different pesticides from various pesticide manufacturers processed or formulated in this facility. The primary pesticide processed in this facility is Product A which involves consideration of the following:

PRODUCT A - Product A is a very acutely toxic compound classed as organophosphate pesticides which are irreversible inhibitors of the enzyme acetylcholinesterase. Severe poisoning and even death have resulted from occupational exposure to organophosphate pesticides. Product A has an acute oral LD50 in the mouse of 3.5 to 9.2 mgm/kg.[1] The symptoms and signs of acute overexposure to Product A and organophosphate poisoning in general develop within 12 hours of exposure. They include headache, dizziness, extreme weakness, sweating, loss of coordination (staggering gait), blurred or dark vision with pinpoint pupils, twitching, tremor, salivation, nausea, vomiting, abdominal cramps, diarrhea, urinary incontinence, watery eyes, nasal secretions, chest tightness, wheezing, and cough productive of sputum. The more severe symptoms include slow heart beat and heart block, pulmonary edema (fluid in the lungs), toxic psychosis, respiratory depression, unconsciousness and convulsions. Continued repeated absorption of an intermediate dosage may cause an influenza-like illness characterized by weakness, loss of appetite and malaise. The other organophosphate compounds processed in the liquid and granular facilities cause identical symptoms.

TERTIARY BUTYL MERCAPTAN - Most of the studies have involved n-butyl mercaptan which showed the substance to be only slightly toxic. The level of 1.5 mg/M^3 exceeds the odor threshold by a thousandfold, and the offensive odor is the main problem at this and lower levels. The major symptom upon exposure to butyl mercaptan is nausea.

"FREE SILICA" - The clay used in absorbing Product A contains "free silica" as cristobalite and/or quartz which is biologically active in causing a pulmonary fibrosis known as silicosis. This normally takes several years to develop at lower levels of exposure. Silicosis is a very debilitating and progressive disease. Silica exposure causes no specific symptoms at the time of the exposure. The dust may cause irritation or dryness of the eyes and throat, stuffy nose, and cough. These are non-specific symptoms of irritation which may be caused by any dust exposure. The cardinal symptom of silicosis which may occur 20 years after the initial exposure is shortness of breath. Cough, usually non-productive, may be present.

2. Liquid Facility

The seed protectant facility processed heptachlor at the time of the survey. This involved mixing of the particular heptachlor with other particulates which are considered inert for purposes of this survey. Other compounds which are processed in the seed protectant facility are lindane, hexachlorobenzene, captan and diazinon®.

CHLORINATED HYDROCARBONS used were HEPTACHLOR (1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene), LINDANE (1,2,3,4,5,6-hexachloro-cyclohexane), and HEXACHLOROBENZENE. Unlike the organophosphates, these compounds are persistent, stored in body tissues (especially fat), and are only slowly biodegradable. Acute accidental or occupational overexposure results in marked stimulation of the central nervous system producing

myoclonus epileptiform seizures, and may progress to coma and death depending on the severity of exposure.

HEPTACHLOR, which has an oral LD50 in male rats of 40-88 mgm/kg[2], has been found to be tumorigenic by a recent National Cancer Institute study, producing hepatocellular carcinomas in mice and thyroid tumors in rats.[3]

LINDANE was found to be tumorigenic in mice by Innes.[4] It is an irritant, skin sensitizer and has an LD50 in rats of 76-200 mgm/kg.[2] Many cases of aplastic anemia secondary to exposure to lindane have been reported in the literature.[5,6]

HEXACHLOROBENZENE with an oral LD50 in the rat of 10,000 mgm/kg[7] is a porphyrinogen. An epidemic of porphyria cutanea tarda occurred in Turkey in the late 1950's when wheat treated with the fungicide for planting purposes was used for food.[8]

MANEB® (manganous ethylene-bis-dithiocarbamate) has an oral LD50 in the rat of 6750 mgm/kg.[7] A contaminant and also a metabolic breakdown product of this fungicide is ethylene thiourea (ETU). ETU has produced thyroid tumors in rats.[9] Innes found it non-tumorigenic in mice.[4] It is structurally different from the carbamates used as insecticides and is not a significant inhibitor of acetylcholinesterase.

CAPTAN (N-trichloromethyl-thio-4-cyclohexane-1,2-dicarboximide) has an oral LD50 in rats of 9,000 mgm/kg.[7] It was found to be non-tumorigenic by Innes.[4] Because of its structural similarities to thalidomide, it has been extensively studied and found to be highly mutagenic in all systems tested.[17] It has, however, only been found to be teratogenic in the chick embryo. Its toxicity is markedly increased in protein deprivation.

DIAZINON® (O,O-diethyl-O-(2-isopropyl-4-methyl-6-pyrimidyl)phosphorothioate) is an organophosphate pesticide and produces symptoms as discussed under Product A above. Diazinon® has an oral LD50 of 250-600 mgm/kg in rats and 85-135 mgm/kg in mice.[2]

The liquid nutrient area was not in use at the time of the survey. The liquid packaging area packaged a mixture of oil, butyl alcohol, mineral spirits, toluene, benzene, and xylene during the survey. The medical effects of this mixture of solvents is one of pre-narcotic and narcotic symptoms such as dizziness, incoordination, ataxia (staggering gait), euphoria, drowsiness, nausea, loss of appetite, and vomiting. Coma and death may result from intense exposures. Some of the individual components of this mixture have additional toxicity. Hexane, found in mineral spirits, may cause damage to the peripheral nerves (peripheral neuropathy). Butyl alcohol is an irritant to the eyes, nose, throat, and upper airways. It may cause tissue damage to the cornea and to the upper airways (bronchitis). It may also cause depression of the red blood cell count in the peripheral blood. Xylene may be a cause of blood dyscrasias, and benzene is a definite cause of blood dyscrasias (e.g., aplastic anemia) and of leukemia.

The liquid packaging area also processes large amounts of 2,4-D and esters and salts of 2,4-D. 2,4-D or 2,4-dichlorophenoxyacetic acid has an oral LD50 in the rat, guinea pig and rabbit of 300-1000 mgm/kg.[10] It is a skin irritant; inhalation toxicity is probably minimal. Innes found it non-tumorigenic[4] and Walker found it to be anti-tumorigenic.[11] Several cases of neuropathy most likely due to 2,4-D have been reported.[12,13]

IV. ENVIRONMENTAL EVALUATION RESULTS

A. Granular Facility

Table IA shows the results of 11 personal and 2 general area air samples obtained during routine operations involving Product A. The sample results varied from 0.022 to a maximum of 0.476 mg/M^3 for Product A with 12 of the 13 samples exceeding the environmental criteria of 0.050 mg/M^3. Even when extrapolating the approximate six hour sampling time to an 8-hour time-weighted average (TWA), 12 of the 13 samples would exceed the environmental criteria of 0.050 mg/M^3 for Product A.

Table IB shows the results of 5 personal air samples obtained during pit cleanup operations involving Product A. The pit cleanup operations were conducted for approximately 1 hour with exposures in the pit for approximately 20 minutes. The sample results varied from 1.28 to 2.65 mg/M^3 for Product A (Note: one sample result of 67.52 mg/M^3 may be invalid). Even when extrapolating the 1 hour sampling time to an 8-hour TWA, the samples would exceed the environmental criteria of 0.050 mg/M^3 for Product A. It should be noted that the pit cleanup operation occurs with approximately 5 or 6 operators after the end of the shift. Therefore, when pit cleanup operations are conducted, the results should be considered to be additive to the exposure received during normal processing operations.

