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NIOSH HEALTH HAZARD EVALUATION REPORT

HETA 98-0212-2788
Claremont Flock Corporation
Claremont, NH

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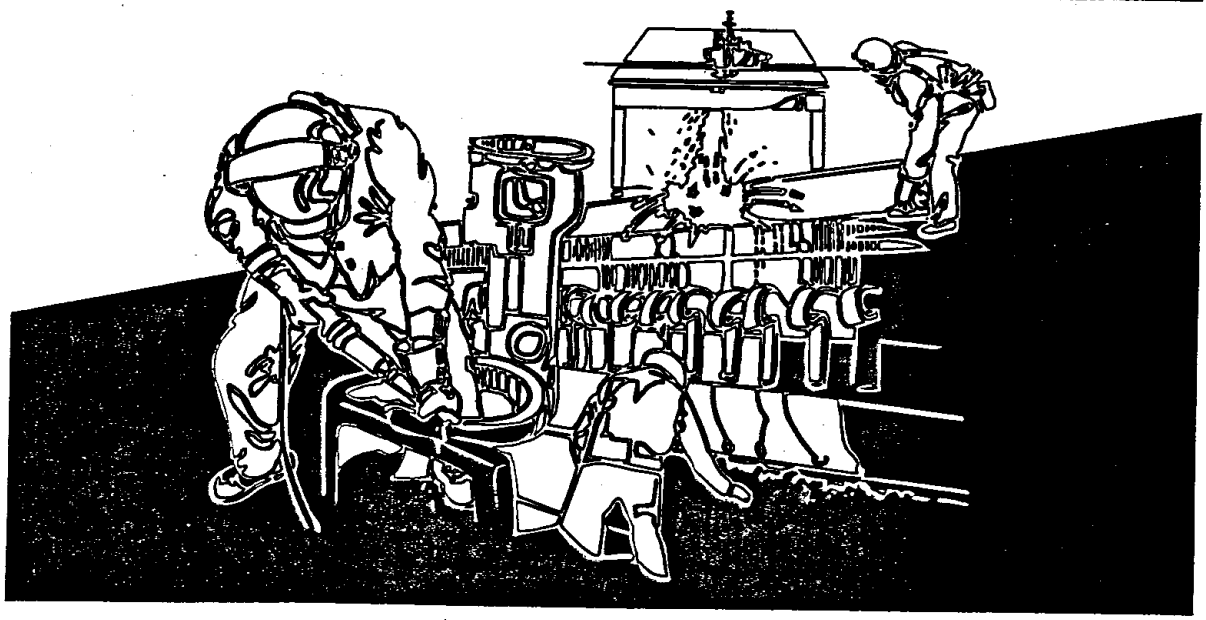

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Highlights of the NIOSH Health Hazard Evaluation at Claremont Flock Corporation

An environmental and health survey was conducted at Claremont Flock Corporation in November 1998. This evaluation was requested by management because a new lung disease (flock workers' lung) was discovered in workers at another flock plant. NIOSH measured dust exposures and their effects on the health of Claremont Flock workers.

What NIOSH Did

- Measured dust and fiber levels in several areas and for most jobs.
- Interviewed workers about symptoms and health complaints.
- Looked at the measurements and interview results for connections between dust or fiber levels and health effects.

What NIOSH Found

- The same types of particles identified at the plant with cases of flock workers' lung (fragments of fiber and finish small enough to enter the lungs) were also present in air samples collected at Claremont Flock.
- Sweeping, bagging, and compressed air cleaning created airborne dust.
- Cleaning with compressed air hoses (blow-downs) and bagging flock were associated with health effects in workers.
- Smoking was associated with health effects.
- Respirators were not used regularly and many workers had not been fit-tested.

What Claremont Flock Managers Can Do

- Stop using blow-downs and sweeping flock as cleaning methods.
- Provide adequate local exhaust ventilation for bagging and drying operations.
- Require respirators for bagging, sweeping, and blow-downs until these changes are made.
- Ensure that workers with frequent fever, aches, or respiratory symptoms receive a medical evaluation to determine the need for placement out of high exposure jobs.
- Inform workers about work-related disease observed among flock workers and how to reduce or control their risk of disease.
- Implement a no-smoking policy at the plant or restrict smoking to separately-ventilated smoking areas.

What Claremont Flock Employees Can Do

- Stop smoking.
- Wear respirators when required.

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NIOSH

PREFACE

Under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace upon request. These investigations, which require a written request from any employer or authorized representative of employees, are undertaken to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found. NIOSH also provides, upon request, technical and consultative assistance to Federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

Primary field investigators were Dr. Feroza Daroowalla, Dr. Mei Lin Wang, Joseph Burkhart, CIH and Chris Piacitelli, CIH of the Field Studies Branch, and Dr. William Jones of the Laboratory Research Branch of the Division of Respiratory Disease Studies (DRDS). Other DRDS staff were involved: Steve Berardinelli, Tara Hood (visiting fellow), and Dan Yereb provided industrial hygiene field assistance; Charity Camaddo (visiting fellow), Christie Kerrigan, Terry Rooney, and Rebecca Stanevich provided medical field assistance; Dr. Michael Attfield provided guidance in data analysis and interpretation; and Drs. Robert Castellan, Kay Kreiss, and William Jones conducted the initial site visit. In addition, Drs. Vince Castranova and Dale Porter of the Health Effects Laboratory Division (HELD) designed and directed toxicological studies. Desktop publishing performed by Terry Rooney.

Copies of this report have been sent to employee and management representatives at Claremont Flock Corporation and to the OSHA Regional Office. This report is not copyrighted and may be freely reproduced. Single copies of this report will be available for a period of three years from the date of this report. To expedite your request, include a self-addressed mailing label along with your written request to:

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HETA 98-0212-2788
Claremont Flock Corporation
Claremont, NH
May 2000

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SUMMARY

The Claremont Flock Corporation produces flock, from tow and cotton scrap fabric, and bags the products in four plants in Massachusetts and New Hampshire. The management requested a health hazard evaluation (HHE) to get a better understanding of the respiratory hazards in the plants. At the time of the request, an extensive HHE at another company's flocking facility in Rhode Island [NIOSH 1998] had uncovered a cluster of cases of a new occupational lung disease (flock workers' lung) [Kern et al. 1998]. In addition, one worker at Claremont Flock had a diagnosis of the same illness.

In November 1998, NIOSH conducted an investigation at the Claremont Flock plants consisting of a symptom and work history questionnaire and personal and area sampling, primarily for respirable dust (dust small enough to reach the deepest areas of the lungs) and fiber counts. About 81% of the workers participated in the survey.

The results and conclusions of the survey are as follows:

- The same types of particles identified at the Rhode Island plant were also present in air samples collected at Claremont Flock.
- Blow-down cleaning with compressed air and bagging flock were associated with symptoms. These tasks, as well as sweeping, should be targeted for control. Decreasing exposures should lead to decreased symptoms and complaints.
- Gravimetric respirable dust measurement appears to be a suitable method for characterizing concentrations in this setting.
- Respirator use was sporadic, and many workers had not been fit-tested.
- Smoking was associated with symptoms.

We recommend the following for this workplace:

- Reduce dust exposures with engineering controls.
- Until engineering controls are in place, limit the use of blow-downs and use personal respiratory protection to control dust exposures.

- Expand the annual medical examination to include a means for identifying workers with frequent fever, aches, or respiratory symptoms such as cough, shortness of breath, wheezing, or phlegm production. Workers with any of these symptoms should receive a medical evaluation and an opportunity to reduce dust exposures by placement out of high exposure jobs.
- Periodically inform workers about work-related disease observed among flock workers and how to reduce or control their risk of disease.
- Implement a no-smoking policy at the plant [NIOSH 1991]. If allowed at all, smoking at the plant should be restricted to designated, separately-ventilated, smoking areas. Workers should be encouraged to stop smoking altogether through an employer-sponsored smoking cessation program and education campaign.

NIOSH investigators determined that a health hazard exists from occupational exposure to flock-associated dust. This risk is characterized by the occurrence of physician-diagnosed interstitial lung disease in at least one worker, and by the results of a respiratory symptom survey that suggest an association of respiratory and systemic symptoms with conducting compressed air cleaning (blow-downs) or bagging flock. Reduction of worker exposures to airborne dust is recommended to protect the health of the workers at these plants.

Keywords: SIC 2299 (Textile goods, Not Elsewhere Classified), nylon, fibers, flock, interstitial lung disease, flock workers' lung, respiratory irritation, particulate not otherwise classified (PNOC), particulate not otherwise regulated (PNOR).

Table of Contents

Preface i

Acknowledgments and Availability of Report i

Summary ii

Introduction 1

Background 1

Methods 3

Results 6

Discussion 9

Conclusions and Recommendations 11

References 12

Tables and Figures 14

Appendix 22

INTRODUCTION

In November 1997, NIOSH representatives met with the management of Claremont Flock Corporation to describe the work NIOSH was conducting in the flocking industry, including the health hazard evaluation (HHE) conducted at a flocking plant in Rhode Island [NIOSH 1998], to observe the flocking operations at Claremont Flock, to discuss the health of the workers, and to inform the management about the NIOSH HHE program. At the time, one worker at Claremont Flock had symptoms and lung biopsy findings consistent with cases of illness described at the Rhode Island plant.

In May 1998, NIOSH received a formal request from Claremont Flock Corporation for an HHE to characterize dust exposures and possible health hazards. The Claremont Flock operation consists of four plants located in Leominster, Massachusetts, and Claremont, New Hampshire.

NIOSH conducted an initial site visit at the Claremont Flock facilities during the week of June 15, 1998. During the week of November 8, 1998, a respiratory symptom and work history questionnaire was administered, and environmental measurements of airborne dust and fibers were obtained. The survey aimed to identify operations which may result in excessive dust exposures, to identify the association of workplace exposures with respiratory health outcomes, and to recommend ways to reduce exposures.

This report presents the results from the medical and industrial hygiene surveys, including analysis of the relationship between symptom prevalence and dust and fiber measurements. In addition, recommendations for preventing occupational lung disease are made.

