

BYSSINOSIS

AN INDUSTRIAL HYGIENE AND MEDICAL SURVEY

OF

THE STEARNS AND FOSTER COMPANY

LOCKLAND, OHIO

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DIVISION OF FIELD STUDIES AND CLINICAL INVESTIGATIONS  
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CINCINNATI, OHIO 45202

DATES OF SURVEY:

APRIL 16 - 20, 23 and 30, 1973

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INDUSTRIAL HYGIENE AND MEDICAL SURVEY

Place visited: The Stearns and Foster Company  
East Wyoming Avenue and Williams  
Cincinnati, Ohio 45215  
513-821-0700

Dates of survey: April 16 - 20, 23 and 30, 1973

Company personnel contacted: William Smetts,  
Vice President for Industrial Relations

Jack Shreffler,  
Industrial Engineer, Mattress Division

John Patterson,  
Safety and Security Director

Purpose of study: To conduct a respiratory function and  
byssinosis survey of production workers  
in a mattress manufacturing operation  
and to determine associated cotton dust  
levels.



## INTRODUCTION

The National Institute for Occupational Safety and Health is charged with the investigation of hazardous substances in the workplace. As part of this mission, the Division of Field Studies and Clinical Investigations has been involved in the study of byssinosis in several facilities dealing with raw cotton. This report is a combined environmental and medical survey of a mattress manufacturing facility initially designed to assess differences in exposures between this and other facilities and differences in reaction by employees to the exposures. Because of various factors, the report as it is here presented is a less general one, and is primarily a descriptive analysis of conditions as they exist in a single facility.

## DESCRIPTION OF PROCESSES

## Mattress Division

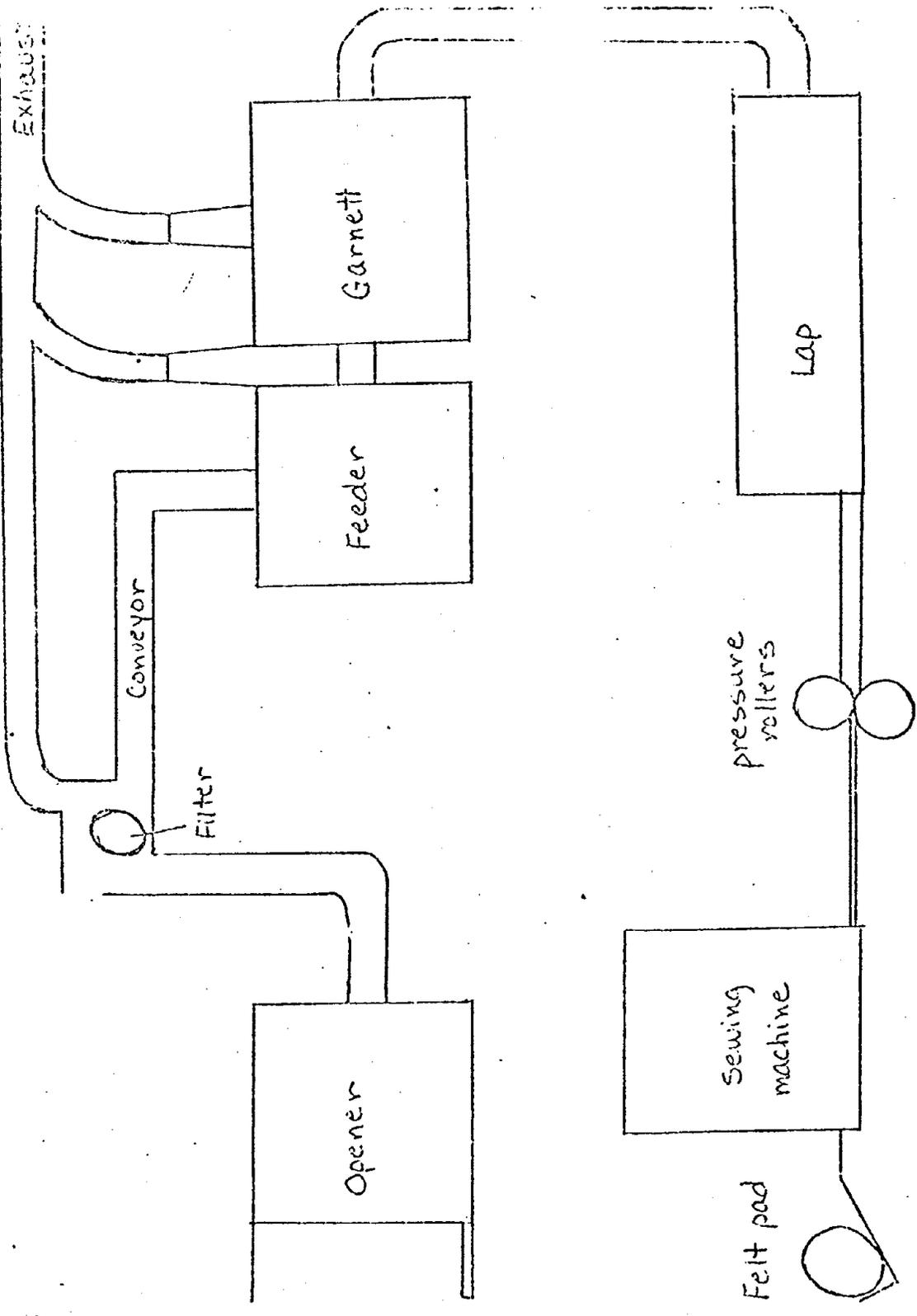
Raw materials for manufacturing mattresses include three types of cotton, tuflex, dacron, polyurethane, horsehair, springs, wood frames, cheese cloth, and ticking. The three types of cotton are of different grades, depending on the supplier. Grade is determined by fiber length and trash content. Usual suppliers are cotton gins and mills, which deliver various grades of linter and picker cottons.

## Garnetting

All of the raw cotton used in the Mattress Division is delivered to the garnett department where it is opened, mixed, garnetted, cross-lapped, pressed, sewn, and cut into felt pads. There are two old and one new garnetting lines. A typical line of machinery consists of an opener, a condenser, a conveyor, a feeder, a garnett, a lap, a moving floor apron with pressure rollers, and a sewing machine, all of which are illustrated in Figure I. Each of the two older lines (line 50 and 51) at Stearns and Foster have four garnetts and produce felt pads for single bed mattresses, while a newer line (line 52) has three larger garnetts for making felt pads for queen and king size bed mattresses.

