# NIOSH HEALTH HAZARD EVALUATION REPORT

## HETA #2004-0186-3011
## Claremont Flock Corporation
## Leominster, Massachusetts

## August 2006

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**DEPARTMENT OF HEALTH AND HUMAN SERVICES**
**Centers for Disease Control and Prevention**
**National Institute for Occupational Safety and Health**

# PREFACE

The Respiratory Disease Hazard Evaluations and Technical Assistance Program (RDHETAP) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSH) Act of 1970, 29 U.S.C. 669(a)(6), or Section 501(a)(11) of the Federal Mine Safety and Health Act of 1977, 30 U.S.C. 951(a)(11), which authorizes the Secretary of Health and Human Services, following a written request from any employers or authorized representatives of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

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# ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

Vinicius Antao and Chris Piacitelli of RDHETAP, Division of Respiratory Disease Studies (DRDS), prepared this report. Environmental field assistance was provided by Randy Boylstein of RDHETAP and David Sylvain of the NIOSH Hazard Evaluations and Technical Assistance Branch. Medical field assistance was provided by Terry Rooney and Elizabeth Lowery. Statistical support was provided by William Miller and Sandra White. DataChem Laboratories, Salt Lake City, Utah provided laboratory analytical support. Desktop publishing was performed by Amber Harton.

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# HIGHLIGHTS OF THE NIOSH HEALTH HAZARD EVALUATION AT CLAREMONT FLOCK CORPORATION

The National Institute for Occupational Safety and Health (NIOSH) conducted environmental and medical surveys at Claremont Flock Corporation in Leominster, Massachusetts in January 2005. The Massachusetts Department of Public Health Occupational Health Surveillance Program had requested technical assistance to determine if there had been improvement in the environmental conditions and to update the health status of the workforce since a NIOSH evaluation in 1998, given that a new case of flock workers' lung occurred in 2003.

## What NIOSH Did

- Measured airborne dust concentrations for most jobs within the plant
- Invited all employees to participate in the medical survey to assess health effects in relation to exposure to airborne particulates associated with flock production operations
- Interviewed employees about symptoms and medical, work, and smoking histories
- Analyzed measurements and interview results for associations between work exposures and health effects

## What NIOSH Found

- Despite engineering control changes since our 1998 evaluation, respirable dust exposures were found to be unchanged or increased
- Bagger/cutter and dryer operators were exposed to the highest concentrations of respirable dust
- Cleaning flock with compressed air, brooms, and shovels and manipulating bags of flock were observed to create airborne dust
- Working with flock and cleaning with compressed air were associated with respiratory health effects in employees

## What Claremont Flock Managers Can Do

- Provide engineering controls and improved material-handling work practices for the bagging stations, including bag filling and bag manipulation for weighing, sewing, and palletizing
- Determine and control the source of elevated dust levels during production in the dryer rooms
- Reposition local exhaust ventilation hoods at the dryer bagging stations to the tops of the bags being filled
- Provide new cleaning methods to replace compressed-air blow-downs, sweeping, and shovelling of flock
- Conduct air sampling regularly to monitor effectiveness of controls
- Expand respiratory protection requirements to include all bagging, dryer room, and flock-cleaning operations (including unplugging of accumulators) until these controls can be implemented, and ensure compliance
- Include in the current respirator program a means of identifying workers with respiratory symptoms such as shortness of breath, wheezing, or phlegm production, and of detecting declines in lung function
- Provide information about flock workers' lung to employees and health consultants responsible for the respirator program
- Continue to offer a smoking cessation program and to enforce the no-smoking policy already in place

## What Employees Can Do

- Wear respirators when required
- Handle bags of flock carefully to prevent airborne flock
- Seek medical evaluation for respiratory symptoms, such as shortness of breath, wheezing, or phlegm production and inform the physician of flock exposures
- Inform management of respiratory symptoms and associated flock exposures

**What To Do For More Information:**
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2004-0186-3011

# Health Hazard Evaluation Report 2004-0186-3011
# Claremont Flock Corporation
# Leominster, Massachusetts
# August 2006


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## SUMMARY


In 1997, a case of flock workers' lung occurred at Claremont Flock Corporation. The National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation (HHE) in 1998 at several of Claremont Flock's plants and found that cleaning with compressed air and bagging flock were associated with worker-reported symptoms. The HHE report provided environmental and medical recommendations to the company to prevent flock-related disease in their plants. In March 2004, based on a case report consistent with flock workers' lung at Claremont Flock's only remaining plant, the Massachusetts Department of Public Health Occupational Health Surveillance Program requested technical assistance to determine if there had been improvement in the environmental conditions and to update the health status of the workforce.

NIOSH conducted environmental and medical surveys at this plant in January 2005 to characterize exposures and symptoms of flock-exposed workers and internal comparison groups. The environmental survey consisted of personal time-integrated gravimetric sampling for respirable dust concentration and sampling with aerosol photometers to obtain real-time continuous relative levels of dust (approximately respirable) during some plant activities. Videotaping was done to record events that might be associated with any observed peaks in real-time readings. We invited all 80 employees to take part in the medical survey. Trained NIOSH interviewers administered computer-based questionnaires that focused on respiratory and systemic symptoms, physician diagnosis of respiratory illnesses, smoking, work history, respirator use, and whether fit-testing had been conducted.

Time-integrated respirable dust sampling results showed that the bagger/cutters and the dryer operators had the highest geometric mean 8-hour time-weighted exposures of 0.13 and 0.80 mg/m$^3$, respectively. For most groups of workers, the exposures were found to be largely unchanged since our previous investigation in 1998, but for these 2 groups of workers the exposures were found to have increased. This happened despite the engineering control changes made in the plant since 1998. Real-time personal sampling results indicated that cleaning operations, such as blowing with compressed air, sweeping, and shovelling of flock, were associated with increases in dust levels around the workers. Manipulation of bags of flock both inside and outside of designated "respirator-required" zones at bagging stations was also associated with elevated levels of dust.

