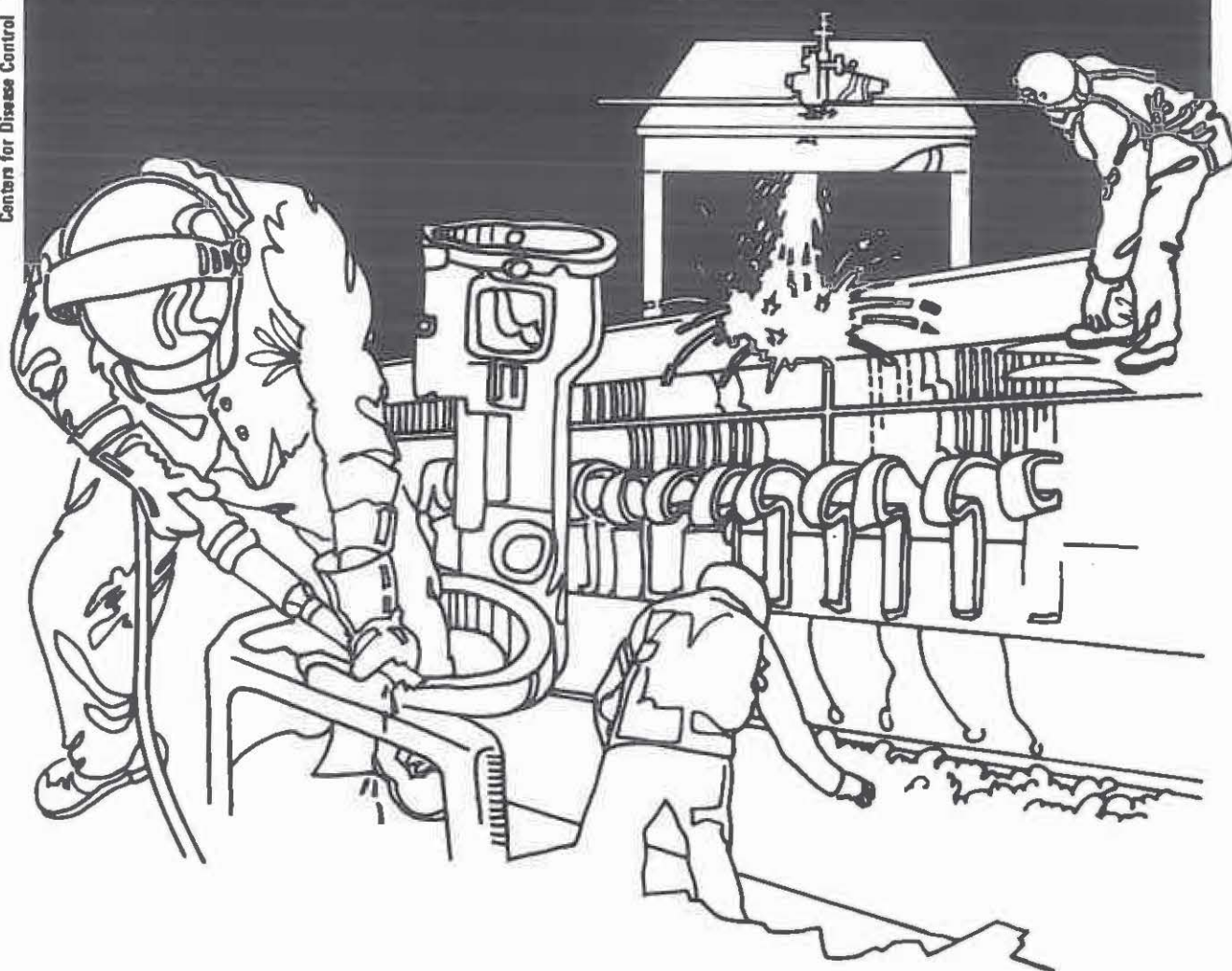


NIOSH



Health Hazard Evaluation Report

HHE 80-49-808
SUPERIOR TUBE COMPANY
COLLEGEVILLE, PENNSYLVANIA

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. 699(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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HE 80-49-808
January, 1981
Superior Tube Company
Collegeville, Pennsylvania

