ASBESTOS DUST
AND
PRELIMINARY INDUSTRIAL HYGIENE SURVEY

Raybestos - Manhattan
Manheim, Pennsylvania

Survey Conducted By:
PENNSYLVANIA STATE HEALTH DEPARTMENT

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Worker exposures to asbestos (1332214) were surveyed at the Manheim Division of the Raybestos-Manhattan Company (SIC-3292) in Pennsylvania on November 15 and 16, 1971. Work processes, worker protection and medical monitoring programs, and workplace ventilation and housekeeping systems were evaluated. A total of 355 personal air samples were collected from the textile, friction and packing areas of the company. Exposures of the waste machine operator, fiber preparation stocker, carding stocker, ring spinner and machine brander exceeded the OSHA 8 hour time weighted average standard of 5 fibers per milliliter greater than 5 microns in length. The OSHA 15 minute peak standard of 10 fibers per milliliter was exceeded at the waste machine, fiber preparation and machine brander stations. Workplace ventilation was insufficient. The author recommends evaluation of the ventilation system in the fiber preparation and carding areas. Ventilation should be provided in the spinning operations area, and local exhaust ventilation should be installed at machine branding sites.

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Introduction

On November 15 and 16, 1971, Ken Wallingford and the writer made a visit to the Manheim Division of the Raybestos-Manhattan Company. Under a contract with the U.S. Public Health Service, the Pennsylvania State Health Department was at the plant to take asbestos dust samples.

After a short conference with plant management and a rapid tour through the plant, Mr. Wallingford worked with the State Health Authorities in beginning their survey while the writer continued a walk-thru Industrial Hygiene Survey of the plant. During the two day visit, several more conferences were held with plant management to discuss plant health practices and housekeeping procedures.

The rather long delay between the plant visit and this report has been to allow the Pennsylvania State Health Department time to analyze the samples which were taken. With these results and those of past P.H.S. surveys, more specific recommendations can be made. A summary of the results of all surveys is given in the appendix.

Description of the Plant

The plant is located in the northern part of the town and employs approximately 1000 persons. The plant is the only major manufacturing concern within the local area. Products of the plant include textiles, friction products, and packing materials. Some of the major product lines include the following:

1. Asbestos textiles (cloth, tape, rope, wick and braid)
2. Woven and wound clutch facings
3. Woven and extruded brake linings
4. Disc brake friction pads
5. Dry process brake linings
6. Various types of packing materials including rubber-asbestos materials and extruded materials.

Description of the Processes

The Manheim Division of the Raybestos-Manhattan Company is a very large plant dealing in many product lines. The following paragraphs will attempt to briefly describe some of the major operations carried on at the plant.

A. *Asbestos Textiles*

Asbestos textile production consists of basically six steps. These steps are:

1. Fiber preparation
2. Carding

3. Spinning
4. Twisting
5. Winding
6. Weaving

These steps are common to all asbestos textile plants; therefore, the reader is referred to the literature for detailed discussions of each of these processes.

Fiber preparation is done on the first floor. Some final crushing of the asbestos fiber takes place. Opening of the asbestos fiber is done on a cone willow and asbestos mixing is done in a "Proctor" mixer. Cotton "lap" for carrying the asbestos fiber is also made in this area. Also located in the area is a W-3 Waste Machine.

Carding and spinning operations are done on the second floor of the building and are in adjacent rooms. Spinning is done at speeds up to 1800 rpm. Twisting, winding and weaving are in another area and are in close proximity to each other.

During the visit only crysotile was noticed being used in the textile operations. However, amosite may be used two to three times per year as stuffing for braided packing. When amosite is being processed lap cards are used in a wet operation. This wet operation was started in 1955.

B. Dry Process Brake Linings

The process by which dry process brake linings are made consists of the following steps:

1. Mixing
2. Preforming
3. Hot Pressing
4. Cutting and trimming
5. Bending
6. Curing
7. Final Drilling and inspection

At Manheim, raw materials are first crushed in a Williams Crusher, screened, and mixed in large mixers. All raw materials used in the process are dry.