A total of 74 employees (participation rate = 92.5%) participated in the medical survey. The majority of employees were male (92%), white (58%), and non-smokers (76%). The mean tenure of Claremont Flock

workers was 8 years, and only 16% of workers had either changed jobs or started working at Claremont Flock within the last 6 months. A total of 22 participants (30%) reported cleaning with compressed air for at least one hour per week, and 23 participants (31%) reported working with cotton in the last 12 months. Except for bagging cotton, there was an increase in the percentage of employees who wear respirators during their activities, when we compared the 2005 and 1998 surveys. The percentage of fit-tested workers also increased in the 2005 survey compared to the 1998 survey.

The most frequently reported symptoms were wheeze apart from colds, throat irritation, and sinus problems. The prevalences of throat irritation, usual and chronic cough, shortness of breath while walking up a slight hill, and wheeze apart from colds were lower among never smokers compared to current or former smokers. When we took into account only symptoms with onset after employment at Claremont Flock, chronic phlegm and shortness of breath were the most frequently reported symptoms. "Wheeze apart from cold" and "pneumonia in the last year" were statistically significantly elevated when we compared symptom prevalences of participating workers to expected prevalences based on national data.

In general, dryers and baggers/cutters, workers who cleaned for one hour or more per week using compressed air, and employees with high cumulative exposure to flock-associated dust (> 0.425 mg-year/$m^3$) had higher prevalences of symptoms than other workers. In multivariate models, cleaning equipment with compressed air was significantly associated with throat irritation. High cumulative exposures were significantly associated with the development of sinus irritation. A comparison of 1998 symptom prevalences for a subgroup that participated in both the 1998 and 2005 surveys indicated that those who continued working had lower symptom prevalences than those who had left after 1998. This is a form of "healthy-worker effect", whereby health effects of a workplace exposure are underestimated by looking at current workers.

We conclude that working with flock and cleaning with compressed air are associated with health effects at this plant.

We recommend that the company prevent flock-associated dust exposures: by providing engineering controls and improving work practices for the bagging process including not only the filling of bags at the bagging stations but also the subsequent manipulation of the bags for weighing, sewing, and palletizing; by determining and controlling the source of elevated dust levels during production in the dryer rooms and repositioning the dryer room bagging station local exhaust ventilation hoods to the tops of the bags being filled with flock; by providing new cleaning methods that will eliminate the elevated dust levels associated with compressed-air blow-downs, sweeping, and shovelling of flock; by verifying effectiveness of controls with regular air sampling; and by expanding respiratory protection requirements, until the controls can be implemented, to all bagging and flock-cleaning processes, including manual unplugging of accumulators (enclosed baghouses), and to the entire production operation in the dryer rooms. In terms of medical recommendations, we suggest that the company continue to offer a smoking cessation program and to enforce the no-smoking policy already in place; include in the current respirator program a means of identifying workers with respiratory symptoms such as shortness of breath, wheezing, or phlegm production, and a means of detecting declines in lung function; and provide information about flock workers' lung to employees and health consultants responsible for the respirator program.

We also recommend that employees wear respirators when required; handle bags of flock with care to prevent airborne flock; seek medical evaluation for respiratory symptoms, such as shortness of breath, wheezing, or phlegm production and inform health care providers of flock exposures; and inform management of respiratory symptoms and associated flock exposures.

The Claremont Flock plant in Leominster, Massachusetts was first evaluated by NIOSH in 1998 as part of its initial investigation of the risk of occupational lung disease from exposure to flock-associated dust. In 2004, after learning that a worker at this plant had been recently identified as having medical findings consistent with flock workers' lung, the Massachusetts Department of Public Health Occupational Health Surveillance Program requested NIOSH technical assistance to determine if there had been improvement in environmental conditions at the plant and to obtain updated information on the health status of the workforce. NIOSH conducted a medical and environmental survey at this plant in January 2005. Despite engineering control changes implemented after 1998, respirable dust levels were found to be unchanged or increased. Upper respiratory symptoms were associated with cleaning equipment with compressed air, and with high cumulative exposure to flock-associated dust. To minimize the risk to workers, management should improve work practices and increase mandatory use of respirators by workers while it identifies and implements additional engineering controls.

Keywords: NAICS 325222 (Noncellulosic Organic Fiber Manufacturing), nylon, flock, interstitial lung disease, flock workers' lung

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# INTRODUCTION

In March 2004, the National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance from the Massachusetts Department of Public Health Occupational Health Surveillance Program. A physician had notified them of a recent suspected work-related case of asthma/hypersensitivity pneumonitis from the Claremont Flock Corporation plant in Leominster, Massachusetts. A prior company-requested health hazard evaluation (HHE) in 1998 involved a case of flock workers' lung [NIOSH 2000]. The health department requester asked NIOSH to revisit the Leominster plant to determine if there had been improvement in the environmental conditions and to update the health status of the workforce.

This request led to our site visit to Claremont Flock on August 30, 2004. During this walk-through visit, we met with management, toured the plant, and spoke privately with many of the workers. After this visit and with Claremont Flock management concurrence, NIOSH planned further investigation, including an environmental survey and a cross-sectional medical symptom survey

The environmental survey took place from January 17 to 21, 2005, when airborne dust measurements were obtained. The medical survey, consisting of a symptom and work history questionnaire, took place on January 18 and 19, 2005. We presented our 1998 findings to current workers on January 19, 2005. This report provides the findings from the 2005 surveys at this plant and a comparison with the 1998 results, and serves to close out this technical assistance request.

