INDUSTRIAL HYGIENE SURVEY OF THE

Johns-Manville Corporation
Fibrous Glass Plant 7
Waterville, Ohio

SURVEY DATE: May 7-10, 1973

SURVEY CONDUCTED BY:

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

PLACE VISITED:	The Johns-Manville Corporation Fibrous Glass Plant 7 Waterville, Ohio
DATE OF VISIT:	May 7-10, 1973
PERSONS MAKING VISIT:	Stephen Bayer, NIOSH John Dement, NIOSH Kenneth Wallingford, NIOSH Ralph Zumwalde, NIOSH Sam Seferian, Ohio Department of Health
PERSONS CONTACTED:	Mr. Jim Givens, Employee Relations Supervisor for Waterville, Ohio Complex Mr. Richard Meyers, Employee Relations Supervisor for Plant 1 Mr. Don Tumblin, Employee Relations Supervisor for Plant 7 Mr. David Bender, Manager, Plant 7
PURPOSE OF VISIT:	To conduct an industrial hygiene survey of Plant 7 with major emphasis on microfiber operations.

INTRODUCTION

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.

As the result of a walk-through survey conducted by Philip Bierbaum and John Dement at the Johns-Manville Fibrous Glass Plant 7 in Waterville, Ohio on March 30, 1973, it was decided to conduct a thorough study of this facility. This survey was conducted by Stephen Bayer, John Dement, Kenneth Wallingford and Ralph Zumwalde during May 7-10, 1973. Mr. Sam Seferian of the Ohio Department of Health also was present during the initial meeting and plant tour on May 7.

During this visit, approximately 133 air samples were taken for evaluation of fibrous glass exposures. In addition, air samples also were taken to evaluate exposures to phenol, formaldehyde, ammonia, and carbon monoxide. Noise measurements also were made in selected areas.

DESCRIPTION OF THE FACILITY

The major products of Plant 7 are microfibers for making filtration papers, microfelt insulation, microquartz refractory fibers (leached glass microfibers) and die pads and larger diameter fibers used for making filter tubes, chopped strand mat and bonded mat.

The microfiber operations began as a research venture in 1950. Microfibers were not commercially produced until approximately 1966. Chopped strand mat production was started in the late 1950's. Bonded mat ("Shuler" process) and filter tube production began in 1967 and 1968, respectively.

The entire workforce of plant 7 is presently approximately 177 persons, with approximately 132 of these persons being hourly employees. The unions in this Plant are Local #20 of the International Brotherhood of Teamsters and Local #4 of the Mechanics Educational Society of America (MESA).

There are presently approximately 50 persons involved in the microfiber operations. A breakdown of the age and duration of employment for persons in the microfiber operations is given in Table 1.

MEDICAL, INDUSTRIAL HYGIENE, AND SAFETY PROGRAMS

The Johns Manville Corporation has a Corporate Medical Director located in Denver, Colorado. A local general practitioner is retained as a consultant to the Plant and performs all physical examinations. A registered nurse is on duty at the Plant during the day shift.

Both pre-employment and voluntary periodic (every two years) physicals are given each employee. These examinations include a physical examination, chest x-ray (14" x 17"), and extensive blood work. No pulmonary function tests are given.

According to Mr. Meyers and Mr. Givens, no acute or chronic effects of fibrous glass exposure have been noted. Initial dermatitis does occur with some employees but is not considered a serious problem. Use of protective creams and ointments appears to alleviate this problem.

Industrial hygiene matters in this Plant are taken care of on a corporate basis. Mr. William Reitze serves as Manager, Accident Prevention and Industrial Health. Industrial hygiene surveys are made in this Plant on an annual basis. In addition, during January and February of 1973, Mr. Sansone of the University of Pittsburgh conducted surveys of the microfiber operations as a part of the fibrous glass study supported by the National Insulation Manufacturers Association.

Industrial safety is also the responsibility of Mr. Reitze, on a corporate basis, with the Employee Relations Supervisor at each plant being in charge of safety. Mr. Jim Givens is Employee Relations Supervisor for the entire Waterville, Ohio complex and Mr. Don Tumblin is the Employee Relations Supervisor for Plant 7. The plant has a Safety Committee composed of hourly and salaried employees and union representatives.

Personal protection programs presently in force at this Plant include hearing protection (ear muffs) in high noise areas and safety glasses in selected areas ("Shuler" mat forming area). Respiratory protection is not presently used in any production operations at Plant 7.

DESCRIPTION OF THE PROCESSES

Microfibers and Microquartz

Microfibers are made with varying diameters, ranging from 0.1 to 3.8μm (see Table 2 for diameters), in Plant 7 using a flame attenuation process. In the process, glass marbles are melted in a small gas fired furnace. The molten glass flows by gravity through platinum bushings in the bottom of the furnace thus forming coarse primary fibers. These primary fibers are next introduced into a very high velocity glass flame where attenuation into the very small diameter "microfibers" takes place. These fibers are collected on a rotating screen forming a thin fiber mat which is rolled onto small mandrels. No binders are applied to these fibers. The rolls of fiber are cut from the mandrel, compressed and boxed for external shipment or further processing in the Plant. Microfibers are sold in bulk to manufacturers of filtration papers and as high efficiency thermal insulation. One principal use of these fibers is in surgical masks. This Plant has one department (J & J Department) for making surgical mask material which involves simply applying muslin to both sides of the microfiber mat. There are no sewing operations in this Plant.