Table IC shows the results of smear sample results obtained on surfaces of various pieces of equipment and fixtures. The results are indicative of smearable contamination (maximum of 72 µg/100 cm^2) on the inside of the air-supplied helmet used by personnel for pit cleanup operations as well as some smearable contamination in the lunch room.

A bulk sample of the "clay absorbent" was analyzed and did not contain fibers such as asbestos but did contain 7.0 ± 4 percent "free silica". "Free silica" is defined as the amount of quartz plus cristobalite for purposes of this report. Tables ID & IE present all sample results obtained during routine operations and pit cleanup operations, respectively. All of the respirable dust samples obtained during both operations were below any environmental criteria for respirable nuisance dusts (5 mg/M^3) or respirable dusts (containing "free silica") as no "free silica" was detected on the respirable samples. It should be noted that a detection limit of 0.03 mg of "free silica" per sample needs a sampling time of 6 hours (612 liters of air) in order to obtain a minimum detectable concentration of 0.049 mg/M^3 which is slightly less than NIOSH's recommended criteria of 0.05 mg/M^3 for respirable "free silica". Therefore, no

conclusion is made concerning those respirable sample results where the sampling period was less than 6 hours such as the pit cleanup operations. Two samples (18.1 mg/M^3 and 25.8 mg/M^3) exceeded the environmental criteria for total nuisance dusts during pit cleanup operations. The average percent "free silica" found in the total airborne dust samples (obtained during routine operations) was approximately 13 percent which results in an environmental criteria of 1.9 mg/M^3 $(\frac{30}{13 + 3})$ using the ACGIH recommendation for dusts containing silica. Five of the six samples (maximum of 7.43 mg/M^3) exceeded the ACGIH recommended level of 1.9 mg/M^3 with 2 samples exceeding 1.9 mg/M^3 when extrapolating to an 8-hour time-weighted average (TWA) during routine operations. The average percent "free silica" found in the total dust samples was 11.3 percent during pit cleanup operations which results in an environmental criteria of 2.1 mg/M^3 using the ACGIH recommendation. Both of the total dust samples (2.9 mg/M^3 and 4.2 mg/M^3) obtained during pit cleanup operations are well above the environmental criteria of 2.1 mg/M^3 when extrapolating to an 8-hour TWA.

There were 9 air samples obtained during routine operations and 4 air samples obtained during pit cleanup operations. These samples were analyzed for tertiary butyl mercaptan which was below detectable levels (less than 0.01 mg/sample) in these samples. The typical mercaptan odor was present during the survey, and the nose is more sensitive to the odor or concentration of mercaptans than the analytical method.

B. Liquid Facility

Table IIA shows the results of 4 personal samples obtained during the routine liquid packaging operations involving Product B. The main concern was the organic solvents and their contaminants. Processing was conducted for a half shift, and the concentration would probably be the same for an 8-hour TWA if processing continued for a full shift. Two of the samples (247 mg/M^3 and 244 mg/M^3) exceeded the environmental criteria of 150 mg/M^3 for aliphatic solvent. Also, the same two samples exceeded the environmental criteria of Em = 1 when considering the combined effect of all the organic solvents. However, assuming only the three and one half hours of exposure as a fraction of the working day with the remainder of the day causing no further exposure, only one sample is above the criteria of Em = 1. All four samples were positive for benzene and one sample (3.8 mg/M^3) exceeded the environmental criteria of 3.2 mg/M^3 for benzene if Product B was processed for an 8-hour period.

Table IIB shows the results of 8 personal air samples obtained during the routine processing of heptachlor at the seed protectant area of the liquid facility. The 8 samples were obtained during morning and afternoon portions of the shift on the 4 persons involved in processing operations. Calculations of the 8-hour TWA for these employees show that three of the four employees exceeded the environmental criteria of 0.5 mg/M^3 for heptachlor. Employee Nos. 1, 2 and 4 were in dusts containing heptachlor

concentrations of 0.92 mg/M^3, 0.92 mg/M^3 and 1.05 mg/M^3 based on an 8-hour time-weighted average concentration assuming there was no exposure during periods when employees were not wearing the sampling apparatus. Although lindane was not processed at the time of the survey, trace amounts of lindane were found in some of the air samples. This is indicative of residual contamination of lindane in and/or around the seed protectant facilities or equipment. A few smear samples were obtained in areas which should not contain any contamination and the results are shown in Table IIB. Only one of 3 samples showed contamination levels of approximately 3 µg/100 $cm/^2$ of lindane on the foreman's desk and book area in the liquid locker room. There appeared to be visible signs of dust or contamination throughout most of the areas (particularly the seed protectant area) in the liquid facility. Analyses of samples included only heptachlor and lindane, and no other analyses were made for the many other compounds processed in this facility.

C. Ventilation

All of the processing equipment is provided with ventilation in the granular facility. Measurements at all of the duct openings (e.g., duct at bagging station, front end dumping station duct, etc.) showed a flow rate of 300 to 400 feet per minute (fpm) at approximately 1 inch from the duct. However, the flow of air at the point of operation (e.g., bagging-sealing operation, front end loading station, etc.) was less than 50 fpm and smoke tubes indicated that ventilation is not adequate for the control of dust at the point of operation. The system did not appear adequately and routinely maintained or monitored (e.g., no manometers, etc.), and there were some openings (e.g., holes, joints not air tight, open ports, etc.) in the system which served no purpose for the control of the dust.

The loading and the filling stations in the seed protectant facility were provided with ventilation. The six inch duct in the back of the hood provided for the loading station and had a face velocity of 600 fpm at the duct and approximately 50 fpm at the face of the hood. The filling station was provided with a four inch duct which had a face velocity of 500 fpm and approximately 75 fpm at the point of operation. Smoke tubes did not indicate that there was adequate ventilation at the point of operation to control the dusts which may be generated. The nutrient mix tanks and filling area have ventilation but were not operational at the time of the survey. The liquid filling station was not provided with local ventilation.

V. MEDICAL EVALUATION RESULTS

A. History of Occupational Medical Problems

In March 1977, 11 workers developed acute organophosphate poisoning. Four required hospitalization and atropine treatment; others were treated and released. The toxic exposure occurred in the granular facility while the employees were cleaning o-ethyl s,s-dipropylphosphorodithioate mixed with clay out of the "pit". At the time of this incident, coveralls, boots,

and respirators were worn. Prior to this episode, isolated episodes of organophosphate toxicity had occurred. Medical histories of the recent and prior incidents were typical of acute organophosphate intoxication. Details of the earlier episodes were not readily available.

B. Medical Surveillance Program

Red blood cell and plasma cholinesterase levels are drawn weekly on employees in the granular facility. The results are supervised by a private physician (a diplomate of the American Board of Family Practice) who is under contract with the company. The policy of the company in relation to the results of these blood tests is as follows:

75% of baseline cholinesterase level -- Alert

70% of baseline cholinesterase level -- Remove employee from the hot areas, by transferring to clay handling areas, box-making, or warehouse duties.

50% of baseline cholinesterase level -- Remove employee from plant completely. Off work until retest level is 90-95% of baseline results.