# BACKGROUND

Flock is composed of synthetic fibers of about 1 millimeter (mm) in length, which have been cut from continuous filaments ("tow") of materials such as nylon, rayon, polyester, acrylic, or polypropylene with typical diameters of 10 to 15 micrometers (μm). These short fibers are applied to adhesive-coated surfaces of many materials, such as fabrics and paper, to create a velvet-like finish to a variety of products, including upholstery coverings, greeting cards, glove boxes for automobiles, etc. The only occupational exposure limits for the dust associated with flock operations are those for particulates not otherwise regulated (PNOR) which is 5 milligrams per cubic meter of air ($mg/m^3$) for respirable dust and 15 $mg/m^3$ for total dust [CFR, 2005]; however, flock-associated dusts have been shown to have health effects below these standards [Daroowalla, 2005].

Our 1998 HHE at four of Claremont Flock's plants (164 employees) in Massachusetts and New Hampshire consisted of a symptom and work history questionnaire and personal and area air sampling. We found that cleaning with compressed air, bagging flock, and smoking were associated with symptoms and that respirator use was sporadic. We recommended the elimination of cleaning with compressed air and sweeping, provision of local exhaust ventilation for bagging and drying operations, and mandatory respirator use during these operations until the changes could be made. Additionally, we recommended a no-smoking policy, that workers be informed about flock-related disease, and that the medical evaluations include a means for identifying workers with frequent fever, aches, or respiratory symptoms to determine the need for placement out of high exposure jobs.

### *Plant and Process Description*

During the previous HHE, the Leominster plant had about 100 workers assigned to 2 shifts. Since then, plant closures have left only the Leominster plant operating. Some equipment from the closed plants was moved into this plant, which continues to operate with an 80-person workforce on two 12-hour shifts (54 on day shift and 26 on night shift), weekdays only. At times, if production is low, the plant will not operate the last day of the week. The plant has several rotary precision cutting ranges that process mostly nylon, but also some polyester, rayon,

and acrylic. There are two employees assigned to each precision cutting range; one monitors the cutting of the tow, the other is responsible for bagging the finished/dried flock, and they relieve each other during breaks. An offline range and guillotine range cut wet flock and bag it without drying. In the random department, cotton undergarment factory scraps are ground into fine random-length flock fibers and then bagged. Some flock goes through a batch dyeing process, followed by drying and bagging in the dryer department. Periodically, a cleaning process referred to as a "blow-down" is performed. In this process, workers use compressed-air guns to blow settled flock from equipment and floors. Blow-downs are performed at the precision ranges and dryers any time a color or material change occurs that might contaminate the next product. Thorough blow-downs of precision areas are done weekly, two ranges per week at the end of the last night shift of the week. Random department blow-downs are performed bimonthly at a minimum. Annual shutdown is during July, and blow-down of the entire plant is done prior to that closing.

Some engineering control changes occurred between 1998 and 2005. Production cyclones at the cutting ranges, rather than being discharged from the top into the plant environment as in 1998, were connected to enclosed baghouses (accumulators) which are exhausted outdoors and have automatic bag shake-outs. Accumulators also replaced open-air baghouses. Local exhaust ventilation through an accumulator was provided for all the dryer bagging stations and for one precision cutting range screen feed chute and bagging station. After 1998, the production cyclones that served these operations were changed from inside-plant to outdoor discharge. The company has recently reported that, following our 2005 survey, air has been re-routed so that it is first filtered through a newly-installed accumulator before being sent outdoors.

The company implemented a comprehensive respiratory protection program in 2000, which was updated in mid-2004, establishing bagging, cotton grinding, and blow-downs as tasks requiring use of half facepiece air-purifying particulate respirators. The area where respirators are required for bagging is restricted to that defined by the "red zone" painted on the floor immediately around the bagging station and scale. The 2004 program update included a provision for disciplinary action against employees refusing to wear respirators and coincided with construction of a respirator cleaning room.

Claremont Flock's hazard communication program identifies flock as a hazardous substance in the plant and provides information on the hazards in employee training. The company developed material safety data sheets (MSDS) for all of their flock products.

The company first performed air sampling in the facility in October 2004 when a consultant conducted personal fiber sampling as well as some real-time dust monitoring.

### *Disease Characteristics*

In 1996, a group of employees from a Rhode Island plant that produces and applies nylon flock was identified as having work-related interstitial lung disease (ILD) [Kern 1997, Kern 1998]. In interstitial lung disease, inflammation of the air sacs and tiny airways and scarring of the lung tissue causes the lungs to become stiff, small, and less effective in transferring oxygen from the air and carbon dioxide from the blood. One year earlier, Canadian scientists had described five cases of ILD in a flock plant owned by the same company [Lougheed 1995]. Patients with this newly recognized disease had breathlessness and dry cough. The symptoms ranged from mild to very severe, and one subject required prolonged mechanical ventilation in a hospital intensive care unit due to respiratory failure. The usual latency between date of hire and onset of symptoms was 5 to 6 years. On chest radiograph, the earliest recognized cases had abnormal opacities described as diffuse reticulonodular infiltrates [Lougheed 1995, Kern 1997, Kern 1998]. Patchy areas of consolidation, ground-glass opacities, and micronodules were the main characteristics on high-resolution computed tomography (CT) of the chest [Weiland 2003]. Pulmonary function tests