"Microquartz" felts and compressed microquartz board (Dyna-Quartz) are made by leaching microfibers until the fibers contain 99+ percent SiO_2. In this process, microfibers are first placed in a leach tank for a prescribed period of time. The leached fibers are next removed from the tank, compressed and dried in an oven. The fibers are then put back into a slightly acidic aqueous suspension and pumped into a vat with a screen in the bottom. The water is pumped out through the screen while a worker

spreads the fibers by hand, thus a felt of uniform thickness is formed. The "microquartz" is next fired at temperatures of approximately 1500-1800°F, cooled and packaged. Die pads, used for extruding stainless steel, are made with basically the same method, the only difference being the final shape.

In the same area where microquartz felts are made, a product known as "microfelt" is also made. This process is essentially the same as that used for microquartz felt except that leaching does not take place.

Bonded Mat

Bonded mat, which is used to make roofing material and pipe insulation, is manufactured in Plant 7 by the "Shuler" process. In this process, glass marbles are melted in glass furnaces. The melted glass then flows through sieve-like bushings to form primary fibers. These fibers then are collected on a rotating drum where the pulling action of the drum on the fibers causes fiber attenuation. Fibers from several of these forming drums are then thrown onto a moving conveyor to form a crossed mat of fiber. The fiber mat is next treated with a binder (urea-formaldehyde or neoprene) and cured in ovens. The edges are next trimmed and the mat rolled onto mandrels.

Chopped Strand Mat

Chopped strand mat, which is used for both a "built-up" roofing material and as reinforcement for plastics is manufactured in this Plant. In this process, fibrous glass rovings are fed from a series of creels into a chopper. The chopped fibers (approximately two inches in length) are blown onto a screen thus forming a mat with fibers of random orientation. The mat is next treated with a latex binder, cured and packaged for shipment.

Fibrous Glass Filter Tubes

Filter tubes for various applications such as gasoline filtration are manufactured in this facility using fibrous glass. The fibers for these filters are manufactured by a flame attenuation process and are larger in diameter than those made in the microfiber operations. In the

process, molten glass flows through platinum bushings in the bottom of a glass furnace, thereby forming primary fibers. These fibers are then met by a high velocity burner flame which attenuates the fibers to the desired diameter. After attenuation, the fibers are sprayed with phenol-formaldehyde binder (using an ammonia modifier) and blown onto a moving conveyor, thus forming a mat. The mat is cut to length and wrapped around a steel mandrel and taken into a curing oven. The mandrel is removed after curing leaving a cylindrical tube approximately 30 inches in length.

These tubes are taken next to the filter tube finishing area. In this operation, the tubes are cut to the desired length, grooved if necessary, and placed in appropriate coverings (sockings). The tubes are next packaged for shipment.

INSPECTION OF PLANT

Potential Health Hazards

Potential health hazards observed during this survey were as follows:

1. Respiratory exposure to small diameter fibrous glass.
2. Dermatitis (mechanical) due to exposure to large diameter fibrous glass.
3. High noise exposures in fibrous glass forming areas.
4. Respiratory exposure to binder materials (urea-formaldehyde, phenol-formaldehyde, and neoprene) liberated during curing.
5. Carbon monoxide exposure in various production operations.
6. Ammonia exposure in filter tube production area.

Ventilation

In the microfiber operations, exhaust ventilation is provided at each forming station. The system consists of a hood over the fiber forming station with air flow provided by a centrifugal fan. The exhaust is discharged to a large roof plenum and a collection system. This collection system was installed in 1971.

In the filter tube production area and in the shuler mat area, exhaust ventilation is provided at the resin curing ovens. These ovens

did appear to have a slight leakage problem as smoke was noted in these areas.

In the filter tube finishing area, local exhaust ventilation is provided at the sawing operations and at the socking stations. These exhaust points are vented to a cyclone collector located outside the building.

HOUSEKEEPING

Housekeeping in this facility appears to be adequate in most operations. Most floor cleaning is done with powered vacuum sweepers; however, some sweeping is done with hand brooms.

The major problem, with respect to housekeeping, in this facility is the frequent use of compressed air, particularly in the microfiber operations. In the microfiber operations, compressed air is used to clean the fiber screens of the machines and for general cleaning. Considerable quantities of airborne fiber were noted during this cleaning.

SURVEY PROCEDURES

General

Air samples were collected in this plant for evaluating exposure to fibrous glass, phenol, formaldehyde, ammonia and carbon monoxide. A noise survey also was conducted. The following paragraphs describe the methods used to collect and analyze the air samples and take noise measurements.

Airborne Fibrous Glass Measurements

Both personal and general area samples for airborne fibrous glass were collected in the various fibrous glass operations for simultaneous evaluation by fiber count and total dust weight. Personal and stationary samples were taken by placing two pumps on each worker or at each sample site with one pump collecting samples for fiber count and the other pump collecting samples for evaluation of total airborne particulate matter. Filters on the fiber count samplers were changed periodically such that fiber concentrations did not become so high as to obscure counting. Weight samples ran all day (6 to 7 hours).

The major portion of this survey was devoted to air sampling in the microfiber and J & J operations. Eight stationary sample sites were chosen in these operations and sampled for three consecutive days. Locations of these sample sites are shown in Figure 1. Types of fibers being made at each machine during the days sampled are shown in Table 3.