NIOSH INVESTIGATORS:
Raymond L. Ruhe, IH
Arthur Watanabe, Pharm. D.
Gary Stein, MD

I. SUMMARY

On December 18, 1979, the National Institute for Occupational Safety and Health (NIOSH) was requested by Local 6816, United Steelworkers of America, at Superior Tube Company, Collegeville, Pennsylvania, to evaluate possible health hazards from excessive exposures to trichloroethylene (TCE), methylene chloride, and acetone vapors in five degreasing operations.

NIOSH conducted site visits at the plant on February 5-7 and May 14-16, 1980. We obtained personal and area air samples for trichloroethylene, methylene chloride, and acetone vapors, and we reviewed work practices and working conditions. Interviews were conducted with exposed workers and with a comparison group. Pre- and post-shift urine samples were collected for TCE analysis. Liver and kidney function were evaluated in relation to TCE exposure.

During the first visit, we found that the mean time-weighted average (TWA) TCE exposure for the operator at one degreaser was 205 milligrams per cubic meter of air (mg/M^3). TCE exposures in that job ranged from 117 to 357 mg/M^3 . NIOSH recommends that TWA exposure to TCE not exceed 134 mg/M^3 . Short-term peak exposures at that same degreaser ranged as high as 2,000 mg/M^3 ; NIOSH recommends a short-term exposure limit of 535 mg/M^3 . TWA and peak exposures of other workers to TCE were within recommended limits. Exposures of all workers to acetone and to methyl chloride were within recommended limits. Seven of 9 exposed workers reported acute symptoms consistent with TCE exposure. The concentration of total TCE metabolites in the urine of the 9 exposed workers increased from 297.5 mg/liter pre-shift to 479.9 mg/liter post-shift.

Improvements in plant ventilation, which had been recommended by NIOSH, were made by management following the February visit. In May 1980, we found that all TWA exposures to TCE had fallen within recommended limits (range: 37-114 mg/M^3). TCE vapor concentrations in 4 of 18 short-term samples still, however, exceeded the NIOSH-recommended short-term limit. Urinary excretion of TCE metabolites had declined to 69.2 mg/liter pre-shift and to 94.9 mg/liter post-shift. Post-shift excretion of TCE metabolites in unexposed workers was 16.4 mg/liter . Liver and kidney function tests were all within normal limits.

Based on these results, NIOSH concluded that a health hazard from overexposure to trichloroethylene existed at Superior Tube Company. Recent improvements in plant ventilation have significantly reduced TCE exposures. However, further steps will need to be taken to reduce short-term peak exposures to within acceptable limits. Recommendations to control this hazard are found in Section VIII of this report.

KEYWORDS: SIC 3317, Trichloroethylene, Acetone, and Methylene Chloride.

INTRODUCTION

In December 1979, NIOSH received a request for a health hazard evaluation at Superior Tube Company, Collegeville, Pennsylvania. The request was initiated by then Senator Richard S. Schweiker and submitted by Mr. James Keller, Local 6816, USWA. The requestors asked NIOSH to evaluate the possible health hazards of trichloroethylene (TCE) exposure in tubing degreaser operators:

BACKGROUND

This health hazard evaluation was initiated following a spill of approximately 1900 gallons of TCE from a broken pipeline at the Superior Tube Company's TCE storage tank. That spill resulted in the contamination of the community water table. During a subsequent community TCE screening and surveillance program established by the Centers for Disease Control, one worker from Superior Tube Company was found to have TCE metabolites in his urine. That finding raised concern over possible occupational exposures to TCE within the plant.

NIOSH distributed Interim Report #1 on this investigation on February 25, 1980, following our first visit to the plant. On April 25, 1980, Interim Report #2 was distributed listing 11 recommendations which would help to reduce employees' exposure to TCE at the degreaser.