generally showed a pattern of not expanding normally (a restrictive pattern) and reduced gas transfer (low carbon monoxide diffusing capacity), in which oxygen does not cross the lung tissue into the blood stream normally. Some patients also had abnormal methacholine challenge tests, indicating very sensitive or "twitchy" airways, a condition called bronchial hyperresponsiveness. Usually months after leaving work, patients' symptoms, radiographs, and pulmonary function tests improved, but typically without complete recovery. Some cases were treated with high doses of corticosteroids; some with supplementary oxygen therapy [Kern 2000]. A unique pattern of lung damage (lymphocytic bronchiolitis and peribronchiolitis with lymphoid hyperplasia) in biopsies is visible with a microscope in "flock workers' lung" [Eschenbacher 1999, Boag 1999]. While the initial case clusters and several sporadic cases of flock workers' lung have been reported in the nylon flock industry in North America, more recently reported cases in Europe have been associated with other types of flock. A case of flock workers' lung was described in a worker exposed to polyethylene flock in Spain [Barroso 2002]. In Turkey, a cross-sectional study in a polypropylene flock plant showed a 3.6-fold increase in respiratory symptoms in exposed workers compared to unexposed controls [Atis 2005]. In a NIOSH investigation of rayon flock workers, increased symptoms and mild changes in lung function tests occurred in flock-exposed workers, particularly those using compressed air for cleaning [NIOSH 2005].

### *Past Flock-associated Health Effects at Claremont Flock*

In November 1998, NIOSH conducted investigations at Claremont Flock plants consisting of a symptom and work history questionnaire and personal and area sampling for respirable dust and fiber counts. A total of 133 (81%) of the workers participated in the survey. Even though the time-integrated dust concentrations were low (most under 0.2 $mg/m^3$), blow-downs were associated with high exposures and respiratory symptoms in workers. One case of flock workers' lung had been diagnosed at that time.

In 2004 we reviewed medical records of a Claremont Flock employee who was diagnosed with occupational asthma and an interstitial disease consistent with flock workers' lung in 2003. He had cough, shortness of breath, wheezing, and chest tightness. A high-resolution computed tomography of the chest revealed multiple nodules bilaterally, and pulmonary function tests showed diminished carbon monoxide diffusing capacity and an abnormal methacholine challenge test. These findings support the diagnosis of flock workers' lung and asthma. This case was reported to the Massachusetts Department of Public Health Occupational Health Surveillance Program and motivated this technical assistance request.

### *Objectives*

The main objectives of this evaluation were to: (1) characterize worker exposures to airborne particulates associated with flock-production operations; (2) assess health effects in relation to exposure to these particulates, by comparison of health status of exposed workers to subgroups within the plant with different degrees of exposure; (3) assess health effects by comparison of health status of workers to national data; and (4) compare the results of this survey with those obtained from the 1998 survey.

# METHODS

## Environmental Survey

### *Time-integrated sampling*

Personal sampling in all areas of the plant included air samples for gravimetric concentration of respirable dust using NIOSH Method 0600 [NIOSH 2003]. Air was drawn at a rate of 4.2 liters per minute through a 37-millimeter diameter, 5-micrometer pore size, preweighed polyvinyl chloride filter in a 3-piece cassette mounted on a cyclone (Model GK-2.69 Respirable/Thoracic Cyclone, BGI, Inc., Waltham, MA) in the personal breathing zone of the workers. We evaluated all distinct production job titles. We obtained area samples

in the office to estimate office worker exposures. Samples were collected for about 8 hours during 2 day shifts and 1 night shift. On a few workers, task-specific partial-shift exposures were measured by replacing the sampling media when the worker switched from operating a machine to cleaning tasks or between cleaning with and without compressed air.

### *Real-time sampling*

We used aerosol photometers (light-scattering aerosol monitors) to obtain real-time continuous relative levels of dust (approximately respirable – instrument optimized for detection of particles up to 10μm) during some plant activities, including cleaning. The device (Model pDR-1000 personalDataRAM, MIE, Inc., Bedford, MA) was strapped to the chest of the worker while performing the tasks. To record events that might be associated with any observed peaks in real-time readings, we utilized video cameras during the measurements.

## Medical Survey

### *Study population*

Company records were provided to NIOSH regarding job and work area of all employees as of January 2005. The study population for the cross-sectional medical survey consisted of all 80 employees who worked on either of the two 12-hour shifts.

### *Questionnaire*

After obtaining written informed consent, trained NIOSH interviewers administered a computer-based questionnaire to each participant. It included sections on upper and lower respiratory symptoms, systemic symptoms, physician diagnosis of respiratory illnesses, smoking and work history, respirator use, and whether respirator fit-testing had been conducted (see Appendix). Questions about lower respiratory symptoms were taken from standard, validated questionnaires [Ferris 1978, NCHS 1994]. Questions on onset dates and work-related patterns were included for the respiratory, nasal, and sinus symptoms.

## Data Analysis

To assess whether Claremont Flock employees had excess symptoms, we compared participant results to national data from the Third National Health and Nutrition Examination Survey (NHANES III). We calculated ratios of the observed number of cases among employees to the expected number of cases for four symptoms and three medically diagnosed conditions. We used indirect standardization for gender, race, age, and smoking status [NCHS, 1996].

The questionnaire information was collected electronically and entered into a database. Statistical analyses of the questionnaire data and the environmental sampling data were conducted using SAS software [SAS, 2004]. The significance of any associations was reported as probability (p) values. Values less than 0.05 were considered to represent an association not likely to be due purely to chance. Covariates for the logistic models on health outcomes included race, tenure, age, and smoking, the last factor being represented by the estimated pack-years (i.e., years-smoked × cigarettes-per-day/20). Because of the small number of female workers, gender was not included. An important limitation for the logistic models was the small number of positive responses for the outcomes. The work of Peduzzi et al. [1996] suggests that a stable estimate (e.g., an estimate which would not be expected to differ substantially with additional sampling) can be obtained by having 10 cases per variable, although some authors, such as Stokes et al. [1995], suggest a general rule of five observations per variable for valid estimation. Therefore, we attempted to limit the number of variables in the logistic models by first fitting the 'covariates only' model, and then adding the predictor of interest. For the logistic models, the goodness-of-fit was assessed using the statistic from Hosmer and Lemeshow [2000]. An essential assumption for the modeling results was that there were no important but unmeasured covariates [Rosenbaum, 2002].