BACKGROUND

PROCESS DESCRIPTION

The operations at Claremont Flock include the conversion of continuous filament fibers (tow) into smaller lengths of fiber (flock). Tow is received as bundles of continuous fiber with diameters in the 10-15 micrometer (μm) range. After cutting, the flock is about 1 millimeter (mm) in length with diameters identical to the tow from which it is cut. Nylon, as well as other types of tow, such as polyester, acrylic, and rayon, are cut into flock. The process begins with washing the tow in a scour solution of soaps and hot water to remove any oils or lubricant. The tow is then dipped in a bath of 'flock finish' containing tannic acid, an ammonium ether of potato starch, and a fatty alcohol derivative. After the finish is applied, the tow is cut into flock by either rotary precision cutters (RPCs) or a guillotine cutter. The flock is then dried, screened, and bagged. Some flock may then undergo batch dyeing, drying, and bagging.

Claremont Flock also has operations where scrap fabric materials, such as cotton (e.g. denim and underwear) and aramid, from the apparel industry are ground into fine random length fibers. This ground flock may also go through the batch dyeing process.

Periodically, a cleaning referred to as a 'blow-down' is performed. In this process, workers use compressed air guns to blow settled flock from equipment and floors. The thoroughness of the blow-down, and thus the duration, is dependent on the tolerance for some contamination of foreign flock on the next product.

Approximately 164 employees work at the following four Claremont Flock plants:

Leominster Plant, Leominster, MA: This is Claremont Flock's largest flock-producing operation with approximately 100 workers assigned to two shifts. This plant has several precision cutting ranges

with bagging stations that process nylon, polyester, and rayon. This plant houses Claremont Flock's batch dyeing and dryer operations.

Main Street Plant, Claremont, NH: In addition to serving as company headquarters, this site also has ranges for rotary precision cutting and bagging nylon tow. A total of 10 production workers (5/shift) were assigned to this operation.

Mulberry Plant, Claremont, NH: This operation consists of several grinding machines used mainly for cotton processing. Occasionally, aramid is also processed here. There were six employees assigned to this plant.

River Road Plant, Claremont, NH: This is Claremont Flock's newest facility. It has rotary precision cutting ranges, a guillotine cutter, and a grinding operation that processes cotton (similar to the Mulberry operation). The rotary precision cutters process nylon, and the guillotine cuts nylon, polyester, and acrylic tow. In addition, there is an offline cutting machine that processes rayon tow which receives only a water rinse prior to being cut. There were 30 production workers assigned to two shifts (15/shift) at this facility.

DISEASE CHARACTERISTICS

A lung disease in nylon flock workers has recently been recognized and named 'flock workers' lung' [NIOSH 1998, Kern et al. 1998]. This interstitial lung disease (ILD) affects the area of the lung where oxygen and carbon dioxide are exchanged between the air and the blood. Flock workers' lung is characterized by cough and shortness of breath, changes on chest computed tomogram (CT scan), a decrease in the volume of air the lungs can hold (restriction), reduction in capability to exchange oxygen and carbon dioxide, and a characteristic tissue biopsy appearance (collections of white cells called lymphocytes around the airways). In addition, some affected workers complain of wheezing and phlegm production and have a decrease in the rate at which air can be blown out of the airways. The latter suggests involvement of the airways in the disease, or a separate occurrence of airways disease in these workers. Frequent fever and ache were reported by some of the workers who had biopsy-documented disease. Features of flock workers' lung include a variable time period between the start of exposure and onset of disease, its reversible nature upon removal from exposure, and possible recurrence with re-exposure [NIOSH 1998, Kern et al. 1998].

Lung tissue biopsies of individuals with flock workers' lung show a concentration of inflammatory cells (lymphocytes) in the walls of the smallest, most distant airways (respiratory bronchioles) [Eschenbacher et al. 1999]. Inflammation in these areas implies exposure to particles that can reach the distant airways (i.e., with an aerodynamic diameter of approximately 5 micrometers (μm) and smaller).

Flock workers' lung is probably related to respirable components of dust generated in flocking operations. Flock itself is too large to reach the most distant, small airways of the respiratory tract. However, the cutting of flock results in respirable shreds. In addition to fiber shreds, the respirable dust in these operations also contains cellulose particles and components of 'flock finish' [NIOSH 1998, Burkhart et al. 1999]. The studies to date have implicated nylon flock operations. Disease associated with other materials (rayon, polyester, acrylic) has not been demonstrated.

Investigations in laboratory animals indicate that airborne dusts from nylon flocking operations cause acute inflammatory reactions in the airways and air sacs [Porter et al. 1999]. However, the animal studies to date have involved a single intra-tracheal instillation of preparations containing airborne dust. Since this type of exposure has limited resemblance to human exposures, conclusive evidence of the specific etiology of inflammation and disease in humans does not exist. Investigations of animal reactions to dusts from flocking operations that utilize materials other than nylon have not been conducted.

Besides cases of flock workers' lung, the Rhode Island investigation uncovered workers experiencing work-related chest symptoms; nosebleeds; and irritation of throat, eyes, and sinuses [NIOSH 1998].

METHODS

A NIOSH information sheet about the survey and an invitation to participate were distributed by management to all workers at Claremont Flock. Volunteers were asked to read, discuss, and sign an informed consent before participation.

ENVIRONMENTAL SURVEY

Environmental measurements of airborne particulate were obtained at the River Road, Mulberry, and Leominster plants during the day shifts of November 9-11, 1998. Nylon, acrylic, polyester, and rayon tow, and cotton fabric were being processed. We made personal and area measurements for respirable particulate using NIOSH method 0600 with nylon cyclones at a flow rate of 1.7 liters per minute [NIOSH 1984], fiber counts using NIOSH method 7400, and flock fiber counts. Because we were sampling particulate that was not well characterized, we used both the A- and B-counting rules included in the 7400 method. A major difference is the diameter limit included in the B-rules. Area measurements were also made for total (NIOSH method 0500) and thoracic dust (NIOSH method 0600 with BGI® stainless steel cyclone at 1.8 liters per minute). Real-time measurements were made for dust using MIE® personal DataRAM® light-scattering monitors. During a subset of these real-time measurements, video recordings were made in an effort to relate workplace dynamics to dust concentration.

MEDICAL SURVEY

Trained interviewers administered the questionnaire. It included modified questions from the American Thoracic Society respiratory disease questionnaire [Ferris 1978], as well as questions on past medical history, smoking status, current job title, and past jobs in the flock industry (Appendix). We also asked workers about respirator use and whether fit-testing had been conducted.

DATA ANALYSIS

We entered data into electronic form using double entry verification techniques and used SAS and SPSS statistical programs for analysis of responses from all participants. Exposure measures, outcome measures and confounders were defined using both *a priori* (i.e., prior to examination of the data) and *post hoc* (i.e., after examination of the data) determinations. The significance of the association between exposures and outcomes are reported as probability *(p)* values. Values less than 0.05 are considered to represent an association that is not likely to be due purely to chance.

Exposure Measures

The exposure variables discussed below refer to non-cotton flock. Work with cotton was entered into the analysis as a categorical (yes-no) variable.

Exposure variables for the analysis were derived in three ways: 1) using measured current dust and fiber (A-rules) concentrations categorized into high, medium, or low; 2) using cumulative exposures based on dust-time or fiber-time parameters; and 3) categorical variables (yes-no) for the performance of particular tasks. The tasks that were *a priori* thought to involve high exposures were blow-downs and bagging flock in current and past jobs. Drying operations were thought to be high exposure tasks but were not used as a separate variable because there were very few dryer operators and all of them were included in the analysis as baggers. Use of respirators was not included in the analysis because of the incomplete and sporadic pattern of use among workers at Claremont Flock.

Current and cumulative exposure estimates: Each personal sample for respirable dust and fibers was linked to a job title by observation during sampling. One or more samples were taken for each job title.

The average (arithmetic mean) of all samples from a particular job title was calculated. Non-detectable samples were assigned the value of half the minimum detectable concentration and were calculated into the average [Hornung and Reed 1990]. We designated this average as the representative summary measure of exposure for all workers in that particular job title. All workers in any given job title were assumed to have that same exposure during the time they were in that job.

In order to compare workers with different current exposures, we divided the study population into three groups each for non-cotton dust and fibers: those with jobs with high current exposures, medium current exposures, and low current exposures. The division into high, medium, and low categories was made using natural break points in the average concentrations to create similar group sizes. Workers who had predominantly cotton exposures were placed in groups that reflected their exposure to non-cotton flock, as reported on their questionnaires.

Cumulative exposure, for each worker, for all work in the flock industry was calculated by summing the products of average dust (or fiber) measurement for each job and time (years) spent in each job. Estimates of exposures in past jobs at Claremont Flock and jobs in other companies were made using concentrations measured in November 1998. Workers with cumulative exposure (yrs-mg/m^3 or yrs-fibers/cm^3) greater than the median were compared with workers with cumulative exposures below the median. We chose the median over the mean as the measure of central tendency because the distributions of cumulative exposures were skewed.

Exposure to specific tasks: The other exposure measures that were used in the analysis are defined here.

Blow-downs in current job: The term blow-down refers to the cleaning of equipment and work space with compressed air. There was wide variation in the number of blow-downs reported by workers. Some of these reported blow-downs referred to the cleaning of clothing—an operation we had not characterized with environmental sampling. Therefore, in order to make the best use of the information regarding the numbers of blow-downs conducted, we used this term as a categorical variable rather than as a continuous variable. We divided workers into three groups: 1- workers who did no blow-downs; 2 - workers who did less than 10 blow-downs in an average week; and 3 - workers who conducted 10 or more blow-downs in an average week. The first two groups were similar in their relationships with the outcomes in preliminary analysis and so were collapsed into one.