Job classifications on each line include: feed man, needle tender, and take off. A feed man rolls off layers of cotton from the proper bales to give the correct blend of picker cotton (used for strength) and linter (used as a filler). The layers are placed on a short conveyor which takes the cotton into the opener. The opener loosens the cotton from its compressed state. At the end of the opener, a light oil and a fluid are sprayed onto the cotton. The process protects the cotton from mildew, and the spray reduced the amount of dust escaping from the opener. The cotton is then sucked up to a condenser, which is an air filter consisting of a perforated metal cylinder, into which air is drawn. The cotton is forced to pass over the condenser before it is belt conveyed to the garnetts. It is dumped into storage hoppers from which a cylinder and comb evenly feed the cotton to the garnett. The garnett consists of two main cylinders and many smaller ones which further separate and form the fibers into a fine web, causing much of the trash to be liberated. This web is combed from the garnett and cross-lapped onto a wide floor conveyor and pressed by rollers. After the pad is trimmed to the correct width, a fabric backing is sewn to the pad with a multi-needle sewing machine operated by the needle tender. The take-off man cuts the felt pads to the specified lengths and identifies them with a marker. The pads are rolled up and carried to the tape edge or quilting areas.

FIGURE I: GARNETT PROCESS



### Sewing and Cutting

Both the box spring and mattress cover fabrics are prepared in the sewing and cutting department. Matching top, bottom, and boarder panels are cut to their appropriate sizes. The boarder panels are then sewn to a washed cotton or synthetic backing and completed with handles and vents. The top and bottom panels are sent to the quilting department, and the boarders are carried to the box spring and tape edge departments.

### Quilting

Eighteen quilting machines are used to sew felt pads (made in garnetting) or dacron pads to top and bottom panels cut in the sewing department. The workers lay the proper pad and panel combination onto one rack while the machine is sewing on another rack. When sewing is complete, loose thread ends are glued down and the completed panels are sent on to the box spring and tape edge departments.

### Coil-Tack and Hand-Tie

Wooden bed frames are prepared in the coil-tack and hand-tie department before being sent to the box spring department for finishing. In coil-tack one man holds the coiled steel springs in place on a wood frame while another fastens them down with a pneumatic stapler. The tops of the coils are then tied together with twine in the hand-tie area. The completed wood frames are conveyed to the box spring department.

### Box Spring and Tape Edge

In the box spring and tape edge (mattress production) departments the materials are put together to form the finished products. For a particular type of box spring or mattress, the proper number and type of cushioning materials are layered onto the springs and stapled in place. Types of cushioning materials used are: felt pads (from garnetting), cotton batting, horsehair, dacron, polyurethane, and tuflex. Felt pads have been replaced by tuflex in the box spring department and the only remaining use of cotton in this department is to pad the corners of the box springs with cotton batting. In the tape edge department, large numbers of felt pads are used. After the padding is on the springs of the mattresses and box springs, they are transferred to another table where the boarders, which are made in the sewing department, are sewn on. The box springs and mattresses then are carried by conveyor to the inspection area and then to the sorting and packing departments.

## Textile Division

The shredding department was the only area visited in the Textile Division of the plant. The shredding process may be considered a pre-step to garnetting. Very low grade and recycled cotton is shredded in machines much like the garnetters to remove trash and comb the cotton into a more uniform fiber length. The shredded cotton is then baled and sent on for further processing.

## INSPECTION OF THE PLANT

A brief overview of the plant conditions, in general, would find that, except for the garnett and shredding areas, housekeeping was good. The only potential health hazard is the cotton dust generated in the garnett area and the shredding area. However, low hanging structures, poor visibility at some corners and intersections, flammable materials, and unguarded parts of machinery do pose potential safety hazards. A few very narrow, wood staircases, which are not enclosed, could also be hazardous in the event of fire, as would the blocking of aisles by the numerous hand carts used to carry mattress materials from one area to another.

Ventilation for the plant is by wall and ceiling fans and open windows during warm weather. Specific dust generating operations have local exhaust ventilation, and in some cases cross-room air movers blow dust away from the work areas.

The garnett department is definitely a problem area in terms of ventilation, housekeeping, and health and safety hazards. Each garnett line has a condenser and a hood on the feeder to the garnett. One other hood is at the middle of each garnett on the older lines and a conopy hood covers the conveyor at the exit of the opener and shredder on the newer line. The exhaust from two of the garnett lines feed to outdoor cyclone dust collectors while the third feeds to an in-room bag filter unit. This ventilation system cannot keep up with the amount of dust and lint produced by the garnetting process. Clouds of dust are continually present in the area, and, despite the efforts of clean-up crews during the last hour and fifteen minutes of both shifts, all surfaces are quickly covered with a deep layer of the dust. The clean-up crews, themselves, cause a dust hazard by using compressed air to blow off the machinery, floors, etc.

All the problems of the garnett department are shared by the shredding department in the Textile Division. Bad ventilation and a dusty operation, processing very trashy and recycled cotton, are combined to make this department very dusty.

Non-toxic dust masks are provided for the workers in garnetting and shredding and, although required, are generally not worn. Respirators designed to protect against toxic dust, such as cotton dust, were not being worn during this survey.

Safety hazards of both garnetting and shredding included open machinery, and bales of cotton and recycled waste covering the floor around the openers making it very difficult to walk through those areas.

## SURVEY PROCEDURES

### Environmental

Since the environmental data collected on this survey was to be combined with the medical data obtained for a respiratory function and byssinosis study, it was necessary to design the environmental survey procedures around certain requirements of the medical study. Environmental sampling was conducted on the same days as the medical survey, three consecutive Mondays in April (16th, 20th, and 23rd), and, in order to attempt to make some dose-response conclusions about byssinosis, environmental sampling was conducted in the departments of the employees involved in the medical study. To insure the accuracy of the cotton dust exposure levels found in the different departments, it was decided that the sampling would proceed throughout the first week (only three additional days due to a company holiday) in addition to the three Mondays.

The garnett department became the focus of both the medical and environmental survey because of the number of men being exposed to excessive levels of raw cotton dust as reported by Fleming,<sup>1,2</sup> in the results of the NIOSH cotton dust survey of this plant conducted in May and August, 1972. Areas of middle and low levels of cotton dust exposure also were chosen on the basis of the Fleming reports. The quilting and tape edge departments were considered medium exposure areas and the box spring and hand-tie and coil-tack departments were chosen as low exposure areas.

Recognized by the American Conference of Governmental Industrial Hygienists (ACGIH) as the state of the art for respirable sampling, vertical elutriators were used for the majority of samples.<sup>3</sup> However, limited sampling was performed utilizing the Occupational Safety and Health Administration (OSHA)<sup>4</sup> method of personal sampling in the garnett and shredding departments.

For both sampling methods, dust was collected on 37mm diameter polyvinyl chloride membrane filters of 5 $\mu$  pore size made by Mine Safety Appliance (MSA). The filters were held in standard three piece cassettes with the cover cap removed exposing the entire face of the filter. All filters were tared and re-weighed on the 20 milligram "A" scale of a Cahn Gram Electrobalance ( $\pm$  1.0 microgram). Initial concerns that moisture absorbed by the cotton dust on the filters would bias the weighing results were proven to be unfounded. In a side experiment which involved 50 of the cotton dust samples collected by both methods, the samples were weighed, vacuum desiccated for 72 hours and then re-weighed, It was shown that less than half of one percent of the total weight could be attributed to the absorption of water by the dust on the filter or the filter itself.

