WALK-THROUGH SURVEY OF

HITCO
Gardena, California

Survey Date:

July 19, 1973

Survey Conducted and Report Written By:

John M. Dement
Philip J. Bierbaum

Report Date:

August 30, 1973

Environmental Investigations Branch
Division of Field Studies and Clinical Investigations
National Institute for Occupational Safety and Health
Cincinnati, Ohio

PLACE VISITED:	HITCO 1600 West 135th Street Gardena, California
DATE OF VISIT:	July 19, 1973
PERSONS MAKING VISIT:	Philip J. Bierbaum John M. Dement
PERSONS CONTACTED:	Mr. J. Himmelheber, Manager of Security and Safety Mr. Marvin Bowman, Vice President Operations, Defense Products Division Mr. Jack Conners, Operations Manager, Materials Division Mr. Mike McCorkle, Safety Engineer
PURPOSE OF VISIT:	To observe the manufacture of aircraft insulation using small diameter fibrous glass and to take preliminary air samples.

INTRODUCTION AND DESCRIPTION OF THE FACILITY

The Division of Field Studies and Clinical Investigations of the National Institute for Occupational Safety and Health has underway an "industrywide" study of the fibrous glass industry. Of particular interest in this study are small diameter, potentially respirable fibers.

On July 19, 1973, Philip Bierbaum and John Dement conducted a walk-through survey of the HITCO facility in Gardena, California. Although the small diameter fibrous glass operations were of major interest during this survey, a tour was made of the entire facility.

The major products of this facility are silica, carbon and graphite fibers, ablative structures (nose cones, aircraft radar dome covers /radomes/ and rocket nozzles), aircraft interior systems and structures, aircraft structural insulation and high temperature insulation products. Operations in this facility are classified into two divisions known as the Materials and Defense Products Divisions.

HITCO began operations in the late 1940's on Aviation Boulevard in Inglewood, California, as H. I. Thompson Fiberglas. They moved into the Gardena facility in 1961, purchasing this site from Zenith Plastics, a division of the 3M Company. HITCO became a mini-conglomerate in the late 1960's, and itself was acquired by Armco Steel in 1969.

The present plant site at 1600 West 135th Street occupies approximately 33 acres and is comprised of numerous one-story buildings. The total work force of this facility is approximately 750 persons with about 50 percent being salaried employees. This facility operates on a three-shift basis (although the workforce on the second and third shifts is very small) five days per week. The union in this plant is Local 19 of the Glass Bottle Blowers Association.

MEDICAL, INDUSTRIAL HYGIENE, AND SAFETY PROGRAMS

Limited inplant medical facilities equipped mainly for first-aid and emergency treatment are included at this plant site. A nurse is on duty at the facility during the day shift and security guards are trained in first aid.

Each employee is given a pre-employment physical examination; however, no chest x-ray or pulmonary function tests are included. No periodic examinations are given with the exception of product inspectors who are given regular eye examinations.

This facility presently employs Mr. Mike McCorkle as a Safety Engineer. Mr. McCorkle conducts air sampling and takes noise measurements in this facility as well as other HITCO facilities. Air sampling includes samples for dusts and solvents. Mr. McCorkle reports to the Plant Engineering Manager.

Safety matters in this facility are the responsibility of Mr. J. Himmelheber. The Armco APF Program was started approximately one year ago. All supervisors are given a 45-hour safety training program which includes such topics as accident prevention, analysis of individual tasks for safety hazards and personal protection. In addition, each employee undergoes a training program for his specific job. Supervisors are required to regularly observe employee work practices and monthly safety inspections are made. Investigations of accidents include detailed descriptions as to the cause of the accident. Safety meetings are held on a monthly basis.

Personal protection programs presently in force at this plant include hearing protection and safety glasses in specified areas. Safety shoes are not required; however, the company has a program to aid in their purchase. Respiratory protection is provided for such operations as sawing and other operations involving asbestos (only small quantities of asbestos, which is received in a wet state, are used in this facility).

DESCRIPTION OF THE PROCESSES

Materials Division

The major products of the Materials Division are silica, carbon and graphite fibers. These products may be either woven or unwoven and are sold in many forms such as bulk fibers, yarn, felt, tape and cloth.