EVALUATION METHODS

A. Environmental:

Personal breathing-zone and general area air samples were collected on February 5-7 and May 14-16, 1980, to evaluate workers' exposure to organic contaminants during the degreasing of metal pipes. The organics were collected and analyzed in accordance with NIOSH method P & CAM 127 using calibrated personal sampling pumps operating at 0.2-1.0 liter per minute and 150 mg of activated charcoal packed into 7-cm long 4mm-I.D. glass tubes. The analytes were desorbed from the activated charcoal with carbon disulfide and analyzed using a gas chromatograph.

B. Medical:

The February walk-through investigation indicated that workers at greatest risk of TCE exposure included those on the large hot degreaser, on two cold degreasers, and in two flush and blow areas. Medical evaluation in February included all workers in those areas plus crane operators who spent a portion of their time working near the larger degreaser. The medical investigation in May included nearly all persons examined in February, plus several newer workers. One worker from the February study was not included because of absence. During both surveys, control subjects were selected for examination from the management office. Industrial hygiene data demonstrated that TCE concentrations were lowest in the office area.

Pre- and post-shift spot urine samples were collected on February 5-7 and on May 14-16, 1980, to evaluate worker exposure to trichloroethylene. The urine samples were analyzed for total trichloroethylene metabolites (total trichloro-compounds and for trichloroacetic acid) according to the method of Tanaka and Ikeda (Br. J. Ind. Med. 25:214, 1968). Trichloroethanol is determined by this calculation: total trichloro-compounds minus trichloroacetic acid equals trichloroethanol.

During the May survey, venous blood samples were collected mid- to post-shift from 10 exposed workers and from 9 controls to evaluate kidney and liver function.

A questionnaire was administered to exposed workers and to controls during both surveys. It was intended to evaluate the acute neurologic effects of trichloroethylene exposure, including drowsiness, dizziness, weakness, tremor, loss of coordination, and mental confusion.

V. EVALUATION CRITERIA

Trichloroethylene:

Acute exposure to trichloroethylene is known to cause symptoms of central nervous system depression including drowsiness, dizziness, weakness, tremor, loss of coordination, and mental confusion.¹ Severe exposures can result in coma, heart rhythm disturbances, and death. Other toxic effects include respiratory tract irritation, nausea, vomiting, abdominal cramps, and liver abnormalities. Intolerance to alcohol has been reported, resulting in excess intoxication and skin flushing after ingestion of relatively small amounts.^{2,3} Alcohol is known to potentiate trichloroethylene liver toxicity in mice and to alter trichloroethylene metabolite metabolism in humans.^{4,5}

Long-term or chronic toxicity of trichloroethylene is not clearly understood. Carcinogenic screening tests have found that short-term exposures to trichloroethylene at anesthetizing concentrations give no positive result, a finding which indicates, at worst, that TCE is a weak carcinogen.⁶ A cohort study of 500 workers exposed to low levels of trichloroethylene in Sweden revealed no excess cancer mortality. However, the authors of that study pointed out that the cancer risk to humans from trichloroethylene cannot be altogether excluded,⁷ particularly since a sufficient time period had not passed for a part of their cohort to have developed any disease.

Acetone:

Acetone may be ingested or inhaled. It is a skin and mucous membrane irritant and a depressant to the central nervous system. Overexposures may produce eczema, conjunctivitis, and corneal erosion. Headaches, dizziness, mental confusion, weakness, and narcosis are the most frequent findings when a worker is exposed to levels exceeding 2400 mg/M³.

Methylene Chloride:

Methylene chloride is an irritant to the eyes and upper respiratory tract and a depressant to the central nervous system. Exposures at or above 500 parts per million may result in potentially harmful carboxy-hemoglobin levels.