### Vertical Elutriators

The vertical elutriators used in this survey are designed to collect only respirable dust, i.e., that dust which is less than 15  $\mu$ m in diameter. A critical orifice regulates each elutriator to a flow rate of approximately 7.4 liters per minute. Electric timers controlled the period of each sample to eight hours except in the case of garnetting where four-hour samples were collected. The elutriators were hung on building support columns to collect dust samples at a height of four to six feet from the floor in positions as close as possible to the areas of interest.

Since the vertical elutriator is an area sampler, it was necessary to do a time study on the workers in the areas surveyed to determine daily Time Weighted Average (TWA) exposures. This was relatively easy to do at Stearns and Foster since most of the men remained at one location during work time, and generally adhered to specified break times quite rigorously (see Appendix I). The resulting TWA exposures represent average dust concentrations in milligrams per cubic meter of air exposed to a worker during a typical eight-hour work period.

The final distribution of vertical elutriators into the high, middle, and low exposure areas was as follows: ten in the high exposure area of garnetting, two each in the middle exposure areas of quilting and tape edge, and two in the low exposure areas (one in the box spring and one in the hand-tie and coil-tack department). In addition to the six day shifts sampled in all areas, three night shifts were sampled in quilting and four night shifts in garnetting. This procedure gave totals of 86 samples in garnetting, 18 in quilting, 10 in tape edge, 5 in box spring, and 5 in hand-tie and coil-tack.

## Personal Samples

Personal gross (total dust) samples were taken in the shredding (Textile Division) and garnetting areas only. Each worker sampled carried a MSA, Model "G" personal pump which drew air through a standard 37mm filter cassette at a calibrated rate of 2.0 liters per minute. The cassette was attached to the worker's clothing near his breathing zone with the exposed filter facing down

Both first and second shifts were sampled on two different days in garnetting. Samples in this area include those from the following workers: 10 feed men, 9 needle tenders, 10 take-off men, three bail truckers, 1 lead man, and 1 mechanic. Sampling times of 2 1/2 and 3 1/2 hours were sufficient in this area.

In the shredding department two shifts of operators were sampled giving a total of five personal samples. Additional data were acquired by setting out four personal samplers in different parts of the shredding room as area samples. Sampling times in the shredding area ranged from 4 - 6 1/2 hours.

## Medical

The medical survey was performed on three successive Mondays (April 16, 20 and 23) after each employee had had a weekend away from the plant. Two Ohio 800 spirometers modified for digital readout of Forced Vital Capacity (FVC) and Forced Expiratory Volume at one second ( $FEV_{1.0}$ ) were utilized. Each employee was tested in the morning prior to entering the plant and again in the afternoon following his shift. The same spirometer was always used for all testing of each employee. Permanent records of flow-volume loops were made using a storage oscilloscope and recording the image of the multiple trials on Polaroid Land Film. Forced expiratory flow measurements at 50 percent of vital capacity (FEF50) were calculated from these photographs. All raw data were converted to Body Temperature and Pressure standard (BTPS) before analysis using standard techniques programmed on a Univac Computer. In addition a respiratory health questionnaire was administered to each tested employee.

## RESULTS AND DISCUSSION

### Environmental

The results of the environmental survey concurred with previous surveys. Virtually no dust was found in any of the departments except garnetting and shredding, and in these areas the exposure to raw cotton dust was many times greater than the present OSHA standard of 1 mg/m<sup>3</sup> total cotton dust and the recommended ACGIH standard of 0.2 mg/m<sup>3</sup> cotton dust measured by the vertical elutriator.

TABLE I.

SUMMARY OF RESPIRABLE DUST CONCENTRATIONS (VERTICAL ELUTRIATOR)  
 Stearns and Foster, Lockland Plant, April 16-20, 23 and 30, 1973

Area	Samplers	No. of Samples	Range Low High	Mean (mg/m <sup>3</sup> )	Std. Dv.	*TWA (mg/m <sup>3</sup> )
Garnet Department	1-10	86	0.28 28.84	6.06	4.95	**3.65
Feed men	1,6	19	0.62 7.52	3.93	1.78	3.52
Needle tenders	2,8	18	1.29 9.79	4.67	2.24	4.18
Take off men	4,7	16	0.59 8.07	3.82	2.46	3.42
West aisle	10	8	0.28 7.59	3.62	2.41	NA
Between garnetters	3,5,9	25	2.89 28.84	10.89	6.39	NA
Tape Edge Department	11,12	10	0.56 3.85	0.36	0.29	0.31
Quilting Department	15,16	18	0.17 0.50	0.28	0.10	0.24
Box Spring Department	13	5	0.26 0.75	0.43	0.21	0.37
Hand Tie and Coil Tack Dept.	14	5	0.10 0.64	0.24	0.23	0.21

\* ACGIH Recommended Standard is 0.2 mg/m<sup>3</sup>.

\*\* Pertains to work areas only

### Vertical Elutriator Data

Table I summarizes the vertical elutriator data found as presented in detail in Appendix II. One hundred and twenty-four respirable dust samples were collected from 16 vertical elutriator sampler positions. Sampler positions 3, 5, and 9 were between garnetters and are not considered work areas; therefore, TWA exposures for the garnett department do not include the data collected at these positions. The decrease in concentrations between each job-type mean and its corresponding TWA exposure levels reflects the no-exposure times of breaks and lunch as given in Appendix I. Even with 50 minutes of assumed no-exposure time, the TWA value of  $3.65 \text{ mg/m}^3$  for the workers in the garnett department is 18 times the ACGIH recommended standard of  $0.2 \text{ mg/m}^3$  for respirable cotton dust.<sup>5</sup> Although the other departments show TWA values greater than  $0.2 \text{ mg/m}^3$ , the use of raw cotton in these departments is so limited or non-existent that these numbers should be considered nuisance dust concentrations.

Table II breaks down the information given in Table I into the high, middle, and low exposure groups used in the medical portion of the survey. It is apparent that better titles for these groups would be excessive and little or no exposure.

### Personal Sampling Data

Table III summarizes the data collected with personal samplers given in detail as Appendix III. The present OSHA standard for total raw cotton dust is based on this personal method and is presently  $1 \text{ mg/m}^3$ .

The 34 samples taken in the garnett room gave a TWA of  $5.99 \text{ mg/m}^3$  which is nearly six times the OSHA standard, and twice the serious hazard level (Appendix IV). Table III concurs with Table II in showing that the needle tender is exposed to more cotton dust than the other two workers on a garnett line; i.e., the feed man and take-off man. It also is noted that the mechanic, who was exposed to the highest exposure concentration of  $10.91 \text{ mg/m}^3$  while working between the garnetts, was never observed wearing a respirator.