Blow-downs or bagging flock in past jobs: This categorical (yes-no) variable represents participation in potentially high-exposure tasks in past jobs. It was assumed that one or both of these tasks were conducted by workers who held these jobs in the past: kettle team leader and operator, material handler, dryer operator, extractor operator, cutter team leader, cutter operator, bagger, grinder team leader, and operator. These two tasks, blow-downs and bagging flock, were combined into one variable because most of those who had done one task in the past had also done the other. Many of the workers who were designated as having bagged flock in the past, also bagged flock in the current job.

Bagging flock in current job: Workers who reported bagging non-cotton flock in the 12 months preceding the time of the interview were designated as bagging flock in the current job. This term was entered into the analysis as a categorical (yes-no) variable.

Working predominantly with cotton: Workers who reported having jobs at the Mulberry facility (cotton grinding facility) or working primarily in the cotton grinding operations at the River Road facility were classified as having predominantly cotton exposure, with a categorical (yes-no) variable in the analysis.

Outcome Measures

The health outcomes we examined in this analysis were symptoms and symptom complexes. The prevalences of cough, phlegm, shortness of breath, wheezing, eye, throat, nose symptoms, fever and

aches were determined. Symptoms were also combined into complexes to serve as indicators of disease processes, including mucous membrane irritation, bronchitis, interstitial lung disease (ILD), asthma, and systemic inflammation. Although symptoms are not always specific indicators for single disease processes, they are a sensitive and useful indicator of lung health. We have used them in the absence of objective health data.

Symptom complexes: The symptom complexes were chosen *a priori*, and represent the types of outcomes that are expected in workers in a flocking operation, based on the literature and previous investigations:

Mucous membrane irritation (MMI): This complex is defined as having three or more episodes in the last 12 months of eye irritation or of throat irritation, soreness, or tickle. Eye or throat irritation may be caused by large particles that are airborne in the environment. These symptoms were examined because of similar complaints in another flocking plant [NIOSH 1998], their potential for being precursors to lower airway disease, and their contribution to discomfort and absenteeism in workers.

Bronchitis-like symptoms: This complex is defined as cough and phlegm. These symptoms were reported by some workers with flock workers' lung, and can accompany the chronic inflammatory changes in larger airways that were seen on biopsies of flock workers' lung. Cough is defined as a report of usually coughing as much as 4-6 times per day for 4 or more days out of the week (ususal cough) or cough on most days 3 or more consecutive months of the year (chronic cough). Phlegm is defined as phlegm twice a day, 4 or more days of the week (usual phlegm), or phlegm on most days 3 or more consecutive months of the year (chronic phlegm).

ILD-like symptoms: This complex is defined as shortness of breath (SOB) and cough. These symptoms have been reported by workers with flock workers' lung. SOB is defined as having no musculo-skeletal reason for difficulty walking and being troubled by shortness of breath when hurrying on level ground or walking up a slight hill, or having to walk slower than people of one's own age on level ground because of shortness of breath. Cough is defined in the same way as described for bronchitis-like symptoms.

Asthma-like symptoms: This complex is defined as one's chest sounding wheezy or whistling most of the time or having an attack of wheezing that has made one feel short of breath. Wheezing implies swelling and narrowing of the airways and has been reported by workers in flock plants.

Systemic symptoms: This complex is defined as three or more episodes of fever or flu-like achiness in the last 12 months. These symptoms can be related to an inflammatory response to materials in the environment and were reported by workers in flock plants, including some of those with flock workers' lung.

Other health outcomes that were deemed important after preliminary examination of the data were also examined.

Multivariate Analysis

In order to examine the association of exposure measures with health outcome measures, while taking into account the potential effects of other factors such as smoking, we conducted multivariate analyses. Potential confounders of the relationship between exposures and the health outcomes were smoking (which was expressed both as current/never/former smoker and as a measure of pack-years smoked), age, and history of asthma or hayfever that occurred prior to starting work in flock. Additionally, we explored the interaction between smoking and current participation in blow-downs. This interaction term was not used as a variable in the final multivariate models because of small numbers.

Never smokers were defined as those that reported never having smoked regularly (less than 100 cigarettes in entire life). Current smokers were defined as those who reported smoking cigarettes at the time of the survey. Former smokers were those

that reported having stopped smoking after a period of regular smoking. Former smokers and never smokers were collapsed into the same category after preliminary analysis did not show major differences between them. A worker was considered as having a history of asthma or hay fever if he or she reported a doctor-diagnosis of either, and the year of onset preceded the year of first work in the flocking industry.

Due to the overlap between the group that conducted bagging in past jobs and the group that did bagging in the current job, we entered the variable for bagging flock and blow-downs in past jobs into a separate model from the one in which we used the variable for bagging flock in the current job.

RESULTS

Of the 164 employees at Claremont Flock at the time of the NIOSH survey, 133 (81%) volunteered to answer the medical questionnaire. Fifty three of the day shift workers wore environmental sampling equipment. Seven of the workers sampled did not complete the medical questionnaire.

WORKER CHARACTERISTICS AND JOB TITLES

Table 1 shows the gender, race, smoking, and other characteristics of the 133 workers who were interviewed. Most of the workers interviewed were male and identified themselves as being white. Workers reported that they usually work 40 to 72 hours in a work-week of 4 to 7 days, and 91% had been in their current job for greater than 6 months (mean time in current job was 4.1 years). The interviewed workers had worked at Claremont Flock for an average of 6.2 years (range: 1 month - 26.8 years) and had worked in the flock industry in general for an average of 6.4 years (range: 1 month - 26.8 years).

Ten workers (7.5%) were engaged in work predominantly with cotton grinding or bagging. Others worked with cotton at times but primarily worked with precision cutting, bagging, and dyeing of nylon and other non-cotton fibers. Workers reported doing jobs with rayon, polyester, aramid, and acrylic, in addition to nylon and cotton. Among those workers who were not primarily in administrative positions, 44% reported that they have worked with polyester in the last year, 64% with rayon, 52% with acrylic, and 11% with aramid.

About 55% were engaged in tasks that *a priori* were thought to involve high exposures (blow-downs with compressed air and bagging flock). Seventy-three (55%) workers reported that they conduct blow-downs. The number of blow-downs conducted in a week varied widely; 14 workers conducted more than 10 blow-downs in an average week. Thirty eight of the 73 workers (52%) who conducted blow-downs wore a respirator (single strap disposable, 2-strap disposable, or half-face cartridge) while conducting some of the blow-downs. Fit-testing for respirator use was not common. Most of the workers who conducted blow-downs worked in cutting and bagging areas. Forty three of these workers also worked near blow-downs that they did not directly conduct. Seventeen others reported being exposed only as a result of working near blow-downs conducted by other workers. Most (48/60, 80%) workers did not wear a respirator when other workers were conducting blow-downs in adjacent areas.

Seventy-three workers reported that they spent time bagging non-cotton flock. Of these, 35 (47%) reported that they wear respiratory protection during some or all of the task.

Table 2 shows the current job as reported at the time of the interview. Seventeen percent of the workers interviewed primarily spent their time in office or administrative tasks.

ENVIRONMENTAL RESULTS

Figure 1 shows area respirable dust levels measured gravimetrically. The line through the bar indicates the standard error of the mean. In cotton-processing areas, the average of two samples from near

grinding/bagging operations was 0.51 milligrams per cubic meter (mg/m^3)—approximately five times the average of two collected in the vicinity of a cotton dryer (0.11mg/m^3). The highest level in the non-cotton areas (0.16 mg/m^3) was found near a dryer operation where nylon flock was being dried and bagged. The average concentration of nine samples from the cutting/bagging areas where nylon, polyester, and rayon tow were being processed was almost half that of the sample from near that dryer. Five samples from other areas in the plant (dyeing, shipping, and offices) had an average that was about one-fifth of that same dryer sample.

Figure 2 provides results of 13 sets of area samples in non-cotton areas and shows the relationship between the different types of measures of exposure. The respirable dust measurements did not correlate well with the thoracic or total dust measures (r = 0.48 and 0.76 respectively). Average fiber counts were about 0.50 and 0.40 fibers per cubic centimeter (fibers/cm^3), for A- and B-rules counts, respectively. The A-rules counts correlated well with the respirable dust concentrations (r = 0.86) with approximately 8.6 fibers/cm^3 corresponding to 1 mg/m^3. A-and B-rules counts also correlated well with each other (r = 0.99)—A-rules counts were 1.3 times the B-rules counts. When we examined the subset of area measurements from the nylon-only operations (10 sets of samples): the thoracic and total dust measurements were nearly double those of respirable dust (r = 0.79, for both). A-rules counts of fibers correlated well with respirable dust with 5.0 fibers/cm^3 corresponding to 1 mg/m^3 (r = 0.89).

Personal respirable dust levels by job are provided in figure 3A. Samples were collected over approximately an eight-hour period. Most of the respirable dust concentrations were below 0.2 mg/m^3—all were under 1.2 mg/m^3. The highest concentration was found on a welder, and because of the appearance of the filter after sampling, it was presumed that the measurement reflected predominantly welding fumes rather than dust exposure. Personal fiber concentrations (A-rules counts) are presented in figure 3B. The only blow-down which occurred during sampling is noted in figures 3A and B. A-rules counts for non-cotton fibers correlated well with B-rules counts (r = 0.99).

Figure 4 shows real-time dust data collected by a monitor on a worker who was cleaning a cotton dryer room. Responses of the monitor during three cleaning operations are depicted. The first two operations are blow-downs of the floor and equipment, and the third is sweeping of the floor of a small enclosed pit underneath a piece of machinery. The highest peaks correspond with times the worker was inside plumes of dust created by his cleaning tasks. The two flat portions on the graph show the minimal measurements while the worker was outside of the dryer room. The portion between the second blow-down and the pit sweeping operation shows the readings while walking across the room to gather his broom and shovel.

Workers were observed filling bags at bagging stations in cutting and drying areas. Visible plumes were ejected from the bags into the faces of the workers when they patted the bags to settle the flock inside, and also when the tops of filled bags were folded prior to sealing.