The cholinesterase levels are measured in a hospital in Omaha, by the ChE-Tel method, supplied as a kit by Pfizer Diagnostics Division. This spectrophotometric method is based on the Garry and Routh method which correlates well with the methods of Hestrin[15] and Michel.[16]

Prior to each group of determinations, the laboratory calibrates to check the color-forming reagent in the kit, as directed by the methods in the kit. This calibration is made by the use of a standard solution of reduced Glutathione. The laboratory also runs two normal sera prior to running the specimens from the pesticide facility. Split samples are examined on two samples selected randomly from the group at every other determination -- every other week. The director reports good correlation of these samples, as well as reports that the "normals" are always within the normal range (RBC-acetyl cholinesterase 210-360; ChE-Tel units and plasma cholinesterase 45-90 ChE-Tel units).

C. Medical Evaluation

Twenty-eight (28) workers were examined. Four (4) were absent from work at the time of the examination. 22 of the workers were from the granular facility, five were from the liquid facility, and one worked both as a secretary and quality laboratory technician. The latter employee was the only woman. One of the employees was black, the rest were white. The average age was 31 years, the median 28 years. (The average is skewed by one employee, a 70 year old man employed part-time as a janitor). The distribution of the duration of employment in each facility and in the plant as a

whole is shown in Table III. The mean duration of employment at the time of our examinations was 5.6 months, the median 2 months. The range of employment duration was from 1 month to 32 months. Only six employees had worked one year or more. Only three of 20 employees who worked in the pit in March 1977 (at the time of the episode of acute organophosphate poisoning) remained in the workforce which is an indication of rapid turnover.

Reproductive: Several of the wives had conceived and born normal children during their husband's employment at the facility.

Skin: A history of acne was obtained in three workers. In only one worker, in the liquid facility, was the acne associated with skin contact with chlorinated hydrocarbons (heptachlor and/or lindane). The other two had had acne prior to employment in the plant. One additional employee had had acne prior to employment in the plant, but was not having any skin eruptions at the time of our examination. Mild acne was present in the physical examination of four workers.

Respiratory and mucous membrane symptoms: A history of acute mucous membrane and upper respiratory irritation was obtained in 12/22 (55%) of the workers in the granular facility, and 4/5 workers in the liquid facility. The most common symptom in both facilities was eye irritation (tearing or burning). Other symptoms included nasal and throat irritation, cough, chest tightness and wheezing. The number of workers experiencing each type of symptom in each facility is shown in Table IV. In the granular facility most of the symptoms were related by the workers to the pesticide dust in the air, although one asthmatic worker also complained of the sand dust. It is possible that some of these symptoms are due to the direct acetyl cholinesterase inhibitory action of organophosphates on membranes of the respiratory system. In the liquid facility, the general dustiness around the seed treatment line was considered to be the cause of symptoms. Irritants such as chlorine, ammonia, and propionic acid also caused problems when used in the liquid facility or encountered (infrequently). The symptoms experienced and the job categories of workers who experienced them are given in Table VI. Those experiencing symptoms on the days of our examination are also noted.

General Symptomatology: Table V is a summary of the prevalence of a history of acute symptoms of employees obtained during the medical interviews. In the granular facility 14 of the 22 workers (64%) had experienced some type of acute symptoms which appeared to be related to work. In the liquid facility, only one worker of five gave a history of any acute symptom which appeared to be related to work. All of the symptoms found are described in greater detail in Table VI. The symptoms include dizziness or lightheadedness, headache, anorexia (loss of appetite), abdominal cramping, nausea, personality change, weakness/fatigue, muscle weakness, sleepiness and loss of concentration. One of the workers interviewed had a history of acute organophosphate intoxication (in March 1977). He had been hospitalized after exposure to o-ethyl s,s-dipropylphosphorodithioate

and required intensive medical care and treatment with atropine and PAM. During this episode, his acetyl cholinesterase activity was reported to be zero.

Physical examination: None of the abnormalities which were found in the physical examinations were considered to be due to occupation, and there was no pattern of abnormalities seen. The blood pressure and pulse measurements did not reveal any of the effects associated with inhibition of acetyl cholinesterase.

Blood test results: Unfortunately, there were results available for only 17 workers in the granular facility and two people in the liquid facility. (Other workers examined in November had left the plant by the time of completion of the blood tests). Seven (7) of the 17 workers in the granular facility (41%) showed some abnormality of the liver function tests. Five (5) of the 7 had multiple abnormalities present, a finding which tends to confirm the validity of the observation that liver function tests are abnormal. Within the group as a whole, there was no specific pattern of abnormalities, and the abnormalities were mild. Repeat liver functions were drawn on 6 of the workers who had abnormalities in the first group of tests. Three (3) of the six workers again had the same abnormalities in the repeat tests and one (1) had different liver tests abnormal on the second test. Two (2) had a normal test battery the second time. Among all those with abnormalities, 4 consumed a moderate amount of alcohol, one or more drink daily, but only 2 consumed more than one drink daily. None were classified as "heavy" drinkers. The number of employees tested is too small to allow any definite conclusions as to whether or not the observed prevalence of disturbances of liver function among the workers is significant or due to occupation.

Five (5) of the blood counts had an abnormality in the white blood cells; however, the type of abnormalities seen were not consistent and are not usually related to the toxic effects of chemicals which would tend to cause more severe changes.

Cholinesterase levels on the examined population were drawn by the plant physician. 20 workers were tested, 17 within 5 weeks of our examination, and three at a later date. Only one worker tested in this group was from the liquid facility. Two workers had red blood cell cholinesterase levels below the normal of 210 ChE-Tel units from the granular facility. Prior to our investigation, cholinesterase levels had been drawn almost weekly from the employees working in the granular facility. We reviewed these results which are summarized below.

Eight persons have been below the normal level for plasma cholinesterase at some time, and five have been below the normal level for red blood cell (RBC) acetyl cholinesterase at some time during their work in the plant. Episodes of sub-normal plasma cholinesterase (<45 units) have occurred 26 times; 31 plasma cholinesterase tests have been below 75% of the individual's baseline cholinesterase level, and 24 have been below 70%. Episodes of sub-normal RBC acetyl cholinesterase (<210 units) have occurred 32 times;

38 RBC acetyl cholinesterase samples have been below 75% of the individual's baseline and 31 have been below 70%. The earliest cholinesterase levels drawn for each employee occur during the first week of employment. The first job given new hires is usually box-making, a work task which is performed in a separate room from the formulation process and involves no direct pesticide exposure. A record of the subsequent work done by each employee on the day of the weekly test is not indicated. Neither is the test administered after any particular complaint, nor after particular assignment to high-exposure work (e.g., pit-cleaning, filter or baghouse cleaning).

VI. OBSERVATIONS AND FINDINGS

A. Based on the above environmental and medical information, it is determined that:

1. Employees are being exposed to concentrations of Product A in the granular facility which are in excess of the environmental criteria and may be toxic considering the medical findings.

2. Employees are being exposed to concentrations of heptachlor in the seed protectant area which are documented as in excess of the environmental criteria for heptachlor.

3. Employees are being exposed to concentrations of organic solvents (e.g., aliphatic solvents, benzene) in excess of environmental criteria during the liquid filling operations involving Product B.

4. The environmental results for the contaminants evaluated during this survey indicate that employees may be exposed to excessive concentrations of other pesticides (e.g., captan, diazinon®, organophosphates, etc.) during similar processing operations in the granular and liquid facilities.

5. There is a potential exposure of employees to "free silica" which may be potentially hazardous to employees in the granular facility over a longer period of time (years). However, the majority of the airborne dust generated appears to be greater than 10 microns and not in the respirable range of less than 10 microns.

It is noted that the type of exposure of employees in the liquid facility varies considerably as the specific pesticide processed changes frequently throughout the year. Also, the ventilation system for the granular processing equipment may not have been properly functioning at the time of the survey.