Although the shredding department processes raw cotton blended with a variety of other materials, the TWA value of  $1 \text{ mg/m}^3$  pertains to this area also in the opinion of OSHA (see Appendix V). The machine operators in this area were exposed to a TWA of  $5.53 \text{ mg/m}^3$ . The area samples taken with the personal sampling method had a mean concentration of  $3.86 \text{ mg/m}^3$ . The area samplers could not be placed as close as the operators to the dust producing parts of the shredders, so the lower concentrations found by the area samplers were expected.

TABLE II

RESPIRABLE DUST CONCENTRATIONS (VERTICAL ELUTRIATORS) OF HIGH, MIDDLE, AND LOW EXPOSURE GROUPS

Stearns and Foster, Lockland Plant, April 16-20, 23 and 30, 1973

EXPOSURE GROUP	LOCATIONS	SAMPLERS	NO. OF SAMPLES	RANGE (mg/m <sup>3</sup> ) LOW	HIGH	MEAN (mg/m <sup>3</sup> )	STD. DEV.	TWA (mg/m <sup>3</sup> )
high	Garnet room work areas only	1,2,4,6,7,8,10	61	0.28	9.79	4.08	2.17	3.65
middle	Tape edge and quilting departments	11,12,15,16	28	0.16	1.10	0.31	0.20	0.27
low	Box spring and hand-tie and coil-tack departments	13,14	10	0.10	0.75	0.33	0.23	0.28

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TABLE III.

SUMMARY OF TOTAL COTTON DUST CONCENTRATIONS USING PERSONAL SAMPLERS  
Stearns and Foster, Lockland Plant, April 16-20, 23 and 30, 1973

Job Classification	Number of Samples	Range (mg/m <sup>3</sup> )		High	Mean (mg/m <sup>3</sup> )	Std. Dev.	*TWA (mg/m <sup>3</sup> )
		Low	High				
Garnet Department	34	1.33	14.50	6.38	3.15	5.99	
Feed men	10	3.12	14.50	7.80	3.69	7.31	
Needle tenders	9	1.33	10.11	5.37	2.69	5.03	
Take off men	10	1.67	10.28	6.10	2.77	5.72	
Bail Truckers	3	2.97	6.57	4.75	1.80	4.45	
Lead man	1	3.78	3.78	3.78	-	3.54	
Mechanic	1	11.64	11.64	11.64	-	10.91	
Shredding Department	9	0.82	9.67	4.99	3.26	-	
Machine operators	5	0.82	9.67	5.9	3.84	5.53	
Area Samples	4	1.38	6.71	3.86	2.36	-	

\* Legal standard is 1 mg/m<sup>3</sup>.

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### General Observations

The levels of concentrations of dust did vary from day to day with existing weather conditions as well as production rate. A review of the data shows that 14 of the 16 vertical elutriator locations had higher than average concentrations recorded on Wednesday, April 18. Conversely, 12 positions recorded lower than average concentrations on Monday, April 23, and Monday, April 30.

First shift dust levels are a bit higher than those recorded for the second shift, but not as much as was expected. Also, there is only a slight increase in dust levels from the first half of an eight hour shift to the last half, even though clean-up operations are done at the ends of each shift.

Observations of the usage of the particle masks provided by the Company in a recently initiated program resulted in the following conclusions. During the first week of sampling, the day shift workers in the garnett room were very consistent in wearing the masks at their working stations. By the third week, however, it was apparent that the workers had grown tired of the masks, and usage dropped to just over half. On a quick walk-through of the area made two weeks after the survey (May 8, 1973), it was observed that only a few men had a mask. There was less participation during the night shift in the garnett area, probably because the area appears to be less dusty at night. But, as stated earlier, the levels of respirable dust are almost as high in the night as they are during the day. No one in the shredding department was ever observed wearing a mask.

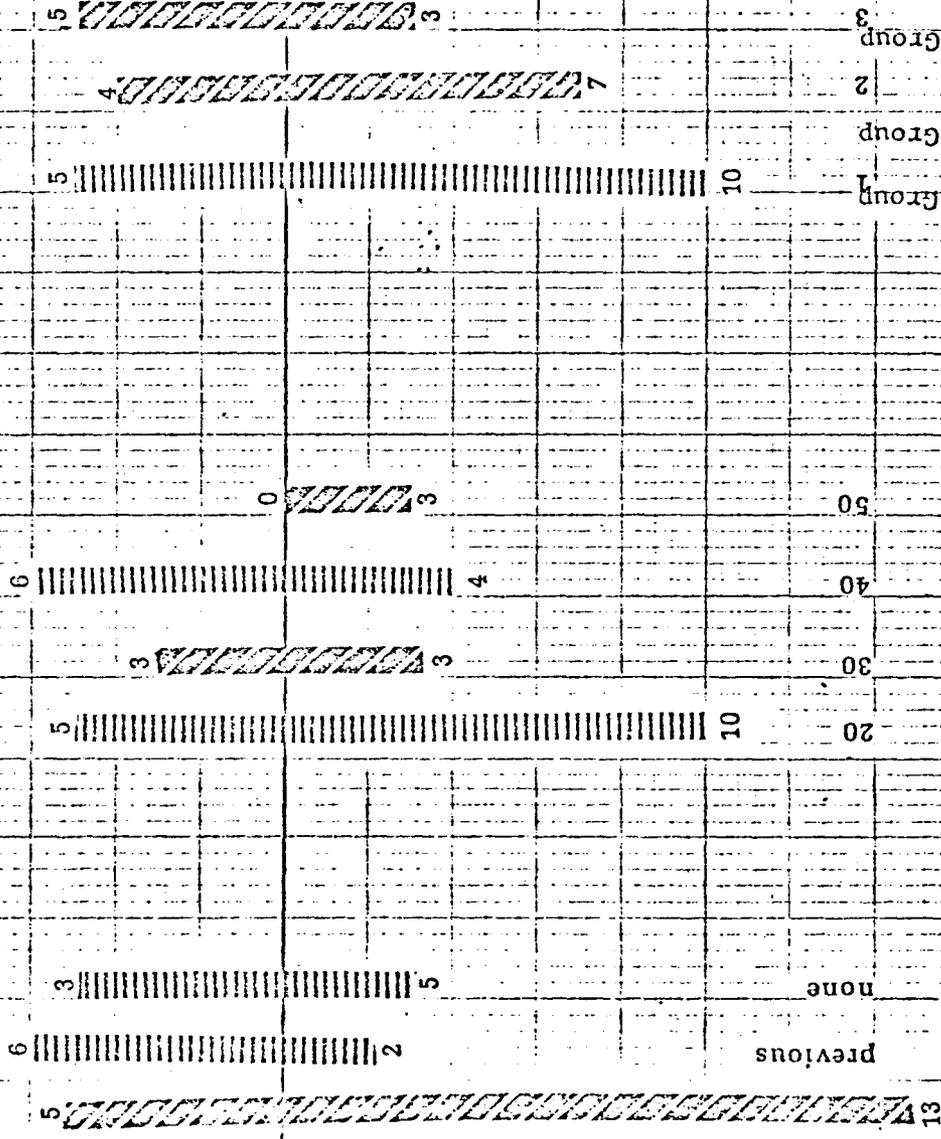
### Medical

Thirty-four individuals were tested for changes in pulmonary function. An initial attempt to age-match the most exposed groups, the garnetters, with other less exposed groups was made. The matching pairs and trials are presented in the following table:

Change of +  
in  
FEV<sub>1.0</sub>

(p.m. - a.m.)