All samples for fiber count were collected on 37mm diameter millipore Type AA cellulose ester membrane filters (0.8µm pore size) at a calibrated sampling rate of 2.01pm with an open filter face.

Laboratory analysis of the collected fiber count samples 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 with oil immersion phase contrast objectives at 1000X magnification (objective N.A. = 1.30, condenser N.A. = 1.25). Fiber size distributions (length and diameter) also were determined for each sample. Fiber concentrations are reported as fibers per milliliter.

In addition to size distributions determined by optical microscopy, fiber size distributions were determined for four of the microfiber personal samples with higher fiber concentrations using transmission electron micrographs and a "Zeiss" particle size analyzer at a total magnification of 14,465X (including photographic enlargement). Photomicrographs also were made of these four samples.

All samples for total airborne particulate matter were collected on 37mm diameter Mine Safety Appliance (MSA) polyvinyl chloride membrane filters (5µm pore size) at a calibrated sampling rate of 2.0 lpm. Three piece Millipore filter holders were used with only the small plug removed (leaving a 4mm diameter opening). All filters were tared and re-weighed on the 20 milligram "A" scale of a "Cahn Gram Electrobalance". Total dust concentrations are reported in milligrams per cubic meter of air sampled.

Formaldehyde

Airborne formaldehyde samples were collected in the area of the forming hoods and resin curing ovens of the filter tube production area by drawing 1.0 lpm of air through a two-stage bubble absorber. Each absorber was equipped with a coarse fritted tube inlet and filled with 20 ml of distilled water. With two absorbers in series, the total collection efficiency for formaldehyde is approximately 95 percent[2]. Laboratory analysis for formaldehyde was performed using the chromotropic acid, colorimetric method recommended by the Intersociety Committee[2,3].

Phenol

Samples for total airborne phenolic compounds also were collected in the area of the forming hoods and resin curing ovens of the filter tube production area. These samples were collected by drawing 1.0 lpm of air through a two-stage absorber equipped with coarse fritted tube inlets. Each absorber was filled with 20 ml of 0.1N sodium hydroxide. Laboratory analysis for total phenolic compounds was performed by distillation from an acidified system and coupling with 4-aminoantipyrine in an alkaline medium containing an oxidant[4].

Inorganic Compounds

Detector tubes were used to evaluate concentrations of ammonia in the filter tube production area and carbon monoxide in the various production areas. Carbon monoxide measurements were made using "Drager Carbon Monoxide 5/c" tubes using the ten stroke (5-150 ppm) measuring scale. Ammonia measurements were made using "Drager Ammonia 5/a" tubes with a measuring range of 5 to 70 ppm.

Noise

In addition to air sampling, noise measurements were made in the microfiber and microquartz areas. A General Radio Type 1565-A sound level meter calibrated with a Type 1562-A calibrator was used for all measurements. The meter response was set on the slow position and measurements made on the "A" and "C" weighing networks in order to get an estimate of the frequency distribution of the noise.

RESULTS AND DISCUSSION

Fibrous Glass Air Samples

Before discussing the specific results of this survey, a brief discussion of fiber respirability is appropriate. 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[5] 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 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[6] in a more recent inhalation experiment with rats using fibrous glass of 0.75-1.5μm in diameter and lengths up to 100μm, found a few fibers up to 50μm in length in the lungs of rats sacrificed during exposure, although the bulk of all fibers found were less than 20μm in length.

Another study conducted by Gross, et al.,[7] concerned itself with fiber size distributions 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 for 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[8] 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[9] reports finding fibers 100μm 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.

Microfiber and J & J Operations*:

Results of each paired count and weight sample are given in Tables 4,5, and 6 and are summarized by day in Table 7. The lowest personal total fiber concentration observed was 5.7 fibers/ml for a J & J fiber spooler and the highest personal total fiber concentration observed was 33.6 fibers/ml for a microfiber spooler. Personal respirable fiber concentrations ranged from 2.7 to 22.8 fibers/ml in the microfiber and J & J operations. Mean personal total fiber exposures from Table 7 ranged from 14.3 fibers/ml on May 8 to 14.5 fibers/ml on May 10 for microfiber workers.

Mean personal respirable fiber exposures in the microfiber operation ranged from 11.8 to 12.2 fibers/ml on May 8 and May 10, respectively. In the J & J operations, a mean personal total fiber exposure of 8.6 fibers/ml was observed on May 8 with a corresponding mean personal respirable fiber exposure of 6.3 fibers/ml.

The lowest total fiber concentration observed for a stationary sample in the microfiber and J & J operations was 0.2 fibers/ml at the hot end of machine 13 and highest was 20.9 fibers/ml at sample site 4. The highest respirable fiber concentration observed for a stationary sample was 14.7 fibers/ml at sample site 6.

Personal samples for total airborne particulate matter in the microfiber operations ranged from 0.24 mg/m^3 to 2.04 mg/m^3 with means of 0.81 mg/m^3 and 0.91 mg/m^3 on May 8 and May 10 respectively. The one personal sample for total airborne particulate matter in the J & J operations showed a concentration of 0.55 mg/m^3.

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*Individual sample results are appended.

Stationary samples for total airborne particulate matter in these operations showed a range of 0.13 to 1.59 mg/m^3.