B. A significant number of workers report acute symptoms apparently due to excessive exposure to pesticides and other dusts in both the granular and liquid facilities as well as the laboratory. In the granular and liquid facilities, respiratory as well as skin absorption may be occurring.

C. There is substantial evidence for excessive exposure to organophosphate pesticides in the granular facility. Cholinesterase levels in several workers had, over time, shown repeated and significant depression. It cannot be stated whether or not the observed prevalence of disturbances of liver function among the workers is significant or due to occupation. Inadequate information has been obtained -- only 68% of the workers had blood chemistries drawn, and there is little information on liver findings in any of the workers formulating seed protectants.

D. Several problems of personal protection and hygiene were apparent during the survey and from interviews with the employees. Protective clothing (e.g., rubber boots, coveralls, etc.) is required in the production area of the granular facility. However, the contaminated boots, coveralls and respirators are worn into the lunch room or "clean" area during breaks and lunch periods. Some workers also sat in their automobiles with family members during lunch or dinner periods. The respiratory protection program was not very effective as some employees had beards and mustaches (not shaved before shift), pieces were missing from respirators, filters not changed, inside of air-supplied helmet contaminated with product, and one or more employees who were in a dusty environment wore the respirators around their necks. Compressed air for breathing purposes was supplied by a common compressor which also supplied the building compressed air. Employees do shower before leaving work at the granular facility. Protective clothing is available for employees in the liquid facility, and most employees use the clothing provided, particularly the respirators while operating in the seed protectant facility. Conditions are very dusty during operations involving the seed protectant equipment and visible contamination was noted on the faces of a few employees while processing heptachlor. Workers normally do not tape the impervious gloves to the coveralls to avoid contamination on the inside of the glove. Visible contamination of heptachlor was noted on a personal jacket of one employee at the end of the shift at the liquid facility.

E. Pit cleaning continues to be a problem. One employee went into the pit without a PVC coverall or air-supplied respirator. The PVC suit itself may cause problems, since it is worn over dusty coveralls and is warm. Sweating may enhance skin absorption of the pesticide dust from the coveralls. In addition, the motor in the pit generates a significant amount of heat. The work of cleaning the pit is hard physical labor and generates increased body heat.

F. The pit operation with the manual shoveling of dusts into barrels generates an undue amount of dust. Although not observed by the authors, it would appear that emptying the bag filters may also generate an undue amount of dust. There are various pieces of equipment and methods (e.g., vacuuming, etc.) available commercially which should greatly reduce the amount of dust generated. For instance, there are enclosed screeners available which would allow not only the flow of appropriate particle-sized product to the packaging machine, but would also allow for the mechanical collection and packaging with ventilation of the non-specification particle-sized product in separate drums.

G. A cursory survey was made of the ventilation systems provided for the processing equipment at the granular and the seed protectant facility. Neither system provided an adequate flow of air at various points of operation such as the loading and packaging areas nor an adequate means for routinely monitoring the ventilation system (e.g., manometers for pressure drop over filters, etc.). Also, the air may be recirculated following the filtration system of the process ventilation system which may account for a portion of airborne dust in the granular production area.

H. There were several observations noted during the survey (e.g., no gloves while handling solvents, no goggles, face shields, or head covering when handling technical material from splash or dust settling, no washing of hands prior to smoking, etc.) which indicated a need for more strict protective clothing controls at the granular facility and, in particular, the liquid facility.

VII. RECOMMENDATIONS

In view of the above information, the following recommendations are offered as suggestions to management for their consideration to alleviate potential hazards and to provide a more desirable working environment for all personnel involved in operations covered by this evaluation:

A. Immediate action should be taken to lower the potential exposure of employees by providing improved engineering controls and practices. Engineering controls such as process enclosures, filling equipment with automatic shut-off, mechanical metering and transferring devices and ventilation systems shall be used as necessary to ensure that the workplace environmental criteria or standard(s) specified for the particular pesticide(s) are not exceeded and to minimize skin exposure. Some general considerations should include:

1. Improved processing equipment and/or local ventilation to preclude dust emissions or exposure of employees should be provided for the front end loading of granular clay, subsequent bagging and sealing of product, and particularly the screening (pit operation) equipment at the granular facility. As noted in item F of the previous section, there are various pieces of equipment and/or

methods available commercially which would greatly reduce the amount of dust generated during pit cleanup operations. A different method (e.g., enclosed conveyor belt, etc.) for handling of raw clay loading to the hopper or improving the face velocity of the hopper by lowering the open surface area at the top of the hopper (grating system, belting) and/or increasing the fpm with a larger fan could be utilized.

2. Improved and/or new local exhaust systems or processing methods should be provided for loaders, blenders, hoppers, mixers, packaging equipment and other sources of pesticide dust in the seed protectant facility. Dust exhaust systems in the granular or other facilities (seed protectant area) shall be vented to dust collectors and air should not be recirculated.

3. Local ventilation should be provided at the point of operation for the liquid packaging equipment.

4. The exhaust system on the tanks and packaging area of the nutrient area in the liquid facility and the emptying of any bag filters should be evaluated and appropriate modifications made to the equipment if the systems do not adequately contain dusts and/or vapors during operations.

5. Air discharged from any pesticide process or room vent should not be recirculated through the employee work area, and should be exhausted six feet above the roof or as required by state and/or local regulations.

6. A program of periodic preventive maintenance, cleaning, and periodic inspection shall be established to ensure maximum effectiveness of ventilation systems. This program shall include air flow measurements, inspection of ductwork for leaks, and examination of collecting elements. These procedures shall be performed at a frequency (at least twice monthly) which will assure proper functioning of the ventilation system during formulating operations. Monitoring devices such as manometers for pressure drops over filters should be installed for the more important features of the ventilation systems which need frequent monitoring.

7. Tanks receiving liquid pesticide or pesticide mixtures should be filled through submerged fill lines to minimize pesticide vaporization. Receiving tanks should be provided with tank level indicators and alarms with automatic cut-off valves.

8. Pesticide processing equipment subject to drips, leaks, spills, and other uncontrolled discharges of pesticide shall be surrounded by curbs or dikes. Curbed or diked process areas shall be drained to waste sumps; they shall not be drained into open or sanitary sewers.

9. Protective shields shall be installed where appropriate to guard against splashes and otherwise reduce worker exposure.

10. Consideration should be given to provision of an improved line of contamination control between "clean" areas (e.g., lunch room, change area) and potentially contaminated and processing areas in the granular facility. Similar provisions (e.g., change room, protective clothing, etc.) should be provided in the liquid facility. This may involve some minor modification to the granular facility and perhaps a major modification to the liquid facility.

B. More frequent cleanup of the screening pit and emptying bag or other filters along with scheduled rotation of personnel for these operations should be implemented until better engineering controls and/or processing methods are provided for those operations which may generate inordinate amounts of dust. This should minimize the duration of potential exposure to each worker on any given day.

C. Strict contamination and decontamination control procedures for product packages, tools, equipment, facilities, and personnel should be implemented for all processing operations with pesticides at these facilities as well as during minor and major maintenance operations. The current procedures should be expanded, reevaluated and rewritten to modify and reflect operating procedures (e.g., routine, emergency in event of a spill, etc.) to be followed in order to contain contamination and preclude unnecessary contamination of tools and equipment outside of designated areas, such as lunch rooms. There is a definite need to provide stricter contamination controls in the liquid facility, particularly in the seed protectant area. Observations during the survey indicate that the procedures should place particular emphasis on contamination control of employees (e.g., protective clothing, etc.), equipment areas, decontamination of personnel and/or equipment, emergency actions, and similar salient aspects which need special consideration in procedures covering these operations. These procedures should be readily available to employees, and employees should be knowledgeable with and follow the procedures.