VI. RESULTS AND DISCUSSION

A. Environmental:

Environmental sampling in February revealed that long-term time-weighted average (TWA) airborne exposures to TCE vapors for one degreaser operator (#1291) ranged from 117 mg/M³ to 357 mg/M³ (Table I). NIOSH recommends that TWA exposure to TCE not exceed 134 mg/M³. Short-term airborne exposure to TCE vapors ranged from 413 mg/M³ to 2000 mg/M³. The NIOSH-recommended ceiling for short-term TCE exposure is 535 mg/M³.

Table II presents the personal breathing-zone exposures of workers at other degreasers to airborne trichloroethylene, methylene chloride, and acetone vapors on February 6, 1980. Trichloroethylene levels ranged from less than detectable to 125 mg/M³; methylene chloride from less than detectable to 141 mg/M³ (permissible exposure limit: 261 mg/M³); and acetone from less than detectable to 2 mg/M³ (permissible exposure limit: 2400 mg/M³).

In our reevaluation of the plant on May 15-16, 1980, we found that all long-term personal breathing-zone samples for TCE at degreaser #1291 were below the NIOSH environmental criterion (Table I). This reduction can be attributed to implementation of some of the NIOSH recommendations on ventilation and work practices which were made in an Interim Report to Superior Tube Company (April 25, 1980). Four of the 18 short-term samples still exceeded the NIOSH short-term criterion of 535 mg/M³. These residual high exposures can be attributed to improper work practices (e.g., keeping lid off degreaser unnecessarily, and standing over degreaser when degreaser is open).

B. Medical:

Nine exposed workers and nine controls were evaluated in February 1980 (Table III). Seven of the exposed group were male and 2 female. The mean ages of the groups were 42.7 and 46.4 years, and their mean job durations were 4.4 and 9.4 years. Seven (77.8%) of the nine exposed workers reported acute symptoms consistent with TCE exposure; no control workers reported any acute symptoms (Table IV). Degreaser operators noted, on average, 4.25 symptoms, flush and blow operators averaged 2 symptoms, and crane operators 1.5 symptoms (Table V). In pre-shift urine samples, the exposed workers excreted, on average, 297.5 mg/liter total TCE metabolites. Mean post-shift excretion was 479.9 mg/liter. Similar increases from the beginning to the end of the work shift were seen for trichloroethanol, but not for trichloroacetic acid. No apparent clustering of any chronic disease was noted in this small group of workers.

In May, 11 exposed workers and nine controls were evaluated (Table III). The total number of workers reporting symptoms in the two groups were seven (63.6%) and two (22.2%) (Table IV). However, as compared to February, a reduction was noted in the average number of symptoms reported per worker (Table V) to 1.5 for degreaser operators, 1.0 for flush and blow workers, and 0.75 for crane operators. A significant reduction was noted also in the intra-shift increase in TCE metabolites excretion (Table VI). No abnormalities were noted in workers' kidney or liver function test results.

VII. CONCLUSION

Based on the results of the environmental and medical evaluations conducted by NIOSH on February 5-7 and May 14-16, 1980, it has been determined that a health hazard from overexposure to trichloroethylene did exist at Superior Tube Company. Although exposures have been reduced, workers are continuing to be exposed to trichloroethylene, as documented by the continuing presence of trichloroethylene products in the urine. The continuing presence of acute symptoms consistent with trichloroethylene toxicity is also indicative of continuing residual exposure to TCE.

Recent improvements in plant ventilation and work practices have significantly reduced these exposures. However, further steps will need to be taken to reduce short-term peak exposures to within acceptable limits.

The most significant source of exposure appears to be in the workplace as opposed to other sources, e.g., drinking water. At the time of the May survey, there was no significant liver or kidney disease detected by laboratory evaluation and medical questionnaire.

VIII. RECOMMENDATIONS

Recommendations 1-10 were presented to Superior Tube Company in Interim Report #2 (April 25, 1980). They will be repeated for reference along with several additional recommendations.

