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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 73 - 78 -0060

OWENS-CORNING FIBERGLASS CORPORATION
HUNTINGDON, PENNSYLVANIA
AUGUST, 1973

I. TOXICITY DETERMINATION

It has been determined that organic vapors (styrene, methylene chloride, toluene, and acetone) and methylene bisphenyl isocyanate (MDI) are not toxic at the concentrations measured within the Non-Corrosive Tank Manufacturing Department during near normal operating conditions. This determination is based upon extensive environmental sampling coupled with medical testing. In general, environmental levels were below occupational health standards. A few short term work operations were found to produce variable exposures which did, on occasion, exceed standard levels. During the three primary days of evaluation in the month of May, 1973, no significant symptoms were found in employees or changes in pulmonary function tests detected.

There is substantial evidence that past conditions within the plant were of such nature to produce toxic effects in employees. This inference is based upon past histories of symptoms from workers consistent with overexposure to the above contaminants, immunologic findings indicative of exposure to MDI and a knowledge of past plant ventilation provisions.

It is believed that the new ventilation system, coupled with respiratory protection programs and medical monitoring programs either presently in effect or planned, will insure safe and healthful working conditions. It must be emphasized that increases in production, poor maintenance of ventilation systems, or relaxation of the respirator program could result in adverse conditions for employees. It is of particular importance that foam machine operators wear approved respirators during foaming. All employees entering confined spaces where organic vapors are likely to reach elevated levels should wear approved respirators and observe safety precautions to include, fire prevention and a "buddy" rescue system.

Based primarily on medical evidence and clinical findings, it was recommended that four employees cease to work in areas where they may come in contact with MDI.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard evaluation Services Branch, NIOSH, U.S. Post Office Building,

Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) Owens-Corning Fiberglass Corporation
   Huntingdon, Pennsylvania
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region III
d) NIOSH - Region III

For the purposes of informing the approximately 115 "affected employees" the employer will promptly "post" the Determination Report in a prominent place(s) near where affected employees work for a period of 30 calendar days.

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 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees regarding exposure to toxic substances in use in the Non-Corrosive Tank Manufacturing Department of the Owens-Corning Fiberglass Corporation Plant in Huntingdon, Pennsylvania. The request was precipitated by a jobsite fatality which caused other workers to seriously question their own occupational safety and health.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

The Non-Corrosive Tank Manufacturing Department is engaged in the construction of large reinforced plastic tanks used primarily by the oil and chemical industries. The tanks are constructed from fiberglass filaments and styrene resin. Tanks vary in size but can reach the approximate dimensions of 12 feet in diameter by well over 20 feet in length.

Tank bodies and endcaps are "layed up" by mechanical spray application of chopped fiberglass and resin to tank forms. Fittings and accessory structures are layed up by hand, using fiberglass matting and roller application of resin. A small percentage of tanks for the chemical industry are coated with a sprayed on layer of rigid polyurethane foam and covered with a protective layer of layed up fiberglass and resin.

The approximately 115 employees working in this department are exposed to a variety of substances in combination. Principal agents are styrene, methylene bisphenyl isocyanate (MDI), methylene chloride, toluene, and acetone.

B. Study Design

Due to the large number of employees and variety of exposures to assorted air contaminants in this study, it was necessary to evaluate exposures in successive stages using a sample population of employees to represent all employees in the Non-Corrosive Tank Manufacturing Department.

Following the preliminary observational survey (April 23-25, 1973) which facilitated recognition of the most probable health hazards, a preliminary medical evaluation of employees was made on May 3-4, 1973. Self-administered body systems review questionnaires were completed by approximately 90 tank department employees. The orientation of the questionnaire and the subsequent interview with a NIOSH physician placed emphasis on occupationally related health problems. In addition, a sample of blood was obtained from participating employees for later use in a laboratory immunologic evaluation of exposures to MDI.

A group of 29 exposed employees was selected for study. Twelve worked in areas of highest expected exposure to MDI and the remaining employees worked in areas of lowest expected exposure to MDI. Once the exposed study group was determined, a group of 8 non-exposed controls matched by age distribution, sex composition, and smoking history to the exposed group was selected from other departments in the plant.

