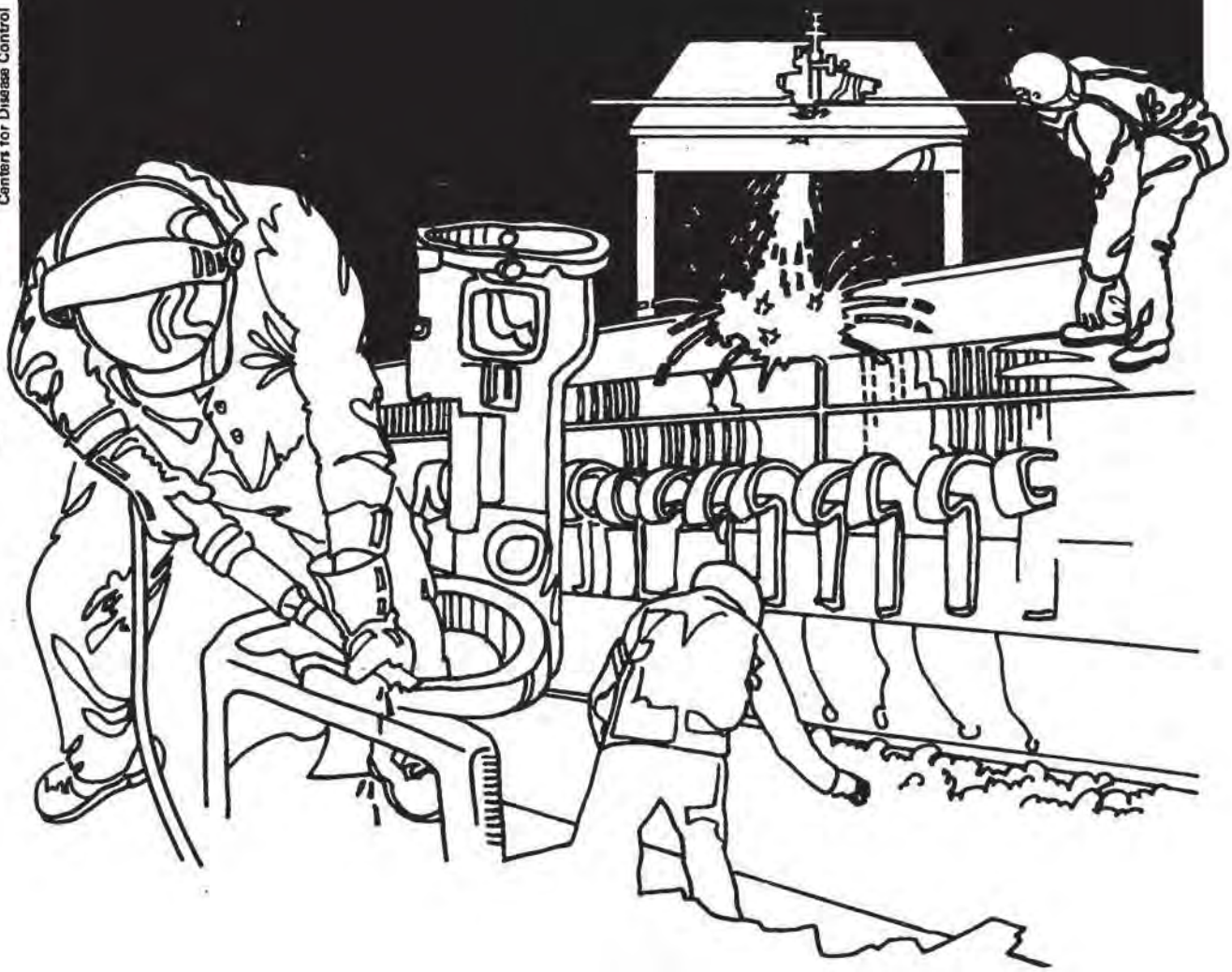
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 81-467-1138
OLIN CHEMICAL CORPORATION
LAKE CHARLES, LOUISIANA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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JULY 1982
OLIN CHEMICAL CORPORATION
LAKE CHARLES, LOUISIANA

NIOSH INVESTIGATORS:
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I. SUMMARY

In September 1981, the National Institute for Occupational Safety and Health (NIOSH) was requested by the local labor union at Olin Chemical, Lake Charles, Louisiana to evaluate the possible health hazards to workers exposed to chlorinated isocyanurates at this plant. At the time of the study, approximately 90 workers were employed in finishing and packaging trichlorisocyanuric acid (TCCA) and sodium dichloroisocyanurate (NaDCC).

On November 3-4, 1981, NIOSH investigators conducted industrial hygiene sampling and employee interviews at the plant. Personal breathing zone air samples were collected on filters and weighed to establish chlorinated isocyanurate dust concentrations. Particle sizing and experimental chemical analyses were also performed. NIOSH medical epidemiologists interviewed 73 (84%) of the exposed workers. Questions were asked about headaches, skin burns, excessive menstrual bleeding, and known irritant effects of chlorine exposure, such as eye and throat irritation, and respiratory symptoms.

Results of the 174 personal breathing zone samples collected by Olin, NIOSH, and OSHA since December 1979, showed that particulate concentrations have ranged from 0.11 to 38 milligrams per cubic meter (mg/M^3) with a mean of 2.4 mg/M^3. About 60% of the dust sampled by NIOSH near the packaging areas was within the respirable size range (<10um aerodynamic equivalent diameter). No OSHA standards or recommended limits for exposure to any chlorinated isocyanurates have been developed and current toxicity data is very limited. Complete body protection including full facepiece respirators are mandatory for entering and working in Pace 4. Three types of respirator facepieces were being used during the NIOSH visit with cartridges generally consisting of high efficiency particulate filters combined with sorbents for chlorine and acid gases.

All production workers reported one or more work related symptoms; the most common ones being eye irritation (89%), and cough (88%). Fourteen of 18 (78%) of the women interviewed reported problems or changes in their menstrual cycle since starting work at Pace 4.

Based on the results of this evaluation, NIOSH concluded that workers at Pace 4 are not adequately protected from the irritant effects of TCCA and NaDCC. Recommendations for controlling this hazard are presented in Section VIII of this report.

KEYWORDS: SIC 286 (Industrial Organic Chemicals) Trichloroisocyanuric acid, sodium dichloroisocyanurate, TCCA, NaDCC, CAS: 87-90-1, CAS: 2893-78-9.

II. INTRODUCTION

In September 1981, NIOSH received a request for a health hazard evaluation at Olin Chemical/Pace Plant #4, Lake Charles, Louisiana. The request was submitted by Local 407, International Union of Operating Engineers who were concerned about the possible health hazards to workers exposed to chlorinated isocyanurates in Pace Plant #4.

Preliminary recommendations stressing the importance of a stronger respirator program were distributed on November 24, 1981, following the NIOSH environmental and medical survey that was conducted on November 3-4, 1981.

III. BACKGROUND

Pace Plant #4 was built in 1979 and employs about 90 workers over four shifts for finishing and packaging trichloroisocyanuric acid (TCCA) and sodium dichloroisocyanurate (NaDCC). TCCA and NaDCC are compacted and granulated to form dry granular products that are packaged in various commercial containers. Some TCCA is further processed into tablets before packaging.

These chlorinating compounds are used as bactericides, fungicides and algicides for sanitizing and disinfecting water. They are frequently used as active ingredients in dry bleaches, dishwashing compounds, scouring powders, and water and sewage treatment.