After the raw materials are throughly mixed, thin sheets approximately 2' x 3' are formed by pressing the dry raw materials in a pneumatic hot-press. Following the hot-press, the edges are trimmed and the sheets cut into strips of the proper width on a Cambell cutter.

After the strips have been cut, the surfaces are sanded in a Gardner grinder and then bent into the proper form and placed in an oven for curing. After having been cured, the linings are drilled, finish sanded and inspected.

C. Extruded Brake Linings

The process by which extruded brake linings are made consists of the following steps:

1. Mixing and grinding
2. Extruding
3. Baking
4. Cutting
5. Final curing
6. Final grinding and drilling

After the final curing, dry process and extruded linings are finished in the same manner.

Raw material mixing is done in a manner similar to dry process lining production the only difference being that a paste is formed. After mixing, the material is extruded in the form of a tape, cut to length, and bent to form on one machine. After extruding, the shoes are clamped in shape and cured in a lunette. Final grinding and drilling is done in the same facility as dry process linings.

D. Woven and Wound Clutch Facings

Woven clutch facings are made in the following steps:

1. Cloth weaving
2. Cloth treating
3. Cloth slitting and calendering
4. Hot pressing
5. Baking
6. Sanding and drilling

Rolls of woven asbestos cloth are received from the textile department and treated with a coating containing rubbers, resins (Polyrez), litharge graphite, zinc oxide, solvents, and a retarder. The cloth is then slit and the strips wound in coils and pressed into shape on a hot press. The resulting clutch facings are then deburred and baked in a curing oven After the facings have cooled, the surfaces are sanded and the edges ground. The facings are then drilled, dusted, inspected, branded, and packed for shipment.

E. Packing Materials

Many different types of packing materials are manufactured at this plant. Some of the major product lines include sewer packing, "Veeplex" gaskets, and high pressure packing materials. Each of these materials makes use of asbestos fiber as a strengthening agent.

Asbestos sewer packings are made by treating asbestos wick with a lubricant. After being treated with a lubricant, several wicks are formed into a reel which is prepared for shipment. Braided packings are also made.

"Veeplex" gaskets are made by first coating asbestos cloth with neoprene rubber and then cutting the material on bias in a cutter. After having been cut, the ends are glued together and a roll started by hand and finished tight in a machine. Following the rolling operation, the roll is cut to lengths and the ends dipped in cement. Finally, the strips are hot pressed to form the desired shape and the inside and outside of the ring trimmed.

High pressure packing material is made in a manner similar to that of "Veeplex" gaskets. First, asbestos cloth is treated with rubber and cut on bias into strips about 4" wide. The strips are then sewed together and then coated with rubber cement. The strips are then rolled around an extruded core on a hose machine. The material is then calendered, lubricated with graphite, wound in a spiral, and boxed.

Inspection of the Plant

Potential Health Hazards: The potential health hazards which were noted during the survey were:

1. Exposure to asbestos dust
2. Exposure to lead and lead compounds
3. Exposure to carbon black
4. Exposure to zinc oxide
5. Exposure to various kinds of resins (see raw materials list)

Potential exists for exposure to almost all the raw materials especially in raw material mixing operations.

Personal Protection and Medical Programs: Respirators are presently worn in the plant on a voluntary basis. The plant provides two types of approved

respirators for any worker who desires to wear a respirator. During this visit respirators were worn in all asbestos mixing operations as well as the fiber preparation area of the textile mill.

Safety glasses and safety shoes are presently worn only by workers in the machine and maintenance shops. The plant encourages the use of safety shoes and has a program of financial assistance for their purchase.

Hearing protection is provided for every worker in a noisy area. During this visit, it was noted that all weavers in the textile mill wore ear plugs.

Personal clothing is provided for only those persons working closely with lead or lead compounds. For these workers, three (3) complete changes are provided per week.

