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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 75-172-317

FMC CORPORATION
FRONT ROYAL, VIRGINIA

AUGUST 1976

I. TOXICITY DETERMINATION

A combined environmental-medical study was conducted in the Viscose Department of FMC Corporation, Front Royal, Virginia during the periods of November 3-4, 1975 and December 16-18, 1975. In this study environmental assessment was conducted by obtaining time-weighted average and peak measurements of worker exposure to carbon disulfide; medical evaluation was accomplished by obtaining medical histories, conducting physical examinations, and collecting and analyzing blood and urine specimens.

All time-weighted average exposures of workers to carbon disulfide were less than the present threshold limit value recommended by the American Conference of Governmental Industrial Hygienists and present Federal Standard (both are 20 parts per million) for this substance; all peak measurements of carbon disulfide exposure were less than the present maximum peak of the Federal Standard of 100 parts per million.

There is no medical or environmental evidence at this time to suggest that excessive exposure to carbon disulfide is occuring or is responsible for illness. Laboratory analyses of blood and urine specimens were within the normal range for most results; a few results, outside the normal range, were probably due to factors other than occupational exposures. Physical examinations were within normal limits with few exceptions; the exceptions noted were not considered unusual considering the age distribution of the workers examined. Some medical problems, complaints and symptoms, were elicited but they did not appear to be unusual in type or frequency.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Copies have been sent to:

a) FMC Corporation, Front Royal, Virginia
b) Authorized Representative of Employees
c) U. S. Department of Labor - Region III
d) NIOSH - Region III

For the purpose of informing the approximately 330 "affected employees" (workers employed in the Viscose Department), the employer shall post a copy of this determination report for a period of 30 calendar days at or near the workplace(s) of affected employees.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees regarding employee exposure to carbon disulfide in the Viscose Department of the FMC Corporation, Front Royal, Virginia.

IV. HEALTH HAZARD EVALUATION

A. Plant Process - Conditions of Use

This plant produces rayon staple, rayon continuous filament tire cord, and polyester staple. The viscose process is used to manufacture the rayon, and there are two viscose rayon departments at this site. The health hazard evaluation involved the operations and workers in both the Viscose No. 1 and Viscose No. 2 Departments. Rayon was being produced at approximately 70% of capacity due to economic conditions at the time of the evaluation. Although both viscose departments are similar, minor differences in operation are noted in the discussion.

The raw material for the viscose process is a cellulose sheet pulp which is purchased in bales. The pulp bales are conveyed to the soda room where they are broken apart and the pulp sheets transported to the presses using hand carts. The pulp sheets are placed in the presses by hand, soaked for a timed cycle in a sodium hydroxide solution, and pressed hydraulically to remove excess caustic solution. Caustic splashes may occur at the presses, and workers in the press area are required to wear gloves and goggles to protect against such splashes. The primary workers in this area are soda room operators.

The caustic treated pulp is dumped from the presses into Pfleiderers which shred the pulp into small fragments referred to as crumbs. The workers in this area are classified as Pfleiderer Operators. The shredded pulp is dumped into large steel cans holding several thousand pounds and transferred to a storage area for aging under conditions of controlled temperature; the length of aging is varied according to the final properties desired in the viscose. Cellar fork truck operators are responsible for moving the steel cans to the storage area and removing them after aging to an elevator for transfer to the Crumb Dump Floor. Workers in areas described to this point have little direct exposure to carbon disulfide.

At the crumb dump level, the steel cans containing the crumb are moved to a drop chute directly above the churn (reactor) to be charged by battery powered trucks. During dumping the churn is open and there appeared to be a potential for exposure to residual carbon disulfide (CS_2) vapors evolved from the churn during this operation.

Churn operators tend the Xanthation reaction at the churns. Duties of these operators include removing the charging hole cover, monitoring of the churn while crumb is being dumped, charging the reactor with CS_2, sampling viscose for viscosity measurement, pumping viscose to mixers after the Xanthation cycle, and monitoring the caustic wash out cycle. These workers appeared to have a greater potential for exposure than other workers in the Viscose Department.

In the Viscose No. 2 Department, there is a mixer room where the viscose is recirculated and any lumps in the viscose are broken up by an attritor. The mixing room in Viscose No. 1 is located on the same level as the churns where the same operation is performed. This difference is the primary process variation between Viscose Departments No. 1 and No. 2 although Viscose No. 1 is an older facility starting operation in 1940 while Viscose No. 2 commenced operations in 1945.

After the "mix cycle" the viscose is transferred to aging tanks; the length of aging depends upon final properties desired in the viscose. The transfers are controlled from an unenclosed panel by the Cellar Operator.

The viscose is pumped from the transfer tanks through filter presses to spin tanks where vacuum is applied during storage to remove entrained air. The viscose is pumped from the spin tanks through a second set of filter presses to the spinning area of the plant. The filter media, muslin cloths, is changed manually by Filter Changers, and these workers could have some exposure from residual CS_2 in the viscose. After removal, the muslin filters are washed in a commercial type laundry room.

Sundrymen perform all of the above jobs as required and also are responsible for entering tanks for the purpose of cleaning them.

B. Study Design

Viscose No. 1 and No. 2 workers representing previously identified job classifications participated in the evaluation. The Personnel Department provided the 1975 rotating-shift-schedule and personnel roster from which the workers were selected. Utilizing a table of random numbers, fifty-two workers were selected. Four workers were excluded from the study since they could not be available for all phases of the survey, leaving a total of 48 workers. These were distributed as follows: A-1 and A-2 shifts - 11 workers; B-1 and B-2 shifts - 17 workers; C-1 and C-2 shifts - 10 workers; D-1 and D-2 shifts - 10 workers. Each worker in the sample provided a pre- and post-shift urine sample and 27 cc's of whole blood. Five NIOSH persons not exposed to the above chemicals provided urine for control purposes and three provided blood samples.

A non-directed and directed medical questionnaire was prepared for administration by NIOSH physicians to randomly selected workers on each of the four shifts. NIOSH medical officers performed a short physical examination emphasizing vital signs and neurologic function.

The workers selected for participation in the medical study were monitored for exposure to carbon disulfide. Some soda room workers also were monitored for sodium hydroxide exposure. From process inspection, job functions, sources of carbon disulfide, and discussion with workers and management; job classifications were selected which were judged to have the greatest potential for CS_2 exposure. In the Viscose Departments, operators, mixer operators, filter changers, and crumb dump operators were judged to have the greatest likelihood of CS_2 exposure. Several workers from these job classifications in addition to those participating in the medical study also were monitored.

Workers were monitored for a full work shift of exposure to CS_2, following pre-shift medical testing. Sampling times for B, C, and D shifts were generally six to seven hours in length. Sampling times for the A shift were approximately six hours in length; the shorter samplings occurring since the shift was only scheduled in the plant for seven hours.