To estimate cumulative exposures, we first conducted an analysis of means for the various job categories and the 1998 and 2005 surveys. We also assumed that any changes in exposure

from the first to the second surveys occurred in January 2002, about midway between the first and second surveys when many process and engineering control changes had been made. For each position and worker combination we calculated the product of the job-tenure (in years) and the assigned dust concentration, and then summed these products for each worker to obtain a cumulative exposure estimate. We classified workers into low and high cumulative exposure groups using the median of these estimates.

We used Chi-square tests to compare 1998 and 2005 prevalences of symptoms and medical conditions.

# RESULTS

## Environmental Survey

### *Time-integrated sampling*

A total of 85 personal respirable dust samples were collected from 54 workers. Twelve of those samples measured task-specific partial-shift concentrations. Two area samples were collected in the office. Eight of the personal samples were voided because flock had overloaded the cyclone sampling device. Three samples did not measure levels above the minimum detectable concentration (MDC) of 0.01 mg/m$^3$, and those samples were assigned a value of half the MDC for calculation purposes.

Figure 1 shows the geometric mean respirable dust concentrations measured during production (non-cleaning) activities on each person and the geometric means of those samples for various job titles collected during this evaluation and the 1998 evaluation in this plant. The geometric mean concentrations during this survey for dryer operators (0.80 mg/m$^3$) and bagger/cutter workers (0.13 mg/m$^3$) were significantly higher (p=0.003 and 0.03, respectively) for this survey compared to 1998 (0.18 and 0.07 mg/m$^3$, respectively). In both surveys, these jobs were among the highest exposed to respirable dust. The geometric mean concentration for all others workers in the plant was 0.05 mg/m$^3$, while 0.01 mg/m$^3$ was found in the office. There was some weak evidence (p=0.10) that the average measurements from the maintenance workers were lower during the 2005 survey. The cotton-grinding operation was not located in this plant during the previous survey, so for comparison purposes we used the 1998 measurements from grinding operations at Claremont Flock's other plants that have since closed. Our sampling revealed that dust levels were again relatively high, nearly 0.60 mg/m$^3$, in cotton-grinding operations.

The three samples collected on bagger/cutter operators of the offline cutting machine who cut and bag wet flock were all about 0.23 mg/m$^3$, whereas the guillotine bagger/cutter operators, who also handle only wet flock, were exposed to 0.05 mg/m$^3$. For bagger/cutter operators, there was no difference (p=0.35) in exposure between those who were primarily bagging flock (0.16 mg/m$^3$) and those who were cutting (0.11 mg/m$^3$).

Some cleaning activities were sampled in 2005 as shown in Figure 2. The geometric mean for the personal respirable dust concentrations was 0.39 mg/m$^3$ for five bagger/cutter workers during cleaning activities lasting 1.5 to 3.5 hours that primarily involved blowing with compressed air. During the sampling time that three of those workers performed cleaning activities other than blowing, such as disassembling and reassembling ductwork, a mean of 0.29 mg/m$^3$ was measured. As shown in the figure, the geometric mean for all bagger/cutters during non-cleaning production operations was 0.13 mg/m$^3$. During some of the sampling intervals, dryer operators conducted cleaning activities. Although some measurements representing only production hours were collected on these workers, no cleaning-exclusive measurements were obtained. The concentrations during the shifts that dryer operators performed cleaning and production operations were higher than the geometric mean concentration from all dryer production-only shifts.

### *Real-time sampling*

Real-time personal airborne dust measurements obtained with an aerosol photometer during a cleaning operation are provided in Figure 3. Included in the figure are a line graph of the measurements obtained in 3-second intervals and bars representing the duration of activities during collection of the measurements, as obtained from the video tapes. The sample was collected on a worker while he cleaned a precision cutting range screen room, first removing tape used to seal ducts in the room and then disassembling the screen equipment. Many times during these tasks, the worker used compressed air to clean flock from the ducts and equipment with associated increased dust levels. The most notable of these increases occurred toward the end of the sampling period when the worker was blowing flock from inside the screen equipment.

Figure 4 shows another cleaning operation at a precision cutting range. The worker started blowing cyclones and ducts with compressed air from a raised lift platform. Halfway through the first blow-down cycle, he cleaned the screen equipment, with a substantial elevation in dust levels. During some brief periods while blowing flock from the equipment, the worker was not visible from a distance of about 30 feet through the cloud of dust generated (Figure 5). Lower levels were measured during his subsequent floor sweeping; however several periods of elevated peak levels were recorded. The worker then used compressed air again to clean the floor around the screen area with a corresponding rise in dust levels. Completion of cleaning with air and broom and commencement of equipment disassembly were marked with considerable decrease in dust levels. Shovelling flock was another cleaning task associated with substantial peaks in dust levels, as evidenced by the elevated real-time personal measurements of Figure 6. The worker was collecting flock that had been blown and swept into a pile on the floor and dumping it into a bag.

Another operation where real-time measurements were obtained on a worker was bagging at a precision cutting range as presented in Figure 7. During the sampling, the worker performed bagging operations in the respirator-required "red zone" consisting of placing bags on the bagging chute, kicking the bag as it was being loaded to settle the mass of flock, removing the full bag and placing it on the scale, and scooping flock into or out of the bag until the target weight was obtained. The worker then pulled the bag from the scale out of the red zone where he sewed the top, pulled it across the floor and tossed it onto a pallet, compressed the bags on the pallet by pushing down from the side of the pallet or by kneeling on the bags, and banding the full pallet of bags with wire strap. The time periods when the worker was inside the red zone are delineated on the chart. Notable on the chart is that many peaks occur when the bagging tasks are performed outside the red zone. The average of the measurements while in the red zone was 0.29 photometric units, while the average obtained while performing bagging tasks outside the red zone was 0.43 photometric units. Toward the end of the sampling period, the worker wore the sampling device while he went to the break room, with an apparent decline in the dust level.