The results of this survey indicate that a significant quantity of the airborne fibers in the microfiber and J & J operations are "potentially" respirable (see Table 8). This conclusion is further substantiated by the results of the electron microscope work on personal samples 3,4,6 and 18. From Table 9, it can be seen that median fiber diameters of approximately 0.16, 0.22, 0.17 and 0.18 micrometers were determined for samples 3,4,6 and 18, respectively. In addition, from Table 10, it can be seen that 36, 28, 32 and 39 percent of the fibers on these samples were below 5.3 micrometers in length (5.3μm length cut-off represents only an instrumental limitation).

Microquartz:

Both personal and stationary samples were collected in the microquartz area on May 9 (Tables 5 and 7). The highest personal total fiber concentration observed was 7.7 fibers/ml for a fiber leach operator. The highest personal respirable fiber concentration was 7.6 fibers/ml also for the fiber leach operator. The fiber leach operator also had the highest concentration of total airborne particulate matter of 0.61 mg/m^3.

Stationary samples in this area showed a range of total fiber concentrations from 0.3 to 1.1 fibers/ml and total airborne particulate matter concentrations ranged from 0.20 to 0.29 mg/m^3.

From Table 8, it is interesting to note the high percentage of all airborne fibers in this operation which fell into the respirable range (86 to 99 percent). There does appear to be some loss in fiber integrity as a result of the leaching process resulting in much shorter airborne fibers.

Other Fibrous Glass Operations:

Spot samples were taken in all the fibrous glass operations of Plant 7 (Tables 4,5 and 7). The only area where any appreciable fiber exposures were observed was the filter tube finishing area. Total fiber concentrations of 0.2 and 1.9 fibers/ml were observed in these operations. For the sample of 1.9 fibers/ml a respirable concentration of 1.7 fibers/ml was determined. Total airborne particulate concentrations for this operation ranged from 0.66 to 1.46 mg/m^3.

Phenol, Formaldehyde, and Ammonia Samples

The results of the phenol and formaldehyde samples are not available at this time and if significant will be reported at a later date.

Results of the ammonia samples in the filter tube production area are shown in Table 11. The concentrations observed appear insignificant, ranging from none detected to 1 ppm.

Carbon Monoxide Samples

Results of the detector tube samples for carbon monoxide are shown in Table 12. The highest carbon monoxide concentration detected was at the burners of the microquartz leach tanks and this value was only approximately 13 ppm.

Noise Measurements

Results of all noise measurements are shown in Table 13. As was anticipated, excessive noise levels were measured in both the microfiber hot end and packing area. Workers in these areas presently wear hearing protection eight hours per day.

CONCLUSIONS AND RECOMMENDATIONS

Based on observations made during this survey and the 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 microfiber, microquartz and J & J operations. There is presently no data 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[10,11,12,13] and studies of health effects on these workers has produced essentially negative results. However, recent animal studies conducted by Stanton[14] and Friedrichs[15] have demonstrated that small diameter fibrous glass is carcinogenic when injected into the pleural cavity of rats.

Based on the foregoing discussion, it would appear prudent that exposures to respirable glass be kept at an absolute minimum by the use of good work practices and engineering controls. The use of compressed air in the microfiber operations should be stopped immediately in favor of much cleaner vacuum methods. In addition, consideration should be given to adding additional local exhaust ventilation (perhaps canopy hoods) at the fiber spooling operations.

2. Due to the glass fiber exposures observed in the microfiber, J & J and microquartz areas and the present lack of knowledge as to the health consequences of such exposure, close medical surveillance of those persons involved in these operations appears warranted. It is recommended that a medical surveillance program be initiated in this facility similar to that 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 chest roentgenogram (14" x 17" posterior-anterior), a history to elicit symptomatology of respiratory disease, and pulmonary function tests (FVC and FEV_1).

3. Due to the high noise exposures in the microfiber operations, the current hearing conservation program in this area should continue to be strictly enforced.

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TABLE 1

EMPLOYEE AGE
&
DURATION OF EMPLOYMENT

MICRO FIBERS - PLANT 07
8/25/72

	LENGTH OF SERVICE	Less 5		5 - 15		15 - 25		Over 25	
	AGE	M	F	M	F	M	F	M	F
OPERATIONS	Under 25	25		1					
	25-35	6							
	35-45	3		6					
	45-55	2		1		1			
	55-65			2					
OFFICE	Under 25								
	25-35								
	35-45								
	45-55								
	55-65								

Table 2

DIAMETERS OF FIBROUS GLASS FIBERS MANUFACTURED IN MICROFIBER OPERATIONS

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Fiber Code*	Average Diameter, Micrometers
112	3.8
110	2.6
108	1.6
106	0.75
104	0.50
102	0.20
100	0.10

*These are codes of the Johns-Manville Corporation.

Table 3

TYPE OF GLASS FIBERS BEING PRODUCED BY EACH MICROFIBER MACHINE

ON THE DAYS SAMPLED

Johns-Manville
Fibrous Glass Plant 7
Wateville, Ohio

May 7-10, 1973

Machine Number*	Type of Fiber Produced**		
	May 8	May 8	May 9
1	112	110	112
2	108	110	108
3	110	112	110
12	104	104	104
13	104	104	104
14	106	106	106
15	106	106	106
16	106	106	106
17	106	106	106
18	106	106	106
19	108	106	106
20	104	104	104
21	102	102	102
22	110	110	110

*Machines 4 through 9 were not in operation during this survey.