On Monday, May 5, 1973, the 37 study population employees were given pre- and post-shift pulmonary function tests and the exposed employees were monitored using personal air sampling equipment to measure exposure to organic vapors. A more complete medical and work history was obtained from each employee and recorded. At the conclusion of the shift, symptoms reported by employees were recorded. No MDI was used in the plant on May 5, 1973.

On Monday, May 14, 1973, employee exposures to MDI were characterized using both personal and area air sampling techniques. During this characterization, employees operating the MDI polyurethane foam equipment wore air supplied hoods and other employees and observers remained at a distance of approximately 50 feet from the foaming operation during foam application.

On Thursday, May 17, 1973, the 37 study population employees were given pre- and post-shift pulmonary function tests and the exposed employees were monitored using personal air sampling equipment to measure exposure to MDI and organic vapors. Only the foam machine operator in the Mandrel area wore a cartridge respirator during mandrel foaming operations. Foam machine operators in other areas of the department did not wear respirators when foaming. At the conclusion of the shift, symptoms reported by employees were recorded. No foaming was conducted in the plant on either May 15 or 16, 1973.

C. Evaluation Methods

1. Organic Vapor Air Sampling

Employee exposures to organic vapors were measured via personal air sampling equipment. Breathing zone air were obtained using charcoal air sampling tubes. Charcoal tubes were returned to Cincinnati and analyzed by the gas chromatographic method reported by White et al.[1]

2. Methylene Bisphenyl Isocyanate (MDI) Air Sampling

Employee exposures to MDI were measured via personal air sampling equipment. Both work area and breathing zone samples were obtained using midget impingers. Reagents and analytical procedures followed the "modified" Marcali method as reported by Grim and Linch.[2] Samples were analyzed within hours after collection by a NIOSH chemist in the field at the plant.

3. Pulmonary Function Testing

Each pulmonary function test required the employee to make two forced expiratory volume practice maneuvers after which three forced expiratory volume maneuvers (reproducible within 5%) were recorded as flow volume loops. A waterless, high fidelity spirometer equipped with an air temperature probe was used. The flow volume loops were displayed on a storage oscilloscope and recorded on magnetic tape. Computer analysis of flow volume loops provided the following parameters corrected to body temperature and pressure standard (BTPS): forced expiratory volume in one second (FEV_1), and forced vital capacity (FVC).

4. Immunologic Assay - Serum Antibody Tests

Each employee serum sample was subjected to a battery of six immunologic test procedures.[3,4] These tests included those specifically designed to detect various types of antibodies resulting from specific isocyanate antigens.

D. Evaluation Criteria

The occupational health standards promulgated by the U.S. Department of Labor (Federal Register, October 18, 1972, Title 29, Chapter XVII, Subpart G, Tables G-1 and G-2) applicable to the individual substances of this evaluation are presented in the table to follow.

Occupational health standards for individual substances are established at levels designed to protect workers occupationally exposed on an 8-hour per day, 40-hour per week basis over a working lifetime. Evaluation of exposures to multiple contaminants requires assessment of "total exposures" with regard to combined, potentiated, or inhibited toxic effects.

Substance	8-hour time weighted average	Acceptable ceiling concentration	Acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift.	
			Concentration	Maximum Duration
Styrene	100 ppm*	200 ppm	600 ppm	5 min. in any 3 hrs.
Methylene bis-phenyl iso-cyanate (MDI)	0.02 ppm C**	-------	-------	---------
Methylene chloride	500 ppm	1000 ppm	2000 ppm	5 min. in any 2 hrs.
Toluene	200 ppm	300 ppm	500 ppm	10 minutes
Acetone	1000 ppm	-------	-------	----------

*ppm - Parts of vapor or gas per million parts of contaminated air by volume.
**C - Ceiling Value: Employee exposures are not to exceed this level.