### *Estimation of cumulative exposures*

As Figure 1 shows, most geometric means for the various job and survey categories varied about an approximate value of 0.05 mg/m$^3$. An analysis of means identified those categories whose geometric means were statistically larger than 0.05 mg/m$^3$ and were also statistically distinct from each other. All other categories (i.e., the remaining categories whose geometric means were statistically indistinguishable) were collapsed into a single 'All Others' category and their geometric means were then combined into a single estimate, irrespective of job title or survey. This resulted in the following distinct job/survey categories and the corresponding geometric mean dust concentrations which were assigned during the calculation of cumulative exposures:

Bagger/Cutter – 2002 to 2005
0.127 mg/m$^3$
Dryers – Before 2002
0.180 mg/m$^3$

Dryers – 2002 to 2005
0.800 mg/$m^3$
Maintenance – Before 2002
0.170 mg/$m^3$
Administration
0.010 mg/$m^3$
All Others
0.051 mg/$m^3$

As discussed in the Methods Section, we assumed that any changes in exposure from the first to the second surveys occurred in January 2002, about midway between the first and second surveys. For example, if a worker was employed since January 2001 as a dryer, the first year of employment would be assigned the lower exposure of 0.180 mg/$m^3$ and the balance of the tenure assigned the higher exposure of 0.80 mg/$m^3$. If a worker was a bagger/cutter, an exposure of 0.051 mg/$m^3$ would be assigned for the years before 2002 and 0.127 mg/$m^3$ for the balance. The median of the cumulative exposure estimates was approximately equal to 0.425 mg-years/$m^3$ for the 74 workers. More complicated definitions of cumulative exposure also incorporated cleaning tasks, but these definitions led to an identical classification of the workers and nearly identical results for any modeling (the additional effect of cleaning was incorporated into the cumulative exposure by first estimating the mean difference between dust concentrations for five bagger/cutter workers who had separate estimates for both cleaning and production).

## Medical Survey

### *Study population demographics*

A total of 74 of the 80 invited workers completed the questionnaire, resulting in an overall participation rate of 92.5%.

Table A shows the distributions of participating workers in terms of gender, race, age, smoking status, tenure, and shift. The majority of employees were male (92%), white (58%), and non-smokers (76%). The mean tenure of Claremont Flock workers was 8 years, and only 16% of workers had either changed jobs or started working at Claremont Flock within the last 6 months.

### *Work practices and respiratory protection*

Table B shows the frequency of cleaning with compressed air and working with cotton, by job group. A total of 44 participants (60%) reported cleaning with compressed air, and half of these did so for at least one hour per week. A total of 23 participants (31%) reported working with cotton in the last 12 months.

Figure 8 demonstrates respirator use for the 2005 survey compared with the results of the 1998 survey at Claremont Flock. Except for bagging cotton, there was an increase in the percentage of employees who wear respirators during their activities. The percentage of fit-tested workers also increased in 2005 compared to the 1998 survey.

### *Symptoms*

The most frequently reported symptoms were wheeze apart from colds (24%), throat irritation (23%), and sinus problems (22%) (Table C). The prevalences of throat irritation, usual and chronic cough, shortness of breath while walking up on a slight hill, and wheeze apart from colds were lower among never smokers when compared with current or former smokers. When we took into account only symptoms with onset after employment at Claremont Flock, chronic phlegm (n=7) and shortness of breath when walking on the level (n=7) were the most frequently reported symptoms. “Wheeze apart from cold” and “pneumonia in the last year” were statistically significantly elevated when we compared symptom prevalences observed among participating workers to expected prevalences based on national population survey data (Table D).

Figure 9 demonstrates that dryers and baggers/cutters had higher prevalences of symptoms than other workers, with the exception of nose bleeds, wheeze, wheeze attacks, and chest symptoms caused by specific materials at work. In contrast, the prevalences of medically diagnosed conditions such as asthma,

chronic bronchitis, hay fever, and pneumonia were lower among dryers and baggers/cutters. Workers who cleaned for one hour or more per week using compressed air had higher symptom prevalences, except for nose bleeds, shortness of breath, and chest symptoms caused by specific materials at work, but lower prevalence of medically diagnosed conditions (Figure 10).

The prevalence of aches, cough, fever, phlegm, sinus irritation, shortness of breath, throat irritation, chest tightness, and wheeze was higher among employees with high cumulative exposure to flock-associated dust (> 0.425 mg-year/$m^3$) than other employees. Except for hay fever, medically diagnosed conditions also were more prevalent in workers in the high cumulative exposure category compared to workers with lower exposure (Figure 11).

### *Multivariate analysis*

In multivariate models, cleaning equipment with compressed air was significantly associated with throat irritation (Table E). The predicted probabilities suggest that non-smoking workers who do not clean machines at least one hour per week have an estimated probability of approximately 12% of having throat irritation. This probability increases to over 30% for non-smoking workers if they cleaned machines at least one hour per week.

High cumulative exposures were significantly associated with the development of sinus irritation (Table E). These results indicate that non-white workers with the minimum cumulative exposure have an estimated probability of about 8% of having sinus symptoms, and this rises to about 10% for non-whites with the median cumulative exposure, and to 20% for non-whites with a cumulative exposure of 1.475 mg-year/$m^3$ (the 90$^{th}$ percentile). For whites, the probabilities of having sinus symptoms are 18% for those with the minimum cumulative exposure, 23% for the median cumulative exposure, and 39% for the cumulative exposure of 1.475 mg-year/$m^3$.