**Code numbers for Johns-Manville fiber grades are shown in this table. Average fiber diameters for these grades are given in Table 2.

Table 4

RESULTS OF PAIRED SAMPLES FOR FIBER COUNT AND DUST WEIGHT TAKEN ON MAY 8, 1973

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Job Description or Sample Location	Fiber Count Samples				Dust Weight Samples			
	Sample No.	Air Vol. Liters	Total Fibers/ml	Resp* Fibers/ml	Sample No.	Dust Wt. mg.	Air Vol. m^3	Conc. mg/m^3
			Microfiber					
Fiber Spooler	1	276	17.2	13.8	524	1.17	0.60	1.95
	20	324	8.9	8.1				
Fiber Spooler	3	284	17.7	14.9	518	0.12	0.50	0.24
	18	216	33.6	29.6				
Fiber Baler	4	258	11.1	7.8	523	0.52	0.59	0.90
	19	328	9.5	5.5				
Fiber Spooler	6	296	10.7	7.5	520	0.35	0.62	0.57
	22	- V O I D - - -						
Fiber Spooler	13	220	14.1	12.1	582	0.22	0.55	0.40
	21	334	11.2	7.6				
Sample Site #1	2	394	9.0	3.6	521	0.71	0.62	1.14
	24	226	6.6	2.9				
Sample Site #6	5	406	5.1	3.8	580	0.19	0.63	0.30
	27	222	8.6	4.9				
Hot End, Machine #13	10	574	0.2	-	505	0.31	0.57	0.54
Sample Site #3	11	336	8.7	6.1	566	0.20	0.56	0.36
	30	226	8.3	6.4				
Sample Site #2	12	332	1.6	0.9	529	0.17	0.56	0.21
	25	230	1.4	-				

Table 4 (Continued)

RESULTS OF PAIRED SAMPLES FOR FIBER COUNT AND DUST WEIGHT TAKEN ON MAY 8, 1973

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Job Description or Sample Location	Fiber Count Samples				Dust Weight Samples			
	Sample No.	Air Vol. Liters	Total Fibers/ml	Resp* Fibers/ml	Sample No.	Dust Wt. mg.	Air Vol. m^3	Conc. mg/m^3
Sample Site #5	15	310	4.3	3.2	569	0.14	0.53	0.26
	26	222	6.1	3.5				
			J & J					
J & J Spooler	9	260	11.5	9.8	526	0.32	0.58	0.55
	23	322	5.7	2.7				
Sample Site #7	7	384	3.9	2.2	564	0.13	0.61	0.21
	29	226	4.6	1.7				
Hot End, J & J	8	598	1.0	0.8	516	0.08	0.60	0.13
Sample Site #8	14	322	4.6	2.9	567	0.17	0.54	0.32
	31	218	7.8	3.3				
			Filter Tube Finishing					
Filter Tube Socker	16	320	0.2	-	541	0.21	0.32	0.66
Filter Tube Sawer	17	318	1.9	1.7	556 (558)	0.47	0.32	1.46
			Shuler Process					
Roll Packer	33	200	0.0	0.0	537	0.13	0.20	0.55
At Process Control Panel	28	248	0.1	-	581	0.06	0.25	0.24

*Respirable fibers are defined in this report as being less than 3.5 micrometers in diameter and less than 50 micrometers in length.

Table 5

RESULTS OF PAIRED SAMPLES FOR FIBER COUNT AND DUST WEIGHT TAKEN ON MAY 9, 1973

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Job Description or Sample Location	Fiber Count Samples				Dust Weight Samples			
	Sample No.	Air Vol. Liters	Total Fibers/ml	Resp* Fibers/ml	Sample No.	Dust Wt. mg.	Air Vol. m^3	Conc. mg/m^3
			Microfiber					
Sample Site #4	34	328	7.6	4.2	565	0.36	0.80	0.45
	50	306	9.3	7.2				
	61	168	20.9	14.0				
Sample Site #5	37	328	12.9	8.5	554	0.30	0.80	0.38
	52	206	6.9	5.0				
	62	166	6.6	3.3				
Sample Site #6	38	330	10.8	4.4	587	0.35	0.80	0.44
	48	304	4.9	3.8				
	60	166	17.5	14.7				
Sample Site #2	39	348	5.5	4.6	543	0.22	0.82	0.27
	54	308	2.6	1.1				
	56	164	1.3	-				
Sample Site #1	42	328	6.4	3.7	552	1.27	0.80	1.59
	49	304	4.4	1.4				
	55	166	7.3	3.9				
Hot End, Machine #2	44	656	1.3	0.9	583	0.14	0.66	0.21
Hot End, Machine #22	46	630	0.9	0.7	579	0.12	0.63	0.19

Table 5 (Continued)