C. Methods of Evaluation

The personal sampling train used for the collection of CS_2 vapors consisted of a drying tube, two charcoal tubes, and a personal sampling pump operated in series at a flowrate of 50 cc/minute. The sampling and analytical method used is described by McCammon et. al.[1] The drying tube was used to remove water vapor since interference with CS_2 adsorption can occur if water vapor is adsorbed onto the charcoal. The second charcoal tube was used to determine if breakthrough from the first tube to the second tube had occurred in any samples.

The personal sampling train for measurement of sodium hydroxide mist consisted of a mixed cellulose esters filter with a 0.8u average pore size contained in a field cassette, with the pins removed during sampling, in series with a personal sampling pump operated at a flowrate of 1.5 liters/ minute. The filters were analyzed by an atomic absorption spectroscopy[2] method for sodium content and reported as sodium hydroxide concentrations.

Two 10 cc tubes of whole blood, plus seven cc's of oxalated blood were drawn from each worker. The tubes of whole blood were allowed to clot and immediately centrifuged to separate the serum from the red blood cells. The serum was then drawn off into a separate container and immediately refrigerated. The oxalated blood also was refrigerated. All blood and serum specimens were sent to National Health Laboratories, Arlington, Virginia (GSA Approved Laboratory) for processing.

The following tests were performed on the blood samples or serum samples: (a) Chemistries; glucose, blood urea nitrogen, creatinine, sodium, potassium, chloride, carbon dioxide, uric acid, total protein, albumin, globulin, albumin-globulin ratio, calcium, phosphate, cholesterol, triglyceride, alkaline phosphatase, SGOT, SGPT, LDH, total bilirubin and cholinesterase; (b) Hematology; red blood cell count, white blood cell count, hemaglobin and hematocrit.

Urine was collected as follows: prior to each shift, workers were given a 125 ml. bottle and asked to collect the specimen and return it immediately. Each worker was then presented with another urine specimen bottle and asked to collect a second specimen prior to the end of the shift and return this to the medical technician or physician.

All specimens were carefully identified and the urines refrigerated immediately for transportation to the NIOSH Laboratory located in Cincinnati, Ohio.

Many fresh urine specimens were field tested using the iodine-azide reaction. These results were recorded and used to demonstrate that refrigeration, storage, and transportation had no deleterious effect on this reaction.

In this study 48 paired, pre- and post-shift, urine specimens were studied. Five unpaired control specimens also were tested. Samples were diluted and analyzed for creatinine by the auto analyzer N-11 method. The iodine-azide test was run according to the method of Djuric, et al.[3]

D. Evaluation Criteria

1. Environmental Criteria

The three primary sources of environmental evaluation criteria considered in the report are : (1) NIOSH Criteria Documents with recommended standards for occupational exposure, (2) American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's) with supporting documentation, and, (3) Federal occupational health standards, promulgated by the Occupational Safety and Health Administration, U. S. Department of Labor. For the substances evaluated during this study, the primary environmental criteria used were:

Substance	Standard or Guide
Carbon Disulfide	20 ppm (1)
Sodium Hydroxide	2 mg/M^3 (2)

(1) The present ACGIH TLV and Federal Standard for an 8-hour time-weighted average exposure. The Federal Standard includes an Acceptable Ceiling Concentration of 30 ppm with a maximum duration of 30 minutes and an Acceptable Maximum Peak Above the Acceptable Ceiling Concentration of 100 ppm. NIOSH has not published a Criteria Document for occupational exposure to carbon disulfide. (2) The NIOSH Criteria Document recommends a 2 mg/M^3 ceiling evaluated by a 15-minute sampling period. The ACGIH TLV is a 2 mg/M^3 ceiling, and the present Federal Standard is 2 mg/M^3 for an 8-hour time-weighted average exposure.

Occupational health exposure limits for individual substances are generally established at levels designed to protect workers occupationally exposed on an 8-hour per day, 40-hour per week basis over a working lifetime.

Although sources other than the Federal Standard were considered in this study for arriving at a Toxicity Determination, the only legal standard is the Federal Standard which is enforced by the Occupational Safety and Health Administration of the Department of Labor.

Discussion of Pathophysiological Effects

Although poisoning by CS_2 was first described in France and Germany more than a hundred years ago, and sporadic reports of clinical symptomatology from CS_2 exposure have appeared in the world's medical literature, it has only been in the last two or three decades that human responses to CS_2 exposure have received serious scientific attention.

After World War I the production of rayon expanded and with it the incidence of acute and chronic poisoning from CS_2.

CS_2 is neurotoxic and the usual clinical signs begin with headache, dizziness, generalized fatigability, tingling, and numbness of the extremities. More advanced stages involve deterioration of normal behavior and toxic polyneuropathies. Other symptoms include complaints of restlessness, confusion, loss of memory, visual and other sensory disturbances.

The mechanism of cerebral dysfunction is unknown but generally thought to be a consequence of arteriosclerotic changes. Lewey[4] reported cerebral arteriosclerosis in nine dogs exposed to CS_2. Vigliani[5] was able to produce hyperplasia and sclerosis in the media and intima of the cerebral arterioles of rats and guinea pigs. Most European investigators believe that vascular encephalopathy requires chronic exposure to CS_2 for 15 years or more.

The observations made by Vigliani and Pernis[6] have lead them to believe vascular changes occur in two forms, one affecting the cerebral arteries and the other affecting the renal arteries. Renal involvement may produce nephropathy and hypertension. Hernberg[7], Lang[8], Sakurai[9], and Tolonen[10] reported that CS_2 exposure can cause hypertension although the cause of this finding was not determined. In the Pennsylvania survey of 1938 Lewey[11] also claimed that chronic exposure to CS_2 raised blood pressure, although the study was not well controlled.

Harashima et.al.[12] has noted higher cholesterol levels in workers exposed chronically to CS_2 concentrations. Tolonen[13] has indicated there are numerous contradictory reports on the cholesterol raising effect of CS_2 exposure, but points out that valid perspective comparisons of cholesterol levels between match exposed and un-exposed male workers has not demonstrated differences.

Coronary heart disease among CS_2 workers was studied by Hernberg[7], between 1942 and 1967, in 410 men with at least five years exposure. They observed a proportional mortality from coronary heart disease of 52% against the expected 31.6%, among Finnish viscose rayon workers. The exposed workers had higher mean systolic and diastolic blood pressures. Tiller, Schilling, and Morris[14] studied mortality rates in one factory manufacturing rayon since 1935. This study demonstrated that men employed for more than 10 years

had higher death rates than expected from coronary heart disease and other cardiovascular diseases, than other men aged 45 to 64. These studies did not attempt to correlate their findings with exposure levels which may have been far higher than those prevailing today. The above studies, however, support the hypothesis of a causal relationship between CS_2 exposure and coronary heart disease.