1. The size and/or position of the viewing window in relationship to distance from control panel does not permit worker to see the far end of the tank (Degreaser #1291), consequently resulting in acute exposure to trichloroethylene.
2. Uncertainty existed as to whether side-way shift of the cross-way transfer was properly aligned in degreaser #1291. Improper alignment may cause the flange of the perforated tray to catch when being raised. This has resulted in the cable breaking and the tray falling into Degreaser #1291 (about 2 years ago).
3. Discontinue the practice of smoking while operating Degreaser #1291.
4. On several occasions, loads of pipes were transferred by crane over the heads of employees and NIOSH personnel. It is strongly recommended that this practice be discontinued.

5. The use of eye protection should be enforced by management in areas where signs requiring eye protection are posted.
6. A review article by Skinner⁹ points out that an important source of air contaminant exposure at many degreasing operations may be "drag-out" of solvent vapor when material being degreased is removed from the tank. It is readily apparent from observation that drag-out is occurring at Degreaser #1291. The effect of drag-out is determined primarily by the speed at which an item is removed from the solvent bath, the area of the item being moved, and its wetted surface area. Consideration should be given to the above factors in designing a revised work practice program.
7. Pursuant to the OSHA Occupational Health Standard 29 CFR 1910.94, any vapor degreasing tank equipped with a condenser, as at Degreaser #1291, must keep the level of vapors below the top edge of the tank by a distance equal to one-half the tank width or 36 inches, whichever is shorter. It should be determined if Degreaser #1291 is in compliance.
8. Until further environmental controls are implemented or existing ones improved, a conscientious respirator program should be initiated and enforced by management with support from the union. OSHA, through 29 CFR Part 1910.134, established the requirement for conducting a formal respiratory protection program for control of occupational diseases caused by breathing air which contains certain contaminants. A NIOSH document, "A Guide to Industrial Respiratory Protection," will serve as a reference source with information for establishing and maintaining a respirator program which meets the requirements of 29 CFR Part 1910.134.
9. Certain respirators have been approved by NIOSH to provide sufficient protection at the concentrations of trichloroethylene measured. Based upon the concentrations of trichloroethylene measured at the breathing-zone of the degreaser operator (#1291), a chemical cartridge respirator with organic vapor cartridge(s) or a Type C demand type supplied-air respirator with half-mask facepiece is applicable.
10. Respirators should be issued with caution. There may be individuals in this group for whom wearing a respirator carries certain specific dangers, i.e., highly increased resistance to airflow in a person with compromised pulmonary function may be associated with acute respiratory insufficiency. Therefore, pulmonary function testing should be carried out prior to requiring any person to wear a respirator.
11. Engineering controls and methods should be evaluated and re-designed to further reduce worker exposures to trichloroethylene. The effectiveness of these procedures is probably best evaluated by quantitative urine testing for trichloroethylene metabolites.

12. Workers should be educated about the possible potentiating effects between alcohol and trichloroethylene. Workers who have been exposed at work to TCE may become excessively intoxicated on just a small amount of alcohol or, more importantly, they may have impairment of their driving ability and machine operation abilities even without noticeable intoxication.

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Evaluation Conducted and
Report Prepared By:

Raymond L. Ruhe
Industrial Hygienist
Industrial Hygiene Section

Arthur Watanabe, Pharm. D.
Medical Officer
Medical Section

Gary Stein, M.D.
Chronic Disease Division
CDC, Atlanta, Georgia

Environmental Evaluation:

John R. Kominsky
Industrial Hygienist
Industrial Hygiene Section

Originating Office:

Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations, and Field Studies
Cincinnati, Ohio

Report Typed By:

Cheryl Maskulka
Temporary Clerk-Typist
Industrial Hygiene Section

XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

Copies of this report have been sent to:

1. Richard S. Schweiker, Washington, D.C.
2. Superior Tube Company, Collegeville, Pennsylvania
3. Authorized Representative of Employees' Local 6816, United Steel Workers of America
4. NIOSH, Region III
5. OSHA, Region III

For the purposes of informing the 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.