The building has five floors with most of the work stations on the first floor at the filling and packaging machines. One or two workers per shift tend to the conveying, compacting, and granulating machinery on the upper levels.

Preplacement medical exams including a history and physical, pulmonary function test and chest x-ray are required of all prospective Olin employees. Periodic exams are offered to all Pace 4 employees on the following basis, every two years for worker up unto and including age 44, and every year for workers age 45 and older. Pulmonary function tests and chest x-rays are part of the periodic exam.

Physical exams are performed upon job transfer and are available to any employee upon termination after one year or more of employment.

IV. EVALUATION DESIGN AND METHODS

Environmental

NIOSH collected 17 personal breathing zone and general area air samples on November 3-4, 1981, to evaluate workers' exposure to chlorinated isocyanurates. The samples were collected on pre-weighed filters using calibrated personal sampling pumps drawing 1.7 liters of air per minute.

Duplicate area samples incorporating ten-millimeter cyclone preselectors were taken next to total dust samples in an attempt to compare respirable versus total dust concentrations. More detailed particle sizing was conducted with 8-stage cascade impactor sampling in major work areas. Air was drawn at a rate of 28.3 liters per minute through pre-weighed filters on each of the impaction discs in a cascade arrangement designed to simulate the particle retention characteristics of the human respiratory tract.

All filter samples were weighed before and after sampling to determine dust exposure. Since chlorinated isocyanurates were the only significant materials handled within the Pace 4 building, airborne dust exposures were expected to consist mainly of those compounds. This situation was deemed advantageous for testing a specific ion electrode method (modification of NIOSH Method No. P&CAM 314) for the analysis of chlorinated isocyanurates. After final weighing, each filter was desorbed with 20 milliliters (ml) of 0.1 % sulfamic acid. Then 0.5 ml of an acid buffer solution was added, followed by 0.5 ml of 0.5 M potassium iodide (KI). The solutions were mixed and allowed to react for two minutes. Then 29 ml of water were added (total volume 50 ml). The solutions were mixed and the concentrations read using an Orion 901 Ion Analyzer with a residual chlorine electrode. Standards were prepared by dissolving NaDCC in water.

Direct-reading colorimetric detector tubes were used for measuring chlorine and hydrogen chloride.

Capture velocities of local exhaust ventilation systems near packaging machinery was measured using an "Alnor Velometer Jr." air velocity meter. The results are reported as linear feet per minure (fpm).

Medical

A questionnaire designed to obtain information regarding health effects workers were experiencing was administered to Pace 4 workers. Questions specifically addressed the symptoms described in the hazard evaluation request (headaches, skin burns, excessive menstrual bleeding), known irritant effects of chlorine exposure, such as eye and throat irritation, and respiratory symptoms.

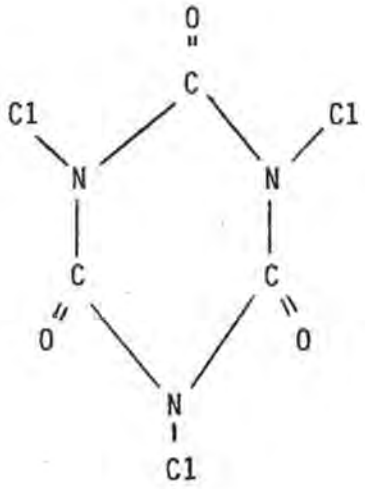
Demographic data, smoking and work history, including previous shift work experience, were also obtained.

V. EVALUATION CRITERIA

Trichloroisocyanuric Acid (TCCA), Sodium Dichloroisocyanurate (NaDCC)

Data in the literature concerning the toxic properties of any of the chlorinated isocyanurates are very scant. No workplace criteria have been developed. Figure I shows the chemical structure and more common synonyms of TCCA and NaDCC.

Figure I: Chemical Structure and Synonyms of TCCA and NADCC

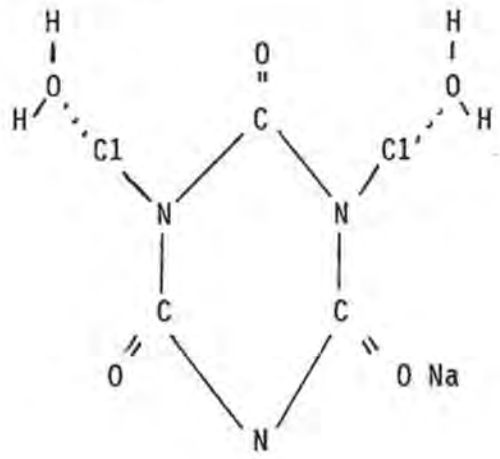


TCCA

Chemical Abstracts Registry Number: 87-90-1
Chemical Abstracts Name: 1,3,5-Trichloro-s-Triazine - 2,4,6 (1H, 3H, 5H) - Trion

Synonyms

Trichlorinated Isocyanuric Acid
Trichlorocyanuric Acid
Trichloroisocyanic Acid
Trichloroisocyanuric Acid
Trichloro-s-Triazinetrione
1,3,5-Trichloro - 2,4,6-Trioxohexahydro-s-Triazine



NaDCC

Chemical Abstracts Registry Number: 2893-78-9
Chemical Abstracts Name: 1,3-Dichloro-s-Triazine-2,4,6-(1H, 3H, 5H) - Trione Sodium Salt

Synonyms

Isocyanuric Acid, Dichloro-, Sodium Salt
Sodium Dichloroisocyanurate
Sodium Salt of Dichloro-s-Triazinetrione

Studies in animals by skin and oral routes of cyanuric acid and some cyanurates have shown a low degree of toxicity. Biochemical or hematologic changes were not found in any of the studies.[1] Because of their chlorine releasing properties however, relatively low concentrations of NaDCC and TCCA dusts can cause irritation of the skin, and mucous membranes of the eyes and upper respiratory passages.[1,2]

The acute toxic effects of one of the chlorinated cyanurates, cyanuric chloride (C_3-Cl_3-N_3), have been investigated by animal studies of the effects of inhalation and skin contact. In a two-hour inhalation study of cyanuric chloride in mice, the lowest lethal concentration was 6 mg/M^3 and the mean lethal concentration (LC_{50}) was 10 mg/M^3. The mice usually died 6-13 days after exposure. Histological examination revealed mild edema of the lungs and brain and inflammatory changes in the lungs.[3] Another study showed the 4-hour LC_{50} in rats to be 25 mg/M^3 (20.4% respirable, 10u or less in diameter). No other details of the study were published.[1]

In a prolonged inhalation study of cyanuric chloride (1.88 mg/M^3, 4 hours a day), 30% of the exposed rats died within 2.5 months. Bronchial pneumonia was found at autopsy.[3]

Further study of the acute and chronic toxic effects of chlorinated isocyanurates and similar chlorine releasing compounds is needed.

VI. RESULTS AND DISCUSSION

Environmental

A. Airborne Dust Concentrations

Six personal breathing-zone, time-weighted average, airborne dust samples collected by NIOSH ranged from 2.0 to 4.4 mg/M^3 with a mean of 2.9 mg/M^3 (Table 1). In October 1981, four personal breathing-zone samples collected by OSHA ranged from 1.3 to 6.3 mg/M^3 with a mean of 3.4 mg/M^3 (Table III). One hundred sixty-four personal breathing-zone samples collected by Olin from December 1979 to June 1981 ranged from 0.11 to 38 mg/M^3 with a mean of 2.4 mg/M^3 (Table IV).