Silica fibers and silica fiber products are made in this facility by leaching fibrous glass. In this process, the glass material to be leached (bulk fiber, cloth, tape, etc.) is placed in bags and put into an acid leach tank for a prescribed period of time. The leaching process removes almost all impurities leaving a high silica product. Glass fibers ranging in diameter from approximately 0.75 to 6.5μm are leached.

Following the leaching operation, most of the silica products are washed and fired to temperatures of approximately 2000°F. This firing revitrifies and further purifies the product in addition to enhancing its shrink resistant properties.

Carbon and graphite fiber products are made in this facility by the controlled thermal degradation of synthetic organic fibers, yarns, or textiles, depending upon the desired product form. Rayon fibers are the principal fibers used.

Carbon fibers and products are made at moderate temperatures of approximately 1500°F. In this process, the rayon to be carbonized is fed into a furnace, where thermal decomposition takes place, at a prescribed rate. The product from the furnace is washed, dried, inspected, checked for quality and packaged for shipment or further processing in the Defense Products Division.

Graphite fibers and products are made by essentially the same process as carbon fibers except at much higher temperatures. The fibers are graphitized at temperatures of approximately 5000°F. Some graphite fibers for special applications are processed in a furnace in an inert atmosphere.

In addition to the regular washing operations for both carbon and graphite fibers, some products are cleaned with perchloroethylene.

Defense Products Division

The major products of the Defense Products Division are ablative structures (nose cones, aircraft radar dome covers, and rocket nozzles), aircraft interior systems and structures and aircraft and high temperature insulation products. The day-to-day operations in this Division are primarily "job oriented" as opposed to "product oriented."

Ablative structures are made by many forming methods using a variety of materials. Nose cones and radomes are made by either a hand lay-up method or a press method (matched metal dies). Glass, carbons and silica fibers (leached glass) and cloth are used. The major resins used for these structures are phenolics and epoxys.

Rocket nozzles of various sizes and geometry are formed by a "tape-wrapping" process. Phenolic resin impregnated asbestos and graphite fibers are married together to form the nozzle inlets and outlets. Solid graphite is used to form the nozzle throat. The nozzles are brought to final dimensions using large turning lathes.

Aircraft interior systems and structures are made in this facility starting with a laminating operation to form light-weight panels. A honey comb structure (approximately 1/2" thick) is placed between two sections of glass cloth impregnated with polyester resin to form the panel. The interior side of the panel is next covered with a plastic covering with the desired color and pattern.

Interior structures are fabricated from the laminated sheets mentioned above. This is essentially a process involving hand work. The laminated sheets are cut to shape, drilled, routed, sanded and fabricated according to customer specifications.

Both aircraft and high temperature insulation are made using glass and silica fibers. This involves cutting the fiber bats to shape, pressing and coating with appropriate materials (rubber coating, etc.). Product size and shape are dependent upon customer specifications and operations may vary considerably from day-to-day.

INSPECTION OF THE FACILITY

Potential Health Hazards

The following are potential health hazards which were noted during this visit:

1. Respiratory exposure to small diameter fibrous glass fibers.

2. Respiratory exposure to asbestos fibers in the ablative composite structure fabrication operations.

3. Skin and respiratory exposure to polyester, epoxy and phenolic resins (and their associated catalysts and modifiers) in the Defense Products operations.

4. Skin and respiratory exposure to various solvents (toluene, methyl ethyl ketone and acetone) in the Defense Products operations.

5. High noise exposures in various plant operations.

Ventilation

In the Materials Division, all treatment furnaces are vented. The high temperature graphitization furnace is equipped with an afterburner. The perchlorethylene treatment tank also is vented.

In the Defense Products Division, lathes used for shaping the various ablative structures are provided with ventilation. In the fabric cutting area, local exhaust ventilation is provided at the cutting tools and vented to an inplant bag collector.

SURVEY PROCEDURES

The major portion of this visit was devoted to observing the plant operations; however, four personal air samples were collected for analysis by fiber count. Three of these samples were taken in the fibrous glass insulation fabrication area and one sample was taken in a fibrous glass reinforced plastic finishing area (routing and drilling). All samples were collected on Millipore Type AA, 37mm diameter membrane filters at a sampling rate of 2.0 lpm. The sample periods ranged from 40 to 46 minutes in duration.