2. Medical Criteria

A copy of the questionnaire/physical examination outline used in this study is attached in the Appendix. The normal hematologic and chemical analysis values used in this study were furnished by National Health Laboratories (ranges of normal values are indicated in Table 8). Hypertension was said to be present if the systolic blood pressure exceeded 140 mm Hg and/or the diastolic blood pressure exceeded 90 mm Hg.

E. Results and Discussion

1. Environmental

Carbon Disulfide Exposures - Viscose No. 1

The time-weighted average results for CS_2 exposures are tabulated by job classification in Table 1 for Viscose Department No. 1. The results show that Crumb Dump Operators, Churn Operators, Mix Room Operators, Cellar Operators, and Filter Changers had the higher average exposures of the several work classifications. The results from CS_2 detector tubes used to evaluate peak exposures to workers in several areas of Viscose Department No. 1 are contained in Table 2. Only one of the detector tube measurements made on the Crumb Dump Floor resulted in a measurable level of CS_2. However, the levels of time-weighted average exposure to carbon disulfide for the Crumb Dump Operators would not necessarily result in measurable levels by the detector tubes since the tubes used have a minimal detection limit of approximately 16 ppm. The Crumb Dump Operators higher exposure as compared to other job classifications may be due at least in part to infiltration from the Churn Floor which is located directly beneath the Crumb Dump Level. There is an increased likelihood for infiltration when the crumb is actually being dumped and the churn is open and residual CS_2 vapors could escape from the churn. The detector tube results of measurements in the Churn Floor area indicate that certain operations: monitoring at the churn while crumb is being dumped, charging churn with CS_2, and sampling viscose for ball-fall tests resulted in the highest peak exposures observed during this study.

None of the individual time-weighted average exposures of workers to CS_2 in Viscose Department No. 1 exceeded the 8-hour time-weighted average TLV of the ACGIH of 20 ppm (Table 1) which was the environmental criteria used in this study. No peak exposures were measured which exceeded the present maximum peak of 100 ppm of the existing Federal Standard for CS_2. (The ACGIH TLV does not include a specific ceiling value for CS_2.)

Carbon Disulfide Exposures - Viscose No. 2

The time-weighted average results for CS_2 are tabulated by job classification in Table 3 for Viscose Department No. 2. Comparing Viscose Department No. 1 with Viscose Department No. 2 the exposures were found to be lower in Viscose Department No. 2. The highest individual time-weighted average exposure in Viscose Department No. 2 was 5.3 ppm which is approximately one-third of the highest time-weighted average exposure recorded in Viscose Department No. 1. Evaluation of peak exposures to CS_2 using detector tubes in Viscose Department No. 2 is contained in Table 4. In all cases results were either non-detected or less than 16 ppm, the detection limit of the tubes used.

None of the individual time-weighted average exposures to CS_2 in Viscose Department No. 2 exceeded the TLV of the ACGIH and the Federal Standard of 20 ppm.

On November 4, 1975 a total of 14 personal samples of one-two hours duration for CS_2 exposure were obtained in Viscose Department No. 1. However, these concentrations were two to three orders of magnitude lower than the results obtained during December 16-18, 1975 and are judged to be invalid. A specific cause for these very low results was not identified although they may have been related to an unidentified analytical error. These results were judged to be invalid since they did not agree with the NIOSH survey results of December nor with company monitoring records of CS_2 exposure in the same plant areas which were reviewed in November. Detector tube readings for CS_2 concentrations also obtained in the same plant areas indicated the results of November 4, 1975 to be substantially in error.

For all CS_2 time-weighted average samples, the second charcoal tube of the sampling train was analyzed for CS_2 to determine if breakthrough had occurred; breakthrough was not detected for any of the samples.

Sodium Hydroxide Exposures - Viscose No. 1 and No. 2

Table 5 contains results of time-weighted average measurements to determine exposure to sodium hydroxide mist for Soda Room Operators or to crumb impregnated with caustic for Pfleiderer Operators and Crumb Dump Operators. The results as time-weighted averages are all less than two percent of present Federal Standard which is based upon an 8-hour time-weighted average (the NIOSH Criteria Document recommended standard and the ACGIH TLV are ceiling values). However, none of these results would exceed the NIOSH Criteria Document recommended standard for a fifteen minute exposure even if the entire amount of sodium hydroxide mist collected had been sampled in any fifteen minute period during sampling. In fact the highest exposure that would be theoretically possible would be less than 1 mg/M^3.

The tank entry procedure was observed at one of the spin tanks during the November 4, 1975 visit; the procedure followed at that time was found to be totally adequate to safeguard the health and safety of workers performing this task.

2. Medical

The age of the cohort of 48 workers varied from 23 to 61 years of age. The average age of the cohort was 39 years. Seven workers were female and seven were black. The length of service in the viscose department varied from two days to 25 years with a mean of 7 years and 4 months.

Iodine-Azide Tests

Pre- and post-shift urine specimens were examined using the iodine-azide reaction after creatinine and specific gravity determinations had been made. Many biologic tests to determine human CS_2 exposure have not proven reliable primarily due to a lack of knowledge concerning the metabolism of the compound. However, a simple test has been developed which gives promise to being a reliable predictor of excessive exposures to CS_2. This test is the iodine-azide test and is based on the presence of urinary metabolities of CS_2 which serve as catalysts in the reaction. Djuric, Surducki and Berkes[3] have successfully used the iodine-azide test in their study of workers exposed to CS_2 during viscose manufacture. The iodine-azide test is considered to be a simple, rapid and inexpensive test of exposure to CS_2. The exposure coefficient at the end of the work period is a reliable index of the average exposure during the shift and the exposure coefficient at the beginning of the work period indicates whether workers have recovered from previous exposure. The exposure coefficient is inversely related to exposure.

Several comments are necessary regarding this test. It was originally developed as a screening test for exposure to CS_2. It cannot be regarded as really quantitative since it measures an unknown substance possibly influenced by other biologic functions. However, in spite of these limitations, the test has been practical for assessing exposure to CS_2. The guidelines set down by Djuric[3] and used by the NIOSH laboratory are listed as follows: (1) urine creatinine values must be between 1 and 3 milligrams per milliliter (mg/ml) for the test to be valid, values outside this range are not reported; (2) specimens that fit this criteria and require more than five hours to react are reported as "N" or normal without calculating an index E; (3) the E or index for normal populations not exposed to CS_2 range from 6.5 - 10.5. Persons exposed to CS_2 frequently show values less than 6.5. Values Below 5 are regarded as definitely reflecting excessive exposure. The index before the start of any shift following exposure indicates the worker's ability to detoxify and eliminate previously absorbed CS_2. If abnormal values are found for start-of-shift specimens, the worker may be at increased risk. Certain drugs may also produce falsely low values, i.e., aspirin, anti-acids, and so forth.