The ion electrode method failed to quantitate chlorinated isocyanurates in the air samples (Tables I, II). The percent chemical analysis/gravimetric analysis ranged unexplainably from <2% to 110%. Further work is needed to determine the cause of the analytical problem.

No chlorine or hydrogen chloride were detected during the NIOSH survey, although Olin officials stated that such emissions, including nitrogen trichloride, were possible, and had occurred in the past when TCCA or NaDCC had inadvertently become contaminated with water.

B. Particle Sizing

The effective cutoff diameter and cumulative percent mass were plotted on logarithmic probability graph paper, such that the particulate mass distribution for any size range can be readily noted (Figures 3-5). Particle sizes appear to approximate log-normal distributions in the two major work areas sampled. About 60% of airborne dust in both the TCCA tablet and granular NaDCC packaging areas was within the respirable size range (<10um aerodynamic equivalent diameter). Total particulate concentrations from the four hour impactor sampling ranged from 0.77 to 1.86 mg/M^3. Particles smaller than 0.4um are not represented in the size distribution figures because the back-up filters were inadvertently omitted during sampling. However, it is doubtful that the inclusion of that data point would significantly alter the cumulative log-normal size distributions that are presented.

The use of cyclone preselectors for collecting respirable dust seemed to give inconsistent results (Table II). The respirable fraction ranged from 3 to 53%, however, the greater respirable fractions were found only in areas with very low overall dust concentrations. In normal work areas with more typical dust levels, the respirable fraction ranged from 3 to 7% with a mean of 5%. These results are considerably lower than those indicated by the cascade impactor sampling in the same work areas. The detailed pattern of air-flow through cyclones depends greatly on the particular design that was developed for specific applications. For instance, the commonly used 10mm nylon cyclone was developed to provide size selection characteristics for testing compliance with exposure limits to free crystalline silica as indicated in Figure 2, at points C.[5] Although the 10mm cyclone has since been found useful in separating other types of "respirable dusts", its application for sampling chlorinated isocyanurates appears to be limited.

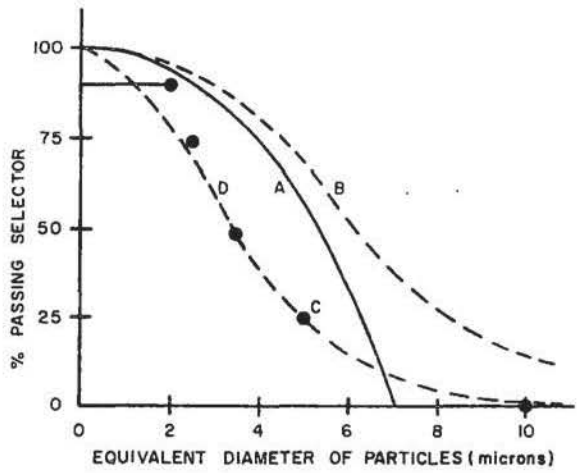


Figure 2. The Performance of Horizontal Elutriators Line A - Streamline flow conditions; elutriator designed to allow 50% of particles of 5 microns equivalent diameter to pass through - Line B - Perfect mixing in elutriator designed as for Line A - Points C - Size selector characteristics recommended by the ACGIH for "respirable" dust sampling - Line D - Perfect mixing conditions; elutriator designed to allow 50% of particles of 3.5 microns equivalent diameter to pass through.

C. Engineering Controls

Local exhaust ventilation at the NaDCC-granule bottle-filling machine consisted of a round duct with a plain opening about a foot from the filling post. Although the face velocity was high (about 800 feet per minute, fpm), the inefficient hood opening, the excessive distance from the emissions, and the misalignment of the duct toward the path of emissions, appeared to cause poor dust capture potential.

The exhaust hoods in the NaDCC barrel-filling area consisted of a flexible sleeve that could be stretched closely over the top of the barrel. The capture velocity was good at about 400-600 fpm.

Local exhaust at the TCCA one-inch table-filling station was provided by a 1/2" slot located at the junction of the filling port and the bottle mouth. The capture velocity was about 75 fpm.

Many sources of dust emissions other than the package filling hoppers were present in the building, mostly due to the leaky process machinery's inability to contain the powdered products. Vibratory conveyor systems especially seemed to contribute to contamination. Settled dust covered most surfaces on the first floor. Contamination was more excessive on most of the upper levels with some floor areas being covered with up to three inches of the fine white powder.

D. Personal Protective Equipment

Full-body protection including full facepiece respirators are mandatory for entering and working in Pace 4. Coveralls are tight-fitting around the ankles and wrists, and rubber gloves are used to protect the hands. Workers are given a choice of the following three respirators:

Facepiece	Cartridge
1. MSA (BM-13D-17)	TC-23C-153 organic vapors, chlorine, hydrogen chloride, sulfur dioxide, and dusts, fumes, mists, and radionuclides
2. Scott-O-Vista Mask Assembly (P/N 802170-01) Adapter Assembly (P/N 802451-01)	TC-23C-115 chlorine, hydrogen chloride, sulfur dioxide and TC-23C-117 filter for dusts, mists, fumes
3. Norton 7600-8S	7500-83 dusts, fumes, mists, organic vapors, acid gases, radionuclides

All of the workers that were observed were wearing their respirators properly and generally indicated that they knew which facepieces fit them the best. NIOSH investigators noted first hand that "qualitative" fit-testing automatically occurred by simply entering typical work areas, whereby any significant facepiece leaks became immediately apparent. TCCA and NaDCC dusts were judged to be just as, if not more, irritating than the typical irritant test smoke (stannic chloride) that is commonly used for qualitatively evaluating respirator fit. No quantitative fit-testing was being conducted at Pace 4.

Confusion existed over who was responsible for the various aspects of the respirator program, such as selection, use, training, fitting, inspection, cleaning, maintenance, and storage. There was no central authority in charge of supervising the program and it appeared that individual workers were given much of that responsibility. It was the contention of Olin management that respirators are personal items, "such as toothbrushes", which should be tended by the individual.

Air-supplied respirators are occasionally used, depending on the extent of the dustiness of the required task. The air generating system is located on the southcentral edge of the plant. Two back-up systems comprised of stored compressed air were available during the NIOSH survey.

Self-contained breathing apparatus were available for escape purposes in readily accessible cabinets in Pace 4. However, some of the cabinets contained inoperable respirators during the NIOSH visit. The facepiece was missing from one cabinet. In another cabinet the plastic bag containing the respirator was torn and the facepiece was heavily contaminated.

Medical

At the time of the evaluation there were 87 hourly workers employed in the Pace 4 building. Seventy-three of these participated in the medical investigation. The remainder were absent from work during the interview period or chose not to participate. Employees from four work shifts were interviewed.

Workers from all job categories participated in the interview. Forty-five (62%) of the 73 workers interviewed worked as shipper-packers; 19 (26%) worked as equipment operators; 3(4%) as supervisors; and 6 (8%) as set-up men. The proportion of workers interviewed in each category was representative of the proportion of workers in the different job categories within the total Pace 4 workforce.

Fifty-five male and 18 female employees were included in the study. Male ages ranged from 19-44 with a median age of 25. Female ages ranged from 19-40 with a median age of 26. The median length of employment among male employees was 21 months and among female employees, 17 months (production of the Pace product began in 1979).

The results obtained through interviews are summarized in Tables V-IX. The most frequently reported symptom was "eye irritation while working" reported by 65 (89%) of those interviewed. Fifty-one of these stated it occurred at least once per week. Skin problems (burns, irritation) were reported by 50 (69%) workers.