Concerning the nature of the airborne dust in these plants, figure 5 is a scanning electron microscope image from an air sample collected during the bagging of nylon flock. The sample included particles of flock (the large fibers in this image) and a variety of small particles. A subset of the small particles were elongated. The elongated particles were found to be predominantly shreds of the synthetic material formed during the cutting and milling of the flock. The compact particles were generally fragments of the various finish components. Additionally, samples collected directly out of the cutter during the processing of polyester, acrylic, and rayon suggested that the tendency to form shreds is not unique to nylon (figure 6). The aerosol observed in areas where cotton was processed and bagged consisted mainly of a mix of polydisperse cellulose fragments.

EXPOSURE GROUPS

Workers were placed into three groups according to average concentrations of non-cotton respirable dust or fibers (A-rules counts). For respirable dust, three groups were formed as follows: The high dust exposure group (greater than 0.08 mg/m^3) included cutter operator, kettle operator, knife grinder, dryer operator, dyehouse maintenance worker, and plantwide maintenance worker. The medium dust exposure group (greater than 0.02 mg/m^3 and less than 0.08 mg/m^3) included lab worker, extractor operator, dock worker, dyehouse team leader, cutting area team leader, and bagger. The low dust exposure group (less than 0.02 mg/m^3) included office and administration staff, cotton grinder operator, and cotton team leader.

For fiber concentration, the groups were as follows: The high exposure group (greater than 0.20 fibers/cm^3) included bagger, cutter operator, kettle operator, dryer operator, and dyehouse maintenance worker and plantwide maintenance worker. The medium exposure group (less than 0.20 and greater than 0.10 fibers/cm^3) included extractor operator, dock worker, dyehouse team leader, knife grinder, cutting area team leader, and cotton dryer operator. The low exposure group (less than 0.10 fibers/cm^3) included office and administration staff, lab worker, cotton grinder operator and cotton team leader.

SYMPTOM PREVALENCE

Frequency of symptoms according to smoking status (at the time of the interview) is presented in table 3. Nose, eye, and throat symptoms were not statistically related to smoking habits. Chronic cough (cough on most days 3 or more months during the year) was highly correlated with smoking status. Smoking was also related to shortness of breath (SOB) when walking up a slight hill. SOB compared to those of own age was much less prevalent than SOB with walking up a slight hill. Occasional wheezing without the presence of a cold was associated with smoking status. Wheezing most of the time and wheezing with attacks of shortness of breath were less prevalent, and had a weaker relationship with smoking status. Fever and ache did not have a clear relationship with smoking in this group.

SYMPTOM COMPLEXES

Table 4 shows the frequency of symptom complexes according to exposure category. This table should be read down the column for each symptom complex to compare low or no exposure groups with higher exposure groups. Results of multivariate analysis, where all the exposure measures and other variables are taken into account, are shown in statistically significant cases.

We also present the smoking status of workers in each exposure category. For exposure to bagging flock in the current job, there was a statistically significant difference with exposed workers being more likely to be current smokers (table 4).

Mucous membrane irritation (MMI): There was a statistically significant association between doing blow-downs or bagging in past jobs and this symptom complex in the multivariate analysis. This symptom complex was also associated with current bagging exposures, in a separate model (table 4).

Bronchitis-like symptoms: These symptoms were associated with conducting blow-downs or bagging flock in past jobs in multivariate analysis (table 4). In the model with bagging flock in the current job, the association approached but did not reach statistical significance.

ILD-like symptoms: Shortness of breath and cough were associated with conducting blow-downs or bagging flock in past jobs in multivariate analysis (table 4).

Asthma-like symptoms: Wheezing most of the time or with attacks of SOB was strongly associated with conducting blow-downs or bagging flock in past jobs in multivariate analyses (table 4). The association with bagging flock in the current job approached but did not

achieve statistical significance in a separate model.

Systemic symptoms: This complex was associated with blow-downs or bagging flock in past jobs in the multivariate model (table 4). There was also an association between this complex and bagging flock in the current job.

DISCUSSION

This evaluation at Claremont Flock extends the exposure characterization in the U.S. flocking industry that was begun in the HHE at Rhode Island [NIOSH 1998]. The evaluation at the Rhode Island plant found that flock cutting and application results in a respirable dust which is highly inflammatory in rat lungs and probably incites inflammation in the human lung as well. The dust from flocking operations has been found to contain shreds of fiber (tow), most likely formed during the cutting process [NIOSH 1998, Burkhart et al. 1999] and then liberated when the flock is milled, dried, screened, bagged, and poured.

In the exposure characterization at Claremont Flock, we used gravimetric dust measurements to indicate all particles within different size categories (respirable, thoracic, and total). Fiber counts were added as a preferential measure of the elongated particles. The results of gravimetric respirable dust measurements correlated well with the fiber counts when compared side-by-side in various areas of the plant. Additionally, when we examined relationships with outcomes, one measure was not more tightly associated with symptoms than the other. Fiber counting is more difficult and is subject to high counter variability. Because of this, and the fact that gravimetric analysis measures all particles, gravimetric measurement seems the better choice for characterizing exposures. With reference to the appropriate size-selective criteria for gravimetric measurements, we cannot draw a conclusion on the suitability of thoracic dust measurements given the poor correlation between respirable and thoracic measurements and the limited sampling at these plants. The wide availability of respirable dust samplers, and the current understanding of flock workers' lung, indicate that respirable dust sampling is a good choice for this industry.

Microscopy indicated that the particulate at the Claremont Flock plants was *qualitatively* similar to that found at the Rhode Island plant. Specifically, the operations in the Claremont plants generated respirable aerosol consisting of fiber and finish particles. The *quantity* of airborne dust at the Claremont facilities was lower. The average area respirable dust level found in the cutting areas of the Rhode island plant was 0.20 mg/m^3, while that at similar areas at the Claremont facilities was about 0.07 mg/m^3. Nonetheless, there was a worker with ILD at one plant, and that worker's occupational history indicates that he performed tasks associated with potential for elevated dust levels, namely blow-downs. Furthermore, in animal (rat) studies, an inflammatory response was seen when size-selected dust from a Claremont bag house on a nylon cutting range was instilled into animal tracheas [Personal communication, Dale Porter, Health Effects Laboratory Division, NIOSH]. This response was generally similar to the highly inflammatory reactions seen in identical experiments using airborne dust in the Rhode Island study [Porter et al. 1999].

At Claremont Flock we also discovered that polyester, acrylic, and rayon tow, like nylon tow, showed the potential for forming shreds when cut. These shreds can be liberated from the flock in the screening and milling process and result in respirable dust. It is not clear whether these fibers behave similarly to nylon in causing inflammation in animals or humans.

The investigation at the Rhode Island plant identified cases of ILD with unique biopsy characteristics. This condition was named flock workers' lung [Kern et al. 1998]. In that study, other workers were found to have work-related respiratory and systemic symptoms that represented either pre-clinical interstitial lung disease or other respiratory illness [NIOSH 1998]. In this study, we chose to explore symptoms that are common in ILD such as SOB and

cough. We also examined phlegm, wheeze, mucous membrane irritation, fever, and aches. We wanted to identify symptom complexes, in addition to flock workers' lung, that may be associated with exposures in this setting.

Mucous membrane irritation (eye or throat irritation) was associated with conducting blow-downs or bagging flock in past jobs as well as bagging flock in current job. These exposures generate clouds of dust that result in the irritation of the eyes and throats of the workers.

Bronchitis-like symptoms (cough and phlegm) were associated with conducting blow-downs or bagging flock in past jobs. The dust generated during these activities can cause irritation and inflammation of the mucous membranes of both small and large airways and results these symptoms.

SOB and cough (the ILD-like symptoms) were also statistically associated with conducting blow-downs or bagging flock in past jobs. This makes sense because high exposures in the past could result in ongoing inflammation leading to these symptoms.

We examined a restrictively defined set of asthma-like symptoms—wheezing most of the time or with attacks of SOB—and found it in 22 persons. Most of these workers (15/22) had their first episode after they began work in the flocking industry but many (11/22) did not have a doctor's diagnosis of asthma. This suggests that workers were developing work-related asthma-like symptoms but were not seeking care or were not identified by a doctor as being asthmatic. These symptoms were associated with blow-downs and bagging flock in past jobs as well as with pack-years of cigarette smoking.

Systemic symptoms of fever or aches occurred in 18 workers (14%) and were highly associated with conducting blow-downs or bagging flock in past jobs as well as bagging flock in the current job. Fever and aches have been reported at other plants by workers with flock workers' lung. Although some mis-classification of viral influenza or other infectious diseases may have occurred, the strong relationship with the exposure history suggests that the workers who were experiencing unusual and frequent fevers or aches were manifesting an inflammatory reaction to exposures at work.

Smoking was found to be associated with asthma-like symptoms in this population. The literature supports the association of smoking with airway inflammation, obstruction (asthma, chronic bronchitis), cough, phlegm production, wheeze, SOB (emphysema), and increased susceptibility to respiratory tract infections.

In the Rhode Island study, high exposure tasks and hours worked were predictors for respiratory and systemic symptoms. This suggested that recurrent high exposures, with little time for the lung to clear the inhaled dust in between exposures, may be the important factor for the development of the symptoms [NIOSH 1998]. In this study at Claremont Flock, we examined participation in blow-downs and bagging in current and past jobs, dust and fiber exposure in the current job, and cumulative exposures for all work done in the flock industry.

Based on observation and this analysis, blow-downs in past jobs and bagging (in cutting, grinding and drying areas) represent the greatest potential for hazardous exposures to dust in these plants. This is consistent with the findings in the Rhode Island study in which conducting blow-downs was found to be associated with health outcomes [NIOSH 1998]. We saw no significant association of symptoms with current participation in blow-downs. This is probably explained by the small numbers of workers in this group. We did not characterize exposures for bystanders near blow-downs, for workers using blow-downs to clean clothing, or for workers who did sweeping, but these activities probably present opportunities for high exposures.

Average dust or fiber exposures in the current job were not found to be an indicator of symptom status. This lack of relationship can be due to several reasons, the most likely being that workers in jobs with high exposures (as measured currently) are the workers who can tolerate these exposures and are therefore the 'healthy workers.' Others who were less tolerant or became ill may have already left high exposure jobs. Longitudinal studies to elucidate the

relationship between current exposures and chronic, sub-chronic and acute health outcomes are needed.