Stearns and Foster, Lockland Plant, April 16-20, 23 and 30, 1973



smoking

age

work area

10a

TABLE IV

subj.	dFEF50	%dFEF	decade	cotton	exposure	smoking	byss	branch	dFEV 1.0	%dFEV 1.0
01	-0.46	-21	4	1	1	28	0	2	-0.22	-7
02	+0.57	+30	4	1	1	03	0	2	0.26	10
03	+0.29	+15	4	1	1	30	0	2	0.13	5
04	-0.18	-7	4	1	1	26	0	2	0.22	7
05	-0.14	-3	3	1	1	13	1	2	-0.10	-2
06	+0.29	+35	4	3	3	35	0	1	0.18	7
07	-0.27	-16	4	3	3	20	0	2	0.04	1
08	-0.28	-16	4	3	3	24	0	2	-0.15	-4
10	-0.32	-21	2	2	2	00	0	0	-0.20	-8
13	-0.57	-29	4	1	1	25	0	0	-0.14	-4
15	-0.15	-9	5	1	1	35	1	3	-0.35	-10
16	-0.04	-4	5	1	1	30	0	1	-0.83	-33
17	-0.11	-4	2	1	1	08	0	2	-0.02	0
18	-0.22	-7	2	1	1	03	0	0	-0.27	-5
19	+0.24	+14	4	2	2	05	0	2	-0.10	-3
20	+0.29	+11	2	2	2	02	2	3	0.08	2
21	+0.21	+8	2	1	1	0.5	0	0	0.01	0
22	-0.82	-28	2	1	1	22	0	4	-0.27	-5
23	-0.14	-12	2	1	1	0.5	0	1	-0.05	-2
24	+0.07	+2	2	1	1	00	0	0	0.20	6
25	-0.39	-20	4	1	1	23	0	0	-0.13	-5
26	-0.07	-3	4	2	2	00	0	0	0.17	4
27	-0.15	-4	2	2	2	00	0	0	-0.04	-1
28	-0.25	-10	5	2	2	00	0	0	-0.11	-3
29	+0.53	+16	3	2	2	00	0	1	0.03	1
30	-0.32	-9	3	2	2	01	0	0	-0.10	-3
31	+0.03	+1	2	2	2	0.5	1	3	0.08	2
32	+0.11	+4	3	3	3	04	0	0	0.13	3
33	-0.36	-14	3	3	3	0.8	0	1	0.18	6
35	0.00	0	2	3	3	04	0	3	-0.08	-2
37	+0.17	+7	2	3	3	08	0	2	0.06	1
38	-1.03	-43	3	3	3	63	0	0	-0.09	-2
39	+0.03	+1	2	2	2	00	0	0	-0.15	-4
40	-0.07	-3	2	2	2	00	0	0	-0.05	-1

Explanation of terms overleaf

TABLE IV (cont.)

Explanation of terms:

subject = randomly assigned identification numbers

dFEF 50 = change morning to evening of Forced Expiratory Flow rate, measured at 50% of vital capacity--a measurement of airway obstruction.

%dFEF 50 = percent change in FEF 50

decade = age by decade

cotton exposure = a relative measure of exposure to cotton dust, 1=high, 2=moderate, 3=low

smoking = relative measure of exposure to cigarettes, expressed in pack-years(packs/day x years smoked)

byss = byssinosis symptom index, based on published reports, on a scale of 0 to 4 maximum

bronch = bronchitis symptoms, based on a scale of 0 to 4 maximum.

dFEV 1.0 = change in forced expiratory flow rate measured at 1.0 second, morning to evening--a measurement of airway obstruction

%dFEV 1.0 = percent change in FEV 1.0

Garnettters	Quilting and Tape Edge	Box spring, Hand-Tie and Coil-Tack
1	26	7
2	19	6
3	*	*
4	29	32
5	30	38
13	*	*
15	28	8
16	*	*
17	40	*
18	27	*
21	31	35
22	10	37
23	20	*
24	39	*
25	*	33

\* = no matching data

The heights of the age-matched individuals averaged to within one inch of each other. Comparisons of group performance were made using individual best test scores, mean of three trials morning and afternoon, and by using the means of the various groups. On an individual basis, a number of employees were felt to have changes which might be consistent with reaction to cotton dust and they and their physicians were so informed. On a mean basis, the groups were felt to be too small to yield statistically valid inferences, and this proved to be the case when the results were analyzed both parametrically and non-parametrically.

Table IV presents a brief summary of the results of the medical testing.

Graph I shows the directions of change in the FEV<sub>1</sub> from morning to evening of the employees, separated by three parameters: smoking history, age by decade, and estimation of cotton dust exposure. As may be seen, no obvious trends manifest themselves.

As is stated by the section dealing with the results of environmental monitoring, the levels of exposure were in certain areas of the plant excessive in regard to cotton dust. It would be expected to follow from this statement that there were cases of byssinosis present among employees so exposed. It is felt this is the case. The fact that there is no statistical trend manifested in these results is probably due to several factors: (1) the small sample size; (2) the probability of self selection by the population, e.g., the most symptomatic individual leaving the work area that causes him symptoms; (3) the wearing of dust masks which might have masked responses that otherwise would have been manifested.

To deal briefly with each of these three points:

- (1) The size of the sample is obviously in this case beyond the control of the surveyors. A more suitable population with better distribution of ages and more perfect matching of individuals might have yielded a result with more general application or more statistical force. This shortcoming is a shortcoming in the sense only of general applicability because there are several individuals with definite evidence of impairment of pulmonary function following exposure to their work environment. This is true whether effort dependent or independent variables are analyzed.
- (2) The probability that someone who is grossly symptomatic in a particular area will leave that area is high. Any existing work population, therefore, that is being examined for an uncomfortable manifestation is likely to have selected those most likely to have this manifestation out of the environment. The findings, therefore, in this group, are in no way typical of the reactions a totally random selection of the population would have on entering this environment.
- (3) The wearing of dust masks, though not of the approved type, is a variable that cannot be dealt with in any systematic way, since there is no detailed time-use information concerning their utilization. Additionally, it is a variable in that even though there is a plant regulation concerning their use, this use is haphazard, and was considerably less wide-spread on a non-survey day than during the period of the survey.