The plant has a new medical facility with four examining rooms. A nurse is on duty full time and a local doctor visits the plant daily. The facility is equipped with X-ray equipment as well as a new audiometric testing booth.

Each worker at the plant is given a complete pre-employment physical. A voluntary program of annual back and chest X-rays is also conducted at the plant for those workers in exposure areas or doing extensive lifting. Office workers are given physicals every 3-6 years. Monthly blood tests are also given to workers who are exposed to litharge or other lead compounds.

Ventilation: The plant makes quite extensive use of local exhaust ventilation. Mr. Anspach, the plant engineer, indicated that they were pulling a total of approximately 300,000 cfm from the plant. He also acknowledged the problem of insufficient make-up air but said that they were working on the problem.

Probably the area which needs the most work in relation to ventilation is the textile mill. Exhaust ventilation is provided on almost all machines and transfer points; however, in some cases the volumes appeared to be low. A rough measurement of one asbestos dumping station in the fiber preparation area showed a velocity of only 25 fpm through the hood. The filling end of the carding machines also appeared to have low velocities.

Housekeeping: Cleaning is done on a daily basis by janitors in each work area. In the textile mill a six hour clean-up is carried out each week. Sweeping is not done with vacuum sweepers. While at the plant, I did not notice compressed air being used to clean production machines.

Survey Procedures and Results

The Pennsylvania State Health Department conducted the asbestos dust survey under a contract with the U.S. Public Health Service. All sampling equipment was furnished and calibrated by the Public Health Service.

A total of 335 personal samples were taken in the textile, friction, and packing areas of the plant. The breakdown was: 117 samples in textile, 149 samples in friction, and 69 samples in packing. In addition, high volume samples were taken at most operations.

All personal samples were collected on Millipore Type AA membrane filters at a flow rate of 1.7 liters per minute. The samples were analyzed by counting asbestos fibers using phase contrast illumination. The counter was trained by the U.S. Public Health Service. The results of the survey and a comparison with past P.H.S. surveys are given in the appendix.

An emergency standard for asbestos dust was published in the Federal Register on December 7, 1971. The standard is as follows:

"The 8-hour time-weighted average airborne concentration of asbestos dust to which employees are exposed shall not exceed five fibers per milliliter greater than five microns in length, as determined by the membrane filter method at 400-450X magnification (4 millimeter objective) phase contrast illumination. Concentrations above five fibers per milliliter, but not to exceed ten fibers per milliliter, may be permitted up to a total of 15 minutes in an hour for up to five hours in an 8-hour day."

The present survey results show that concentrations in the following jobs exceeded the average standard:

1. Waste Machine Operator (textile)
2. Fiber Preparation Stocker (textile)
3. Carding Stocker (textile)
4. Ring Spinner (textile)
5. Machine Brander (friction)

In addition to exceeding the average standard, three of the above mentioned jobs had concentrations which exceeded the peak standard. These jobs are:

1. Waste Machine Operator (textile)
2. Fiber Preparation Stocker (textile)
3. Machine Brander (friction)

Conclusions and Recommendations

In general, the only areas of the plant which appear to have a serious asbestos dust problem is the textile mill and the finishing area of friction products. The following are recommendations which are necessary to lower asbestos exposur

1. A thorough evaluation of existing ventilation in the fiber preparation and carding areas of the textile mill should be made as present volumes and velocities appear low. This evaluation should include a thorough study of the present make-up air system.
2. Spinning operations should be provided with ventilation immediately.
3. Although dusting of clutch facings and brake linings is done prior to machine branding, all surveys indicate that branders experience rather high concentrations. Local exhaust ventilation should be provided at these machines.

A P P E N D I X

Table #	Title
1	Production Raw Materials List
2	Number of Employees by Areas
3	Results of Asbestos Dust Survey Conducted by Pennsylvania State Health Department
4	Comparison of Past U.S.P.H.S. Surveys and Present Survey

RAYBESTOS MANHATTAN INC.