RESULTS OF PAIRED SAMPLES FOR FIBER COUNT AND DUST WEIGHT TAKEN ON MAY 9, 1973

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Job Description or Sample Location	Fiber Count Samples: Sample No.	Air Vol. Liters	Total Fibers/ml	Resp* Fibers/ml	Dust Weight Samples: Sample No.	Dust Wt. mg.	Air Vol. m^3	Conc. mg/m^3
			J & J					
Sample Site #7	40	322	5.6	3.5	553	0.57	0.79	0.72
	53	306	9.6	5.9				
	63	166	6.4	5.4				
Sample Site #8	41	322	14.3	7.3	568	0.16	0.79	0.20
	51	304	8.0	3.4				
	64	166	8.8	7.4				
			Microquartz					
Felts Operator	35	320	6.5	6.3	571	0.25	0.72	0.21
	59	398	2.6	2.5				
Fiber Leacher	43	180	7.7	7.6	532	0.13	0.18	0.61
Stat. @ Drier Exit	32	688	1.1	0.9	572	0.15	0.72	0.21
" @ Die Pad Packing	36	690	0.3	-	584	0.14	0.69	0.20
On Rail @ Leach Tanks	45	582	0.3	-	538	0.16	0.58	0.28
On Platform Before Spreading	47	702	0.4	-	551	0.20	0.70	0.29
			Chopped Strand Mat					
Roll Operator	57	200	0.00	-	555	0.18	0.29	0.62
At Flame Blower Platform	58	198	0.00	-	585	0.05	0.25	0.20

*Respirable fibers are defined in this report as being less than 3.5 micrometers in diameter and less than 50 micrometers in length.

Table 6

RESULTS OF PAIRED SAMPLES FOR FIBER COUNT AND DUST WEIGHT TAKEN ON MAY 10, 1973

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Job Description or Sample Location	Fiber Count Samples				Dust Weight Samples			
	Sample No.	Air Vol. Liters	Total Fibers/ml	Resp* Fibers/ml	Sample No.	Dust Wt. mg.	Air Vol. m^3	Conc. mg/m^3
			Microfiber					
Fiber Spooler	72	264	11.4	6.3	586	0.25	0.48	0.52
	79	222	19.3	14.6				
Fiber Baler	73	218	13.4	9.5	531	0.45	0.44	1.00
	80	218	25.3	22.8				
Fiber Spooler & Baler	74	246	15.9	14.8	558	0.18	0.29	0.62
	83	224	9.0	8.6				
Fiber Spooler & Baler	75	252	13.2	11.8	557	0.63	0.47	0.38
	81	220	14.2	13.9				
Fiber Baler	78	218	12.0	9.7	542	1.67	0.82	2.04
	88	268	11.0	9.5				
Sample Site #2	65	282	0.9	-	544	0.24	0.51	0.48
	86	224	5.4	3.8				
Sample Site #4	66	282	5.4	4.1	539	0.23	0.50	0.46
	87	222	11.2	6.9				
Sample Site #5	67	282	5.8	5.7	540	0.18	0.51	0.36
	84	222	10.0	6.3				
Sample Site #1	69	282	2.3	1.9	570	0.29	0.50	0.58
	77	222	6.6	-				

Table 6

RESULTS OF PAIRED SAMPLES FOR FIBER COUNT AND DUST WEIGHT TAKEN ON MAY 10, 1973

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Job Description or Sample Location	Fiber Count Samples				Dust Weight Samples			
	Sample No.	Air Vol. Liters	Total Fibers/ml	Resp* Fibers/ml	Sample No.	Dust Wt. mg.	Air Vol. m^3	Conc. mg/m^3
Sample Site #6	71	284	5.4	5.0	573	0.24	0.51	0.48
	82	222	5.2	5.0				
		J & J						
Sample Site #7	68	242	4.1	3.2	530	0.11	0.46	0.24
	85	220	2.0	-				
Sample Site #8	70	278	4.5	2.8	545	0.13	0.32	0.41
	76	140	5.0	4.1				

*Respirable fibers are defined in this report as being less than 3.5 micrometers in diameter and less than 50 micrometers in length.

TABLE 7

AVERAGE FIBER AND TOTAL DUST EXPOSURE BY DAY FOR EACH OPERATION
GROUPED BY SAMPLE TYPE AND LOCATION

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio
May 7-10, 1973

Sample Type & Location	May 8			May 9			May 10		
	Fibers/ml		Total Dust	Fibers/ml		Total Dust	Fibers/ml		Total Dust
	Total	Resp.*	mg/m^3	Total	Resp.*	mg/m^3	Total	Resp.*	mg/m^3
Microfiber									
Microfiber Pers. Samples	14.3	11.8	0.81	-	-	-	14.5	12.2	0.91
Stationary Site #1**	7.8	3.3	1.14	6.0	3.0	1.59	4.5	1.9	0.58
Stationary Site #2	1.5	0.9	0.26	3.1	2.9	0.27	3.2	-	0.48
Stationary Site #3	8.5	6.3	0.36	-	-	-	-	-	-
Stationary Site #4	-	-	-	12.6	8.5	0.45	8.3	5.5	0.46
Stationary Site #5	5.2	3.3	0.26	8.8	5.6	0.38	7.9	6.0	0.36
Stationary Site #6	6.9	4.4	0.30	11.1	7.6	0.44	5.3	5.0	0.48
Stat. Samples in Hot End	0.2	-	0.54	1.1	0.8	0.20	-	-	-
J & J									
J & J Personal Samples	8.6	6.3	0.55	-	-	-	-	-	-
Stationary Site #7	4.3	1.9	0.21	7.2	4.9	0.72	3.1	-	0.24
Stationary Site #8	6.2	3.1	0.32	10.4	6.0	0.20	4.8	3.5	0.41
Microquartz									
Microqtz. Pers. Samples	-	-	-	5.6	5.4	0.34	-	-	-
All Stat. Samples	-	-	-	0.5	-	0.25	-	-	-
Other Operations									
All Samples, Filt. Tube Fnshg.	1.1	-	1.06						
" Shuler Mat	0.1	0.0	0.39						
" Chopped Strand Mat				0.0	0.0	0.41			

*Respirable fibers are defined in this report as being less than 3.5 micrometers in diameter & less than 50 micrometers in length.
**Locations of stationary sample sites are given in Figure 1.