At the time of the interview, all production workers reported one or more of the following symptoms: cough, wheezing, shortness of breath, increased phlegm production, irritated eyes and/or throat, nosebleeds, headaches, skin problems, and increased bruising. Other health effects were reported, with sinus trouble most frequently mentioned. Fifteen (21%) of the 73 workers reported having experienced 1-3 of the above symptoms, 24 (33%) reported 4-6 symptoms, while 34 (47%) reported seven or more. There was no difference in the prevalence of reported complaints among job categories (Table V).

When questioned about respiratory symptoms, 64 (88%) workers reported cough with 60 of these reporting it was work-related. Shortness of breath was reported by 37 (51%) with 34 reporting it was work-related (Table VI). Thirty-five (48%) of those interviewed smoked cigarettes. When the prevalences of respiratory symptoms among smokers and non-smokers were compared, there was no significant difference ($p>.50$) between the two groups (Table VII).

Other health effects described during interviews covered a wide range of symptoms. The most common complaint was sinus problems, reported by 15 employees (Table VIII).

Fourteen (78%) of 18 women interviewed reported they "have or have had problems with or changes in their menstrual cycle since starting work at Pace 4". Of the 14 women reporting a problem or change, two reported only an increase in the number of days they bleed each month. Two reported only an increase in the amount they bleed each month, while 7 (50%) of the women reported experiencing both of these changes. Seven (50%) of the women reported having consulted a doctor or nurse regarding this problem. Women first noticed these changes anywhere from less than one month to two years after beginning work in Pace 4. The date of onset was not consistent from one worker to another.

Thirty (41%) of the 73 employees interviewed reported having done shift work prior to working at Olin (40% of males, 42% of females). Among the 10 female workers who had no prior experience with rotating shift work, seven reported problems or changes in their menstrual cycle. Among the eight female employees who had done prior shift work, seven reported problems. When these two groups were compared statistically, there is no significant difference ($p>.3137$) between the prevalence of symptoms reported among employees with and those without prior shift work experience (Table IX).

VII. CONCLUSIONS AND DISCUSSION

Irritation

TCCA and NaDCC dusts are extremely irritating at relatively low concentrations and their potential for causing serious injury to the respiratory system should not be underestimated.

Based on the results of medical interviews of 73 Pace 4 employees, NIOSH has determined that workers experience irritant and respiratory effects from exposure to TCCA and NaDCC, and that these effects occur in spite of the use of personal protective equipment. Eye and throat irritation were reported by almost all employees. Respiratory symptoms, noted since starting work in Pace 4, were reported by a majority of the workforce. These symptoms were equally prevalent among smokers and non-smokers. The results of the investigation indicate that workers are not adequately protected from the irritant effects of trichloroisocyanuric (TCCA) and sodium dichloroisocyanuric acid (NaDCC) dust during work in Pace 4.

Pace 4 operations began in 1979. It is unlikely that workers would be experiencing chronic respiratory effects after only two years (or less in many cases) of exposure. Medical surveillance in the form of history, physical and pulmonary function tests should be continued according to current Olin policy to monitor long-term effects of these substances on the lungs.

Menstrual Problems

The survey documented complaints of menstrual problems and changes among 78% of female employees in Pace 4. There is little in the literature regarding chronic health effects related to NaDCC and TCCA, therefore, it is difficult to relate these reported menstrual problems to the exposures.

If the menstrual problems were associated with exposure to TCCA and NaDCC, a possible explanation for the extended menstrual bleeding could be that these substances act as anticoagulants and therefore exposed persons tend to bleed longer and in greater amounts. In order to assess this possibility, workers were questioned about the occurrence of nosebleeds since beginning work in Pace 4, and if they had noticed they bruised more easily since beginning work. Women who reported increased bleeding did not report nosebleeds or bruising easily, with any greater frequency than women who reported no problems with their menstrual cycle. Animal studies involving oral doses of cyanuric acid and cyanurates report no biochemical or hematological changes.[1]

A second factor considered was the role of shift work in menstrual cycle disorders. A question of prior shift work experience was included in the interview. There was no difference in the frequency of menstrual problems reported by those with and without prior shift work experience.

NIOSH's investigation of these reported menstrual problems was limited by a number of factors. First, and most significantly, the investigation did not include a non-exposed (control) group. Although the requester stated that the problem only existed in Pace 4, women from other work areas need to be interviewed to confirm this information.

Documentation of menstrual problems and changes among Pace 4 employees was obtained through on-the-spot interviews. Obtaining an accurate menstrual history is essential and should involve keeping a record of menstrual cycle for approximately one year.

There is little available group data stating normal frequencies of menstrual problems and changes among working population. Therefore, it is difficult to state what frequency of change is abnormal, although 78% of women reporting problems certainly would not be expected.

The number of women involved in this study was small (18). It is difficult to draw valid conclusions from such a small study population.

At the present time there are no known deleterious effects of irregular menstrual periods. Therefore, it is not possible to state what the significance of these changes may be. Certainly, women who are experiencing problems, especially those who have noticed increased bleeding should consult their physician in order to ascertain the need for iron replacement.

VIII. RECOMMENDATIONS

1. Engineering controls should be used as the primary approach to reducing dust levels as much as possible in Pace Plant #4. Processing, conveying, and packaging systems need considerable "tightening up" in order to provide more thorough containment of chlorinated isocyanurate dusts.

2. The performance of much of the local exhaust ventilation for packaging and tablet-making machinery could be improved with more efficient hood designs. Ducts with plain openings are the least efficient. Exhaust openings should also be located as close to the source of emission as possible, and directly aligned toward the path of emission.

3. Improved housekeeping methods, such as vacuum cleaning, should be used to prevent the excessive settled dust contamination that pervades much of the building.

4. Medical Surveillance, including history and physical, pulmonary function tests and chest x-rays should be performed according to current Olin policy; to monitor both acute and chronic effects of TCCA and NaDCC on the lungs.

5. The respiratory protection program should be re-evaluated. The interview data indicate that workers are not adequately protected from the irritant effects of TCCA and NaDCC. It may be possible that air purifying respirators are not protective enough in some of the dustier areas, or some workers are not properly fitted, or some respirators are not being thoroughly cleaned of chlorinated isocyanurate contaminants.

a. A respirator program administrator should be chosen to supervise the respirator program. The administrator should have the knowledge and authority to ensure that the established respirator program is effective and that all aspects of the program are enforced through continual examination. Allowing the individual workers to carry out the responsibilities of the respirator program is not recommended.

b. If the use of air-purifying respirators is to continue, workers should be quantitatively fit tested to assure the best possible facepiece fit.

c. Escape respirators should be maintained in a usable condition. Compressed air cylinders should be frequently checked and facepieces should be stored such that they remain free of contamination. Standard escape and rescue procedures should be practiced through frequent drills.

d. Solitary areas in Pace 4, particularly those on the upper levels, should have at least two workers to avoid the possibility of a single worker incurring an unnoticed accident in potentially dangerous atmospheres.

e. Air that is generated for use in air-supplied respirators should undergo the sampling and analytical requirements specified in ANSI Z86.1-1973, "Commodity Specification for Air".