In this study, the values were almost all within the normal range. These results are shown in Tables 6A and 6B. Only two individuals showed E values less than 5.5 (5.1 and 5.4); two additional individuals showed values in the range of 5.5 - 6.5 (6.3 and 6.4). All remaining values were normal or were not reportable. The ability of this test to effectively monitor exposures to low levels of CS_2 is unknown so these results must be interpreted with caution. It should be noted, however, that of the 24 paired specimens suitable for comparison, 18 had post-exposure values that were lower than pre-exposure values whereas only six pairs had higher values. This difference is significant ($p < .02$) and suggests the test has some validity even in low exposure situations.

A control comparison of iodine-azide test results from NIOSH field and laboratory personnel generally showed good agreement with field data showing slightly lower E values. The results shown in Table 6A and 6B are all from the NIOSH Cincinnati laboratory.

A crude statistical analysis was carried out to see how closely the iodine-azide test results correlated with CS_2 environmental concentrations. Workers were placed into one of two groups depending upon whether their iodine-azide tests indicated some minimum exposure to CS_2 or no exposure. The means for CS_2 personal exposure levels in ppm were then calculated for each of these two classifications and statistically compared. While the means for the two groups differed considerably (2.12 ppm for the "non-exposed" and 4.92 ppm for the "exposed") very wide ranges and standard deviations were present ("non-exposed" range 0.13 - 7.08 ppm, "exposed" range 1.06 - 13.64 ppm). Despite this the difference between the groups reached near statistical significance ($p = .07$) strongly suggesting that the iodine-azide test was an index of exposure, but probably not significantly sensitive on an individual case basis to prove of value in assessing worker exposure to atmospheric levels consistently below the TLV.

Cholinesterase Tests

Table 7 reports cholinesterase values for the cohort and controls. Cholinesterase was studied since several investigators have reported various changes in the level of this enzyme in response to CS_2 exposure. Juntunen et. al.[15], reported in 1974 that after five months exposure to CS_2 there was intense, increased nonspecific cholinesterase activity along the nerve trunks in the anterior tibial nerve of rats with CS_2 induced polyneuropathy. This group concluded that cholinesterase activity can be employed as an indicator of early axonal degeneration and progressive neuropathy. Artamonova and Klishova[16] reported in 1972 that in cases of chronic CS_2 poisoning the serum level of cholinesterase decreases. However, Misiakiewicz, Szulinska and Chyba[17] reported in 1972 the only change observed in rats exposed to CS_2 for six months was a 16% increase in blood cholinesterase activity. Toxicologic studies have indicated that CS_2 probably inhibits enzyme activity and that Berman[17] in his study of the diagnosis of CS_2 poisoning has concluded that a serum or red cell analysis for cholinesterase may be an important diagnostic tool.

It should be noted that the mean cholinesterase value for the exposed group (68.6) differs slightly from the mean of the control (63.5). Thus, a statistical analysis was done (Table 7) to determine if this increase is significant. The range for the cohort was 26-95 and the range of the control values was 24-74. The t-test indicates there is no significant difference in cholinesterase values between the 48 workers in the cohort and the 21 controls ($P = 0.1549$).

Serum Cholesterol and Triglyceride Tests

Table 8 presents triglyceride and cholesterol serum levels and results of the other biologic parameters studied, along with accepted normal values.

Prolonged exposure to CS_2 has been suspected of leading to increases of serum cholesterol and triglycerides due to changes in lipid metabolism. The mean of cholesterol and triglyceride values falls within the accepted standards. Only nine workers in the study have elevated triglycerides and only three workers had increased cholesterol.

Physical Examinations, Medical Histories

Eight workers were judged to have hypertension (Table 9) based on systolic pressures in excess of 140 mmHg and/or diastolic values in excess of 90 mmHg. The mean systolic blood pressure was 122.7 mm/Hg and the mean diastolic was 75.8 mm/Hg. These mean blood pressure values are well within the normal range for persons of this age distribution. The systolic range was 88-170, and the diastolic range was 48-110. This number of hypertensives was not judged excessive considering the size, sex, and age composition of the group studied. One worker was found to have hyperglycemia. This worker comes from a diabetic family.

An analysis of the questionnaire responses indicates that only 25% of the sample reported symptoms. Subjectively this is fewer complaints than usually encountered in the industrial setting. Table 10 gives the percentage response by symptom. The frequency distribution indicates that bad dreams, depression and nervousness are the most common complaints. Numbness and tingling were thought to be due to vibration effects from motorcycle riding in the majority with this sympton. Nervousness was not accompanied by tremors and was not judged to be exesssive. Bad dreams and depression appeared to be corollary complaints elicited from those responding affirmatively and frequently took the form of concern for their employment security or family matters. Physical examinations were judged normal by NIOSH medical officers except for the following findings: hypertension (8), irregular pulse (2), dermatitis (1), and gross obesity (1). No neurologic abnormalities of any type were identified by physical examination.

One worker had no symptoms or complaints, and his physical examination was negative except for obesity and hypertension. This worker's iodine-azide test was judged indicative of CS_2 exposure and the cholesterol, triglyceride, uric acid, SGOT and SGPT were elevated. This worker was noted to be grossly obese and his abnormal findings are possibly, at least in part, accounted for by this condition.

Conclusions

A follow-up environmental and medical survey at FMC Corporation, Front Royal, Virginia, was concluded December 16-17, 1975. All time-weighted average exposures of workers to CS_2 were less than the present threshold limit value recommended by the American Conference of Governmental Industrial Hygienists and present Federal Standard for this substance (both are 20 ppm); all peak measurements of CS_2 were less than the present maximum peak of the Federal Standard of 100 ppm. Medical problems, complaints and symptoms were elicited during the visit, but these findings do not appear to be unusual in type or in frequency. Many of the complaints were transitory in nature and some had occurred only occasionally or infrequently. Almost all test results were determined to be within the normal range or were otherwise accounted for.

There does not appear to be sufficient environmental or medical evidence at this time to suggest that excessive exposure to CS_2 is occurring or is responsible for illness.

The total number of persons working in the viscose department at FMC is fairly large and the exposure in man years approximates more than 80 entire working life-times. If chronic toxicity was occurring, more in the way of classic neurologic manifestations would be expected and presumably detected during a survey of this type.

V. RECOMMENDATIONS

1. All workers new to the viscose department and all presently employed workers in this department should receive preplacement and periodic medical examinations consisting minimally of neurologic testing, blood pressure, cardiovascular examination, dermatological examination, and mental status.