TABLE I

Results of Breathing Zone Samples for Trichloroethylene at Degreaser #1291

Superior Tube Company
Collegeville, Pennsylvania
HE 80-49

February 6-7 and May 15-16, 1980

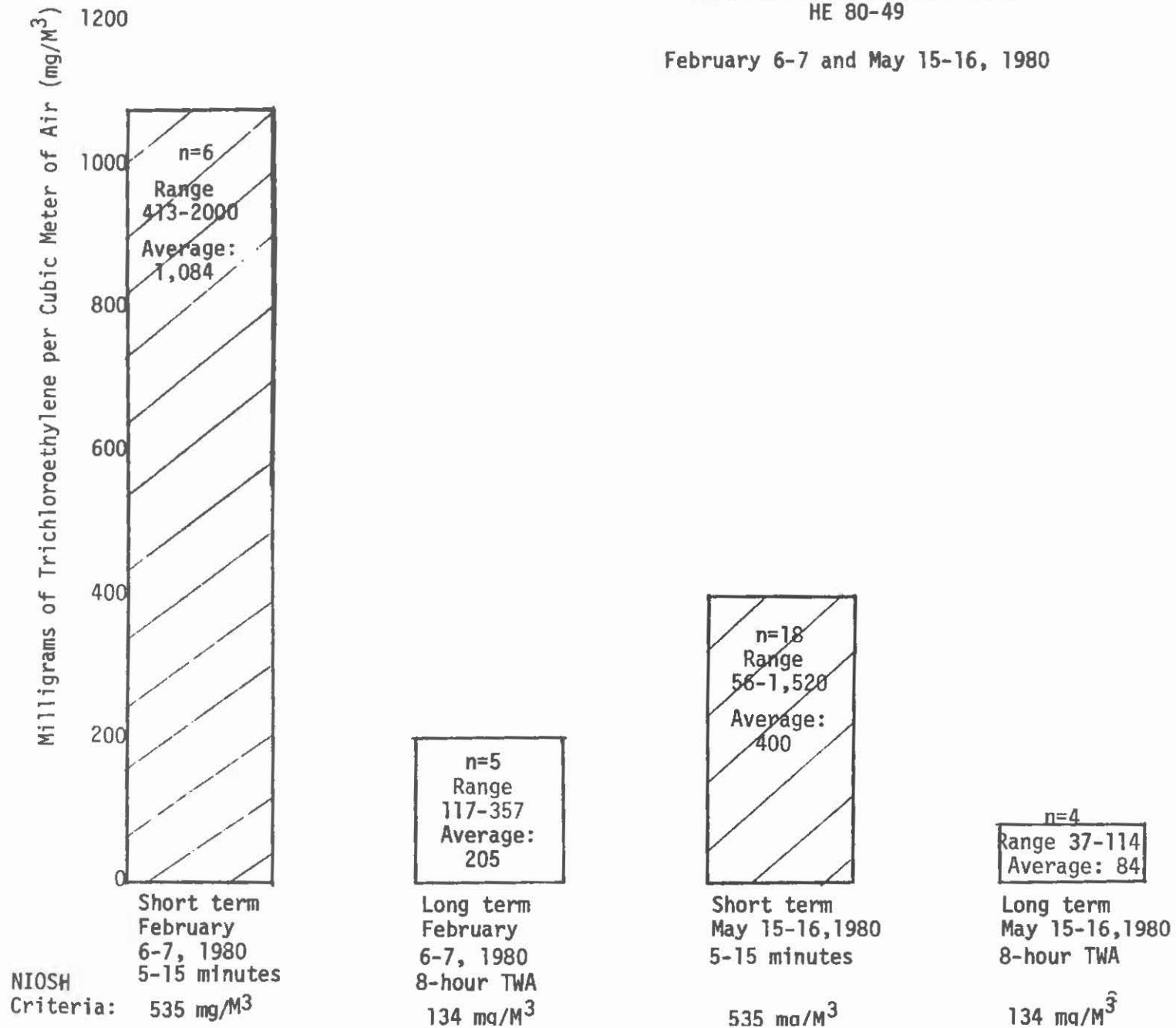


TABLE II

Results of Breathing-Zone and Area Samples
for Trichloroethylene, Methylene Chloride and Acetone