VIII. REFERENCES

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Olin Chemical Corporation, Lake Charles, Louisiana
2. Local 407, International Union of Operating Engineers
3. NIOSH, Region VI
4. OSHA, Region VI

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

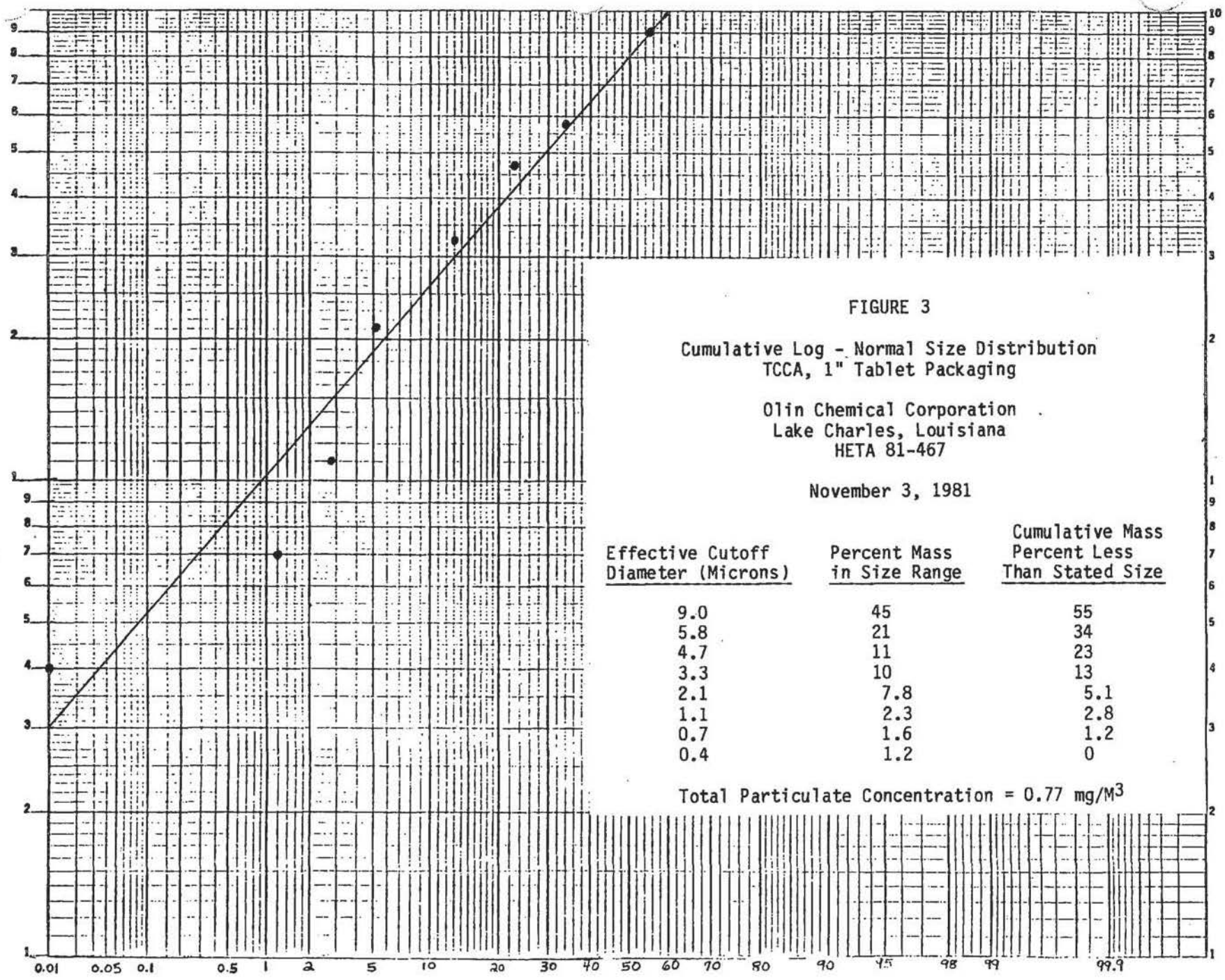

FIGURE 3

Cumulative Log - Normal Size Distribution
TCCA, 1" Tablet Packaging

Olin Chemical Corporation
Lake Charles, Louisiana
HETA 81-467

November 3, 1981

Effective Cutoff Diameter (Microns)	Percent Mass in Size Range	Cumulative Mass Percent Less Than Stated Size
9.0	45	55
5.8	21	34
4.7	11	23
3.3	10	13
2.1	7.8	5.1
1.1	2.3	2.8
0.7	1.6	1.2
0.4	1.2	0