Blood chemistries should minimally include glucose, creatinine, BUN, cholesterol, triglycerides, and liver function tests. Hematological examination should minimally include RBC, WBC and differential, hemoglobin, and hematocrit. A routine urinalysis should be performed. The above blood tests can usually be accomplished at minimal expense by ordering an SMA-12 test.

2. A post-shift iodine-azide test should be carried out periodically on each potentially exposed worker as a spot check to insure that unknown overexposures are not occurring.

3. A training program should be instituted with joint responsibility between management and the union. This training program should fully discuss the hazardous nature of CS_2, the precautions necessary for safe handling, emergency procedures and the need for strict compliance. Each new employee should receive this instruction prior to assignment in the viscose department, and existing workers should receive a refresher course at least annually.

4. Worker confidence should be restored in the available medical services and the workers should be encouraged to report any symptoms regularly experienced.

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Table 1

Time-Weighted Average Exposure to Airborne Carbon Disulfide
by Job Classification

FMC Corporation - Viscose Department No. 1
Front Royal, Virginia

December 16-18, 1975

Job Classification	Number of Samples	Average Exposure	Range
Crumb Dump Operators	4	11.70	(7.6-14.3)
Churn Operators	12	8.78	(2.0-16.4)
Mix Room Operators	4	6.90	(2.4-11.4)
Cellar Operators	4	5.53	(2.6-11.0)
Filter Changes	15	3.47	(0.7- 7.8)
Sundrymen	4	1.83	(0.3- 3.0)
nover Operator	1	0.4	
Soda Room, Pfleiderer, and Mercerizing Cellar Operators	5	0.36	(<0.1- 0.7)
ACGIH TLV and Federal Standard for an eight hour time-weighted average exposure			20

Table .

Peak Exposures to Airborne Carbon Disulfide Evaluated with Detector Tubes

FMC Corporation - Viscose Department No. 1
Front Royal, Virginia

December 18, 1975

Location	Time	Concentration (ppm)	Comments
Churn Floor	9:40am	24-48	At operator's station
Mix Room	9:46am	16-24	Near open mixer
Churn Floor	9:50am	16-24	Changing #8 churn with CS_2
Churn Floor	9:55am	24-48	Taking viscose sample
Churn Floor	10:00am	24-48	Near churn #14
Churn Floor	10:05am	16	Changing Crumb to Chrun #12
Crumb Dump	10:15am	24	Dumping crumb
Filter Presses	10:20am	<16	Removing filter cloth
Filter Presses	10:25am	<16	Near filter press
Crumb Dump	10:30am	<16	Dumping crumb
Crumb Dump	10:44am	<16	Dumping crumb
Churn Floor	10:50am	48-74	Loading Churn #21 with Crumb
Churn Floor	10:55am	16-24	Beside Churn #21 after loading
Mixer Room	11:05am	24-48	Sampling viscose at Mixer #11
Churn Floor	11:07am	<16	Opening churn #18 for loading
Churn Floor	11:10am	24-48	Loading Crumb to Churn #17
Churn Floor	11:12am	<16	Charging Churn #11 with CS_2
Churn Floor	11:16am	<16	Lifting drop sleeve at Churn #17
Churn Floor	11:20am	24-48	Sampling Crumb Churn #15
Federal Standard for Maximum Peak Exposure		100	

Table 3

Time-Wieghted Average Exposures to Airborne Carbon Disulfide
by Job Classification

FMC Corporation - Viscose Department No. 2
Front Royal, Virginia

December 18, 1975

Job Classification	Number of Samples	Average Exposures (ppm)	Range (ppm)
Crumb Dump Operators	2	3.40	(2.4-4.4)
Filter Changers	12	2.94	(0.8-5.3)
Turnover Operator	1	2.8	
Churn Operators	15	2.62	(<0.3-5.0)
Sundrymen	4	2.28	(1.3-3.4)
Mix Room Operators	6	0.42	(<0.2-0.9)
la Room, Pfleiderer, and rcerizing Cellar Operators	6	0.25	(<0.2-0.3)
Cellar Operator	1	0.2	
ACGIH TLV and Federal Standard for an eight hour time-weighted Average Exposure			20

Table 5

Peak Exposures to Airborne Carbon Disulfide and Hydrogen Sulfide
Evaluated with Detector Tubes

FMC Corporation - Viscose Department No. 2
Front Royal, Virginia

December 18, 1975

Location	Time	Concentration (ppm)	Comments
Crumb Dump	10:30am	N.D.	Operator dumping crumb
Churn Floor	10:40am	N.D.	Operator at control board
Mixer Room	10:47am	N.D.	Operator taking viscose samples
Churn Floor	12:02pm	<16	Charging Churn #21 with CS_2
Churn Floor	12:11pm	<16	Loading Crumb into Churn #15
Churn Floor	12:14pm	<16	Loading Crumb into Churn #23
Churn Floor	12:20pm	<16	Lifting drop sleeve Churn #23
Filter Presses	12:52pm	<16	Changing filter cloth
Filter Presses	12:55pm	N.D.*	Changing filter cloth
Filter Presses	12:57pm	<16	Changing filter cloth
Filter Presses	12:59pm	N.D.*	Changing filter cloth
Filter Presses	1:05pm	<16	Changing filter cloth
Filter Presses	1:08pm	N.D.*	Changing filter cloth
Filter Presses	1:10pm	<16	Emptying catch pan

*Indicates detector tube used for H_2S measurement; all other results for CS_2.
N.D. No color change could be observed in detector tube indicating layer

Table 5

Time-Weighted Average Exposures to
Sodium Hydroxide Aerosol

FMC Corporation
Front Royal, Virginia

December 16-18, 1975

Job Description	Location	Time of Sample (min.)	Concentration(mg/m^3)
Crumb Dump Operator	Viscose #2	308	0.002
Soda Room Operator	Viscose #2	302	N.D.*
Crumb Dump Operator	Viscose #1	307	0.007
Soda Room Operator	Viscose #1	170	0.004
Crumb Dump Area	Viscose #1	315	0.002
Crumb Dump Operator	Viscose #1	317	0.036
ıa Room Operator	Viscose #1	301	0.016
Pfleiderer Operator	Viscose #2	285	0.005
Crumb Dump Operator	Viscose #2	156	0.004
Federal Standard for an eight hour time weighted average exposure **			2

*N.D. - Result less than the detection limit of the analytical procedure of 0.001 mg

** Exposure would not exceed the NIOSH Criteria Document recommended standard of 2 mg/m^3 for a 15 minute sampling period for any result.