Analysis of the collected samples for fiber concentrations was done by an optical count method similar to that used for asbestos[1]. Due to the presence of very small diameter fibers, these counts were done using oil immersion phase contrast microscopy at 1000X magnification. A Zeiss positive phase contrast binocular microscope equipped with a 100X acromat oil immersion objective (NA = 1.30), 10X Huygenian eyepieces, and a Zernike type condenser (NA = 0.90) was used for all fiber counts. Fiber size distributions were determined for each sample by comparison with a calibrated "Porton" eyepiece reticle. Fiber concentrations are reported as fibers/ml.

RESULTS AND DISCUSSION

Results of the air samples for fiber count and fiber size distribution are shown in Tables 1 through 4. The highest concentration obtained was 24.4 fibers/ml for a worker laminating glass insulating bats to form thicker bats. The next highest concentration of 14.8 fibers/ml was observed for the "band saw operator and oven tender". A concentration 3.2 fibers/ml was observed for a fibrous glass press operator and a concentration of 2.1 fibers/ml was observed for a worker routing and drilling fibrous glass reinforced plastic laminates.

In considering potential health effects of glass fiber exposure, consideration must be given to fiber respirability (i.e., those fibers which penetrate deeply into lungs). Although the respirability of airborne fibers is not clearly understood, this characteristic is thought to be chiefly diameter dependent and fibers greater than 10μm in diameter certainly have little chance of deep pulmonary penetration. Timbrell's[2] work suggests that the two major mechanisms of fiber deposition in the upper airways (settlement under gravity and inertial deposition) are chiefly dependent upon particle free falling speed and fibers with densities less than 3.5 g/cm^3 and less than 3.5μm in diameter may escape deposition by these two mechanisms and penetrate deeply into the lungs. Timbrell's work further suggests that the limitation on the lengths of fibers which reach the deep pulmonary air spaces is imposed by the nasal hairs and small diameters of the respiratory bronchioles. Timbrell and Skidmore[3] in a more recent inhalation experiment with rats using fibrous glass 0.75-1.5μm in diameter and lengths up to 100μm, found a few fibers as long as 50μm in length in the lungs of rats sacrificed during exposure, although the bulk of all found were less than 20μm in length.

Another study conducted by Gross et al.[4] concerned itself with fiber size distribution in the lungs of previous fibrous glass workers. Postmortem examinations were made of lung sections of 20 fiber glass workers who had been exposed to fibrous glass dust between 16 and 32 years. In this study approximately 95 percent of all fibers observed were less than approximately 40μm in length. Occasionally, fibers 50 to 60μm in length were observed. However, it must be pointed out that these size distributions were made following the lung clearing process; therefore, no statement can be made regarding initial deposition of fibers.

In contrast to the above quoted articles, Murphy[5] reported a case of acute pulmonary involvement following a short fibrous glass exposure. A lower lobectomy was performed and careful pathological studies demonstrated the presence of glass fibers up to 14μm in diameter and 60μm in length in the terminal bronchioles. In addition, Balber[6] reports finding fibers 100 μm to 200μm in length in the alveolar regions of asbestos workers at autopsy.

As can be seen, considerable difference of opinion exists as to the true nature of a respirable fiber. For purposes of this discussion, based on the above cited studies, "potentially" respirable glass fibers shall be defined as those less than 3.5μm in diameter and less than 50μm in length. From Tables 2 through 4, it can be seen that 84 to 97 percent of the airborne fibers in the insulation operations satisfied this criteria of respirability. Although an insufficient number of fibers were observed for a complete size distribution for the sample in the reinforced plastics operations (Table 1), it was estimated at 50 percent of the airborne fibers satisfied the stated criteria for respirability.

There is presently no data available relating human experience with respirable glass fiber exposures of the magnitude found in these operations. All human experience to date has been with fibers of much larger size and at much lower concentrations[7,8,9,10] and studies of the health effects on these workers has produced essentially negative results. However, recent animal studies conducted by Stanton[11] and Friedrichs[12] have demonstrated that small diameter fibrous glass is carcinogenic when injected into the pleural cavity of rats.