Models using other frequently reported symptoms, such as wheeze or pneumonia as the outcome, did not produce statistically significant results.

### *Comparisons between 1998 and 2005 surveys*

A total of 31 employees participated in both surveys. Compared with the 1998 survey, more of these employees reported throat irritation, sinus symptoms, wheeze apart from colds, body aches, and shortness of breath when walking on the level in the 2005 survey (Table F).

When we compared the answers in the 1998 survey for current and former workers, the 34 current workers had reported less nose bleeds, throat and eye irritation, sinus symptoms, shortness of breath, and body aches in the 1998 survey than the 99 workers who left employment after 1998 (Table G).

When we compared the answers of current workers hired before and after the 1998 survey, workers hired after the 1998 survey reported more symptoms in most categories, except for sinus symptoms, shortness of breath, and wheeze (Table H).

## DISCUSSION

During our environmental survey, the offline and guillotine cutting machines operated throughout the sampling periods. Except for a couple hours of cleaning one day, this was also true for all the dryer rooms. At least half of the precision cutting ranges were operating during all the sampling periods, while the remainder were either operating or down for maintenance or cleaning during some sampling times. Workers reported no decline in typical production rate during our visit.

Despite engineering control changes that were installed in the plant between 1998 and 2005, we found personal respirable dust measurements to be largely unchanged for most workers and higher for bagger/cutter workers and dryer operators. In that same time, the comprehensive respiratory protection program that was established made it mandatory that respirators be

worn by these workers when in the "red zone" painted on the floor around the bagging stations. Our real-time personal air monitoring at a precision range bagging station indicated that dust levels were not lower when the worker performed bagging tasks outside of the designated respirator-required zone. We assume that this might also be true in and out of red zones at the bagging stations of the drying operations. Several workers were seen at times still wearing their respirators when outside the red zones, even though not required. Mandatory use of respirators for all bagging-related tasks, regardless of the red zone demarcations, are necessary until improved material-handling work practices and/or engineering controls can be developed. Some possible changes would include provision of local exhaust ventilation for bagging tasks, less handling of the bags (for example, sewing the top while the bag is still on the scale), and less aggressive handling, such as kicking and tossing of the bags.

The reason for the higher dust concentrations measured in 2005 in the dryer rooms is not apparent. The production process and rate are unchanged, open-top cyclone discharge into the rooms was eliminated with the provision of ducting to the outside, and local exhaust ventilation hoods are now available at every dryer bagging station. Given those circumstances, it would be expected that the latest measurements would have been lower than those obtained in 1998. The location of the hoods several feet above the tops of the bags being filled with flock makes it unlikely that they were effectively capturing dust, but their improper location should have at worst had no effect on dust concentrations. Notably, the bagging rate is typically slower in the dryer rooms than in the cutting operations where lower concentrations were measured. Determination of the source of the airborne dust in the dryer rooms is necessary so that a plan for control can be implemented. Until then, expansion of the respirator-required zone from just around the bagging machine to the entire dryer room would be prudent.

Surprisingly, some of the highest dust measurements for bagger/cutters were found on workers handling damp flock at the offline cutting machine. Attention should also be given to locating the source of that exposure.

As in the 1998 evaluation, dust levels were relatively high in cotton-grinding operations. This probably does not represent a health risk, especially given that the cotton material processed is a woven fabric and not raw cotton.

We recommended discontinuing the use of compressed air cleaning in the 1998 evaluation because it was clearly associated with symptoms. Cleaning with compressed air is still utilized at this plant as it is seen as necessary to the production process. The other tasks involved in cleaning, such as sweeping, shoveling, and, at times, disassembly of ductwork, produced peaks in dust levels as well. These findings point to the need for alternative methods for cleaning. Until new methods are in place, use of the existing methods could be minimized, possibly by vacuuming as much settled flock as possible first. However, it is important to note that even a vacuum cleaning system can generate airborne dust if not equipped with a high efficiency particulate air (HEPA) filter, if the motor exhaust air disturbs settled dust, or if the task of emptying the canister is not controlled. Claremont Flock is collaborating with NIOSH in a research project to evaluate a prototype vacuum system as a potentially suitable cleaning device.

The accumulators in the plant have automatic internal air-pulse shake-downs to purge them of collected material. Subsequent removal of the material from the bottom of the units is facilitated with screw auger chutes. Workers reported frequent plugging of the accumulators necessitating manual unplugging, which often included blowing with compressed air. Although we did not observe workers unplugging accumulators during our survey, workers stated that it is a very messy task because large amounts of dust get disturbed whether or not a blow-down is performed. Blow-downs are already included as respirator-required tasks, but use of respirators during the entire process of manually cleaning accumulators should be made mandatory in the respiratory protection program.

Although all workers required by the company's respiratory protection program to wear respirators were seen wearing them during the environmental survey, compliance was high but not complete according to the respiratory symptom and work history questionnaire.

Gravimetric respirable dust sampling, rather than fiber counting, was recommended in our previous evaluation for the characterization of exposures. It remains the better choice because of its easier use, lower cost, lower analytical variability, and inclusion of non-fibrous particulate, which may be pertinent to risk of adverse health outcomes [Daroowalla 2005]. Periodic sampling would help verify effectiveness of control measures.