Cumulative exposure during all years spent by a worker in the flock industry was not associated with symptoms. This is similar to the finding at the Rhode Island plant—that tenure in the plant was not associated with symptoms [NIOSH 1998]. If an association between symptoms and cumulative exposure existed, it is possible that such a relationship was obscured by the small numbers of workers in this study and the limited exposure assessment we conducted. It is also possible that workers with symptoms had left the workplace and were not part of the analysis which would make this association difficult to detect.

We also examined the relationship between working predominantly with cotton operations and symptoms. We did not find a statistically significant association, but this may be due to the small numbers of workers who work mostly with cotton (10/133). Our sampling revealed that dust levels are relatively high in cotton operations, especially in grinding areas. Most of this dust is composed of cellulose particles; the inflammatory potential of this dust, which is likely to be different from that of dust generated in nylon and other fiber operations, was not explored in this study.

Claremont Flock appeared to have a much lower rate of cases of interstitial lung disease than the Rhode Island plant. However, a comparison between case rates at the two facilities is not valid because the detailed case-finding and clinical work-up of symptomatic workers performed at Rhode Island was not done in the present investigation.

Respirable dust levels measured in this plant were below the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) of 5 mg/m^3 for particulate not otherwise regulated (PNOR) and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 3 mg/m^3 for particulate not otherwise classified (PNOC) [CFR 1999, ACGIH 1999]. However, these are not appropriate standards for the non-cotton dust which has inflammatory potential. The occurrence of a case of flock workers' lung at Claremont Flock, the association between symptoms and exposure to blow-downs or bagging flock, and the inflammatory nature of this dust in animal experiments support the need for further lowering of exposures in this plant.

CONCLUSIONS AND RECOMMENDATIONS

We conclude the following from this investigation:

- The same types of particles identified at the Rhode Island plant were also present in air samples collected at Claremont Flock.
- Blow-down cleaning with compressed air and bagging flock were associated with symptoms. These tasks, as well as sweeping, should be targeted for control. Decreasing exposures should lead to decreased symptoms and complaints.
- Gravimetric respirable dust measurement appears to be a suitable method for characterizing concentrations in this setting.
- Respirator use was sporadic, and many workers had not been fit-tested.
- Smoking was associated with symptoms.

We recommend the following for this workplace:

1. **Reduce dust exposures with engineering controls.**
    - Eliminate the use of blow-downs (compressed air) and sweeping flock as means of cleaning.
    - Provide adequate local exhaust ventilation for bagging and drying operations.
2. **Until engineering controls are in place, limit the use of blow-downs and use personal respiratory protection to control dust exposures.**
    - Institute a formal respiratory protection program in accordance with OSHA regulations [29 CFR 1910.134].

- Designate bagging, sweeping, and blow-downs as respirator-required tasks.
- Require that a NIOSH-certified approval class N95 dust respirator be worn when bagging.
- Require that a full-facepiece, powered air-purifying respirator (PAPR) equipped with a high efficiency particulate air (HEPA) filter be worn when performing blow-downs or sweeping flock.

3. **Expand the annual medical examination to include a means for identifying workers with frequent fever, aches, or respiratory symptoms such as cough, shortness of breath, wheezing, or phlegm production. Workers with any of these symptoms should receive a medical evaluation and an opportunity to reduce dust exposures by placement out of high exposure jobs.**

4. **Periodically inform workers about work-related disease observed among flock workers and how to reduce or control their risk of disease.**

5. **Implement a no-smoking policy at the plant [NIOSH 1991]. If allowed at all, smoking at the plant should be restricted to designated, separately-ventilated smoking rooms. Workers should be encouraged to stop smoking altogether through an employer-sponsored smoking cessation program and education campaign.**

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Table 1: Worker characteristics, Claremont Flock Corporation, 1998

Characteristics	Number (%) n=133
Males	116 (87 %)
Non-white	14 (10 %)
Age in years - mean (min.- max.)	37 (20-67)
Smoking Status:	
Current smokers	48 (36 %) (avg. pack years = 21)
Former smokers	36 (27 %) (avg. pack years = 24)
Never smokers	49 (37 %)
Day Shift	94 (71 %)
Blow-downs in current job*†	73 (55 %)
Bagging non-cotton flock in current job *	73 (55 %)
Work predominantly with cotton (in the last 12 months)	10 (8 %)

* These groups share 57 of the same workers.
† Fourteen of these workers conduct 10 or more blow-downs in an average week.

Table 2: Current job title of workers who participated in medical survey, Claremont Flock Corporation, 1998

Job Title	Number of workers (%) n = 133
Plantwide material handler	0 *
Knife grinder	2 (2 %)
Dyehouse maintenance	2 (2 %)
Cotton area team leader	4 (3 %)
Dyehouse team leader	4 (3 %)
Dryer operator	4 (3 %)
Extractor operator	5 (4 %)
Cotton grinder operator	6 (5 %)
Dock worker	6 (5 %)
Dyehouse kettle operator	6 (5 %)
Lab worker	8 (6%)
Cutting area bagger	9 (7 %)
Cutting area team leader	14 (11 %)
Plant maintenance	14 (11 %)
Office and administration	23 (17%)
Cutter operator	26 (20 %)

* Environmental sampling data were obtained on these workers

Table 3: Prevalence of symptoms in all workers according to smoking status, Claremont Flock, 1998

Symptom	Number (%) n=133	Smoking Status		
		Current n = 48	Former n = 36	Never n = 49
3 or more episodes in the last 12 months:				
Nosebleeds	12 (9 %)	4 (8 %)	3 (8 %)	5 (10 %)
Throat irritation	35 (26 %)	11 (23 %)	12 (33 %)	12 (25 %)
Eye irritation	21 (16 %)	10 (21 %)	4 (11 %)	7 (14 %)
Sinus symptoms	39 (29 %)	17 (35 %)	10 (28 %)	12 (25 %)
Hayfever	18 (14 %)	5 (11 %)	5 (14 %)	8 (16 %)
Mucous membrane irritation	48 (36 %)	18 (38 %)	14 (39 %)	16 (33 %)
Chronic cough	22 (17%)	11 (23 %)	6 (17 %)	5 (10 %)
Usual phlegm	24 (18 %)	9 (19 %)	9 (25 %)	6 (12 %)
Chronic phlegm	27 (20 %)	10 (21 %)	6 (17 %)	11 (22 %)
Bronchitis-like symptoms	19 (14 %)	7 (15 %)	7 (19 %)	5 (10 %)
SOB on slight hill (and no other reason for difficult walking)	25 (19 %)	12 (25 %)	7 (19 %)	6 (12 %)
SOB own age (and no other reason for difficult walking)	3 (2 %)	2 (4 %)	0	1 (2 %)
ILD-like symptoms	11 (8 %)	6 (13 %)	1 (3 %)	4 (8 %)
Wheeze apart from colds	25 (19 %)	15 (31 %)	8 (22 %)	2 (4 %)
Wheeze most of the time	2 (2 %)	1 (2 %)	0	1 (2 %)
Wheeze with SOB	21 (16 %)	10 (21 %)	6 (17 %)	5 (10 %)
Asthma-like Symptoms	22 (17 %)	11 (23 %)	6 (17 %)	5 (10 %)
3 or more episodes in the last 12 months:				
Fever	8 (6 %)	4 (8 %)	3 (8 %)	1 (2 %)
Aches	16 (12 %)	6 (13 %)	5 (14 %)	5 (10 %)
Systemic Symptoms	18 (14 %)	7 (15 %)	5 (14 %)	6 (12 %)

Table 4: Prevalence of smoking status and symptom complexes in each exposure category

Exposure	n		Prevalence of symptom complex n (%)					
			Current smokers	MMI+	Bronchitis-like	ILD-like	Asthma-like	Systemic
Blow-downs in current job++	119	No	44 (37%)	42 (35%)	15 (13%)	9 (8%)	20 (17%)	16 (13%)
	14	Yes	4 (29%)	6 (43%)	4 (29%)	2 (14%)	2 (14%)	2 (14%)
Bagging flock in current job	60	No	14 (23%)	15 (25%)	5 (8%)	4 (7%)	7 (12%)	4 (7%)
	73	Yes	34 (47%)	33 (45%)*	14 (19%)	7 (10%)	15 (21%)	14 (19%)*
Blow-downs or Bagging flock in past jobs	64	No	22 (34%)	17 (27%)	2 (3%)	1 (2%)	5 (8%)	3 (5%)
	69	Yes	26 (38%)	31 (45%)**	17 (25%)**	10 (14%)**	17 (25%)**	15 (22%)**
Respirable dust in current job	33	Low	9 (27%)	7 (21%)	3 (9%)	0	5 (15%)	3 (9%)
	46	Medium	19 (41%)	18 (39%)	7 (15%)	5 (11%)	9 (20%)	5 (11%)
	54	High	20 (37%)	23 (43%)	9 (17%)	6 (11%)	8 (15%)	10 (19%)
Fibers in current job	41	Low	11 (27%)	10 (24%)	3 (7%)	0	7 (17%)	4 (10%)
	33	Medium	14 (42%)	15 (45%)	7 (21%)	7 (21%)	7 (21%)	5 (15%)
	59	High	23 (39%)	23 (39%)	9 (15%)	4 (7%)	8 (14%)	9 (15%)
Cumulative respirable dust (yrs-mg/m^3)	67	below median	27 (40%)	24 (36%)	7 (10%)	5 (7%)	12 (18%)	9 (13%)
	66	above median	21 (32%)	24 (36%)	12 (18%)	6 (9%)	10 (15%)	9 (14%)
Cumulative fiber (yrs-fibers/cm^3)	67	below median	26 (39%)	24 (36%)	5 (7%)	4 (6%)	10 (15%)	9 (13%)
	66	above median	22 (33%)	24 (36%)	14 (21%)	7 (11%)	12 (18%)	9 (14%)
Exposure to cotton in current job	123	No	42 (34%)	46 (37%)	17 (14%)	11 (9%)	19 (15%)	16 (13%)
	10	Yes	6 (60%)	2 (20%)	2 (20%)	0	3 (30%)	2 (20%)

+ MMI refers to mucous membrane irritation which is defined as eye or throat irritation.
++ refers to 10 or more blow-downs in an average week.
* p-value is less than 0.05 for the model (accounts for smoking status, packyears of smoking, age, pre-existing asthma or hayfever, blow-downs in current job, bagging flock in current job, current job dust concentrations, cumulative (dust or fiber) exposures and exposure to predominantly cotton in current job).
** p-value is less than 0.05 for the model (accounts for smoking status, packyears of smoking, age, pre-existing asthma or hayfever, blow-downs in current job, blow-downs or bagging in past jobs, current job dust concentrations, cumulative (dust or fiber) exposures and exposure to predominantly cotton in current job).