Total Particulate Concentration = 0.77 mg/M^3

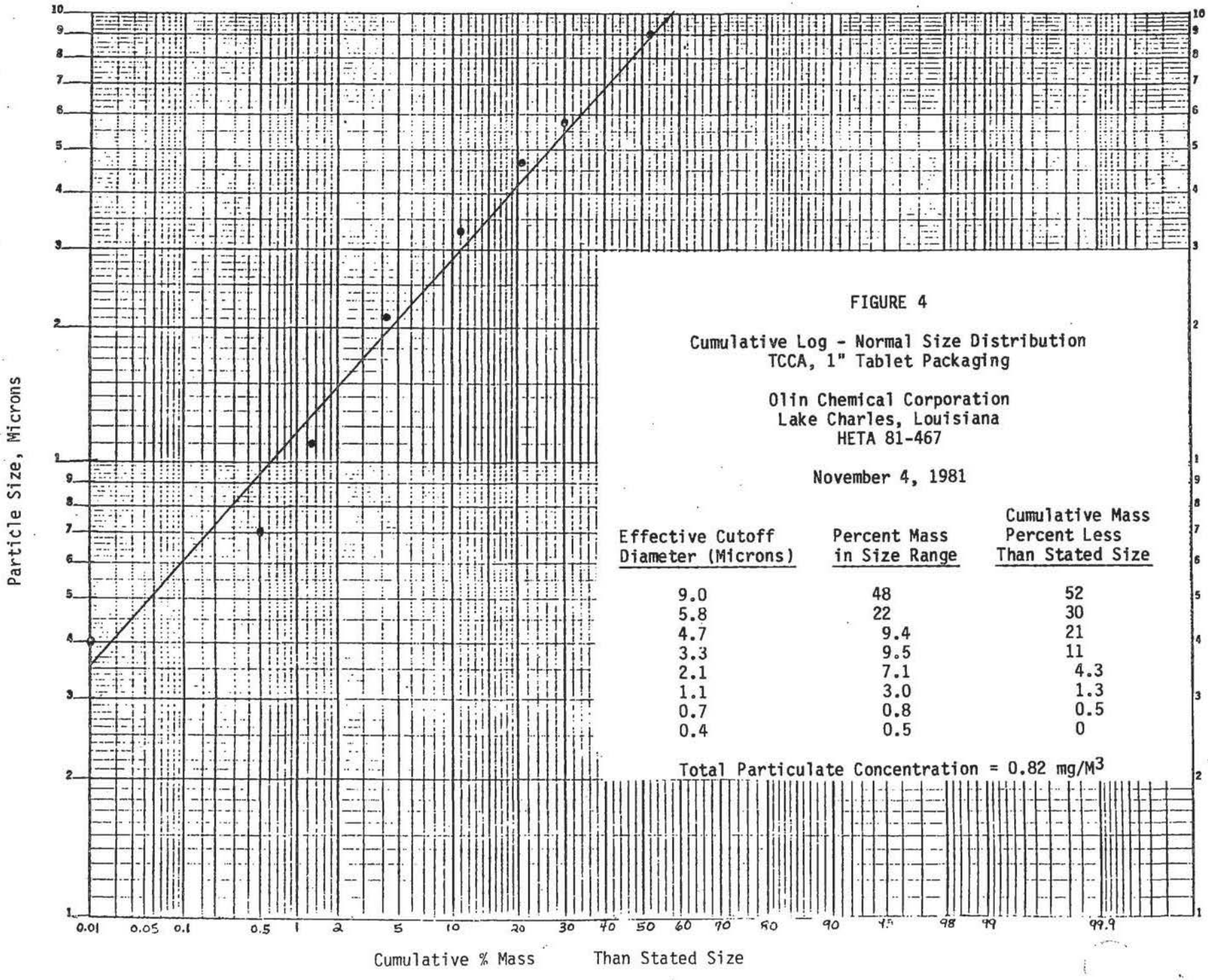

FIGURE 4

Cumulative Log - Normal Size Distribution
TCCA, 1" Tablet Packaging

Olin Chemical Corporation
Lake Charles, Louisiana
HETA 81-467

November 4, 1981

Effective Cutoff Diameter (Microns)	Percent Mass in Size Range	Cumulative Mass Percent Less Than Stated Size
9.0	48	52
5.8	22	30
4.7	9.4	21
3.3	9.5	11
2.1	7.1	4.3
1.1	3.0	1.3
0.7	0.8	0.5
0.4	0.5	0

Total Particulate Concentration = 0.82 mg/M^3

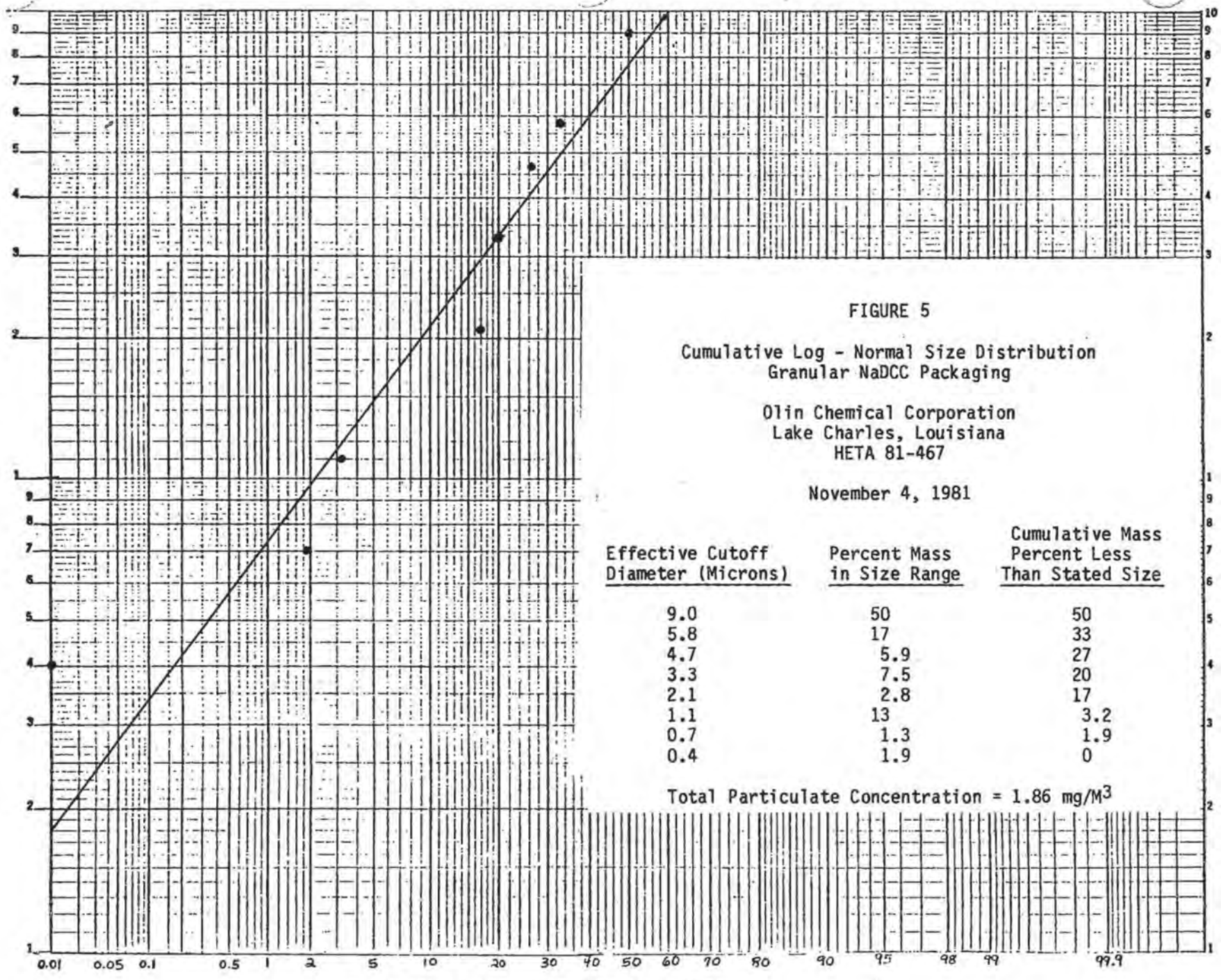

FIGURE 5

Cumulative Log - Normal Size Distribution
Granular NaDCC Packaging

Olin Chemical Corporation
Lake Charles, Louisiana
HETA 81-467

November 4, 1981

Effective Cutoff Diameter (Microns)	Percent Mass in Size Range	Cumulative Mass Percent Less Than Stated Size
9.0	50	50
5.8	17	33
4.7	5.9	27
3.3	7.5	20
2.1	2.8	17
1.1	13	3.2
0.7	1.3	1.9
0.4	1.9	0

Total Particulate Concentration = 1.86 mg/M^3

TABLE I

NIOSH RESULTS OF PERSONAL BREATHING-ZONE SAMPLES FOR CHLORINATED ISOCYANURATES

OLIN CHEMICAL CORPORATION
LAKE CHARLES, LOUISIANA
HETA 81-467

November 3-4, 1981

Job/Location Time-Weighted Average Samples	Sampling Period	Total Particulate (mg/M^3)	Ion Electrode Method (mg/M^3)	% Chemical / Gravimetric Analysis
Upper level TCCA equipment operator	7:39-15:33	2.0	1.6	80
Upper level NaDCC equipment operator	7:45-15:12	4.4	2.2	50
Granular NaDCC packaging	7:50-15:14	2.4	1.3	54
Granular NaDCC packaging	8:32-15:27	2.2	0.51	23
TCCA, 1" tablet packaging	7:55-15:07	3.9	0.15	4
TCCA, 1" tablet packaging	8:03-15:03	2.4	0.06	3
15-Minute Samples				
Granular NaDCC packaging	13:59-14:14	3.1	-	-
Granular NaDCC packaging	14:14-14:29	3.9	-	-
TCCA, 1" tablet packaging	14:05-14:20	1.6	-	-
TCCA, 1" tablet packaging	14:20-14:35	1.6	-	-
TCCA, 1" tablet compaction	14:07-14:22	non-detectable	-	-
TCCA, 1" tablet compaction	14:22-14:37	0.4	-	-