D. A program of employee and management education should be instituted. Educational materials from pesticide manufacturers, government, and others should be used to demonstrate to the workers the proper handling and potential toxicity of pesticides. Audiovisual material would be especially important in this educational process. It is important that supervisors convey a respect for these extremely toxic chemicals by their actions in the plant. The small details of work practices and personal hygiene practiced by management and supervisory personnel sets the tone of the behavior of the entire workforce. Particular emphasis should be placed on the necessity of good personal hygiene habits of all employees and informing employees of the hazards from various pesticides processed at these facilities.

E. A respiratory protection program (e.g., use of respirators, fresh air helmets, etc.) should not be used in lieu of appropriate engineering and administrative controls. Until appropriate engineering and administrative controls can be in effect, the current respiratory protection program should be immediately modified to assure compliance with requirements described (outlined as eleven criteria for a "minimal acceptable program") in the Occupational Safety and Health Administration Standard, Title 29 of the Code of Federal Regulations, Part 1910, Section 134.

F. Improvements in respirator care, personal protection, personal hygiene work practices and housekeeping are also required as may be noted in other recommendations.

G. Employees' direct contact (e.g., soiled clothing, spill, etc.) with pesticides should be avoided by wearing appropriate protective clothing. Areas of the skin which may be covered by hair (face, head, etc.) should also not be contaminated. Good work practices, emergency and first aid procedures, should also be included in the employees' educational program.

H. Emergency showers and eye wash facilities shall be checked periodically to assure proper operation as well as possible contamination. Pathways to these facilities should be kept free of all obstacles. Deluge showers and eye wash fountains should be present in all locations where exposure to pesticides may occur.

I. Appropriate posting of areas should be accomplished concerning the hazards in the production areas and appropriate actions in the event of emergencies (e.g., spill, fire, etc.) and to prevent any entry to these areas by unauthorized or uninformed persons.

J. The company should have industrial hygiene resources available for routine periodic monitoring of various operations where contaminants (e.g., vapors, dusts, etc.) may become airborne at levels of fifty percent or more of the environmental criteria or standard for the particular contaminant (e.g., pesticide, organic solvent, etc.). If monitoring of an employee's exposure reveals an exposure in excess of the environmental criteria or standard, engineering and a administrative control measures shall be initiated and the employee notified of his exposure and of the control measures being implemented to correct the situation. Monitoring should continue until two consecutive samplings, at least a week apart, indicate that employee exposure no longer exceeds the environmental criteria.

K. The company should discontinue the use or organic solvent mixtures which contain significant amounts of benzene and substitute mixtures containing less toxic materials or those that do not contain significant amounts of benzene.

L. The recommendations contained in the NIOSH "Health and Safety Guide for Pesticide Formulators" DHEW (NIOSH) Publication No. 77-100 and particularly NIOSH's Criteria Document: Recommendations for an Occupational Exposure Standard for Pesticide Manufacturers and Formulation should be implemented as appropriate. (Note: The criteria document should be published in the near future).

M. The medical consultant should determine if the employees are continuing to have acute symptoms, depression of cholinesterase levels and liver function abnormalities as a measure of the adequacy of engineering controls and hygienic work practices. Other salient medical considerations are:

1. The medical surveillance of cholinesterase levels of workers in the granular facility should be structured to include a record of work performed and acute symptoms occurring on the day of the blood test. (If the blood test is performed in the morning, prior to the shift, the work done on the preceding day should be recorded).

2. Because of potential exposure to organophosphates in the formulation of seed protectants, workers in the liquid facility should also have regular examinations of cholinesterase levels when processing organophosphates.

3. Cholinesterase levels should be determined on specific employees who are performing work with a potentially high exposure, such as pit cleaning, baghouse or filter cleaning. This blood test should be performed following the completion of the task or at the beginning of the next work day. A record of the task and acute symptoms occurring on the day of (or prior to) the blood test should be maintained by the plant physician.

4. Workers with repeated depression of cholinesterase levels should be screened for the presence of atypical plasma cholinesterase,[18, 19] a genetic abnormality which causes increased sensitivity to the toxic effects of organophosphate exposure. Any worker with this genetic abnormality should be rotated to work with minimal exposure to organophosphate pesticides, until substantial dust control is accomplished.

5. Liver function tests including SGOT, γGTP, alkaline phosphatase, LDH, and bilirubin should be performed every six months on the exposed workforce unless it is clear that no further alterations of liver function are occurring which may be due to the work environment.

6. If the results of the liver function identify a continued presence of abnormalities, these workers should be investigated to determine whether the cause is non-occupational, occupational, or an interaction between the occupational environment and other health factors.

7. Employees should be examined annually by a physician. The examination should include, at a minimum, a medical history, physical examination, complete blood count, BUN, urinanalysis and other such indices as may be indicated at the time.

8. In view of the presence of graphite and silica dust in the operations, it is recommended that each employee have a pre-employment chest x-ray. Any employee in the plant for more than five years should have bi-annual chest x-rays, after ten years, the x-rays should be performed annually.

VIII. REFERENCES

1. Farm Chemicals Handbook. Meister Publishing Co., 1978

2. Kenaga, E.E., End, Cheryl S.; Commercial and Experimental Organic Insecticides, Entomological Society, 1974 Revision.

3. National Cancer Institute; Report on Carcinogenesis Bioassay of Chlordane and Heptachlor, Technical Background Information, Sept. 1977.

4. Innes, J.R.M. et al.; Bioassay of Pesticides and Industrial Chemicals for Tumorigenicity in Mice: A Preliminary Note, Journal National Cancer Institute 42:1101-14, June 1969.

5. Han, R.; Aplastic Anemia Following Exposure to Lindane, Journal American Medical Association 236(9):1009-10, Aug. 1976.

6. Loge, J.P.; Aplastic Anemia Following Exposure to Lindane, Journal of American Medical Association 193:110-14, 1965.

7. Spencer, E.Y.; Guide to Chemicals Used in Crop Protection, Agriculture Canada, 6th Edition, 1973.

8. Cam, C.; Acquired Porphyria Cutanea Tarda due to Hexachlorobenzene, Journal American Medical Association 183:88-91, 1963.

9. Ulland, B.; Thyroid Cancers in Rats from Ethylene Thiourea Intake, Journal National Cancer Institute 49:583-4, 1972.

10. Herbicide Handbook, Weed Science Society, 3rd Edition, 1974.

11. Durham, W.F.; Mutagenic, Teratogenic and Carcinogenic Aspects of Pesticides, Annual Review Entomology 17:123-48, 1972.

12. Desi, I.; Nervous System Effects of a Chemical Herbicide, Archives of Environmental Health 4:95-108, June, 1962.

13. Goldstein, N.P., et al.; Peripheral Neuropathy After Exposure to an Ester of Dichlorophenoxyacetic Acid, Journal American Medical Association 171:1306-9, 1959.

14. Garry, P.J. and Routh, J.I.; A Micromethod for Serum Cholinesterase. Clinical Chemistry 11:91-96, 1965.

15. Hestrin S.; J.; The Reaction of Acetylcholine and other Carboxylic Acid Derivatives with Hydroxylamine, and its analytical Application, J. Biol. Chem. 180:249 (1949)

16. Michel, H.O., An Electrometric Method for Determination of Red Blood Cell and Plasma Cholinesterase Activity. J. Lab. Clin. Med. 34:1564-68 (1949).