Manheim, Pennsylvania

PRODUCTION RAW MATERIALS LIST

	# TYPES	
1. *Asbestos Fibers*		
20 Grades		
2. *Cements and Adhesives*		
6 Products - Phenolic and/or Hycar		
3. *Chemicals*		
Processing Aids (organic)	9	
Processing Oils (hydrocarbon)	2	
Rubber Antioxidants	3	
Rubber Accelerators	6	
Lubricants	22	
Hexamethylenetetramine	2	Grades
Ammonium Bicarbonate		
Magnesium Oxide		
Anhydrous Ammonia		
Ammonia Chloride		
Wetting Agents	2	
Talcs	2	
Sodium Silicate		
Zinc Stearate		
Zinc Oxide		
Aluminum Stearate		
Lead Acetate		
Sodium Chloride		
Sodium Acetate		
Chrome Oxide		
Aluminum Oxide		
Antimony Oxide		
Molybdenum Di Sulfide		
Triethanolamine		
4. *Coloring Agents*		
Iron Oxides	5	
Organic Pigments	5	
Dyes	2	

PRODUCTION RAW MATERIALS LIST	# TYPES	TABLE I
5. *Organic Fibers*		
Cotton	2 Grades	
Flax	4 Grades	
Jute	5 Grades	
Rayon	4 Grades	
Dacron	1 Grades	
Nylon	2 Grades	
6. *Fillers and Compounding Ingredients*		
Graphites	9	
Litharges	4	
Carbons	12	
Waxes	3	
Silicates	9	
Barium Sulfates	3	
Corks	2	
Micas	2	
Starches	2	
Sulfurs	2	
Cryolite	1	
Calcium Carbonate	1	
Wood Flour	1	
7. *Fluorocarbon Products*		
TFE Resins and Compounds	21	
FEP	1	
CTFE	1	
Dispersions	2	
Filament	3	
8. *Metals*		
Brass	7 Forms	(Powder, Chips, Wire, etc.)
Copper	3 Forms	(Powder, Chips, Wire, etc.)
Zinc	5 Forms	(Powder, Chips, Wire, etc.)
Iron	3 Forms	(Powder, Chips, Wire, etc.)
Lead	7 Forms	(Powder, Chips, Wire, etc.)
Sodium	1 Form	(Powder, Chips, Wire, etc.)
Aluminum	1 Form	(Powder, Chips, Wire, etc.)
Monel	2 Forms	(Powder, Chips, Wire, etc.)
Stainless Steel	6 Forms	(Powder, Chips, Wire, etc.)
Inconel	1	
Steel	1	

PRODUCTION RAW MATERIALS LIST	*# TYPES*
9. Resins	TABLE I
Phenolic	40
Drying Oils	2
Bitumens	3
Silicone	2
Terpene	1
10. Rubbers	
NR	3
SBR	4
NBR	4
IIR	1
CR	1
Viton	1
11. Solvents	
Hydrocarbon	6
Oxygenated	4
12. Miscellaneous	
Fiberglass	4 Forms (Cloth, Roving, Tape, etc.)
Cloth	4
Metal Brake Shoes, rivets	
Polyethylene and other wrapping, and separators, films	
Nylon and Steel Strapping	
Operating supplies - lubricants, abrasives, cutting tools, etc.	

TABLE II

NUMBER OF EMPLOYEES BY AREAS

First Shift Only

I.	TEXTILE	
	1. Fiber Preparation	7
	2. Carding	30
	3. Spinning	12
	4. Twisting & Speeders	19
	5. Winding	9
	6. Weaving	57
	7. Rope, Wick, Braid, Cord Production	1
	TOTAL	135
II.	FRICTION (CLUTCH & BRAKE)	
	1. Mixing, Coating & Extruding	8
	2. Forming (Chevron Winding, Preforming, etc.)	22
	3. Hot Pressing	18
	4. Baking	2
	5. Grinding and Sanding	20
	6. Cutting and Drilling	16
	7. Bonding and Riveting	8
	8. Inspection and Packing	20
	9. Miscellaneous (Truck, Stock, Service)	30
	TOTAL	144
III.	PACKING	
	1. Braiding & Yarn Winding	8
	2. Mixing & Calendering	11
	3. Coating Operations	7
	4. Forming, Pressing, Wrapping, Sewing, Molding	15
	5. Cutting & Trimming	6
	TOTAL	57