## RECOMMENDATIONS

## Environmental

Excessive cotton dust levels in the garnett and shredding departments indicate that further dust control measures are essential. Four approaches to lowering the dust levels are: a change in materials, improved work practices, adequate ventilation and control practices, and improved system design. In box springs, the felt pad has been replaced by tuflex pad, and if a synthetic or non-toxic material such as tuflex could be substituted for felt pads in mattresses and for the other padding applications of cotton batting, the cotton dust problem would not exist. Material substitution is already the trend in automotive upholstery and furniture manufacturing. Also, the use of cotton with less trash content could significantly reduce dust concentrations.

Work practices should be studied to determine if there are dust producing activities which can be eliminated. An obvious target would be curtailing the use of compressed air for clean-up purposes. Efforts should be made to develop a vacuum system to meet this need. Another work practice adding to the overall dust problem is the recycling of waste from clean-up operations. This waste is the cotton which is blown and raked from under machinery and swept up from the floor, and it contains much more trash than the raw cotton. Cleaning this cotton before it is recycled would prevent the recycling of much trash also. Improved methods of cotton handling, such as holding the cotton as far as possible from the breathing zone and placing the cotton on the conveyors instead of tossing it, should be developed and used.

A third approach, which should be used in conjunction with the second, is adequate ventilation. Local exhaust ventilation can be applied to those machines which generate the dust, such as the garnetts, openers, and shredders. Hoods should enclose all of the dust generating areas with sufficient air velocities to capture the respirable size particles and transport them to a collector. A total enclosure may be necessary on the garnetts to efficiently remove the dust while a partial enclosure may work effectively for the openers and shredders.

System design is mentioned mainly as a recommendation for the construction of a new facility instead of modification of an existing one. Along with good work practices, well designed, completely enclosed operations of shredding, opening, conveying, and garnetting would solve the dust problem, and isolate the workers from the hazardous exposed machinery of these operations. Major clean-up of the enclosed areas could be done at the end of the production day, with crews properly protected against any dust that they may stir up themselves.

A final suggestion of washing or steaming the raw cotton before processing would not lower the dust levels of the ginning and shredding rooms, but would remove the health risks in these areas. The OSHA standard for raw cotton dust would no longer apply (see Appendix V) and both ginning and shredding are presently below the OSHA standard for nuisance dust of  $15 \text{ mg/m}^3$ .

Until the concentration of raw cotton dust is reduced to safe levels, vigorous programs should be enforced to guard the workers against restrictive lung diseases. Cartridge-type respirators which are approved by the Bureau of Mines for pneumoniosis-producing dust should be worn in the ginning and shredding rooms.

### Medical

Certain individuals who manifest severe reactions on exposure to cotton dust should seek medical advice from their physicians concerning continued exposure. These individuals and their physicians have already been notified of the findings of these studies, and their reactions will presumably be appropriate to the situation. The Company will be notified in a separate and privileged communication concerning specific individual results of those workers who requested that this information be sent to management.

As far as general medical practices are concerned, the company should establish as part of its normal pre-employment physical examination a set of screening pulmonary function examinations for employees expected to be employed in a high cotton dust exposure area. This testing will serve the dual purpose of protecting the susceptible or diseased individual from continued adverse stimulation and inform the Company concerning potential problems. As with all physiologic functions, the pulmonary system is not stable with time but may alter dynamically. Repeated pulmonary function testing at intervals is, therefore, indicated in exposed workers.

It might be noted that if it is planned to temporarily protect individual workers with cartridge respirators, that there might be individuals in this group for whom the wearing of a respirator carries certain specific dangers, i.e. highly increased resistance to airflow in an individual with compromised pulmonary function may be associated with acute respiratory insufficiency. Therefore, pulmonary function testing should be carried out prior to requiring any individual to wear a mask.

## REFERENCES

1. Fleming, Roy M., "Cotton Dust and Industrial Hygiene Survey," May 1972.
2. Fleming, Roy M., "Cotton Dust Measurements in Mattress Manufacturing," August 1972.
3. Carson, George A.; and Jeremiah R. Lynch, "Calibration of the Vertical Elutriator Cotton Dust Sampler," May 1973.
4. OSHA Sampling Data Sheet #5, January 3, 1972, (see Appendix IV).
5. ACGIH, "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1972," 1972.

APPENDIX

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APPENDIX I

WORK SCHEDULE

Department	Time In	1st Break	Lunch	2nd Break	Time Out
Garnet & shredding	7:00	9:00-9:10	11:30-12:00	2:00-2:10	3:30
	1530	1750-1800	2030-2100	2230-2240	2400
Tape edge	7:00	9:00-9:10	11:45-12:30	2:00-2:10	3:45
Box spring & hand tie	7:00	9:00-9:10	12:00-12:45	2:00-2:10	3:45
Quilting	7:00	8:45-8:55	11:45-12:30	2:15-2:25	3:45

NOTE: These times were used in calculating time weighted averages (TWA) exposures from the vertical elutriator samples. It was assumed that a worker received no exposure during breaks or lunch.

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APPENDIX II

RESPIRABLE DUST CONCENTRATIONS  
USING VERTICAL ELUTRIATORS

Stearns and Foster, Lockland Plant

April 16-20, 23 and 30, 1973

V.E. No.	Location	Date	Sample No.	Time On	Time Off	Flow Rate (lpm)	Total Dust (mg)	Conc. mg/m <sup>3</sup>
1	Garnet Line 52 Feed man area	4/16	362	750	1150	7.58	8.42	4.63
		17	391	755	1155		6.40	3.52
		30	483	730	1130		6.21	3.41
		18	414	1200	1600		4.67	2.57
		19	438	1200	1600		12.43	6.83
		23	474	1205	1555		7.89	4.53
		16	334	1620	2020		4.70	2.58
		17	406	1635	2035		4.82	2.65
		18	422	2000	2400		3.43	1.89
		19	458	2000	2400	7.58	9.79	5.38
6	Garnet Line 50 Feed man area	18	419	810	1210	6.97	1.03	.62
		19	450	820	1220		7.82	4.67
		23	456	815	1215		12.58	7.52
		16	352	1200	1600		7.80	4.66
		17	392	1200	1600		9.39	5.61
		30	480	1130	1530		8.20	4.90
		18	421	1640	2040		3.40	2.03
		16	369	2000	2400		7.60	4.54
		17	410	2000	2400	6.97	3.72	2.22
2	Garnet Line 52 Needle tender area	17	385	755	1155	7.2	8.96	5.19
		18	418	805	1205		3.91	2.26
		19	441	815	1215		6.87	3.98
		23	472	810	1210		16.91	9.79
		16	355	1200	1600		5.28	3.06
		30	477	1130	1530		9.34	5.41
		18	424	1635	2035		4.76	2.75
		16	350	2000	2400		6.64	3.84
		17	397	2000	2400	7.2	10.25	5.93
8	Garnet Line 50 Needle tender area	18	420	815	1215	7.5	2.32	1.29
		19	445	825	1225		11.24	6.24
		23	452	815	1215		13.69	7.61
		16	364	1200	1600		5.54	3.08
		17	387	1200	1600		11.87	6.59