17. Bridges, B.A.; The mutagenicity of Captan and Related Fungicides, Mutation Research 32:3-34, 1975.

18. Kalow, W.; A Method for the Detection of Atypical Forms of Human Serum Cholinesterase - Determination of Dibucain. Canadian Journal of Biochemistry and Physiology. Volume 35 - Page 339-346. 1957

19. Kalow, W.; On Distribution and Inheritance of Atypical Forms of Human Serum Cholinesterase as Indicated by Dibucain Numbers. Canadian Journal of Biochemistry and Physiology. Volume 35 - Pages 1305-1320. 1957.

IX. ACKNOWLEDGEMENTS

Environmental Survey Conducted By: Raymond L. Hervin
Regional Industrial Hygienist
Kansas City, Missouri

Raymond L. Ruhe
Clifford Moseley
Industrial Hygienists
Cincinnati, Ohio

Medical Survey Conducted By: Dr. Susan Daum, M.D.
Dr. Marion Moses, M.D.
Mt. Sinai School of Medicine
New York, New York

Originating Office: Jerome P. Flesch, Acting Chief
Hazard Evaluation and Technical
Assistance Branch

Laboratory Analysis : Richard Kupel
Chemist, NIOSH
Cincinnati, Ohio

James Perkins
Supervisor, Utah Biomedical Test Lab
Salt Lake City, Utah

Wendell Reese, Laboratory Manager
Memorial Hospital of Dodge County
Fremont, Nebraska

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977

TABLE IA

CONCENTRATIONS OF PRODUCT A FOUND DURING ROUTINE PROCESSING OPERATIONS AT THE GRANULAR FACILITY

Job and/or Area Classification	Date	Sample Number	Time of Sample	Product A mg/M^3*
Box Stacker Operator #1	11/15	AA-5	14:00-20:21	0.126 (0.100)**
Bagging Operator #2	11/15	AA-10	14:00-20:37	0.202 (0.167)
Sealing Operator #3	11/15	AA-4	14:00-20:28	0.241 (0.194)
Stapler, Full Boxes, Operator #4	11/15	AA-12	14:00-20:26	0.117 (0.094)
Mixer Operator #5	11/15	AA-7	14:00-20:30	0.108 (0.087)
Sampler & Cleanup Operator #6	11/15	AA-9	14:00-20:35	0.186 (0.153)
Packing Bags into Cartons Operator #7	11/15	AA-6	14:00-20:33	0.134 (0.110)
Foreman & Forklift Operator #8	11/15	AA-8	14:04-20:23	0.091 (0.072)
Maintenance Operator #9	11/15	AA-3	14:35-18:48	0.022 (0.012)
Mixer Operations-Area #1	11/15	AA-2	14:27-20:19	0.108 (0.079)
Bagger Operations-Area #2	11/15	AA-1	14:31-20:16	0.174 (0.125)
Bagging Operator #2	11/16	AA-57	13:58-17:14	0.476 (0.194)
Mixer Operator #5	11/16	AA-13	13:58-17:12	0.155 (0.063)

Environmental Criteria for Product A is 0.050 mg/M^3.

*mg/M^3 - approximate milligrams of substance per cubic meter of air.

**( ) - Resulting 8-hour time-weighted average concentration from the above concentration assuming no additional exposure in the 8 hour period.

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977

TABLE IB

CONCENTRATIONS OF PRODUCT A FOUND DURING PIT CLEANUP OPERATIONS AT THE GRANULAR FACILITY

Job and/or Area Classification	Date	Sample Number	Time of Sample	Product A mg/M^3*
Operator A	11/16	AA-19	11:11-12:29	1.28 (0.21)**
Operator B	11/16	AA-14	11:11-12:29	1.37 (0.22)
Operator C	11/16	AA-16	11:11-12:29	2.65 (0.43)
Operator D	11/16	AA-18	11:11-12:29	67.52*** (10.972)
Operator E	11/16	AA-55	11:11-12:31	1.58 (0.26)

Environmental Criteria for Product A is 0.050 mg/M^3.

*mg/M^3 - approximate milligrams of substance per cubic meter of air.

**( ) - Resulting 8-hour time-weighted average concentration from the above concentration assuming no additional exposure in the 8 hour period.

***This result may not be considered as valid as over an order of magnitude greater than the other samples.

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977

TABLE IC

CONCENTRATIONS OF SMEARABLE CONTAMINATION OF PRODUCT A FOUND ON THE SURFACES OF SOME EQUIPMENT AND AREAS AT THE GRANULAR FACILITY

Sample Number	Location	Smear Sample Results mg/100 cm^2*
Smear #5	Inside of air-supplied helmet after decontamination	0.072
Smear #4	Inside of 2nd helmet	0.006
Smear #11	Outlet for supplied air mask	0.002
Smear #12	Hose connection to supplied air mask	0.003
Smear #6	Clean change area	0.004
Smear #3	Desk and chair and equipment in lunch room, file cabinet	0.001
Smear #2	Sink in lunch room	0.008
Smear #1	Floor in lunch room	0.012

*approximate milligrams of substance per 100 square centimeters of surface area smeared.

NOTE: No environmental criteria has been established for smearable contamination.

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977

TABLE ID

CONCENTRATIONS OF TOTAL DUST (T-SAMPLE NO.), RESPIRABLE DUST (R-SAMPLE NO.), AND TOTAL FREE SILICA (QUARTZ AND CRISTOBALITE) FOUND DURING ROUTINE PROCESSING OPERATIONS AT THE GRANULAR FACILITY

Job and/or Area Classification	Date	Sample Number	Time of Sample	Total Dust mg/M^3*	Quartz mg/M^3*	Cristobalite mg/M^3*	Free Silica mg/M^3*
Box Stacker Operator #1	11/15	T-1523	14:00-20:21	2.52 T (2.00)**	0.19	0.06	0.25
Bagging Operator #2	11/15	R-1207	14:00-20:37	0.58 R	ND	ND	----
Sealing Operator #3	11/15	R-1211	14:00-20:28	0.68 R	ND	ND	----
Stapler, Full Boxes Operator #4	11/15	T-1514	14:00-20:26	1.94 T (1.56)	0.20	0.08	0.28
Mixer Operator #5	11/15	R-1215	14:00-20:30	1.34 R	ND	ND	----
Sampler & Cleanup Operator #6	11/15	T-1516	14:00-20:35	1.98 T (1.63)	0.24	0.06	0.30
Bagger Operations-Area #2	11/15	T-1509	14:33-20:16	1.58 T (1.13)	0.15	0.09	0.24
Bagger Operations-Area #2	11/15	R-1213	14:32-20:16	0.65 R	ND	ND	----
Bagging Operator #2	11/16	R-1222	13:58-17:14	0.84 R	ND	ND	----
Bagging Operator #2	11/16	T-1217	13:58-17:14	4.41 T (1.80)	0.60	0.18	0.78
Mixing Operator #5	11/16	T-1515	13:58-17:12	7.43 T (3.00)	0.49	ND	0.49
Mixing Operator #5	11/16	R-1223	13:58-17:12	0.91 R	ND	ND	----

*mg/M^3 - approximate milligrams of substance per cubic meter of air.

**( ) - Resulting 8-hour time-weighted average concentration from the above concentration assuming no additional exposure in the 8 hour period.