TABLE III

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY & HEALTH
Division of Field Studies & Clinical Investigations
February 3, 1972 *Plants 8, 9, & 10*

RAYBESTOS MANHATTAN INC.
Manheim, Pennsylvania

Textiles, Friction Products, Packing Materials

PENNSYLVANIA STATE HEALTH DEPARTMENT
November 15, 1971
to
December 3, 1971

PERSONAL SAMPLES

OPERATION & JOB	SAMPLE #	PERSONAL SAMPLE CONC. FIBERS >5μ/ml
TEXTILE		
100 - Fiber Preparation		
Waste Machine Operator	1	23.7
Waste Machine Operator	4	6.6
Cotton Machine Operator	2	4.2
Cotton Machine Operator	5	5.3
Stocker	6	11.5
Mechanic	3	4.3
Scholfield Crusher Operator	322	2.9
110 - Carding		
Lap Card Operator	7	4.1
Lap Card Operator	12	1.9
Lap Card Operator	132	4.9
Card Tender	11	7.6
Card Tender	136	3.6
Card Tender	137	1.9
Card Tender	138	4.1
Fixer Carding	15	4.1
Fixer Carding	133	1.2
Fixer Carding	134	1.2
Stocker	10	7.2
Stocker	139	5.8
Grinder	8	3.7
Grinder	9	2.0
Sweeper	14	3.3
Sweeper	135	2.3

TABLE III

OPERATION & JOB	SAMPLE #	PERSONAL SAMPLE CONC. FIBERS >5μ/ml
120 - Spinning		
Ring Spinner	16	6.7
Ring Spinner	17	5.4
Ring Spinner	18	2.3
Ring Spinner	19	5.1
Ring Spinner	20	3.7
Ring Spinner	21	6.2
Ring Spinner	22	6.1
Speeder	332	2.1
Speeder	333	2.4
130 - Twisting		
Twister	52	1.9
Twister	53	1.2
Twister	57	1.9
Twister	61	2.3
140 - Winding		
Winder	36	0.5
Winder	37	0.6
Winder	38	1.8
Winder	39	1.4
Winder	40	1.4
Winder	327	1.4
150 - Weaving		
Cloth Weaver	23	0.3
Cloth Weaver	35	2.8
Cloth Weaver	41	2.0
Cloth Weaver	43	3.1
Cloth Weaver	46	1.7
Cloth Weaver	47	2.2
Cloth Weaver	62	0.6
Cloth Weaver	326	2.5
Tape Weaver	185	3.4
Tape Weaver	186	0.1
Tape Weaver	189	4.7
Tape Weaver	190	0.4
Tape Weaver	192	0.3
Tape Weaver	193	0.8
Tape Weaver	195	0.4

TABLE III

OPERATION & JOB	SAMPLE #	PERSONAL SAMPLE CONC. FIBERS >5μ/ml
150 - Weaving (continued)		
Tape Weaver	196	0.0
Tape Weaver	199	1.7
Tape Weaver	201	0.5
Tape Weaver	206	0.8
Tape Weaver	227	0.0
Tape Weaver	230	0.0
Tape Weaver	231	0.1
Tape Weaver	232	0.1
Cop Winder	328	1.4
Cop Winder	330	2.0
Cop Winder	334	1.8
Creeler	24	1.6
Creeler	34	2.0
Creeler	44	1.6
Creeler	45	0.9
Creeler	187	0.8
Creeler	198	0.8
Creeler	202	1.1
Creeler	228	0.1
Stocker	48	0.2
Stocker	49	2.2
Stocker	50	1.0
Stocker	51	1.9
Stocker	54	1.2
Fixer	56	0.3
Sweeper	60	1.7
Sweeper	191	0.3
Loom Inspector	188	0.9
Loom Cleaner	194	0.4
Loom Cleaner	205	0.7
160 - Rope, Wick, Braid & Cord		
Wick Card Operator	13	5.8
Slubber Operator	55	1.5
Slubber Operator	58	1.7
Slubber Operator	59	3.9
Slubber Operator	331	2.2
Roper Operator	100	1.2
170 - Finishing		
Cloth Dryer	25	3.5
Cloth Dryer	26	2.4
Cloth Dryer	27	4.6
Cloth Dryer	28	2.7