Table 6A

Iodine Azide Test Results

FMC Corporation
Front Royal, Virginia

December 23, 1975

Specimen Number	Time Weighted Average Exposure to Airborne CS_2 (ppm)	Creatinine (mg/ml)		Exposure Coefficient (E*)	
		Pre-shift	Post-shift	Pre-shift	Post-shift
1	3.4	1.5	2.3	N	8.8
2	4.2	2.3	2.1	N**	N
3		2.7	2.1	11.1	N
4	5.3	3.2	3.4	***	***
5	0.4	1.8	2.5	N	10.2
6	2.0	1.7	0.5	5.4	***
7	<0.1	2.1	1.8	N	N
8	0.7	4.2	3.9	***	***
9		1.9	2.0	N	N
10	2.1	0.5	0.5	***	***
11	2.5	0.8	2.7	***	9.7
12	1.5	1.5	2.9	N	11.5
13	0.9	0.4	1.8	***	N
14	2.8	2.6	3.2	10.2	***
15	0.2	1.4	3.0	N	11.8
16	4.4	0.9	2.6	***	9.9
17	0.3	1.6	1.1	N	N
18	0.4	2.2	2.7	9.1	10.4
19	1.0	2.5	3.7	9.8	***
20	5.7	2.1	1.7	N	7.0
21	1.9	1.6	2.2	6.5	8.4
22	0.3	2.0	2.4	7.9	9.3
23	<0.2	2.0	1.1	7.8	N
24	2.2	1.7	1.8	N	8.8
25	1.4	2.4	1.9	9.0	6.9
26	1.1	1.2	2.0	N	8.0
27	1.1	2.2	1.6	7.8	6.4
28	9.9	2.8	2.7	10.9	7.1
29	<0.2	1.3	3.2	N	***

Table 6A (contd)

FMC Corporation
Front Royal, Virginia

Specimen Number	Time Weighted Average Exposure to Airborne CS_2 (ppm)	Creatinine (mg/ml) Pre-shift	Creatinine (mg/ml) Post-shift	Exposure Coefficient (E*) Pre-shift	Exposure Coefficient (E*) Post-shift
30	7.0	1.9	2.8	N	9.8
31	8.1	0.2	1.1	***	N
32	1.3	1.8	2.0	N	8.5
33	3.2	3.0	2.7		9.1
34	3.9	1.0	2.7	11.5	9.3
35	3.2	0.8	1.8	***	7.3
36	2.8	1.9	2.0	N	8.2
37	3.7	0.2	2.0	***	N
38	8.0	1.4	1.6	N	N
39	3.0	0.3	2.6	***	9.9
40	2.8	2.1	1.6	8.7	6.5
41	11.0	1.6	0.7	N	***
42	0.2	2.8	2.6	11.8	10.4
43	2.6	3.8	1.7	***	6.6
44	11.4	2.4	0.4	9.1	***
45	3.6	1.5	2.0	N	7.6
46	0.3	1.7	0.5	N	***
47	13.6	1.5	1.2	6.3	5.1
48	1.8	1.6	1.7	6.7	6.9

* - Exposure Coefficient (E) - calculated from the equation.

E = Creatinine (mg/ml) x log t (where t is the time in seconds for the sample to react).

** - N - Values considered normal, within the acceptable creatinine levels but requiring more than 5 hours for reaction.

*** - Results not valid due to creatinine levels outside the suggested range of 1-3 mg/ml.

Table 6B

Iodine Azide Test Results

FMC Corporation
Front Royal, Virginia

December 23, 1975

Controls	Creatinine	E
c-1	2.0	N
c-2	2.8	11.3
c-3	2.8	11.1
c-4	3.0	11.8
c-5	2.6	10.2

Table 7

Serum Cholinesterase Determination Results

FMC Corporation
Front Royal, Virginia

December 16-18, 1975

	SUMMARY				
	No.	Mean	Mode	Median	Range
COHORT	48	68.6	74	71	26-97
CONTROLS	21	63.5	65	65	24-74