E. Evaluation Results

1. Organic Vapor Air Sampling

May 7, 1973: Breathing zone air concentrations of organic vapors (styrene, methylene chloride, toluene, and acetone) were measured by monitoring 18 employees with personal air sampling equipment. The average time sampled for each employee was approximately 6.5 hours. A total of 71 air samples were collected. Only a few parts per million of methylene chloride, toluene and acetone were found. Styrene concentrations of 10 to 86 ppm were found in 18 of the samples. One sample from the Gas Assembly area showed a styrene concentration of 210 ppm averaged over a 65 minute period, however, the employee being sampled was wearing a cartridge respirator at the time of this exposure. Thus, in general, employee exposures were within established acceptable limits.

May 17, 1973: Organic vapor air concentrations were monitored as on May 7, 1973. Thirteen employees were monitored with an average time sampled of approximately 7.1 hours. A total of 53 air samples were collected. Again only a few parts per million of methylene chloride, toluene and acetone were found. Styrene concentrations of 10 to 35 ppm were found in 13 of the samples. Two air samples collected in the Chemical Assembly area showed styrene concentrations of 130 ppm for periods of 110 and 18 minutes. Again, average employee exposures were within acceptable limits.

2. Methylene Bisphenyl Isocyanate (MDI) Air Sampling

May 14, 1973: To characterize exposures to MDI, 38 work area samples and 4 personal breathing zone samples were collected. MDI concentrations

have been adjusted to reflect MDI concentrations during foam application.

In the Mandrel area one breathing zone sample showed the foam operator's exposure during foaming to be approximately 0.012 ppm for a period of 30 minutes. Sixteen area samples placed on the foam carriage and at distances of up to 60 feet from the carriage ranged from 0 to 0.026 ppm during foam application. Highest concentrations were found within 3 feet of the mandrel being foamed. Concentrations were found to fall off very rapidly beyond 6 feet from the applied foam. Two samples collected during the 20 minutes directly following the foam application showed concentrations of 0.003 ppm at a location less than 3 feet from the foamed mandrel.

Thirteen samples collected in the Endcap area showed a high of 0.004 ppm during and directly following the 7 minute foaming operation. Analytical difficulties prevented accurate assessment of exposures in this area. These difficulties stemmed from collection of insufficient sample due to the brevity of the endcap foaming operation and from inconsistent color development during sample analysis.

One sample collected in the Chemical Assembly area showed the foam operator's exposure to be approximately 0.025 ppm during the 8 minute foaming operation, while 3 samples collected within 3 feet of the foamed seam ranged from 0 to over 1.0 ppm. Concentrations within 15 feet of the foamed seam were measured to be approximately 0.013 ppm during foam application. Two samples collected during the first 30 minutes after foaming showed only traces of residual MDI.

From this day's sampling it was concluded that only foam operators and their immediate helpers can be occasionally exposed to potentially toxic levels of MDI, and that elevated MDI levels are present in close proximity to foaming guns.

May 17, 1973: Employee exposures to MDI were measured through the collection of 18 breathing zone samples from 12 employees working in the Mandrel, Chemical Assembly, and Endcap areas. In addition, a total of 18 area samples were collected in the three work areas. All MDI concentrations have been adjusted to reflect concentrations during foam application.

Breathing zone concentrations ranged from 0 to 0.011 ppm during foaming. Highest concentrations were found in samples from foam operators. Other individuals showed average exposures of less than 0.005 ppm.

Thirteen area samples showed MDI concentrations within 3 feet of foaming operations to range from 0.003 to 0.025 ppm with 7 samples showing in excess of 0.015 ppm. Area samples collected more than 3 feet from foaming operations ranged in concentration from 0 to 0.015 ppm with only two samples above 0.003 ppm.

This day's sampling showed all employee exposures to be within acceptable limits.

3. Pulmonary Function Testing

Pulmonary function tests were carried out on 29 exposed workmen and on 8 salaried personnel who served as controls. One individual was noted to have an abnormal FEV_1 test, which was less than 75% of his predicted value. Three workmen including the man with the low FEV_1 had abnormally low FEV_1/FVC ratios.[5] An abnormal ratio is usually considered as evidence for early obstructive lung disease which may be due to numerous causes including smoking. All men with this abnormality were noted to be smokers. Each individual with abnormal pulmonary function test results has been privately contacted.