TABLE III

OPERATION & JOB	SAMPLE #	PERSONAL SAMPLE CONC. FIBERS >5μ/ml
170 - Finishing (continued)		
Cloth Dryer	29	6.7
Cloth Dryer	30	2.2
Cloth Dryer	31	3.5
Cloth Dryer	32	3.0
Cloth Dryer	33	4.5
Packer	63	0.6
Packer	64	0.4
Clerk	203	0.6
Clerk	329	1.8
Slitter Operator	65	0.5
Slitter Operator	66	0.5
Inspector	71	0.1
Tape Cutter	204	0.6
Tape Cutter	229	0.0
Calender Operator	208	0.6
Tape Inspector	207	0.5
180 - Miscellaneous		
Foreman (T-3, T-1)	67	0.2
Foreman (T-12)	197	0.3
Utility Operator	200	0.4
Williams Crusher Operator	335	6.2
FRICTION PRODUCTS		
210 - Mixing, Coating & Extruding		
Mixer	182	2.1
Mixer	294	2.0
Crusher Operator	97	0.1
Extruder Operator	98	0.0
Preform Operator	242	0.0
Preform Operator	243	0.2
220 - Forming		
3-Roll Calender Operator	108	1.3
Block Rock Calender Operator	109	2.1
Form Fitter	155	1.7
Form Fitter	163	0.7
Form Fitter	164	1.1
Form Fitter	224	0.0
Form Fitter	225	0.2
Slitter Operator	157	2.5
Slitter Operator	160	1.1
Slitter Operator	161	0.8

TABLE III

OPERATION & JOB	SAMPLE #	PERSONAL SAMPLE CONC. FIBERS >5μ/ml
220 - Forming (continued)		
Bender Operator	162	2.2
Convexor	219	0.1
Chevron Winder	233	0.2
Chevron Winder	234	0.4
Chevron Winder	235	0.3
Chevron Winder	237	0.0
Chevron Winder	238	0.2
Chevron Winder	239	0.1
Chevron Winder	240	0.6
Chevron Winder	241	0.0
Material Handler	236	0.0
230 - Hot Pressing		
Hot Press Operator	140	1.6
Hot Press Operator	141	0.8
Hot Press Operator	181	3.8
Hot Press Operator	244	0.1
Hot Press Operator	245	0.0
Hot Press Operator	246	0.1
Hot Press Operator	247	0.0
Hot Press Operator	248	0.2
Hot Press Operator	249	0.0
Hot Press Operator	251	0.0
Hot Press Operator	252	0.0
Hot Press Operator	253	0.0
Hot Press Operator	295	0.5
Material Handler	254	0.0
240 - Baking		
Oven Operator	72	0.7
Oven Operator	73	0.9
Oven Operator	101	0.2
Oven Operator	143	2.8
Oven Operator	279	0.5
250 - Grinding & Sanding		
Radius Grinder Operator	85	0.0
Radius Grinder Operator	166	0.8
Radius Grinder Operator	218	0.6
ID & OD Grinder Operator	266	0.2
ID & OD Grinder Operator	269	0.4
OD Grinder Operator	147	1.1
Grinder Operator	149	0.6
Grinder Operator	156	1.9
Grinder Operator	217	0.9
Grinder Operator	256	0.0