Table 8

Serum Mu[illegible]ic Analysis Results

FMC Corporation
Front Royal, Virginia

December 18, 1975

Number	Time-weighted average exposure to CS_2 (ppm)	Glucose	Bun	Creatinine	Na+	K+	Cl-	CO_2	UR.A	T.P.	Alb.	Glob.	A/G	Calc.
1	3.4	43	08	1.0	141	4.2	99	27	6.5	7.7	5.0	2.7	1.85	10.7
2	4.2	48	20	1.4	141	4.5	104	25	5.3	7.5	4.1	3.4	1.21	9.6
3	-	108	15	1.0	140	4.3	103	24	6.7	6.9	4.1	2.8	1.46	9.2
4	5.3	61	16	1.1	142	4.2	103	26	6.6	6.9	4.2	2.7	1.56	9.4
5	0.4	76	13	1.1	138	4.5	99	26	4.4	7.5	4.6	2.9	1.59	10.1
6	2.0	88	12	0.7	140	4.4	100	29	4.2	6.7	4.1	2.6	1.58	9.8
7	<0.1	79	16	0.8	139	4.7	102	25	4.3	7.0	4.0	3.0	1.33	9.2
8	0.7	79	13	1.0	142	4.7	102	25	5.8	7.4	4.5	2.9	1.55	10.0
9	-	84	11	1.0	140	5.0	101	28	6.0	7.7	4.6	3.1	1.48	9.9
10	2.1	159	17	1.0	138	3.9	99	29	5.2	6.5	3.8	2.7	1.41	9.5
11	2.5	119	13	0.8	146	4.3	100	27	6.9	7.4	4.5	2.9	1.55	9.9
12	1.5	94	12	0.9	143	4.4	100	26	7.6	7.7	4.6	3.1	1.48	10.2
13	0.9	90	12	1.0	141	4.6	101	25	6.0	6.4	4.0	2.4	1.67	8.5
14	2.8	104	12	1.0	142	3.7	99	24	8.0	7.8	4.5	3.3	1.36	9.9
15	0.2	112	12	1.0	145	4.1	98	28	6.9	7.7	4.8	2.9	1.66	10.5
16	4.4	125	12	0.8	141	4.9	98	27	5.5	7.7	4.4	3.3	1.33	9.9
17	0.3	72	14	0.9	142	4.1	99	27	4.8	7.1	4.3	2.8	1.54	9.4
18	0.4	98	14	1.0	141	4.1	100	24	5.8	8.2	4.9	3.3	1.48	10.0
19	1.0	101	23	1.2	139	3.5	100	26	5.1	6.7	3.9	2.8	1.39	8.5
20	5.7	123	16	1.0	142	4.5	100	25	5.8	7.4	4.4	3.0	1.47	10.6
21	1.9	100	11	0.9	138	4.2	99	26	7.4	7.1	4.2	2.9	1.45	10.1
22	0.3	86	11	0.8	143	4.3	104	27	5.5	7.0	3.8	3.2	1.19	9.2
23	<0.2	82	15	1.0	135	4.7	96	26	6.7	7.7	3.9	3.8	1.03	10.4
24	2.2	91	13	1.3	135	4.3	100	25	5.2	6.4	3.7	2.7	1.37	9.0
25	1.4	91	15	0.8	141	4.5	103	24	5.4	7.2	4.2	3.0	1.40	9.9
26	1.1	116	16	0.9	136	4.5	98	25	4.8	7.0	4.2	2.8	1.50	9.9
27	1.1	77	11	0.9	140	4.5	104	21	4.6	7.3	4.2	3.1	1.35	9.8
28	9.9	88	11	0.9	139	4.3	100	23	6.2	7.2	4.3	2.9	1.48	9.6
29	<0.2	122	12	0.9	138	4.1	100	22	5.2	7.5	4.4	3.1	1.42	9.9
30	7.0	96	12	1.0	139	4.1	100	23	4.4	6.6	4.0	2.6	1.54	8.5
31	8.1	90	09	1.0	138	4.5	100	23	6.9	7.4	4.1	3.3	1.24	8.8
32	1.3	155	22	1.2	142	4.1	98	26	6.6	7.4	4.7	2.7	1.74	10.4
33	3.2	114	09	0.9	139	3.4	101	25	4.8	6.3	4.1	2.2	1.86	9.2
34	3.9	80	13	1.1	141	4.4	102	26	7.2	7.6	4.2	3.4	1.24	10.1
35	3.2	87	12	1.2	140	4.0	102	26	5.6	7.0	3.8	3.2	1.19	9.2
36	2.8	85	17	0.9	140	4.6	102	24	6.8	6.8	4.3	2.5	1.72	9.8
37	3.7	100	20	1.2	139	4.5	101	25	5.9	7.1	4.2	2.9	1.45	10.0
38	8.0	98	18	1.2	142	4.9	102	26	7.5	7.3	4.1	3.2	1.28	10.0
39	3.0	73	14	1.5	139	3.7	101	24	7.5	7.0	4.4	2.6	1.69	10.2
40	2.8	78	18	1.1	141	4.0	100	29	7.4	6.9	4.3	2.6	1.65	10.1
41	11.0	63	14	0.9	142	4.4	98	27	4.9	7.8	4.6	3.2	1.44	10.1
42	0.2	93	13	1.1	140	4.0	97	25	8.6	8.1	4.6	3.5	1.31	10.6
43	2.6	74	11	0.9	144	3.9	102	27	5.4	7.0	4.2	2.8	1.5	9.6
44	11.4	94	24	1.1	142	4.6	104	25	5.4	7.0	4.1	2.9	1.41	9.7
45	3.6	83	17	1.3	141	4.5	103	24	4.3	7.0	4.2	2.8	1.50	10.1
46	0.3	100	15	1.4	138	4.3	102	26	7.4	7.3	4.0	3.3	1.21	9.5
47	13.6	100	12	1.0	138	4.0	100	25	9.0	7.5	4.2	3.3	1.27	9.9
48	1.8	87	12	1.1	141	4.5	102	26	6.2	7.2	4.1	3.1	1.32	9.4
Mean		93.25	14.13	1.03	140.29	4.3	100.58	25.08	6.05	7.22	4.26	2.96	1.45	9.75
Standard Deviation		21.82	3.53	.17	2.25	.34	1.93	3.16	1.18	.44	.29	.31	.18	.54
Normal Range		65-110**	10-25	0.7-1.4	135-145	3.5-5.0	95-100	24-32	2.5-8.0	6.0-8.0	3.5-5.0	2.5-3.2	0.9-1.9	8.5-11.0

Table B (contd)

Serum Mu ic Analysis Results

[illegible] Corporation
Front Royal, Virginia

December 18, 1975

Number	Phos.	Chol.	Tri.G.	Alk.Phos.	SGOT	SGPT	L.D.H.	T.Bili.	Chlns.	RBC*	WBC	Hb*	HCT.*
1	1.8	331	181	79	17	23	190	0.3	57	4.85	7.6	15.1	45.9
2	2.5	268	81	74	21	26	207	0.8	46	5.53	4.9	14.8	44.9
3	3.4	175	215	87	11	29	172	0.3	95	5.34	9.3	15.2	45.7
4	4.2	163	81	51	27	43	196	0.4	88	5.07	4.0	15.0	44.9
5	3.6	223	45	48	13	24	157	0.7	71	5.41	5.8	14.2	43.8
6	4.2	155	96	62	14	19	155	0.2	76	4.95*	8.1	14.3*	42.1*
7	4.3	191	54	94	14	21	209	0.3	85	4.65*	5.4	13.6*	40.9*
8	2.9	148	34	39	14	17	207	1.1	71	4.89*	6.4	14.8*	43.9*
9	3.5	191	66	66	18	31	166	0.6	83	4.41	6.2	13.7	40.2
10	3.3	185	100	53	18	32	179	0.4	69	4.90	5.0	14.2	42.6
11	5.1	192	399	76	27	21	105	0.2	78	5.39	7.4	15.5	46.3
12	3.5	230	298	65	27	11	142	0.5	65	5.21	5.4	15.3	44.7
13	2.8	198	128	62	30	11	237	0.3	65	4.86*	4.9	14.8*	43.8*
14	4.4	228	367	74	30	27	182	0.4	50	4.99	6.6	14.6	42.8
15	3.0	199	226	96	32	24	164	0.6	65	5.37	6.9	17.1	50.5
16	3.8	193	153	88	27	12	130	1.0	60	5.08	8.1	15.7	46.7
17	3.2	208	182	79	25	12	155	0.4	60	4.79	7.8	14.7	43.7
18	3.0	314	388	100	34	24	193	0.3	78	5.42	8.7	15.7	45.8
19	3.6	200	170	63	27	27	185	0.4	60	5.15	4.9	13.3	41.3
20	4.5	230	258	69	34	21	173	0.5	45	5.62	7.5	16.7	48.8
21	3.5	219	235	39	36	38	84	0.5	74	4.51	5.0	15.4	45.7
22	3.2	204	221	48	25	5.0	176	0.3	51	4.54*	6.2	12.5*	37.5*
23	3.0	165	133	27	37	26	168	0.4	60	5.14	7.3	16.5	48.2
24	3.0	213	184	88	25	5.0	193	0.4	42	5.64	5.3	14.5	43.5
25	3.3	202	84	62	36	22	157	0.4	78	4.62	8.4	13.8	41.2
26	3.4	220	338	77	31	17	142	0.5	97	4.61	4.3	15.1	44.1
27	3.5	184	165	45	23	3.0	160	0.4	70	5.01*	8.6	15.5*	46.1*
28	3.6	172	125	69	21	5.0	129	0.5	40	4.92	8.5	14.8	43.8
29	3.3	216	308	59	23	9.0	119	0.3	74	5.25	7.1	15.4	46.8
30	3.1	199	144	58	18	9.0	166	0.5	72	4.57*	7.4	12.4*	38.4*
31	3.6	250	410	70	27	23	149	0.2	93	4.92	6.9	14.8	44.2
32	2.6	313	310	74	15	28	152	0.4	76	5.07	6.8	15.6	44.7
33	3.7	185	124	73	33	26	166	1.1	57	4.77	9.9	14.9	44.4
34	2.9	200	109	63	31	20	182	0.5	74	4.92	4.2	15.1	45.9
35	2.0	233	225	43	32	32	168	1.0	74	4.75	9.9	14.3	43.3
36	4.3	173	81	68	18	08	153	0.4	68	4.58	5.7	15.0	44.1
37	2.9	206	99	70	24	29	155	0.6	49	5.12	7.5	16.3	46.8
38	2.2	248	241	56	26	25	156	0.8	73	5.26	7.2	15.4	45.9
39	2.5	252	136	64	26	34	191	1.1	68	5.53	5.1	16.2	47.1
40	2.8	244	122	58	25	17	175	0.8	79	5.78	7.2	17.0	49.9
41	3.4	205	105	65	37	45	186	0.5	71	5.50	5.6	15.9	47.0
42	2.9	248	50	67	45	36	173	0.8	77	4.67	7.3	15.6	45.9
43	3.3	160	105	61	24	15	120	0.5	68	5.44	6.6	15.6	47.3
44	2.6	225	155	71	25	22	148	0.4	79	5.07	6.7	15.3	44.7
45	3.1	184	108	57	27	31	212	0.6	74	5.16	6.8	14.9	44.1
46	3.0	254	310	63	16	12	123	0.5	79	5.05	6.4	14.7	43.4
47	2.4	270	423	67	48	39	166	0.6	85	5.10	7.1	16.2	46.6
48	3.7	174	95	57	19	10	129	0.4	26	5.30	8.3	16.5	49.0
Mean	3.26	213.33	180.56	65.5	25.69	21.98	160.88	.51	68.65	5.103 4.78*	6.75	15.26 13.99*	45.27 41.81*
Standard Deviation	.67	40.66	107.1	15.06	8.17	10.83	37.21	.24	14.76	3.349 1.91*	1.46	0.87 1.20*	2.25 3.10*