Environmental Criteria: Total dust (nuisance)-10 mg/M^3; Respirable dust (nuisance)-5 mg/M^3; Total dust containing free silica (quartz and/or cristobalite)-1.9 mg/M^3 See text for further explanation of environmental results and criteria.

NOTE: The positive results for cristobalite may be viewed with some caution as these levels are too low to permit confirmation of cristobalite.

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977

TABLE IE

CONCENTRATIONS OF TOTAL DUST (T-SAMPLE NO.), RESPIRABLE DUST (R-SAMPLE NO.), AND TOTAL FREE SILICA (QUARTZ AND CRISTOBALITE) FOUND DURING PIT CLEANUP OPERATIONS OF THE FINAL PRODUCT AT THE GRANULAR FACILITY

Job and/or Area Classification	Date	Sample Number	Time of Sample	Total Dust mg/M^3*	Quartz mg/M^3*	Cristobalite mg/M^3*
Operator A	11/16	R-1212	11:11-12:29	0.68 R	ND	ND
Operator B	11/16	T-1511	11:11-12:29	18.10 T (2.94)**	1.43	ND
Operator C	11/16	R-1218	11:11-12:29	0.83 R	ND	ND
Operator D	11/16	T-1517	11:11-12:29	25.87 T (4.20)	3.80	ND

*mg/M^3 - approximate milligrams of substance per cubic meter of air.

**( ) - Resulting 8-hour time-weighted average concentration from the above concentration assuming no additional exposure in the 8 hour period.

Environmental Criteria: Total dust (nuisance)-10 mg/M^3;
Respirable dust (nuisance)-5 mg/M^3;
Total dust containing free silica (quartz and/or cristobalite)- 2.1 mg/M^3

See text for further explanation of environmental results and criteria.

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977

TABLE IIA

CONCENTRATIONS OF BUTYL ALCOHOL, MINERAL SPIRITS, BENZENE, TOLUENE, AND XYLENE DURING LIQUID PACKAGING OPERATIONS AT THE LIQUID FACILITY

Job and/or Area Classification	Date	Sample Number	Time of Sample	Butyl Alcohol mg/M³*	Aliphatic Solvent "140 Flash" mg/M³*	Benzene mg/M³*	Toluene mg/M³*	Em (--)**
Materials Handler #1	11/15	CT-1	12:08-15:30	53.6 (0.36) (0.15)	247.1 (1.65) (0.69)	.0.7 (0.22) (0.09)	2.9 (<0.01) (<0.01)	ND (2.23) (0.93)
Materials Handler #2	11/15	CT-2	12:05-15:30	21.5 (0.14) (0.06)	31.6 (0.21) (0.09)	1.8 (0.56) (0.24)	1.8 (<0.01) (<0.01)	ND (0.91) (0.39)
Materials Handler #3	11/15	CT-3	12:06-15:30	10.1 (0.07) (0.03)	20.6 (0.14) (0.06)	0.8 (0.25) (0.11)	1.0 (<0.01) (<0.01)	ND (0.46) (0.20)
Materials Handler #4	11/15	CT-4	12:09-15:30	84.0 (0.56) (0.23)	244.5 (1.63) (0.68)	3.8 (1.19) (0.50)	5.3 (<0.01) (<0.01)	ND (3.39) (1.41)
Environmental Criteria for these substances are				150.0	150.0	3.2	375.0	1.0

*mg/M³ - approximate milligrams of substance per cubic meter of air.

**Em( ): Em is the equivalent exposure for the mixture. $Em = \frac{C_1}{L_1} + \frac{C_2}{L_2} \ldots \frac{C_n}{L_n}$ where Em is the equivalent exposure for the mixture. C is the concentration of the particular contaminant. L is the exposure limit or criteria for that contaminant. The value of $\frac{C}{L}$ or Em shall not exceed the value of 1. The ( ) to the right of the concentration found represents the $\frac{C}{L}$ value if employees exposure was calculated for an 8-hour production cycle at levels found. The ( ) below the concentration represents the $\frac{C}{L}$ value assuming no further exposure of employees in the 8 hour period. Em values show the cumulative effects of combined exposure with and without additional exposure in the 8 hour period.

NOTE: Samples were also analyzed for xylene and no xylene was detected or less than 0.01 mg per sample.

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 17, 1977

TABLE IIB

CONCENTRATIONS OF HEPTACHLOR AND LINDANE DURING MIXING AND PACKAGING OPERATIONS OF HEPTACHLOR (SEED PROTECTANT AREA) AT THE LIQUID FACILITY

Job and/or Area Classification	Sample Number	Time of Sample	Heptachlor mg/M^3*	Lindane mg/M^3*
Materials Handler #4	GF-6	8:22-11:00	3.13	0.008
	GF-16	12:12-15:07	0.06	ND
	GF-6 & 16	see above	(1.05)**	
Materials Handler #1	GF-7	8:25-11:00	2.76	ND
	GF-14	12:14-15:06	0.08	0.005
	GF-7 & 14	see above	(0.911)	
Materials Handler #3	GF-13	8:28-11:00	0.04	0.009
	GF-17		VOID	VOID
	GF-13 & 17		(VOID)	
Materials Handler #2	GF-9	8:31-11:00	0.25	0.007
	GF-8	12:09-15:05	2.29	0.007
	GF-9 & 8	see above	(0.920)	
Environmental Criteria			0.5	0.5

*mg/M^3 - approximate milligrams of substance per cubic meter of air.

**( ) - Resulting 8-hour time-weighted average concentration from the above concentration assuming no additional exposure in the 8 hour period.

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977

TABLE IIC

SMEAR SAMPLE RESULTS AT LIQUID FACILITY

Sample Number	Location	Smear Sample Results mg/100 cm^{2}*	
		Lindane	Heptachlor
#10	Desk in locker room area, books	0.003	ND
# 9	Floor area, locker room	ND	ND
# 8	Sink, paper towel area, first aid kit	ND	ND

*approximate milligrams of substance per 100 square centimeters of surface area smeared.

There is no environmental criteria for smearable contamination.

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977

TABLE III

Length of employment at pesticide facility

Duration of work in months	Granular number	Liquid number	Total number
1	5	1	6
2	9	2	11
3	2		2
5	1		1
6	-	1	2
8	-	1	1
9	1		
12	1		1
16	1		1
25	1		1
32	1		1
Total	22	5	28
mean	5.6 mos.	5.8 mos.	5.6 mos.
median	2 mos.	2 mos.	2 mos.

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977

TABLE IV

Prevalence of irritative symptoms

	Mucous membrane symptoms					Upper respiratory symptoms			
Facility #	Eye irritation	Nose irritation	Throat irritation	Cough	Total mucous membrane symptoms	chest tightness	Wheezing	Total upper respiratory symptoms	Total: Any symptoms
Granular 22	7 (32%)	6 (27%)	4 (18%)	3 (14%)	9 (41%)	2 (9%)	2 (9%)	4 (18%)	12 (55%)
Liquid 5	3 (60%)	2 (40%)	1 (20%)	2 (40%)	3 (60%)	1 (20%)	1 (20%)	1 (20%)	4 (80%)
Laboratory 1	1	1	1		1	0	0	0	1

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977

TABLE V

Prevalence of neurologic symptoms

Number	Dizzyness/ Lightheadedness	Headache	Anorexia	Abdominal cramp	Nausea	Self-reported personality change	Weakness or fatigue	Muscle weakness	Sleepiness	Loss of concentration	Unconsciousness	Total any sympt reporte
Granular facility												
22	6	4	3	1	1	1	3	2	1	1		14 (*
			*	*	*		*	*	*	*	*	
Liquid facility												
5	1	0	0	0	0	0	0	0	0	0	0	1 (*
Laboratory												
1	0	0	0	0	0	0	0	0	0	0	0	

*Symptoms in one worker with acute organosphate intoxication, secondary to ethoprop exposure. Spring 1976. Additional symptoms: Staggering gait, blurry vision, muscle twitching.