TABLE II

NIOSH RESULTS OF AREA SAMPLING FOR
CHLORINATED ISOCYANURATES

OLIN CHEMICAL CORPORATION
LAKE CHARLES, LOUISIANA
HETA 81-467

November 4, 1981

Location	Sampling Period	Total Particulate (mg/M^3)	Ion Electrode Method (mg/M^3)	% Chemical Analysis	Gravimetric Analysis	Respirable Particulate [via cyclone (mg/M^3)]	% Respirable (via cyclone)
Granular NaDCC bottle filling machine	8:13-13:20	1.1	0.23	21		0.06	5
Granular NaDCC packaging	8:10-13:17	1.1	0.52	47		0.08	7
TCCA, 1" tablet packaging	8:05-13:15	0.17	0.01	7		0.09	53
3rd floor near compactor	7:45-13:23	2.9	3.1	110		0.09	3
Lunchroom	7:56-14:55	0.28	N.D.	2		0.07	25

TABLE III

OSHA RESULTS OF PERSONAL BREATHING-ZONE
SAMPLES FOR CHLORINATED ISOCYANURATES

OLIN CHEMICAL CORPORATION
LAKE CHARLES, LOUISIANA
HETA 81-467

October 20, 1981

Job/Location	Sampling Time	Total Particulate (mg/M^3)
Upper level equipment operator	7:45-15:10	2.4
1" tablet line	7:46-15:08	6.3
1" tablet line	8:08-15:00	1.3
NaDCC drum filling	7:52-15:05	3.7

TABLE IV

OLIN RESULTS OF PERSONAL
BREATHING-ZONE SAMPLES FOR CHLORINATED ISOCYANURATES

OLIN CHEMICAL CORPORATION
LAKE CHARLES, LOUISIANA
HETA 81-467

October 20, 1981

Job/Location	Date	Sampling Period	Total Particulate (mg/M^3)
3" tablet operator	1/31/80	10:04-15:15	0.90
3" tablet line	1/31/80	10:04-15:15	0.85
3" tablet line	1/31/80	9:50-15:15	0.89
3" tablet line	1/31/80	9:54-15:15	1.2
3" tablet line	2/1/80	12:20-15:40	0.43
3" tablet line	2/1/80	12:20-19:40	0.53
3" tablet line	2/1/80	12:20-15:40	0.28
3" tablet line	2/1/80	12:20-18:10	1.2
3" tablet line	2/1/80	12:20-15:30	2.2
3" tablet line	2/5/80	8:36-15:21	1.2
1" tablet operator	2/5/80	8:40-15:24	1.1
3" tablet line	2/5/80	8:45-11:30	5.3
1" tablet line	2/5/80	8:52-15:13	1.4
TCCA, fifth floor	2/7/80	9:20-14:20	2.1
NaDCC, second floor	2/8/80	10:35-14:20	1.2
NaDCC, drum loading	2/8/80	10:35-14:15	1.6
NaDCC, drum loading	2/8/80	10:35-14:15	1.3
cartridge loading	2/20/80	12:02-15:23	0.30
1" tablet drum loading	2/20/80	12:00-15:24	1.4
1" tablet line	2/26/80	11:03-15:30	0.39
1" tablet line	2/26/80	11:05-15:28	1.6
1" tablet line	2/26/80	11:10-15:30	1.6
1" tablet line	2/27/80	10:38-15:21	1.0
First floor equipment operator	2/27/80	10:42-15:23	1.4
1" tablet line	2/27/80	11:04-15:25	1.1
1" tablet line	2/27/80	11:04-15:24	1.1
Upper level equipment operator	3/4/80	11:27-15:25	1.0
"	3/4/80	11:27-15:25	0.86
"	3/4/80	11:27-15:25	2.0
"	3/5/80	9:20-15:10	0.76
"	3/5/80	9:20-15:10	0.17
"	3/5/80	9:20-15:10	2.0
Fork Operator	3/6/80	9:34-15:30	1.3
First floor equipment operator	3/6/80	9:30-15:30	1.4
Upper level equipment operator	3/7/80	8:49-14:55	1.8
Fork operator	3/7/80	8:53-14:35	1.0
3" tablet line	3/10/80	10:05-13:53	1.6
Fork operator	3/20/80	9:55-14:15	1.1
First floor equipment operator	3/10/80	10:01-13:53	1.8
Shipper/packer	4/21/80	10:05-15:32	0.93
Tablet room	4/21/80	10:15-15:31	1.9
1" table line	4/22/80	8:54-15:01	0.4
Tablet room	4/22/80	9:43-14:59	2.4
3" tablet line	6/16/80	9:30-15:28	2.0
Shipper/packer	6/16/80	9:34-15:30	1.2
3" tablet line	6/16/80	9:35-15:28	0.48
3" tablet line	6/26/80	9:47-15:26	4.9
3" tablet line	6/17/80	9:03-15:28	0.97
3" tablet line	6/17/80	9:06-15:28	2.8
3" tablet line	6/17/80	9:08-15:28	1.9
Tablet room	6/17/80	9:11-15:28	38
Upper level equipment operator	6/19/80	9:17-15:32	1.1
"	6/18/80	9:04-14:52	1.8

Table IV (continued)

Job/Location	Date	Sampling Period	Total Particulate (mg/M^3)
First floor equipment operator	6/18/80	9:18-14:52	2.5
Upper level equipment operator	7/7/80	9:00-15:00	0.53
1" tablet line	7/7/80	9:00-14:50	6.7
1" tablet line	7/7/80	9:00-14:55	1.7
1" tablet line	7/8/80	8:25-15:40	12
1" tablet line	7/8/80	8:25-15:40	6.4
Upper level equipment operator	7/8/80	8:25-15:30	1.7
NaDCC packaging	7/10/80	9:00-15:34	4.3
NaDCC packaging	7/10/80	7:00-15:34	3.5
NaDCC packaging	7/10/80	9:00-15:30	5.7
Granular TCCA drum loading	7/10/80	9:00-15:34	12
Tablet room	7/15/80	8:30-11:05	9.8
Tablet room	7/15/80	8:30-15:25	3.1
1" tablet line	7/16/80	8:30-15:30	5.6
3" tablet line	10/15/80	9:25-15:10	2.3
1" tablet line	10/15/80	9:25-15:10	3.4
1" tablet line	10/16/80	8:50-14:30	0.65
3" tablet line	10/16/80	8:50-14:35	0.97
3" tablet line	10/20/80	8:40-15:15	2.4
1" tablet line	10/20/80	8:40-11:35	0.91
1" tablet line	10/20/80	11:35-15:15	4.7
3" tablet line	10/21/80	8:55-14:55	0.63
1" tablet line	10/21/80	9:00-11:30	2.2
3" tablet line	10/29/80	13:32-15:39	0.43
Set-up operator	10/29/80	13:48-15:19	0.43
1" tablet line	10/29/80	14:04-15:47	4.6
1" tablet line	10/29/80	14:12-15:39	2.5
Shipper/packer	12/17/79	14:34-18:16	2.0
"	12/17/79	14:34-18:16	2.0
"	12/17/79	18:17-23:20	1.2
"	12/17/79	14:39-18:20	1.8
"	12/17/79	18:21-23:18	2.4
"	12/17/79	14:41-18:30	2.6
"	12/17/79	18:30-23:19	1.2
"	12/17/79	14:46-18:31	1.8
"	12/17/79	18:32-21:45	1.8
"	12/18/79	0:45-5:27	0.76
"	12/18/79	5:27-8:54	0.60
"	12/18/79	2:33-5:30	1.6
"	12/18/79	5:30-8:35	2.0
"	12/18/79	2:55-5:32	1.7
"	12/18/79	5:32-8:40	1.0
"	12/19/79	1:02-5:15	0.38
"	12/19/79	5:15-7:30	0.66
"	12/19/79	1:12-5:11	1.0
"	12/19/79	5:11-7:30	2.5
Tablet room	12/18/79	12:20-18:51	0.11
Tablet room	12/18/79	18:51-22:57	1.2
Set-up operator	12/18/79	12:27-16:30	0.2
Set-up operator	12/18/79	18:43-22:52	1.0
Tablet room	12/19/79	12:57-5:21	0.67
Tablet room	12/19/79	5:21-9:15	1.4
Upper level equipment operator	12/18/79	12:22-18:55	1.6
"	12/18/79	18:56-23:00	0.97
3" pack wrapper	12/18/79	12:32-18:49	0.14
Upper level equipment operator	12/31/80	8:35-15:37	1.6
Shipper packer	12/31/80	8:35-15:37	1.7
Set-up operator	12/22/80	8:40-15:10	1.3
1" tablet line	12/22/80	8:40-15:10	6.7
3" tablet line	12/22/80	8:40-15:10	2.0
1" tablet line	12/29/80	10:00-14:00	1.3
3" tablet line	12/29/80	10:00-14:00	1.7