Superior Tube Company
Collegeville, Pennsylvania
HE 80-49

February 6, 1980

<u>Job and/or Location</u>	<u>Sampling Period</u>	<u>Sample Volume (Liters)</u>	<u>Type of Sample</u>	<u>Trichloro- ethylene (mg/M³)*</u>	<u>Methylene Chloride (mg/M³)</u>	<u>Acetone (mg/M³)</u>
Crane Operator: Degreaser #1369	0804-1429	21.1	BZ**	100	ND****	ND
Flush & Blow Operator #1960	0815-1441	20.8	BZ	125	52	2
Flush & Blow Operator #1603	0818-1450	19.1	BZ	ND	141	1
Small Tube Parts: Degreaser #1498	0824-1435	18.4	BZ	108	ND	ND
Crane Operator: Detreaser #1369	1612-2319	23.2	BZ	35	ND	ND
Flush & Blow Operator #1603	1613-2335	19.5	BZ	ND	59	1
Operator Bench: Degreaser #1369	1626-2355	93.1	GA***	32	ND	ND
NIOSH Criteria (8-hour TWA):				134	261	2400
OSHA Criteria (8-hour TWA):				535	1700	2400

* mg/M³ = Milligrams of substance per cubic meter of air.

** BZ = Breathing-Zone Sample

*** GA = General Area Sample

**** ND = None Detected

Trichloroethylene - Limit of Detection 0.01 mg/Sample

Methylene Chloride - Limit of Detection 0.01 mg/Sample

Acetone - Limit of Detection 0.01 mg/Sample

TABLE III
STUDY GROUP CHARACTERISTICS

SUPERIOR TUBE COMPANY
COLLEGEVILLE, PENNSYLVANIA
HHE 80-49

FEBRUARY AND MAY 1980

FEBRUARY, 1980

	<u>Male</u>	<u>Female</u>	<u>Mean Age(S.D.)</u>	<u>Mean Job Duration(S.D.)</u>
Workers	7	2	42.7 (15.7)	4.42 (3.93)
Controls	7	2	46.4 (15.7)	9.7 (12.6)

MAY 1980

	<u>Male</u>	<u>Female</u>	<u>Mean Age(S.D.)</u>	<u>Mean Job Duration(S.D.)</u>
Workers	9	2	42.4 (16.5)	6.5 (6.9)
Controls	9	0	44.1 (15.3)	9.9 (8.3)

S.D. = Standard Deviation

TABLE IV

Acute Symptom Prevalence in Workers and Controls

Superior Tube Company
 Collegeville, Pennsylvania
 HE 80-49

February and May 1980

<u>Symptoms</u>	<u>February</u>		<u>May</u>	
	<u>Worker (9)</u>	<u>Control (9)</u>	<u>Worker (9)</u>	<u>Control (9)</u>
Fatigue	7	----	4	----
Light Headedness	4	----	1	----
Sleepiness	4	----	6	----
Eye Irritation	4	----	3	----
Cough	1	----	2	----
Shortness of Breath	4	----	1	----
Dyspnea on Exertion	3	----	----	----
Skin Irritation	2	----	1	----
Palpitations	----	----	1	1
Nausea	3	----	2	----
Headache	1	----	----	----
% Reporting Symptoms:	77.8%	0.0%	63.6%	22.2%