Figure 1
Area Respirable Dust Levels

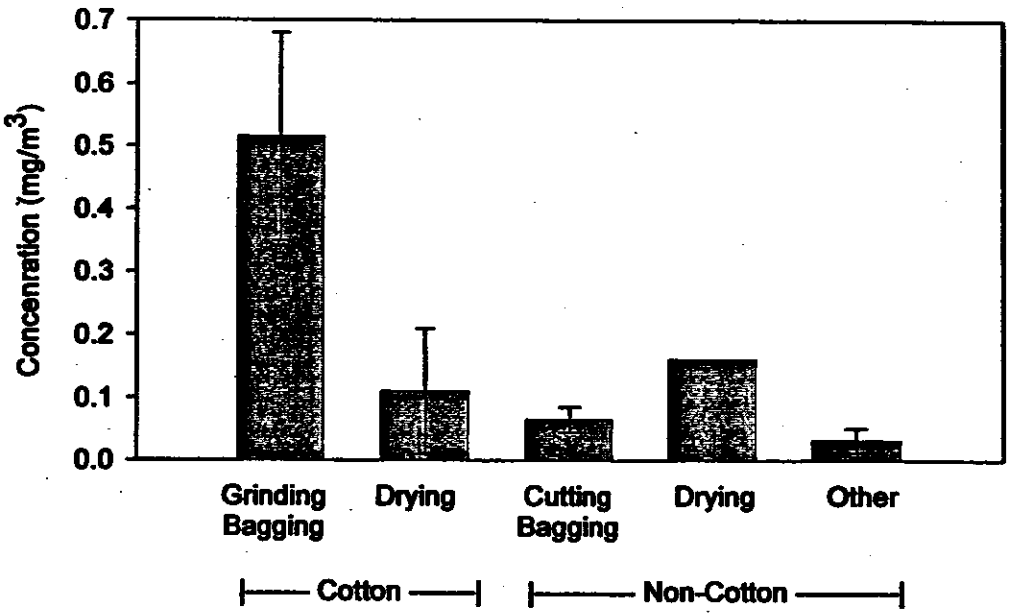


Figure 2
Comparison of Various Area Measures of Concentration in Non-Cotton Areas

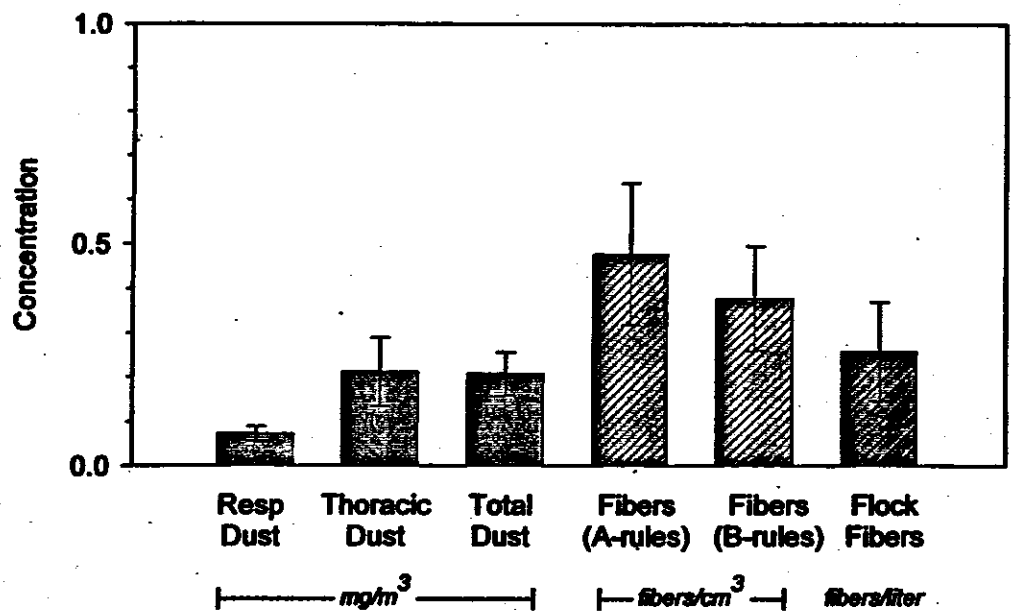


Figure 3A
Personal Respirable Dust Measurements

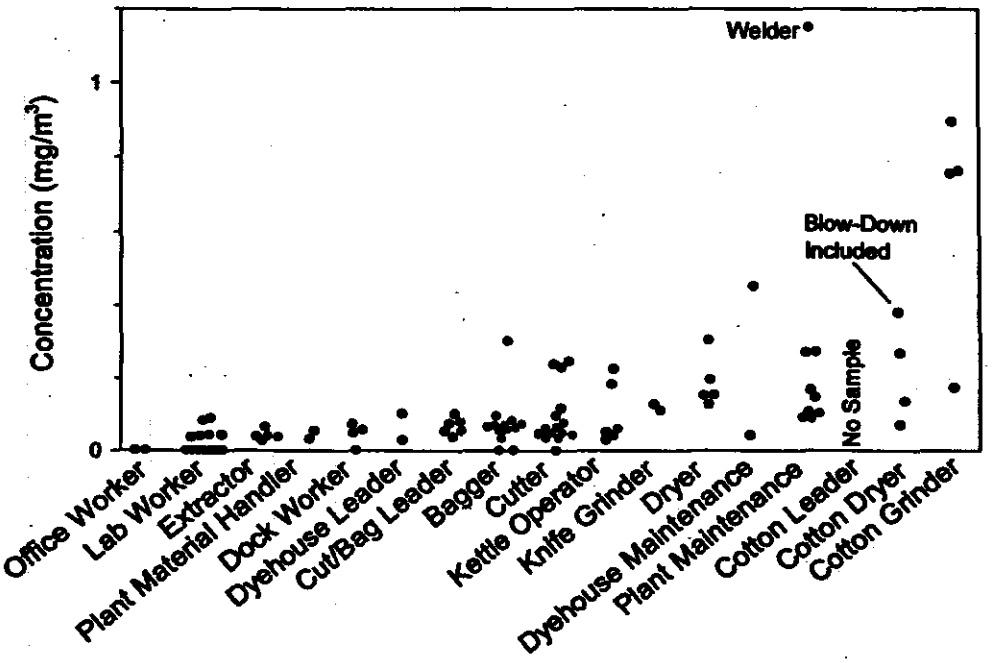


Figure 3B
Personal Fiber (A-rules) Measurements

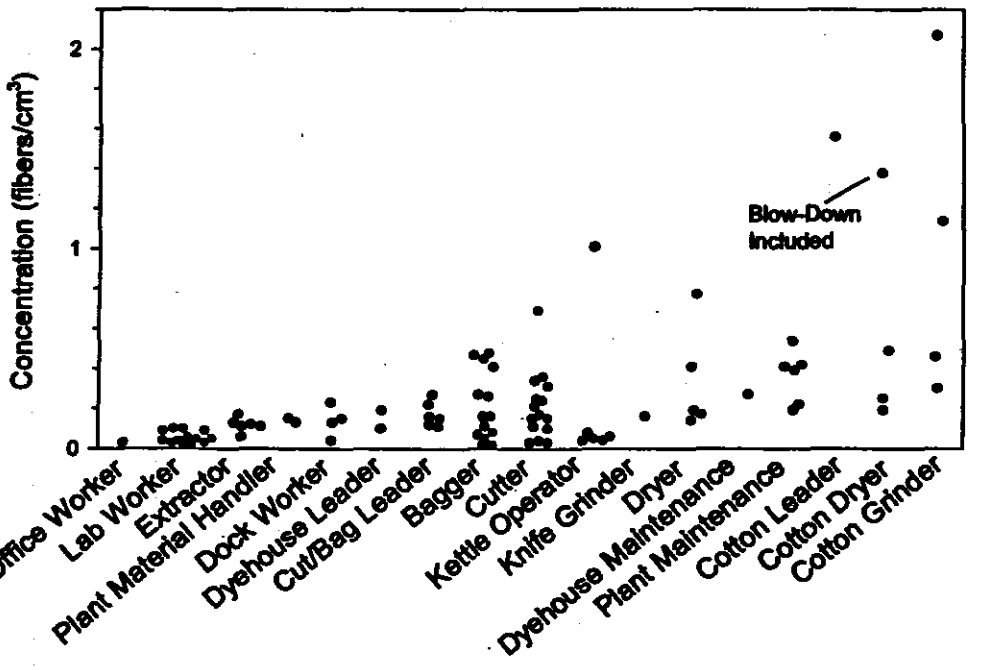


Figure 4
Real-Time Personal Dust Measurements
during Cleaning of Cotton Dryer Room