Table IV (continued)

Job/Location	Date	Sampling Period	Total Particulate (mg/M^3)
Upper level equipment operator	12/30/80	8:47-15:00	1.1
1" tablet line	12/30/80	8:47-15:00	1.1
Tablet room	12/30/80	8:47-15:00	1.9
1" tablet line	12/30/80	8:47-15:00	1.1
1" tablet line	1/15/81	9:08-15:10	1.8
Tablet room	1/15/81	9:08-15:15	1.9
Tablet room	1/15/81	9:08-15:17	1.6
Tablet room	1/15/81	9:08-15:20	2.2
Upper level equipment operator	1/16/81	9:13-11:15	2.0
"	1/16/81	9:13-11:15	3.3
3" tablet line	1/16/81	9:25-15:10	3.2
Shipper/packer	1/16/81	9:25-15:10	3.6
Upper level equipment operator	1/16/81	9:13-11:15	2.8
"	1/19/81	8:55-14:00	4.0
3" tablet line	1/19/81	10:35-14:20	1.3
1" tablet line	1/19/81	8:55-14:20	1.7
1" tablet line	1/19/81	8:55-14:20	1.2
1" tablet line	1/20/81	9:25-15:45	0.59
3" tablet line	1/20/81	9:25-15:45	0.26
3" tablet line	1/20/81	9:25-15:45	0.75
3" tablet line	1/20/81	9:25-15:45	1.5
Set-up operator	2/6/81	10:20-14:40	0.28
Set-up operator	2/17/81	8:30-9:00	2.3
3" tablet line	2/17/81	8:22-11:00	5.0
1" tablet line	2/17/81	8:24-10:47	1.8
Set-up operator	2/17/81	9:33-11:00	0.92
1" tablet line	2/17/81	10:55-15:00	6.6
3" tablet line	2/17/81	11:00-15:00	5.7
Set-up operator	2/17/81	11:01-15:00	2.3
1" tablet line	2/20/81	9:00-15:05	2.0
1" tablet line	2/23/81	8:46-15:10	1.9
1" tablet line	2/23/81	8:46-15:15	16
1" tablet line	2/23/81	8:46-15:12	0.56
NaDCC, packaging	2/24/81	10:27-13:50	8.1
NaDCC, packaging	2/24/81	10:27-13:50	3.7
Upper level equipment operator	2/25/81	9:25-15:40	2.0
Set-up operator	3/3/81	9:20-14:55	2.2
1" tablet line	3/3/81	9:20-10:55	0.55
3" tablet line	3/3/81	9:20-14:55	2.4
3" tablet line	3/4/81	10:15-15:00	2.6
1" tablet line	3/4/81	10:15-15:20	1.2
Set-up operator	3/4/81	10:15-15:00	2.3
Repacker	4/27/81	9:30-14:45	1.3
1" tablet line	5/4/81	8:45-14:25	1.3
1" tablet line	6/2/81	13:16-14:30	1.6
1" tablet line	6/4/81	8:25-11:45	1.8
3" tablet line	6/4/81	8:25-11:45	2.1
Set-up operator	6/18/81	8:55-15:00	0.53
3" tablet line	6/23/81	8:55-14:33	8.4

TABLE V

PREVALENCE OF HEALTH SYSTEMS AMONG JOB CATEGORIES
REPORTED DURING INTERVIEWS WITH PACE 4 EMPLOYEES

OLIN CHEMICAL CORPORATION
LAKE CHARLES, LOUISIANA
HETA 81-467

November 2-3, 1981

Job Categories	No. of Respondents Reporting 1-3 Symptoms	4-6 Symptoms	7 or more Symptoms
Shipper-packer	9	15	21
Operator	5	4	10
Supervisor-leaderman	0	1	2
Set-up man	1	4	1

TABLE VI

RESPIRATORY EFFECTS REPORTED DURING INTERVIEWS
WITH PACE 4 EMPLOYEES

OLIN CHEMICAL CORPORATION
LAKE CHARLES, LOUISIANA
HETA 81-467

November 2-3, 1981

	No. of Respondents Reporting Symptoms (73 Respondents)	No. of Respondents Reporting Symptoms as Work-Related
Cough	64 (88%)	60
Wheezing	35 (48%)	35
Shortness of Breath	37 (51%)	34
Increased Phlegm Production	48 (66%)	47

TABLE VII

RESPIRATORY SYMPTOMS REPORTED BY SMOKERS AND NON-SMOKERS
DURING INTERVIEWS WITH PACE 4 EMPLOYEES

OLIN CHEMICAL CORPORATION
LAKE CHARLES, LOUISIANA
HETA 81-467

November 2-3, 1981

	No. of Respondents Reporting 0-1 Respiratory Symptoms	No. of Respondents Reporting 2-4 Respiratory Symptoms	Total
Smokers	7	28	35
Non-smokers	10	28	38
Total	17	56	73

$p > .50$ by Chi-square test ($x^2 = .130$, d.f. 1)

TABLE VIII

HEALTH EFFECTS REPORTED
DURING INTERVIEWS WITH PACE 4 EMPLOYEES

OLIN CHEMICAL CORPORATION
LAKE CHARLES, LOUISIANA
HETA 81-467

November 2-3, 1981

	No. of Respondents Reporting Symptoms (73 Respondents)
Eye Irritation	65 (89%)
Cough	64 (88%)
Skin Problems	50 (68%)
Increased Phlegm Production	48 (66%)
Throat Irritation	45 (62%)
Shortness of Breath	37 (51%)
Wheezing	35 (48%)
Headaches	32 (44%)
Nosebleeds	18 (25%)
Sinus Trouble	15 (21%)
Increased Bruising	5 (7%)
Other Problems	19 (26%)

TABLE IX

MENSTRUAL PROBLEMS AMONG EMPLOYEES WITH AND WITHOUT PREVIOUS SHIFT WORK EXPERIENCE REPORTED BY EMPLOYEES IN PACE 4

OLIN CHEMICAL CORPORATION
LAKE CHARLES, LOUISIANA
HETA 81-467

November 2-3, 1981

	No. of Respondents Reporting Problem (18 Respondents)	No. of Respondents Reporting no Problem	Total
Prior shift work experience	7	1	8
No prior shift work experience	7	3	10
Total	14	4	18

p>.3137, Fisher's exact text