TABLE III

OPERATION & JOB	SAMPLE #	PERSONAL SAMPLE CONC. FIBERS >5μ/ml
250 - Grinding & Sanding (continued)		
Grinder Operator	257	0.0
Edge Grinder	293	1.4
Blanchard Operator	260	0.9
Blanchard Operator	261	0.0
Blanchard Operator	262	0.0
Hanchett Operator	263	0.0
P&W Sander Operator	103	1.3
Buffer Operator	107	0.3
Buffer Operator	145	1.8
Stocker	264	0.0
Stocker	265	0.1
260 - Cutting & Drilling		
Punch Press Operator	104	0.8
Arto Cutter Operator	105	0.9
Drill Press Operator	106	1.6
Groover	146	0.7
Auto Drill Operator	150	2.7
Auto Drill Operator	223	0.0
Hand-Drill Operator	151	1.4
Kingsburg Drill Operator	153	0.6
Kingsburg Drill Operator	221	0.4
Kingsburg Drill Operator	222	0.2
Pexto Cutter Operator	159	1.3
Pexto Cutter Operator	296	1.1
Multiple Drill Operator	267	0.0
Drill Set Up Man	268	0.1
Slip Spindle Drill Operator	270	0.8
Slip Spindle Drill Operator	271	3.6
Slip Spindle Drill Operator	272	3.0
Slip Spindle Drill Operator	281	0.4
270 - Bonding & Riveting		
Bonder	74	0.1
Bonder	75	1.3
Bonder	76	0.1
Bonder	77	0.2
Rivetor	83	0.0
Rivetor	84	0.0
De-rivetor	319	0.1
Alpine Debander	317	1.0
Stocker	318	0.4

TABLE III

OPERATION & JOB	SAMPLE #	PERSONAL SAMPLE CONC. FIBERS >5μ/ml
280 - Inspecting & Packing		
Dipper	79	0.0
Inspector	86	0.0
Inspector	87	0.0
Inspector (F-19)	102	0.4
Inspector	142	1.6
Inspector	143	1.1
Inspector	169	0.6
Inspector	171	3.1
Inspector	172	0.0
Inspector	176	1.4
Inspector	184	0.0
Inspector	278	9.5
Inspector	282	8.0
Inspector	283	2.2
Inspector (F-23)	284	3.3
Spray Painter	88	0.0
Brander (Brake)	89	0.2
Machine Brander	168	0.2
Hand Brander	170	3.1
Machine Brander	286	7.3
Machine Brander	287	6.7
Machine Brander	288	10.3
Packer	90	0.0
Packer	99	0.0
Packer	177	0.4
Packer	178	0.3
Packer	179	0.0
Packer	289	3.3
Packer	290	6.5
Packer	292	2.4
Shipper	91	0.0
Dusting Machine Operator	275	2.3
290 - Miscellaneous		
Stocker	80	0.0
Stocker	81	0.0
Stocker	94	0.0
Stocker	158	1.3
Stocker	165	1.0

TABLE III

OPERATION & JOB	SAMPLE #	PERSONAL SAMPLE CONC. FIBERS >5μ/ml
290 - Miscellaneous (continued)		
"Tumblast" Operator	91	0.2
"Tumblast" Operator	92	0.3
Foreman (Brake)	95	0.0
Foreman (F-19)	111	0.2
Foreman	149	0.3
Mechanic	110	0.5
Mechanic	276	0.1
Mechanic	277	0.1
Supervisor (F-29)	291	0.0
Tool Mechanic	273	0.4
Stocker	173	0.0
Maintenance	250	0.2
Sweeper	255	0.3
Stock-Serviceman	258	0.0
Stock Serviceman	259	0.0
Group Leader (Packing)	180	0.1
Cement Machine Operator	174	0.3
Cement Machine Operator	175	0.9
PACKING		
400 - Braiding		
Lattice Braider	117	0.1
Lattice Braider	118	0.1
Lattice Braider	119	0.0
Braider	209	1.4
Braider	210	0.5
Braider	213	0.4
Square Braider	215	0.0
Flax & Jute Braider	299	1.7
Yarn Service	212	0.1
410 - Mixing & Calendering		
Weigher	313	0.0
Calender Operator	316	3.0
420 - Coating		
Ring Preform Dipper	131	0.7
Yarn Lubricator	214	0.3
Lubricator	305	0.2
Vulcanizer	309	0.1