No evidence of a significant decrement in ventilatory capacity over the course of one shifts exposure was found in subjects who were exposed to maximal concentrations of isocyanate when compared with non-exposed controls on a day when foaming was carried out in the usual manner. In addition, no evidence of a significant decrement in ventilatory capacity was noted in subjects exposed to other work place substances, excluding isocyanate, when compared with non-exposed controls on a day when operations except foaming were performed as usual.

4. Immunologic Assay - Serum Antibody Tests

Ninety men had blood drawn for immunologic testing. Three tests (P-K, PCA, and Agglutination) were carried out with a specially prepared isocyanate antigen. The same three test procedures were also carried out with a mixed pollen antigen designed to detect persons with atopic diathesis (i.e. a constitutional predisposition to hay fever, asthma, etc.). Twelve persons had reactive P-K tests with isocyanate antigen and, of these, ten also had reactive PCA tests. The former test indicates the capacity to react to isocyanate in an immediate manner producing symptoms of asthma, hay fever, laryngospasm, etc. Reactivity in the PCA test indicates immunity which in many cases is probably of sufficient degree to produce a protective buffering effect mitigating the adverse effects of an immediate type reaction. Either isolated P-K reactions or the combination P-K and PCA reaction can be significant. Correlation with the clinical histories and the tests for general allergy strongly suggest that two individuals are reacting in an adverse manner to isocyanate exposure and that such exposure should be terminated. Seven individuals apparently are well "hardened" to MDI and are no longer reacting adversely to it. Of the remaining three men, two need pulmonary function tests to more fully evaluate their situations, and one already has been found to have somewhat compromised pulmonary function strongly suggesting that further isocyanate exposure is ill advised.

Only one man was noted to have positive agglutination to isocyanate antigen, a reaction sometimes associated with delayed type allergy. The most common clinical problem associated with this form of allergy is contact dermatitis. This man, however, is asymptomatic and is in no apparent danger from sudden, acute type reactions.

Thirty-nine men had isolated PCA reactions which are interpreted as immune responses to isocyanate. These individuals are apparently "hardened" and can tolerate further exposure without developing problems.

Thirty-eight men exhibited no reaction to isocyanate antigen in any of the three test systems. The most likely explanation is that their exposures have not been of sufficient duration or degree to induce an immune response. Thus, they are unlikely to have experienced symptoms on this basis to date. It is entirely possible that some men in this group may develop an immunologic response resulting in clinical symptoms at some future date given sufficient exposure.

In summary, past exposure has been sufficient to result in antibody formation in 52 of the 90 individuals whose sera were examined. Of these, the large majority have developed an immune or "hardened" status. A few individuals have developed an abnormal antibody pattern of the type associated frequently with clinical illness. Of these individuals several gave a history of symptoms or have abnormal pulmonary function test results indicating that further isocyanate exposure must be terminated. Each such individual was privately contacted and his situation explained to him by a NIOSH physician on July 31 - August 2, 1973. Where applicable additional pulmonary function tests were performed and blood samples were obtained. Those employees with significant blood test results will be contacted privately when results become available.

5. Other Medical Tests

Because of suspicious clinical histories or symptoms, six men had electrocardiograms taken and one man a chest x-ray. All of these examinations were within normal limits.

V. REFERENCES

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2. Grim, K.E. and A.L. Linch. Recent Isocyanate-in-Air Analysis Studies. Am. Ind. Hyg. Assoc. J., Vol. 25, May-June, 1964.

3. Scheel, L.D., R. Killens, and A. Josephson. Immuno-chemical Aspects of Toluene Diisocyanate (TDI) Toxicity. Am. Ind. Hyg. Assoc. J., Vol. 25, (179) 1964.

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5. European Coal and Steel Community Reference Tables for Spirometric Examinations, 1967.

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