CONCLUSIONS AND RECOMMENDATIONS

Based on observations made during this survey and results of the air samples, the following conclusions are drawn and recommendations for improvements made:

1. There appears to be significant exposures to respirable glass fibers in the insulation fabrication operations. While no data presently exist to indicate respiratory problems due to such exposures, it must be emphasized that human experience with such fibers is severely limited. It would appear prudent, at this time, that exposures to respirable glass fibers be kept to an absolute minimum by the use of engineering controls and appropriate work practices. This should include addition of local exhaust ventilation at the band saw in the insulation fabrication operations and the possible use of low volume high velocity[13,14] ventilation at the hand cutting tools in the reinforced plastics finishing operations. In addition, those persons handling bulk fibrous glass (such as those laminating bats together or placing fiber into bags for leaching) should be provided with respiratory protection unless they have existing health problems which prohibit this, in which case, they probably should be removed from this work environment.

2. In view of the glass fiber exposures observed during this survey and the present lack of knowledge as to potential health effects, close medical surveillance of those workers exposed to small diameter fibrous glass appears warranted. It is recommended that a medical surveillance program be initiated in this facility as outlined in the current asbestos standard (Federal Register, Volume 37, October 18, 1972, Section 1910.93a). This program includes both pre-employment and annual examinations consisting of a chest roentgenogram (14" x 17" posterior-anterior), a history to elicit symptomatology of respiratory disease, and pulmonary function tests (FVC and FEV_1).

REFERENCES

1. "Criteria for a Recommended Standard: Occupational Exposure to Asbestos", USDHEW, Public Health Service, National Institute for Occupational Safety and Health, 1972.

2. Timbrell, V., "The Inhalation of Fibrous Dusts". Annals of the New York Academy of Sciences, Volume 132, Art I, pp. 225-253, 1965.

3. Timbrell, V. and J. W. Skidmore, "The Effects of Shape on Particle Penetration and Retention in Animal Lungs". Proc. Third Int. Conf. Inhaled Particles and Vapors, pp. 49-57, Unwin Bros. London (1971).

4. Gross, P., Jiri Tuma and R.T.P. deTreville, "Lungs of Workers Exposed to Fiber Glass: A Study of Their Pathologic Changes and Their Dust Content". Arch. Env. Health, Vol. 23, pp. 67-71, July 1971.

5. Murphy, George B., "Fiber Glass Pneumoconiosis", Arch. Env. Health, Vol. 3, pp. 102-108, December 1961.

6. Balber, J. L., Discussion, Proc. Third International Conference Inhaled Particles and Vapors, p. 57, Unwin Bros., London (1971).

7. Wright, George B., "Airborne Fibrous Glass Particles: Chest Roentgenograms of Persons With Prolonged Exposure". Arch. Environ. Health, Vol. 16, February 1968.

8. Murphy George B., "Fiber Glass Pneumoconiosis", Arch. Env. Health, Vol. III, December 1961.

9. Nasr, A.N.M., T.M. Ditchek and P. A. Schottens, "The Prevalence of Radiographic Abnormalities in the Chests of Fiber Glass Workers", J. Occup. Med. 13:371-376, 1971.

10. Utidjian, H.M.D. and R.T.P. deTreville, "Fibrous Glass Manufacture and Health: Report of an Epidemiological Study: Part I and II". Read before the 35th annual meeting of the Industrial Health Foundation, Pittsburgh, Pennsylvania, 1970.

11. Stanton, M. F. and C. Wrench, "Mechanisms of Mesothelioma Induction with Asbestos and Fibrous Glass", J. Natl. Cancer Inst. 48:797-821, 1972.

12. Pott, F. and K. H. Friedrichs, "Tumors in Rats After Intraperitoneal Injection of Fibrous Dusts, Die Naturwissenschaften, 59:318, 1972.

13. Industrial Ventilation: A Manual of Recommended Practice, 12th Ed., ACGIH, 1972.

14. Cusumano, Guy F., High Velocity/Low Volume Dust Control, Published by Hoffman Air Systems Division of Clarkson Industries, Inc., 1973.