TABLE 8

PERCENTAGE (MEAN AND RANGE) OF ALL AIRBORNE FIBERS CONSIDERED RESPIRABLE** IN THE MICROFIBER AND J & J OPERATIONS BY DAY

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Sample Type or Site*	Average & (Range) of Percentage Resp. Fibers			
	May 8	May 9	May 10	All Samples
All Personal Samples	75	-	84	76
in Microfiber & J & J	(48-91)	-	(55-98)	(48-98)
Sample Site #1	43 (44-45)	48 (32-58)	81 (81-81)	52 (32-81)
Sample Site #2	53 (53-53)	64 (44-84)	70 (70-70)	63 (44-84)
Sample Site #3	73 (70-77)	- -	- -	73 (70-77)
Sample Site #4	- -	66 (55-77)	69 (62-75)	67 (55-77)
Sample Site #5	66 (57-74)	62 (50-71)	81 (63-98)	68 (50-98)
Sample Site #6	66 (57-74)	68 (41-84)	94 (93-97)	75 (41-97)
Sample Site #7	46 (38-56)	69 (61-84)	78 (78-78)	63 (38-84)
Sample Site #8	53 (42-64)	59 (43-84)	72 (62-81)	61 (42-84)
All Samples, Microquartz		95 (86-99)		95 (86-99)

*Locations of stationary sample sites are given in Figure 1.

**Respirable fibers are defined in this report as being less than 3.5 micrometers in diameter and less than 50 micrometers in length.

TABLE 9

AIRBORNE FIBER DIAMETER DISTRIBUTIONS BY ELECTRON MICROSCOPY
FOR PERSONAL SAMPLES TAKEN IN THE MICROFIBER OPERATIONS

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Upper Class Limit, μm	Percent of Fibers ≤ Upper Class Limit			
	Sample 3	Sample 4	Sample 6	Sample 18
0.09	2	2	0	2
0.10	4	4	2	6
0.12	15	10	15	22
0.14	34	20	34	35
0.16	49	32	45	39
0.18	56	42	54	49
0.20	60	47	59	53
0.30	77	71	75	73
0.40	84	78	82	78
0.50	86	84	87	82
0.75	90	93	97	89
1.00	95	97	99	92
1.75	97	98	100	97

TABLE 10

AIRBORNE FIBER LENGTH DISTRIBUTIONS BY ELECTRON MICROSCOPY FOR PERSONAL SAMPLES TAKEN IN THE MICROFIBER OPERATIONS

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Uper Class Limit, μm	Percent of Fibers ≤ Upper Class Limit			
	Sample 3	Sample 4	Sample 6	Sample 18
1.0	6	3	7	6
1.8	15	5	8	13
2.6	22	7	12	20
3.7	29	13	29	26
4.4	34	20	30	27
5.3	36	28	32	29
6.2	36	37	33	30

TABLE 11

RESULTS OF DETECTOR TUBE SAMPLES FOR AMMONIA IN FILTER TUBE AREA

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Sample Site	Approximate Concentration ppm**
Near Binder Application	N.D.*
At Curing Oven	1
At Curing Oven Exit	<1

*N.D. - None Detected.

**The present OSHA standard for ammonia exposure is 50 ppm on an eight-hour time-weighted average basis.

TABLE 12

RESULTS OF DETECTOR TUBE SAMPLES FOR CARBON MONOXIDE IN PRODUCTION AREAS

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

May 7-10, 1973

Sample Site	Approximate Concentration ppm**
At Filter Tube Forming Hood	<1
At Filter Tube Curing Oven	<1
At Drier in Microquartz Area	4
At Microquartz Leach Tanks	12-13
At Burner, Chopped Strand Mat	2-3
Chopped Strand Mat Packing Area	N.D.*
At Microfiber Blowers	<1
Microfiber Packing	N.D.*

*N.D. = None Detected.