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977
TABLE VI

Analysis of positive responses to symptom questionnaire

Character of symptoms	Frequency	Usual job description	Comment
Case #			
#5. Employed 2 months. Anorexia daily, first week of employment. Onset 3-8 hours after beginning work. Improvement after weekend.	Occurred once	-Bag tucker	-He attributes his symptoms to the odor (mercaptans)
#6. Employed 16 months. Eye irritation, runny nose, sore throat, dizziness with lightheadedness. Onset 1-3 hours after beginning of shift. Improvement over weekend.	About monthly	-Box filler. Cleans pit as needed	--
#9. Employed 2 months. Dizziness and lightheadedness on the day of our examination.	Occurred once	-Bag sealer	--
#12. Employed 25 months. Difficulty breathing when working night shift only. Onset 3-8 hours after beginning shift.	Daily since 2/77	-Mixer	-Associates it with Terbufos dust
Headache. Onset at end of shift. Improves after shift.	Daily		
#13. Employed 2 months. Tearing and nose and throat irritation and cough. Onset when dusty. Improves when dust levels low; and improves further when away from plant on weekends.	Daily	-Subforeman	--
Weakness and fatigue. Onset of	Daily		--

TABLE VI (continued)

Character of symptoms	Frequency	Usual job description	Comment
#14. Employed 9 months. Wheezing. Onset 3-8 hours after beginning of shift History of acute cholinestrase intoxication. RBC cholinestrase of zero; Symptoms: Weakness, muscle fatigue, staggering gait, muscle twitching, blurry vision, abdominal cramps. Anorexia, nausea, sleepiness, loss of consciousness	Monthly	-Boxing bags, later emptying bags of quality control	-May occur off job. Reactivation of quiescent asthma. -Acute episode; cleaning pit without protective PVC suit. Exposure to ethoprop.
#15. Employed 2 months. Eye, nose and throat irritation. Onset 3-8 hours after beginning of shift. Lasts 1-2 hours after shift. Wheezing.	Daily including day of examination	-Box making; boxing bags. Occassional pit cleaning. Sealing bags on line.	
Short of breath, thirst, breathing hard, irritation of the eyes, nose & throat on the day of examination.	Once. Day of examination Three times	-One time	-Related to dust and increased pace of work.
Dizziness and lightheadedness. Onset 1½ hours after beginning of exposure. Recovery, 1 hour after exposure ceased.			-Exposure to terbufos while cleaning pit in each case. Using usual coveralls (not PVC) and usual respirator not air supply.
Nausea	Twice		-Pit cleaning inder same circumstances. Odor may contribute to nausea
Headache; onset rapidly with pesticide dust exposure. Recovery 1-2 hours after dust exposure	Four times		-Sealer, pit in above conditions
Anorexia. Onset 1-2 hours after dust exposure. Rapidly improves after dust exposure	Once-twice		-Occurred while sealing bags

TABLE VI (continued)

Character of symptoms	Frequency	Usual job description	Comment
(#15 continued)			
Abdominal cramp. Onset 4-6 hours after beginning of shift. Better when lying down at end of shift. Personality change; angrier.	Rare		-In pit in above conditions
#16. Employed 3 months. Eye irritation ("brief") and weekly sneezing. Fatigue.		-Boxing bags. Closing boxes (stapling); stacking boxes (pallet loader)	-Symptoms related to hard physical work.
Slight lightheadedness	Once (during our hazard evaluation)	-cleaning pit	
#17. Employed 2 months. Dizziness & lightheadedness. Fatigue and weakness; muscle fatigue. Onset: 3-8 hours after beginning of shift. Improves after shift and more improvement after weekend break. Tearing and eye irritation.	Monthly	-Sampling (most of time) also boxing bags, loading boxes on pallets	-Terbufos dust -Occasional chlorine exposure
#19. Employed 1 month. Eye irritation (burning). Onset early 1 work day, then disappears.	Daily	-Bag tucker	-"Dustiness"
#20. Employed 1 month. Eye irritation; brief after several hours of work.	Daily	-Pallet loader	-Dust
Dizziness and lightheadedness	Occasionally		--
#21. Employed 2 months. Nasal cattarh. Onset at beginning of shift; continues until ½ hour after shift; further im-	Daily	-Job changes: Making bags with pesticide, checking of bags. Casing boxes.	-Terbufos and general dustiness

TABLE VI (continued)

Character of symptoms	Frequency	Usual job description	Comment
(#21 continued)			
Anorexia: Onset more than 12 hours after exposure	Once		-Exposure: in pit without PVC suit. He also noted dip in plasma- CHe after episode (to 37 units).
#26. Employed 3 months. Nasal catarrah (runny). Onset 1-2 hours after beginning shift; improves immediately after shift.	Daily including day of examination	-Mixer	-Terbufos dust
Weakness, fatigue, muscle fatigue, sleepiness. Continuous since onset of work at plant.	Daily		
Rhinorrhea on the day of examination.			
#27. Employed 2 months. Eye and nasal irritation, cough; immediate symptoms with exposure to pit dust and immediate improvement when exposure ceases.	Monthly	-Boxmaking, maintenance	-Occurs only when he cleans pit
Dizziness and lightheadedness, with loss of concentration. Onset 1½ hours after entry to pit. Recovers rapidly after exposure ceases	Monthly		-Pit cleaning
	Liquid facility		
#2. Employed 16 months. Eye irritation; immediate onset with exposure to irritant; improves immediately after	Occasional	-On seed treatment 'line'.	-Ammonia and propionic acid fumes from tank

TABLE VI (continued)

Liquid facility (continued)

Character of symptoms	Frequency	Usual job description	Comment
#3. Employed 2 months. Nasal and throat irritation; cough chest tightness and wheezing; Onset 3-8 hours after shift; improves slowly after shift and more over weekend.	Daily	-On seed treatment 'line'.	-Dust of heptachlor diazazon, mixture
#4. Employed 2 months. Eye irritation. Dizziness and lightheadedness; onset early in shift. Improvement after exposure.	Once	-Box and can sealer	-Occurred when filters on ventilation equipment were plugged (2,4. D exposure)
#11. Employed 1 month. Eye, nasal irritation and cough. Onset at beginning of shift; improvement immediately after shift.		-Seed treatment 'line'.	-Dust: heptachlor, graphite, diazinon
Laboratory			
#35. Employed 6 months. Acute eye, nose and throat irritation; improvement immediately after exposure.		-Technician-quality control	- Propionic acid and other volatile substances.

PLATTE CHEMICAL COMPANY
FREMONT, NEBRASKA
TA 77-66
NOVEMBER 15-16, 1977

TABLE VII

Prevalence of abnormal liver function test

n = #of employees	Bilirubin	Alkaline phosphatase	SGOT	LDH	GTP	Any abnormality
n= 19	1	3	5	5	2	7
	(5%)	(16%)	(26%)	(26%)	(11%)	(41%)

Prevalence of abnormal white blood count

n = # of employees	$<5000/mm^3$	$>10,000/mm^3$
n=19	4	1