TABLE V

Average Number of Symptoms Per Worker Exposed to Trichloroethylene

Superior Tube Company
Collegeville, Pennsylvania
HE 80-49

February 6-7 and May 15-16, 1980

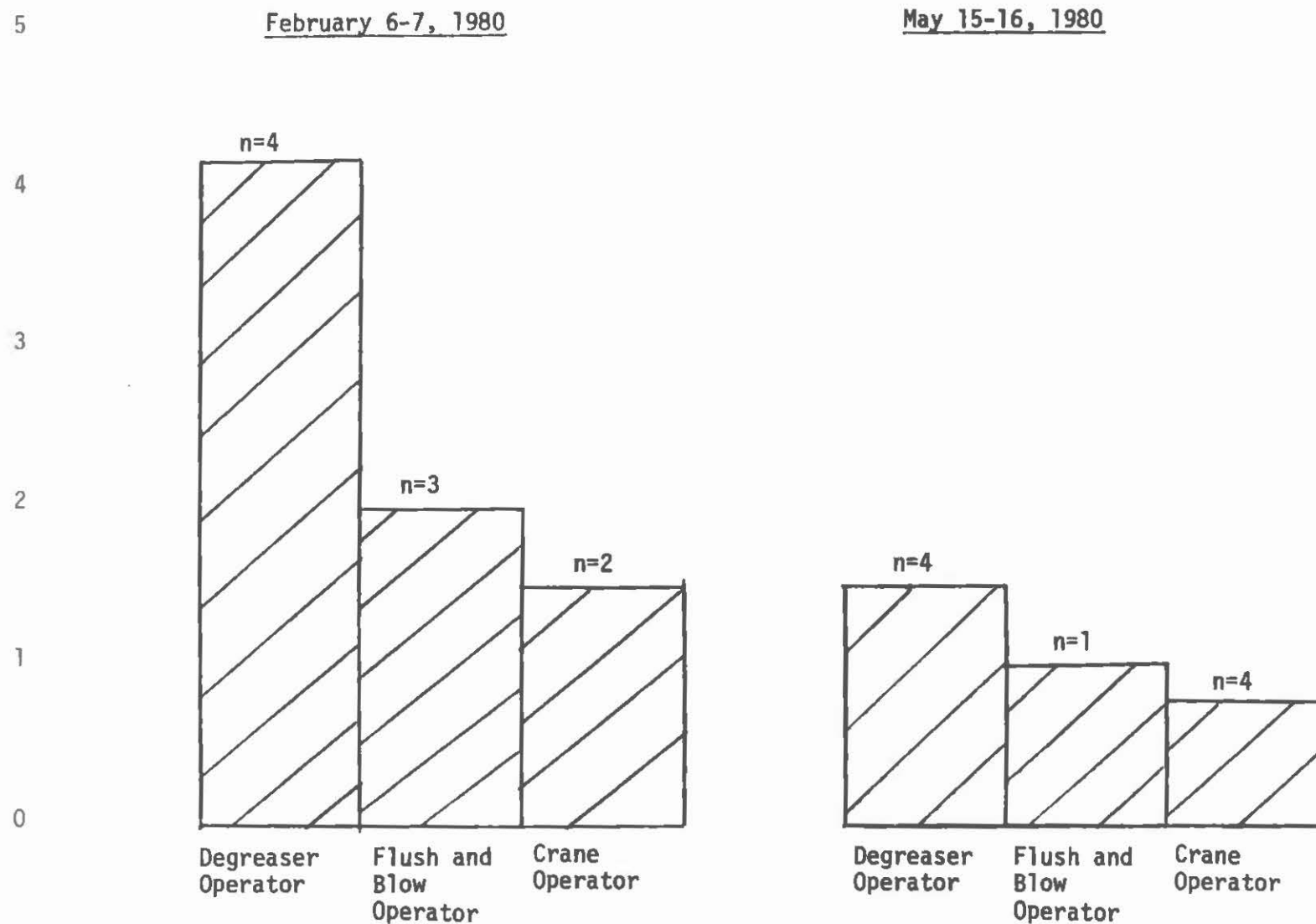


TABLE VI

Urinary Excretion of Trichloroethylene Metabolites

Superior Tube Company
Collegeville, Pennsylvania
HE 80-49

February 6-7 and May 15-16, 1980