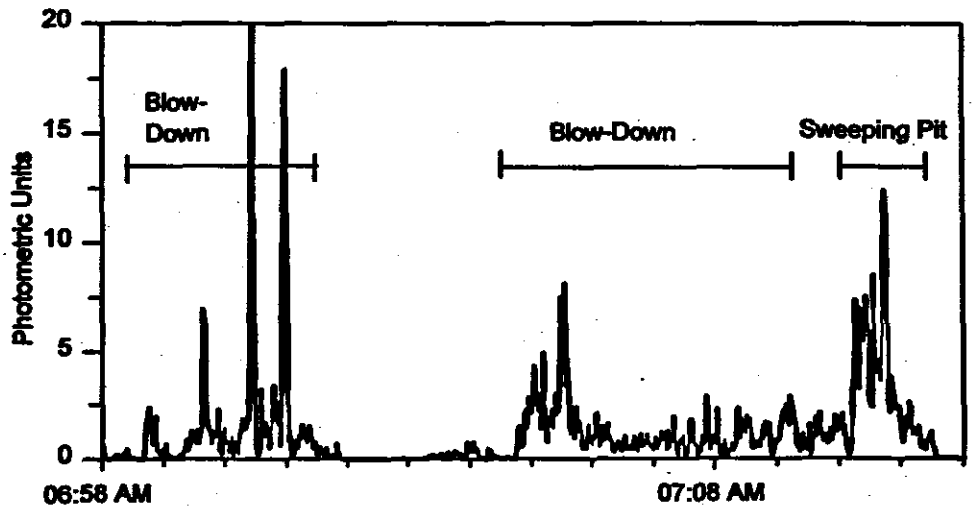


Figure 5
Scanning Electron Microscope Image of Air Sample Collected near Nylon Flock Bagging Operation

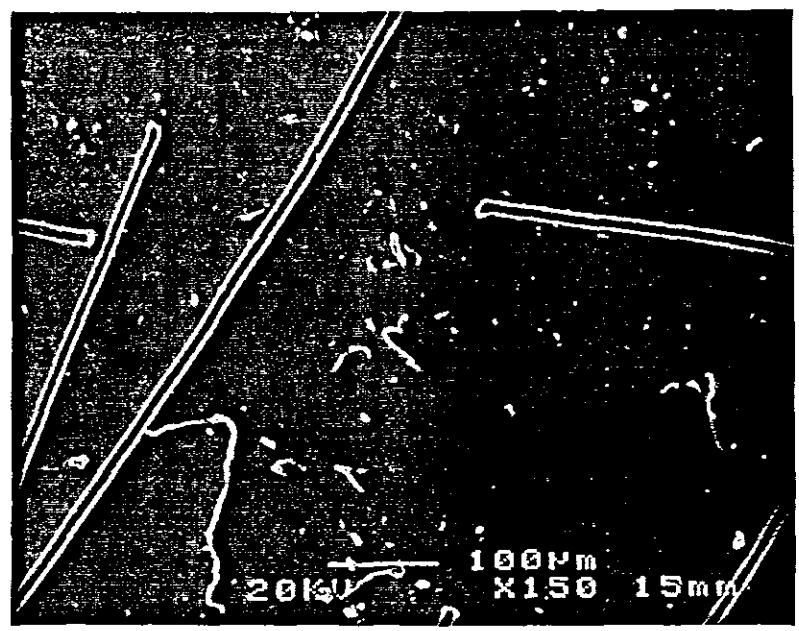
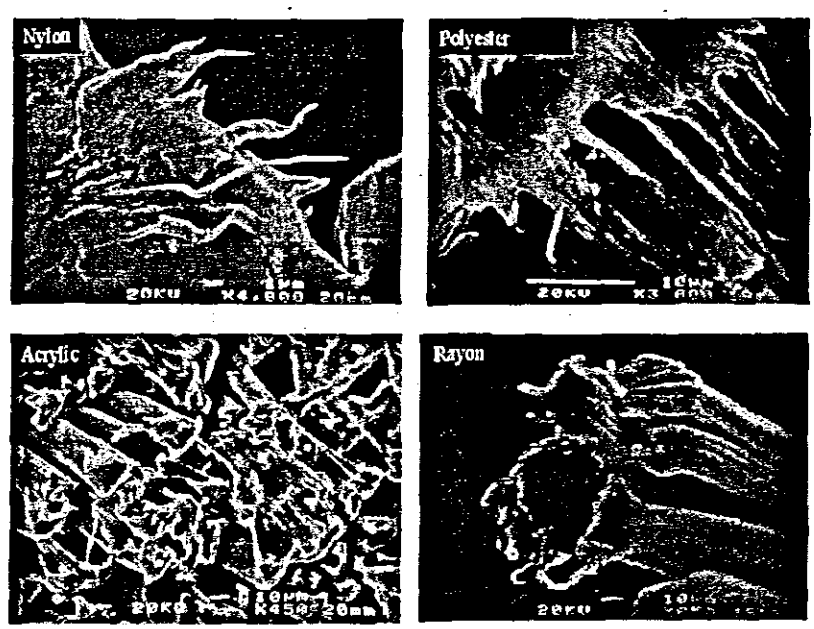


Figure 6
Scanning Electron Microscope Images of Cut Fiber Ends



APPENDIX

CLAREMONT

RDHETA 98-0212

1a. Interviewer's Initials:

_____ _____ _____

1b. Today's Date:

_____/_____/19____

Month/Day/Year

1c. Plant Location:

1 Leominster (MA)
2 River Road (NH)
3 Main Street (NH)
4 Mulberry (NH)

Thank you for participating in this survey. I will be collecting some information about you, your health, and your work.

_____

2a. (Last name) 2b. (First name) 2c. (MI)

_____

2d. (Street)

_____ _____

2e. (City) 2f. (State) 2g. (Zip Code)

2h. (Home Phone) _____/_____-_____

2i. (Date of Birth) _____/_____/_____
(Month) (Day) (Year)

2j. (Social Security Number) _____-_____-_____

2k. (Sex) 1 Male 2 Female

2l. (Race)

1 White or Caucasian
2 African-American or Black
3 Asian
4 American Indian or Alaskan Native
5 Native Hawaiian or Other Pacific Islander
6 Other (specify)_____

B. CHEST SYMPTOMS

I am now going to ask you some questions, mainly about your chest. Please answer Yes or No. If you are in doubt about whether your answer is Yes or No, please say No.

COUGH

3a. Do you usually have a cough? This includes a cough with first smoke or on first going out-of-doors, but does not include clearing of throat. 1 Yes 2 No

If "No", skip to Question 4a (PHLEGM).
If "Yes", ask the following questions:

3b.	Do you usually cough as much as 4 to 6 times a day, for 4 or more days out of the week?	1 Yes	2 No		3N/A
3c.	Do you usually cough like this on most days for 3 or more consecutive months during the year?	1 Yes	2 No		3N/A
3d.	In what year did you first notice this cough?	19__ __			
		5555	Don't know		
		7777	N/A		

PHLEGM

4a. Do you usually bring up phlegm from your chest? This includes phlegm with a first smoke, on first going out-of-doors, and swallowed phlegm; but does not count phlegm from the nose. 1 Yes 2 No

If "No", skip to Question 5a (WHEEZING).
If "Yes", ask the following questions:

4b.	Do you usually bring up phlegm like this as much as twice a day, 4 or more days out the week?	1 Yes	2 No	3	N/A
4c.	Do you bring up phlegm like this on most days for 3 or more consecutive months during the year?	1 Yes	2 No	3	N/A
4d.	In what year did you first notice this phlegm?	19__ __			
		5555	Don't know		
		7777	N/A		

WHEEZING

5a. Does your chest sound wheezy or whistling occasionally apart from colds? 1 Yes 2 No

If "No", skip to Question 6a.
If "Yes", ask the following question:

5b.	In what year did you start wheezing like this?	19__ __	
		5555	Don't know
		7777	N/A

6a. Does your chest sound wheezy or whistling most of the time? 1 Yes 2 No

If "No", skip to Question 7a (ATTACKS OF WHEEZING).
If "Yes", ask the following question:

6b.	In what year did you start wheezing like this?	19__ __	
		5555	Don't know
		7777	N/A

ATTACKS OF WHEEZING

7a. Have you had an attack of wheezing that has made you feel short of breath? 1 Yes 2 No

If "No", skip to Question 8a (BREATHLESSNESS).
If "Yes", ask the following questions:

7b.	In what year did you first have an attack of wheezing with shortness of breath?	19__ __	
		5555	Don't know
		7777	N/A
7c.	Have you ever required medicine or treatment for the(se) attack(s)?	1 Yes	2 No 3 N/A

BREATHLESSNESS

8a. Do you have any nerve, muscle, bone problems or heart trouble that makes walking difficult for you? 1 Yes 2 No

If "Yes", ask for description of difficulty:
8b._____

9a. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill? 1 Yes 2 No

If "No", skip to Section Question 10a.
If "Yes", ask the following question:

9b.	In what year did you first notice this shortness of breath?	19__ __ 5555 Don't know 7777 N/A

10a. Do you have to walk slower than people of your own age on the level because of shortness of breath? 1 Yes 2 No

If "No", skip to Section C (SYSTEMIC SYMPTOMS).
If "Yes", ask the following question:

10b.	In what year did you first notice this shortness of breath?	19__ __ 5555 Don't know 7777 N/A

C. SYSTEMIC SYMPTOMS

FEVER

11a. In the last 12 months, have you had 3 or more episodes of fever? 1 Yes 2 No

If "No", skip to Question 12a (ACHES)
If "Yes", ask the following questions:

11b.	In what year did you first notice fevers like this?	19__ __ 5555 Don't know 7777 N/A
11c.	When do you usually get these episodes of fever?	1 Usually on workdays 2 Usually on days off work 3 No noticeable pattern 4 Don't know 5 N/A

ACHES

12a. In the last 12 months, have you had 3 or more episodes of flu-like achiness or aches all over your body? 1 Yes 2 No

If "No", skip to Section D (IRRITANT SYMPTOMS).
If "Yes", ask the following questions:

12b.	In what year did you first notice aches like this?	19__ __ 5555 Don't know 7777 N/A

12c.	When do you usually get these aches?	1 Usually on workdays 2 Usually on days off work 3 No noticeable pattern 4 Don't know 5 N/A

D. IRRITANT SYMPTOMS

NOSE

13a. In the last 12 months, have you had 3 or more nosebleeds? 1 Yes 2 No

If "No", skip to Question 14a (THROAT).
If "Yes", ask the following questions:

13b.	In what year did you first notice these nosebleeds?	19__ __ 5555 Don't know 7777 N/A
13c.	When do you usually have these nosebleeds?	1 Usually on workdays 2 Usually on days off work 3 No noticeable pattern 4 Don't know 5 N/A

THROAT

14a. In the last 12 months, have you had 3 or more episodes of throat irritation, soreness, or tickle? 1 Yes 2 No

If "No", skip to Question 15a (EYES).
If "Yes", ask the following questions:

14b.	In what year did you first notice throat irritations like this?	19__ __ 5555 Don't know 7777 N/A
14c.	When do you usually have this throat irritation?	1 Usually on workdays 2 Usually on days off work 3 No noticeable pattern 4 Don't know 5 N/A

EYES

15a. In the last 12 months, have you had 3 or more episodes of eye irritation? 1 Yes 2 No

If "No", skip to Question 16a (SINUS).
If "Yes", ask the following questions:

15b.	In what year did you first notice these episodes of eye irritation?	19__ __ 5555 Don't know 7777 N/A
15c.	When do you usually have this eye irritation?	1 Usually on workdays 2 Usually on days off work 3 No noticeable pattern 4 Don't know 5 N/A

SINUS

16a. In the last 12 months, have you had 3 or more episodes of sinus fullness, drainage, or sinus pain? 1 Yes 2 No

If "No", skip to Section E (PAST ILLNESSES).
If "Yes", ask the following questions:

16b.	In what year did you first notice these sinus symptoms?	19__ __ 5555 Don't know 7777 N/A
16c.	When do these sinus symptoms usually occur?	1 Usually on workdays 2 Usually on days off work 3 No noticeable pattern 4 Don't know 5 N/A

E. PAST ILLNESSES

PNEUMONIA

17a. Have you ever been told by a doctor that you had pneumonia? 1 Yes 2 No

If "No", skip to Question 18a (ASTHMA).
If "Yes", ask the following questions:

17b.	In what year did you last have pneumonia?	19___ ___	
		5555	Don't know
		7777	N/A
17c.	How many episodes of pneumonia have you had in the last year?	___ ___ episodes	
		00	N/A

ASTHMA

18a. Has a doctor ever told you that you have asthma? 1 Yes 2 No

If "No", skip to Question 19a (HAY FEVER).
If "Yes", ask the following questions:

18b.	At what age were you first told that you had asthma?	___ ___ (Age in years)	99	N/A
18c.	Do you still have asthma?	1 Yes	2 No	3 N/A
	If "Yes", skip to Question 19a (HAY FEVER). *If "No, ask":*			
18d.	At what age did it stop?	___ ___ (Age in years)	99	N/A

HAY FEVER

19a. Has a doctor ever told you that you have hay fever? 1 Yes 2 No

If "No", skip to Question 20a (CHEST ILLNESSES).
If "Yes", ask the following questions:

19b.	At what age were you first told you had hay fever?	___ ___ (Age in years)	99	N/A
19c.	Do you still have symptoms of hay fever?	1 Yes	2 No	3 N/A
	If "Yes", skip to Question 20a (CHEST ILLNESSES). *If "No," ask the following question:*			
19d.	At what age did you stop having hay fever symptoms?	___ ___ (Age in years)	99	N/A

CHEST ILLNESS

Have you ever had any of the following chest illnesses or conditions?

						If "Yes", year most recently had:
20a. Bronchitis?	1	Yes	2	No	20b.	19__ __ 5555 Don't know 7777 N/A
21a. Pleurisy?	1	Yes	2	No	21b.	19__ __ 5555 Don't know 7777 N/A
22a. Tuberculosis (TB)?	1	Yes	2	No	22b.	19__ __ 5555 Don't know 7777 N/A
23a. Heart problems?	1	Yes	2	No	23b.	19__ __ 5555 Don't know 7777 N/A

23c. *If "Yes," ask:* What heart problems do you have? _____

24a. Chest injury?	1	Yes	2	No	24b.	19__ __ 5555 Don't know 7777 N/A

24c. *If "Yes," ask:* What chest injury have you had? _____

F. OCCUPATIONAL HISTORY

I am now going to ask you questions about your current job

CURRENT JOB

25a. What is your current department? _____

26a. What is your current job title? _____

27a. What shift do you usually work? a Day b Night c Rotate shifts

28a. How many hours do you usually work in a week? __ __ Hours/Week

29a. How many days do you usually work in a week ? _____ Days/Week

BLOWDOWNS

30a. During an average week, how many blowdowns do you conduct or directly help conduct? ___ ___ ___# of blowdowns

If "Zero", skip to Question 31a.
If a number is given, ask the following questions:

30b.	Do you wear a mask or respirator when conducting a blowdown?	1Yes	2 No	3 N/A
	If "No", skip to Question 31a. *If "Yes", ask the following question:*			
30c.	Do you wear a mask:	1 2 3 4	during all blowdowns? during most blowdowns? during some blowdowns? N/A	
30d.	Which type of mask or respirator do you wear? (See Diagram)	01 02 03 04 05 06 07 other_____ 08	single strap 2-strap half face piece full face piece PAPR SCBA N/A	
30e.	Were you fit tested for this respirator before you used it?	1 Yes	2 No	3 N/A

NEAR BLOWDOWNS

31a. In an average week, how many blowdowns happen near your work area that you don't directly conduct? ___ ___ ___ # of blowdowns

If "Zero", skip to Question 32a (BAGGING FLOCK).
If a number is given, ask the following questions:

31b.	Do you wear a mask or respirator when these blowdowns are occurring?	1Yes	2 No3 N/A
	If "No", skip to Question 6 (BAGGING FLOCK). *If "Yes," ask the following questions:*		

31c.	Do you wear a mask:	1	during all blowdowns
		2	during most blowdowns
		3	during some blowdowns
		4	N/A
31d.	Which type of mask or respirator do you wear? (See Diagram)	01	single strap
		02	2-strap
		03	half face piece
		04	full face piece
		05	PAPR
		06	SCBA
		07	Other
		08	N/A
31e.	Were you fit tested for this respirator before you used it?	1 Yes	2 No 3 N/A

BAGGING FLOCK

32a. In the last 12 months, have you spent any time bagging flock (not cotton flock)? 1 Yes 2 No

If "No", skip to Question 33a (BAGGING COTTON).
If "Yes", ask the following questions:

32b.	In an average shift, how many hours do you spend bagging flock?	_____ hours in a shift 99 N/A	
32c.	Do you wear a mask or respirator while you are bagging flock?	1Yes	2 No 3 N/A
	If "No", skip to Question 33a (BAGGING COTTON) *If "Yes," Ask the following questions:*		
32d.	When do you wear the mask or respirator?	1	during all bagging
		2	during most bagging
		3	during some bagging
		4	N/A

32e.	Which type of mask or respirator do you wear? (See Diagram)	01 02 03 04 05 06 07 Other_____ 00	single strap 2-strap half face piece full face piece PAPR SCBA N/A
32f.	Were you fit tested for this respirator before you used it?	1 Yes	2 No 3 N/A

BAGGING COTTON

33a. In the last 12 months, have you spent any time bagging cotton? 1 Yes 2No

If "No", skip to Question 34a (ALL MATERIALS).
If "Yes", ask the following questions:

33b.	In an average shift, how many hours do you spend bagging cotton?	___ ___ hours in a shift 99 N/A	
33c.	Do you wear a mask or respirator while you are bagging cotton?	1Yes	2 No 3N/A
	If "No", skip to Question 34a (ALL MATERIALS) *If "Yes," ask the following questions:*		
33d.	When do you wear the mask or respirator?	1 2 3 4	during all bagging during most bagging during some bagging N/A
33e.	Which type of mask or respirator do you wear? (See Diagram)	01 02 03 04 05 06 07 Other_____ 08	single strap 2-strap half face piece full face piece PAPR SCBA N/A
33f.	Were you fit tested for this respirator before you used it?	1 Yes	2 No 3 N/A

ALL MATERIALS

34a. Have you noticed that any materials at work cause you to have chest symptoms such as cough, phlegm, wheezing, attacks of wheezing, or shortness of breath? 1 Yes 2 No

If "No", skip to Question 35a.
If "Yes", list the Material(s) and Symptom(s):

34b. Material _____ 34c. Symptom _____

34d. Material _____ 34e. Symptom _____

34f. Material _____ 34g. Symptom _____

34h. Material _____ 34i. Symptom _____

In the past 12 months have you worked on the range, module, dye house or bagging station with the following materials:

	EVERY MONTH in the last 12 months	LESS THAN EVERY MONTH in the last 12 months	NEVER in the last 12 months
35a. NYLON	1	2	3
35b. RAYON	1	2	3
35c. POLYESTER	1	2	3
35d. COTTON	1	2	3
35e. ARAMID	1	2	3
35f. ACRYLIC	1	2	3

G. CIGARETTE SMOKING

Now I would like to ask you about cigarette smoking.

36a. Have you ever smoked cigarettes regularly? Please say "Yes" if you have smoked 100 cigarettes or more in your entire life. (100 cigarettes = 5 packs) 1 Yes 2 No

If "No," skip to Section H (WORK HISTORY):
If "Yes", ask the following questions:

36b.	How old were you when you first started smoking cigarettes regularly?	___ ___ (Age in years)	99 N/A
36c.	On average, for the entire time that you smoked, how many cigarettes did you smoke per day? (20 cigarettes = 1 pack)	___ ___ ___ (# Cigs/day)	999 N/A

36d.	Do you now smoke cigarettes (as of 1 month ago)? *If "Yes," skip to Section H. (WORK HISTORY)* *If No ask:*	1Yes	2 No	3	N/A
36e.	If you have stopped smoking cigarettes completely, how old were you when you stopped?	__ __ (Age in years)		99	N/A

For Information on Other Occupational Safety and Health Concerns

Call NIOSH at:
1-800-35-NIOSH (356-4676)
or visit the NIOSH Homepage at:
http://www.cdc.gov/niosh/homepage.html

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