Table 9

Results of Blood Pressure Measurements

FMC Corporation
Front Royal, Virginia

December 16-18, 1975

Number	Systolic	Diastolic	Number	Systolic	Diastolic
1	100	60	25	125	78
2	120	80	26	106	68
3	110	70	27	92	52
4	112	68	28	118	68
5	100	60	29	130	84
6	90	50	30	88	48
7	92	62	31	132	78
8	100	60	32	136	88
9	140	85	33	90	50
10	145	90	34	140	85
11	140	60	35	108	54
'2	160	100	36	130	72
13	102	86	37	110	60
14	100	74	38	120	80
15	122	86	39	158	102
16	130	78	40	110	60
17	105	80	41	118	75
18	120	78	42	150	100
19	150	96	43	120	68
20	126	74	44	135	92
21	134	78	45	170	100
22	106	60	46	124	78
23	160	110	47	140	90
24	144	82	48	132	82
			Mean	122.7	75.8
			Range	88-170	48-110

Table 10

Medical Questionnaire Results

FMC Corporation
Front Royal, Virginia

November 4, 1975 and December 16-18, 1975

Symptoms	Number with Complaint
Depression	9
Bad Dreams	8
Nervousness	7
Numbness or Tingling	5
Mood Changes	4
Headaches	4
Dermatitis	4
Shortness of Breath	3
Irritable	2
Listlessness	2
Insomnia	1
Fatigue	1

Number of workers interviewed = 48

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
518 POST OFFICE BUILDING
CINCINNATI, OHIO 45202

CONSENT

I voluntarily agree to participate in a study at the FMC Company, Front Royal, Va., conducted by the Public Health Service. I understand that the medical evaluation will consist of my answering questions about health and possibly taking a breathing test.

I understand that my participation in this study is voluntary and that all information obtained will be considered confidential in accordance with U.S. Public Health Service Regulation (42 CFR Part 1).

Date _____ Signature _____

Print Name _____

AUTHORITY TO GIVE MEDICAL REPORT

I agree to allow the Public Health Service to inform:

A. My personal physician

Name _____

Address _____ _____
Signature

City _____

B. Plant physician

Name _____

Address _____ _____
Signature

City _____

of any significant results of this study.

Information obtained in this study will be kept confidential in accordance with U.S. Public Health Service Regulation (42 CFR Part 1).

(11/75)

Check List for CS_2

Name _____ Date of Birth _____

Shift _____ Position _____ Total length of employment in plant _____

Length of time in present job _____ Dept. No. _____

Complaints _____

_____ When _____

Previous medical problems _____

Previous hospitalization _____

Symptoms:

Headache (describe) _____ Fatigue _____

Abdominal pain _____ Vomiting _____ Nausea _____

Appetite change _____ Chest pain or shortness of breath _____

Diarrhea or constipation _____ Sleep pattern disturbance _____

Insomnia _____ Sleepiness _____ Bad dreams _____

Mood or behavioral changes _____ Irritability _____ Anger _____

Melancholia or depression _____ Listlessness _____

Loss of memory _____ Mania _____ Hallucinations _____

Dizziness _____ Tremor _____ Jerking _____

Muscle weakness _____ Staggering _____ Aches or muscle cramps _____

Numbness or tingling of limbs or hands _____ Libido changes _____

Dermatitis _____ Weight gain or loss _____ Nervousness _____

Visual disturbances _____

Examination: Pulse _____ B/P _____

Skin _____

Mental status _____

Neurologic (reflexes, gait, etc.) _____

_____

1. Name _____
   Last First Middle

2. Current Address:

   _____

   _____

3. Phone Number _____

4. Birthday (month, day, year) _____

5. Age Last Birthday _____

6. Sex: Male _____ Female _____

7. Race: Black _____ White _____ Other _____

8. Do you wear a respiratory when working? _____

9. Do you wear protective clothing and gloves? _____

10. Any difficulty with the above? _____

OCCUPATIONAL HISTORY TABLE

INDUSTRY AND LOCATION	TENURE OF EMPLOYMENT From To 19 19	SPECIFIC OCCUPATION (include job title)	AVERAGE NO. OF DAYS WORKED PER WEEK