**The present OSHA standard for carbon monoxide exposure is 50 ppm on an eight-hour time-weighted average basis.

TABLE 13

RESULTS OF NOISE MEASUREMENTS IN PRODUCTION AREAS

Johns-Manville
Fibrous Glass Plant 7
Waterville, Ohio

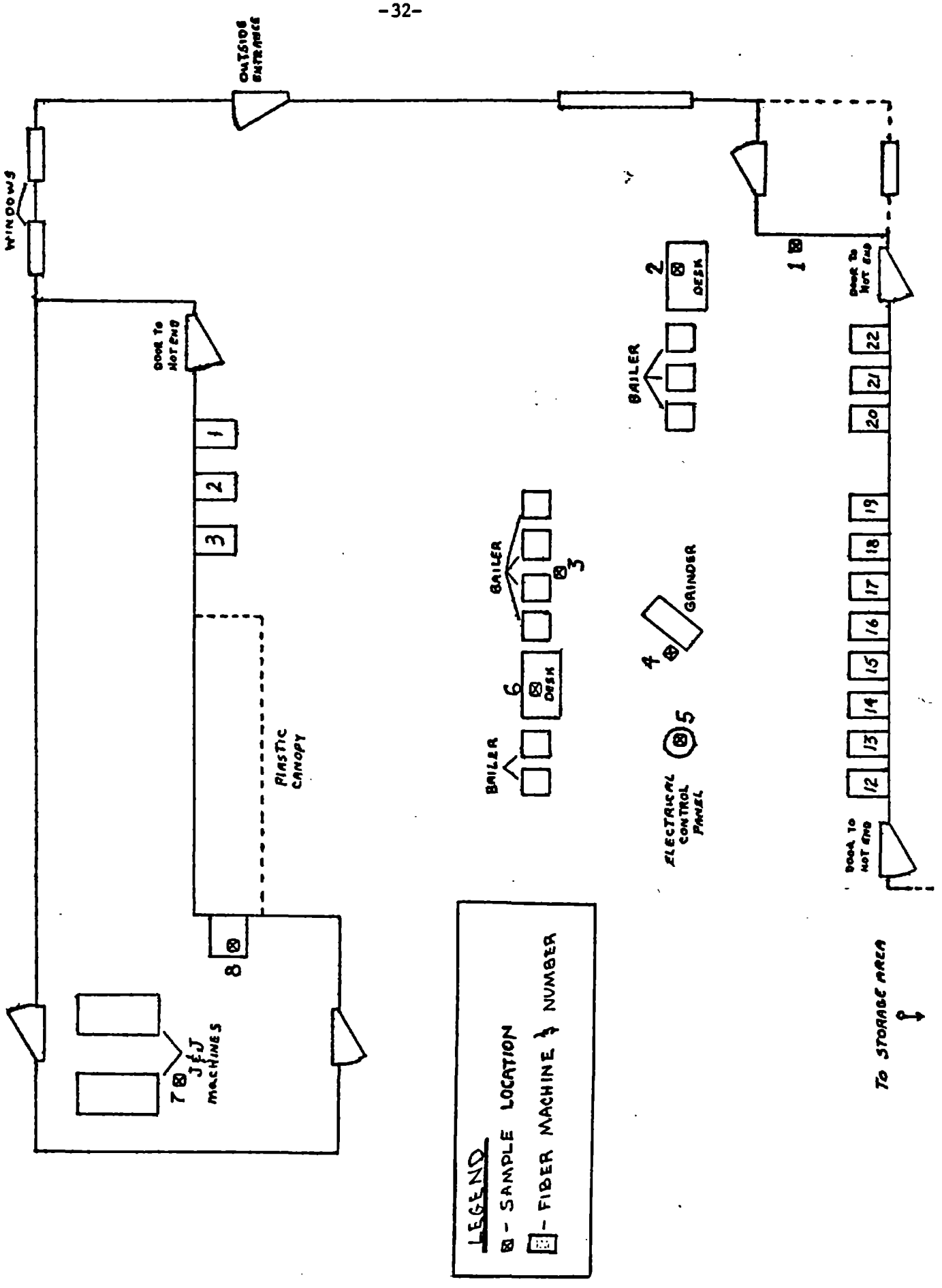
May 7-10, 1973

Area of Measurement	Noise Level A_S*	Noise Level C_S
Microfiber Area		
Hot End of Machine #2 (2 bushings)	113	113
Hot End of Machine #22 (4 bushings)	110	111
Hot End of Machine #18	115	115
Packing Area Near Machine #22	92	96+
Packing Area Near Machine #18	97	99
J & J Packing Area	96-	98-
Microquartz Area		
In Felt Forming Area	66	78
At Drying Oven Exit	77	86

*The present OSHA standard for a continuous eight-hour exposure is 90dBA.

Figure 1

LOCATION OF STATIONARY SAMPLE SITES



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16. Abstract (Limit: 200 words)
Worker exposures to small diameter glass fibers were surveyed at Johns-Manville Corporation (SIC-3229) in Waterville, Ohio during May 7 to 10, 1973. About 177 persons were employed at the facility. The corporation retained a general practitioner to perform physical examinations During the day shift a nurse was on duty. Pre-employment and voluntary periodic physical examinations were given, including chest X-rays and blood tests, but not pulmonary function tests. The factory had industrial hygiene, safety and personal protection programs and a safety committee. Personal and general air samples were collected to determine glass fibers and carbon-monoxide (630080) concentraitons, and noise levels were measured. Personal total fiber concentrations ranged from 5.7 to 33.6 fibers per milliliter (fibers/ml). Personal respirable fiber concentrations ranged from 2.7 to 22.8 fibers/ml in the microfiber and J and J operations. Area samples of total fiber concentrations, ranged from 0.2 to 20.9 fibers/ml. Personal airborne particulate matter samples ranged from 0.24 to 2.04 milligrams per cubic meter (mg/cu m). The highest carbon-monoxide condentration was 13 parts per million. Noise levels ranged from 66 to 115 and 78 to 115 decibels in the A and C weighing nitworks, respectively. The author concludes that exposures to significant amounts of respirable glass fibers were found in the microfiber, microquartz and J and J operations. He recommends that exposures to respirable glass fibers be kept at an absolute minimum with good work practices and engineering controls. The use of compressed ari should be stopped and cleaner vacuum methods should be employed. Medical surveillance of persons working in the microfiber, microquartz and J and J areas is also recommended.

17. Document Analysis a. Descriptors
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