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## Appendix II (continued)

V.E. No.	Location	Date	Sample No.	Time On	Time Off	Flow Rate (lpm)	Total Dust (mg)	Conc. mg/m <sup>3</sup>
8	(continued)	30	476	1130	1530	7.5	11.28	6.27
		18	427	1645	2045		3.39	1.88
		16	370	2000	2400		10.72	5.96
		17	407	2000	2400	7.5	5.37	2.98
4	Garnet Line 51 Take off area	19	434	800	1200	7.69	4.70	2.55
		23	468	810	1210		13.77	7.46
		16	363	1200	1600		3.70	2.00
		17	349	1200	1600		8.61	4.67
		18	401	1200	1600		5.37	2.91
		30	485	1130	1530		9.23	5.00
		19	461	1605	2005	7.69	14.64	7.93
7	Garnet Line 50 Take off area	16	353	805	1205	7.17	3.04	1.77
		17	390	800	1200		7.11	4.13
		30	478	730	1130		13.38	8.07
		18	417	1200	1600		3.87	2.25
		19	459	1200	1600		1.02	0.59
		23	454	1200	1600		10.68	6.21
		16	371	1635	2035		3.68	2.14
		17	403	1615	2015		2.85	1.66
		18	435	2000	2400	7.17	3.04	1.77
3	Garnet Line 52 Between garnets (non-work area)	16	333	755	1155	6.84	12.03	7.33
		17	388	800	1200		17.02	10.37
		30	482	730	1130		22.92	13.96
		18	415	1200	1600		28.77	17.53
		19	451	1200	1600		47.35	28.84
		23	473	1205	1555		28.98	18.42
		16	361	1625	2025		24.96	15.20
		17	411	1630	2030		4.75	2.89
		18	431	2000	2400		17.80	10.84
		19	453	2000	2400	6.84	29.21	17.79
5	Garnet Line 51 Between garnets (non-work area)	16	358	800	1200	7.25	10.80	6.21
		17	372	800	1200		13.75	7.90
		18	404	800	1200		6.48	3.72
		30	484	730	1130		25.49	14.65
		19	432	1200	1600		10.91	6.27
		23	470	1200	1600		20.90	12.01
		19	464	2000	2400	7.25	33.53	19.27

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## Appendix II (continued)

V.E. No.	Location	Date	Sample No.	Time		Flow Rate (lpm)	Total Dust (mg)	Conc. mg/m <sup>3</sup>
				On	Off			
9	Garnet Line 50 Between garnets (non-work area)	16	336	810	1210	7.19	4.77	2.76
		17	383	805	1205		15.73	9.12
		30	475	730	1130		17.02	9.86
		18	413	1200	1600		8.76	5.08
		19	442	1200	1600		13.63	7.90
		23	460	1200	1600		26.19	15.18
		17	409	1620	2020		5.94	3.44
		18	429	2000	2400	7.19	9.65	5.59
10	Garnet Line 50 West aisle area	18	416	820	1220	7.36	.50	.28
		19	437	825	1225		13.40	7.59
		16	351	1200	1600		2.28	1.29
		17	389	1200	1600		8.34	4.72
		30	487	1130	1530		7.10	4.02
		18	423	1645	2045		3.09	1.75
		16	373	2000	2400		9.59	5.41
		17	402	2000	2400	7.36	6.89	3.90
11	North Tape Edge	16	359	820	1620	7.2	.84	.24
		18	400	830	1630		.63	.18
		19	436	750	1550		.76	.22
		23	465	745	1535		.73	.22
		30	486	730	1530	7.2	2.62	.76
12	South Tape Edge	16	360	825	1625	7.32	.67	.19
		18	399	830	1630		.56	.16
		19	425	750	1550		3.85	1.10
		23	459	745	1535		1.02	.30
		30	481	730	1530	7.32	1.20	.34
13	Box Spring Area	16	348	825	1625	7.23	.90	.26
		18	405	830	1630		.94	.27
		19	433	750	1550		1.22	.35
		23	462	750	1540		2.54	.75
		30	488	730	1530	7.23	1.78	.51
14	Hand Tie Area	16	357	830	1630	7.23	2.22	.64
		18	408	830	1630		.58	.17
		19	426	750	1550		.33	.10
		23	457	800	1552		.43	.13
		30	489	730	1530	7.23	.55	.16

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## Appendix II (continued)

V.E. No.	Location	Date	Sample No.	Time On	Time Off	Flow Rate (lpm)	Total Dust (mg)	Conc. mg/m <sup>3</sup>
15	North Quilting Area	16	356	835	1635	7.27	1.28	.37
		17	386	820	1620		.99	.28
		18	398	830	1630		.79	.23
		19	448	800	1600		.93	.27
		23	471	755	1545		1.49	.44
		30	490	730	1530		1.32	.38
		16	368	1705	105		.67	.19
		18	430	1630	2430		.65	.19
		19	466	1645	2445	7.27	.73	.21
16	South Quilting Area	16	347	840	1640	7.18	.71	.21
		17	384	820	1620		1.27	.37
		18	412	830	1630		.89	.26
		19	449	800	1600		.75	.22
		23	469	750	1550		.98	.28
		30	479	730	1530		1.74	.50
		16	365	1600	2400		.59	.17
		18	428	1625	2425		.71	.21
		19	467	1640	2440	7.18	.60	.17

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APPENDIX III

TOTAL DUST CONCENTRATIONS  
USING PERSONAL PUMPS

Location	Date	Sample No.	Time		Flow (lpm)	Dust wt. (mg)	Conc. (ng/m <sup>3</sup> )
			On	Off			
Garnet Line 50 Feed men	16	343	930	1200	2.0	1.37	4.57
	30	493	900	1200		3.05	8.47
	16	378	1650	2012		3.89	9.63
Garnet Line 51 Feed men	16	345	925	1200	2.0	2.45	7.90
	30	492	900	1200		5.22	14.50
	30	502	2115	2400		4.16	12.61
Garnet Line 52 Feed men	16	339	920	1200	2.0	1.94	6.06
	30	495	900	1200		1.42	3.94
	16	382	1700	2005		2.65	7.16
	30	507	2115	2400		1.03	3.12
Garnet Line 50 Needle tenders	16	338	930	1200	2.0	1.08	3.60
	30	496	900	1200		1.99	5.53
	16	375	1650	2015		2.13	5.20
Garnet Line 51 Needle tenders	30	497	900	1200	2.0	2.23	6.19
	30	501	915	1200	2.0	2.80	8.48
Garnet Line 52 Needle tenders	16	342	920	1200	2.0	1.52	4.75
	30	491	900	1200		1.13	3.14
	16	379	1655	2003		3.80	10.11
	30	504	2115	2400		.44	1.33
Garnet Line 50 Take-off men	16	335	930	1200	2.0	.50	1.67
	30	500	900	1200		3.17	8.81
	16	377	1650	2015		2.05	5.00
Garnet Line 51	16	341	925	1200	2.0	2.63	8.48
	30	494	900	1200		3.70	10.28
	16	503	2115	2400		2.18	6.61
Garnet Line 52 Take-off men	16	346	920	1200	2.0	1.57	4.91
	30	499	900	1200		2.16	6.00
	16	380	1700	2004		2.59	7.04
	30	506	2115	2400		.72	2.18