Table 1

FIBROUS GLASS SAMPLE DATA

HITCO
Gardena, California
July 19, 1973

Sample Number: 1

Sample Type: Personal

Operation: Trim Room, L10-11

Job or Sample Location: Plastics Router and Driller

Number of Fields Counted: 200

Average Fibers Per Field: 0.23

Air Volume, Liters: 80

Fiber Concentration, Fibers/Milliliter: 2.1

FIBER SIZE DISTRIBUTION: PERCENT OF FIBERS ≤ GIVEN DIAMETER AND LENGTH CATEGORIES

Fiber length

Fiber diameter	≤1.00μm	≤5.4μm	≤10.9μm	≤21.7μm	≤30.7μm	≤46.1μm
≤0.50μm	NOT ENOUGH FIBERS OBSERVED FOR COMPLETE SIZE DISTRIBUTION.					
≤ 0.75μm	ESTIMATED 50% ≤ 3.5μm in Diameter and ≤ 50μm in length.					
≤ 1.00μm						
≤1.50μm						
≤3.00μm						
≤3.80μm						

Total Fibers Sized: 46

Table 2

FIBROUS GLASS SAMPLE DATA

HITCO
Gardena, California
July 19, 1973

Sample Number: 2

Sample Type: Personal

Operation: Insulation, Department 49

Job or Sample Location: Band Saw Operator and Oven Tender

Number of Fields Counted: 60

Average Fibers Per Field: 1.76

Air Volume, Liters: 88

Fiber Concentration, Fibers/Milliliter: 14.8

FIBER SIZE DISTRIBUTION: PERCENT OF FIBERS ≤ GIVEN DIAMETER AND LENGTH CATEGORIES

Fiber diameter \ Fiber length	≤1.00μm	≤5.4μm	≤10.9μm	≤21.7μm	≤30.7μm	≤46.1μm
≤0.50μm	2	45	58	68	70	72
≤0.75μm			60	72	77	80
≤1.00μm					78	81
≤1.50μm					80	82
≤3.00μm						83
≤3.80μm						84

Total Fibers Sized: 106

Table 3

FIBROUS GLASS SAMPLE DATA

HITCO
Gardena, California
July 19, 1973

Sample Number: 3

Sample Type: Personal

Operation: Insulation, Department 49, Building 3

Job or Sample Location: Laminating Glass Bats to Form Thicker Bats

Number of Fields Counted: 40

Average Fibers Per Field: 3.03

Air Volume, Liters: 92

Fiber Concentration, Fibers/Milliliter: 24.4

FIBER SIZE DISTRIBUTION: PERCENT OF FIBERS ≤
GIVEN DIAMETER AND LENGTH CATEGORIES

Fiber diameter \ Fiber length	≤1.00μm	≤5.4μm	≤10.9μm	≤21.7μm	≤30.7μm	≤46.1μm
≤0.50μm	3	43	57	64	68	74
≤0.75μm		44	68	70	76	82
≤1.00μm				73	80	88
≤1.50μm					81	89
≤3.00μm						89
≤3.80μm						89

Total Fibers Sized: 121

Table 4

FIBROUS GLASS SAMPLE DATA

HITCO
Gardena, California
July 19, 1973

Sample Number: 4

Sample Type: Personal

Operation: Insulation Department 49, Building 3

Job or Sample Location: Fibrous Glass Press Operator

Number of Fields Counted: 100

Average Fibers Per Field: 0.38

Air Volume, Liters: 88

Fiber Concentration, Fibers/Milliliter: 3.2

FIBER SIZE DISTRIBUTION: PERCENT OF FIBERS ≤
GIVEN DIAMETER AND LENGTH CATEGORIES

Fiber diameter	Fiber length					
	≤1.00µm	≤5.4µm	≤10.9µm	≤21.7µm	≤30.7µm	≤46.1µm
≤0.50µm	<1	32	50	63	65	67
< 0.75µm		38	61	79	83	85
< 1.00µm				81	89	92
≤1.50µm				82	90	94
≤3.00µm				84	92	97
≤3.80µm						97

Total Fibers Sized: 100