TABLE III

OPERATION & JOB	SAMPLE #	PERSONAL SAMPLE CONC. FIBERS >5μ/ml
430 - Forming		
Spiral Operator	125	0.2
Spiral Operator	307	0.0
Packing Maker	112	0.1
Preformer	114	0.0
Preformer	128	0.3
Spiral Press Operator	126	0.2
Hot Press Operator	127	0.7
Hose Machine Operator	129	0.3
Hose Machine Operator	311	0.0
Lead Wrapper	303	0.0
Rubber Machine Operator	312	0.0
440 - Cutting & Trimming		
Spiral Trimmer	116	0.1
Hand Ring Cutter	120	0.0
Cloth Bias Cutter	121	0.0
Preform Cutter	131	0.8
Unit Ring Cutter	300	0.6
Punch Press Operator	301	0.0
440 - Inspection & Packing		
Ring Inspector	122	0.0
Ring Inspector	124	0.2
Inspector	216	0.3
Inspector	297	0.1
Inspector	304	0.0
Inspector	306	0.0
Packer	115	0.0
Packer	314	0.0
Packer	315	0.0
Box Maker	308	0.0
490 - Miscellaneous		
Sweeper	113	0.3
Stock Servicer	123	0.0
Machine Cleaner	211	0.2
Foreman	298	0.0

TABLE IV

COMPARISON OF PAST U.S.P.H.S. SURVEYS AND PRESENT SURVEY

OPERATION	MEAN CONCENTRATION (FIBERS >5μ IN LENGTH/ml) AND NUMBER OF SAMPLES ( )			
	AUGUST 1964	AUGUST 1967	JANUARY 1971	NOVEMBER 1971
TEXTILE				
Fiber Preparation	2.5 (7)	6.9 (6)	11.0 (2)	8.4 (7)
Carding	2.8 (42)	8.5 (7)	6.1 (14)	3.7 (16)
Spinning	1.9 (17)	5.8 (5)	6.9 (6)	4.4 (9)
Twisting	3.3 (27)	2.6 (6)	3.2 (8)	1.9 (4)
Winding	2.9 (8)	-------	2.0 (5)	1.2 (6)
Weaving	2.3 (70)	2.2 (11)	4.8 (12)	1.3 (45)
Finishing	--------	-------	2.5 (3)	2.0 (20)
FRICTION				
Mixing, Extruding	4.1 (4)	0.7 (2)	5.3 (2)	0.7 (6)
Forming	1.4 (13)	2.1 (8)	0.5 (6)	0.7 (21)
Hot Pressing	1.1 (14)	1.4 (5)	0.5 (7)	0.5 (14)
Baking	1.0 (8)	0.6 (4)	0.4 (2)	1.0 (5)
Grinding & Sanding	3.2 (23)	1.3 (9)	1.1 (10)	0.6 (21)
Cutting & Drilling	1.2 (25)	2.7 (6)	4.0 (12)	1.1 (18)
Bonding & Riveting	0.8 (6)	0.2 (2)	2.8 (4)	0.4 (9)
Inspection & Packing	3.3 (20)	6.8 (1)	3.3 (13)	2.3 (32)
PACKING				
Braiding	3.1 (11)	12.8 (1)	0.3 (5)	0.5 (9)
Mixing & Calendering	0.2 (13)	1.8 (2)	0.2 (3)	1.5 (2)
Coating	0.4 (7)	2.1 (1)	0.6 (1)	0.3 (4)
Forming	0.2 (21)	2.4 (5)	1.3 (9)	0.2 (11)
Cutting & Trimming	0.3 (10)	0.6 (1)	1.6 (8)	0.3 (6)
Weaving	--------	-------	13.6 (5)	--------
Inspection	1.3 (8)	-------	0.9 (2)	0.1 (10)