## Appendix III (continued)

Location	Date	Sample No.	Time On	Time Off	Flow (lpm)	Dust wt. (mg)	Conc. (mg/m <sup>3</sup> )
Garnet Lead Man	16	381	1645	2002	2.0	1.49	3.78
Garnet Bail Truckers	16	340	930	1200	2.0	1.41	4.70
	30	498	900	1200		1.07	2.97
	16	376	1700	2005		2.43	6.57
Garnet Mechanic	30	508	2115	2400	2.0	3.84	11.64
Shredding Room	18	393	755	1430	2.0	.65	.82
Machine operators	18	395	755	1430		6.87	8.70
	19	394	755	1200		1.42	2.90
	19	396	755	1200		3.62	7.39
	19	447	755	1200		4.74	9.67
Shredding Room	19	440	800	1200	2.0	1.25	2.60
Area samplers	19	443	800	1200		.66	1.38
	19	444	800	1200		2.28	4.75
	19	446	800	1200		3.22	6.71

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APPENDIX IV

OSHA SAMPLING DATA SHEET #5

Introduction:

With each batch of samples collected, two additional filters should be subjected to exactly the same handling except that no air is drawn through them. These should be used as blanks.

Shipping:

The cassettes in which samples are collected should be shipped in a suitable container, designed to prevent damage in transit.

Imminent Danger Situations:

Generally not applicable.

Serious Hazard:

An 8-hour time-weighted average above  $3 \text{ mg/m}^3$  for identified worker.  $3 \times \text{TLV}$ .

Nonserious Hazard:

An 8-hour time-weighted average above  $1 \text{ mg/m}^3$  and below  $3 \text{ mg/m}^3$  for an identified worker.

De Minimis Violation:

Not applicable.

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COTTON SAMPLING DATA SHEET #5Substance:

Cotton dust (raw).

Standard: 29 CFR 1910.93(b), Table G-1 of August 13, 19718-hour time-weighted average: 1 mg/m<sup>3</sup>.Analytical Method:

Net weight of gross airborne dust, using balance with sensitivity of 0.01 mg.

Sampling Equipment - Personal Samplers:

Cotton is to be determined primarily with the personal sampler attached to the workman's clothing with the face of the filter pointing down. The filter should not be covered. Our experience is that at least a 4- and preferably a 6-hour sample (at 1.5 l/m) is required in a textile plant opening or carding area to obtain reliable results. A preweighed filter (0.01 mg) should be used and reweighed to the same accuracy.

There is no ceiling or any limit on excursions.

Because of the nature of both the sampling method and the development of byssinosis, it is neither desirable nor possible to get grab samples.

Sampling Equipment - General Work Area:

Preweighed Gelman VM-1 or MSA type FWS-B 5 u pore size filter in 3-piece cassette, located in the general work area with the cap removed and the filter facing down. Suction provided by Gast 1531 pump with a 7.4 l/m critical orifice. The vacuum relief valve should be adjusted to maintain 10-15 in. Hg suction. Sampling rate: 7.4 l/m for recommended minimum of 60 minutes. Longer period samples up to full shift are preferable. Filters should not be so heavily loaded that the sample is dislodged in transit.

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U.S. DEPARTMENT OF LABOR  
Occupational Safety and Health Administration  
WASHINGTON, D.C. 20200



Office of the Assistant Secretary

MARK 7/26/72

MEMORANDUM TO:

ALL REGIONAL ADMINISTRATORS, AREA DIRECTORS AND THE  
TRAINING INSTITUTE DIRECTOR

Subject: Use of SIC Number Lists as a Basis for Initiating TIEHP  
Inspections and Information on Raw Cotton Dust

On July 14, 1972, Fred Bishoff sent a memorandum to all Regional Administrators with attached lists of SIC code numbers for the Target Health Hazards. These lists were not meant to be limiting nor did they guarantee that any establishment with an included SIC code number would yield a valid inspection. The lists were meant as general guidance, not limiting, and not all inclusive. Telephone books, State Directories of Manufacturing and any other source which may lead to a valid inspection may be used in scheduling.

Listing a particular SIC code number does not necessarily imply that a worker has been known to have an occupational illness in that type of establishment. It does imply that the hazardous substance is likely to be found there. There will be exceptions, as in the case of battery salesrooms and distribution firms. They may be listed as SIC 3691. Planning and pre-investigation will help to eliminate unnecessary trips.

Also, if a firm uses as its initial raw product cotton thread or woven cloth, broadcloth, bleached, recently washed, steamed or starched cotton or 100 percent synthetic fibers, do not schedule a TIEHP inspection for raw cotton dust. If a firm uses or processes packaged or baled raw cotton, raw cotton and synthetic blend, unwashed, unsteamed or unbleached cotton (raw cotton), raw cotton twine, rope, yarn, bats (or rolls), slivers, string, cotton trash, reprocessed (garnetted) raw cotton, you may schedule the firm for a TIEHP inspection. We are not scheduling cotton gins because of the agriculture SIC code number and because we do not have specific standards in certain agricultural establishments. However, you may inspect a cotton gin as a result of a fatality, catastrophe,

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imminent danger or complaint. In such a gin you may cite for exposure to raw cotton dust and other serious hazards under Section 5(e) of the Act if the exposure is deemed "serious" and if the gin operator should have likely known that a hazard existed in his firm.

If a firm uses a blend of raw cotton and synthetic fibers, you should weigh and use as your basis 100 percent of the dust you collect. Do not use a percentage based on the blend. We are collecting cotton plant leaf, stem and boll trash, mold bacteria and other contamination associated with cotton growing, harvesting, ginning, storing and processing in our sampling procedure. There should be very little lint or linters from cotton or synthetics on the sample filter paper in most cases. Synthetics are practically trash free and thus should not produce a heavy sample on the filter.

Scheduling should be done with the worst exposures in mind and every effort should be made to eliminate firms not using raw cotton from our scheduling of THNP raw cotton inspections. It is not productive to have 7(c)(1) State inspectors visit hosiery, underwear or garment firms which start with thread or woven cloth instead of baled raw cotton, bats, sliver or coarse yarn. This practice should be eliminated for all THNP inspections of raw cotton dust. Any questions should be directed to Ray McClure, 202-961-2726.

Please inform all 7(c)(1) State Industrial Hygienists and State Program Directors.

*Chain Robbins*

Chain Robbins  
Acting Assistant Secretary of Labor

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