We found evidence of work-related health effects among Claremont Flock employees. First, there is an excess of wheezing among employees compared to national rates. Within the plant, dryer operators and baggers/cutters, who had the highest exposures to respirable dust, had increased prevalences of most symptoms compared to other workers. Employees using compressed air for cleaning, which is associated with high peak dust exposures, also had more symptoms than other employees. A high cumulative exposure to flock-associated dusts was also associated with high prevalences of symptoms and medically diagnosed conditions. In models that controlled for factors that may contribute to throat irritation and sinus symptoms, cleaning with compressed air and high cumulative exposures, respectively, remained significantly associated with these symptoms.

However, the overall prevalence of symptoms was lower at Claremont Flock when compared with results of previous NIOSH investigations in plants where flock was produced/processed [Washko 2000, Daroowalla 2005]. The difference in prevalences may in part be explained by the fact that more workers are wearing respiratory protection currently than in the past. The only exception was when we compared the prevalence of symptoms among workers with high cumulative exposure (>0.4 mg-year/$m^3$): current Claremont Flock workers had a higher prevalence of wheeze than workers from five flock plants in New England, including Claremont Flock, in 1998 [Daroowalla 2005]. The high prevalence of wheeze suggests that these workers may also have some degree of bronchial hyperresponsiveness (twitchy airways, as found in asthma). Recently, we described a four-fold increase in the likelihood of having an abnormal methacholine challenge test (MCT) among flock workers compared to non-flock workers [NIOSH 2005]. Bronchial hyperresponsiveness has also been found in some patients with flock workers' lung [Kern 2000]. This suggests that further studies of flock workers with MCTs are needed to conclusively elucidate the connection between exposure to flock-associated dust and bronchial hyperresponsiveness.

Another possible explanation for the generally lower prevalences of symptoms among current workers is the so-called "healthy-worker effect". A healthy worker effect is commonly observed in occupational disease studies that include only workers employed at a particular point in time (i.e., cross-sectional studies). Workers who left employment after the 1998 survey had reported more symptoms in 1998 than those who remained at the plant until the 2005 survey. Similarly, long-term workers reported fewer symptoms in 2005 than short-term workers hired since 1998. Both of these observations support a healthy worker effect.

This workplace evaluation has limitations. The subjective nature of the symptom reporting may lead to a misestimation of the actual risk of flock-associated dust exposures, and medical records were not available to validate this information. Also, the small sample size limited statistical power and prevented more sophisticated statistical analysis. However, the high participation rate and the follow-up of a subset of the workers over time, providing insight into the healthy-worker effect, constitute important strengths of this survey.

In summary, continued uncontrolled exposures to flock-associated dust were observed at this plant. Despite measures taken to reduce these exposures, which included both engineering

controls and personal respiratory protection, health hazards still exist as evidenced by the recent case of flock workers' lung and the findings of excess symptoms associated with exposures. These symptoms were mainly upper respiratory, such as throat irritation and sinus problems. Further efforts are necessary to implement effective control measures to minimize the risk of lung disease and the respiratory problems among flock workers in this plant.

# RECOMMENDATIONS

**We recommend the following for management of this workplace:**

- Provide engineering controls and improved work practices for the bagging process, to include not only the filling of bags at the bagging stations but also the subsequent manipulation of the bags for weighing, sewing, and palletizing.
- Determine and control the source of elevated dust levels during production in the dryer rooms.
- Reposition the local exhaust ventilation hoods at the dryer bagging stations to the tops of the bags being filled with flock
- Provide new cleaning methods that will minimize dust levels associated with compressed-air blow-downs, sweeping, shovelling of flock, and other flock-cleaning tasks.
- Conduct air sampling on a regular basis to monitor effectiveness of controls
- Until these controls can be implemented, expand respiratory protection requirements to all bagging and flock-cleaning processes, including manual unplugging of accumulators, and to the entire production operation in the dryer rooms. Ensure employees comply with requirements to wear respirators
- Continue to offer a smoking cessation program and to enforce the no-smoking policy already in place
- Include in the current respirator program a means of identifying workers with respiratory symptoms such as shortness of breath, wheezing, or phlegm production, and a means of detecting declines in lung function
- Provide information about flock workers' lung to employees and health consultants responsible for the respirator program

**We recommend the following for employees of this workplace**:

- Wear respirators when required
- Handle bags of flock with care to prevent airborne flock
- Seek medical evaluation for respiratory symptoms, such as shortness of breath, wheezing, or phlegm production and inform their health care providers of flock exposures
- Inform management of respiratory symptoms and associated flock exposures

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# TABLES AND FIGURES

Table A. Demographics of the 74 participating workers in the survey at Claremont Flock Corporation, 2005.

| Characteristic | Number or (Mean) | % or [SD] |
|---|---|---|
| Gender (Male) | 68 | 92 |
| Race | | |
| White, Non-Hispanic | 43 | 58 |
| Black, Non-Hispanic | 19 | 26 |
| Asian | 6 | 8 |
| Hispanic | 4 | 5 |
| Other* | 2 | 3 |
| Age in years (Mean) [SD] | (42) | [11] |
| Smoking status | | |
| Current | 18 | 24 |
| Former | 23 | 31 |
| Never | 33 | 45 |
| Day shift | 49 | 66 |
| Tenure in years (Mean) [SD] | (8) | [7] |
| Changed job title or was hired in the last 6 months | 12 | 16 |

*Includes White/American Indian or Alaskan Native, Hispanic/American Indian or Alaskan Native

Table B. Frequency of cleaning with compressed air and working with cotton, by job group, Claremont Flock Corporation, 2005.

| Job | Number of workers | Clean with compressed air for ≥ 1 hr/week | | Bagged cotton in last 12 months | |
|---|---|---|---|---|---|
| | | Number | % | Number | % |
| Bagger/Cutter | 19 | 13 | 68 | 7 | 37 |
| Dryer Operator | 6 | 6 | 100 | 5 | 83 |
| Extractor Operator | 6 | 2 | 33 | 5 | 83 |
| Kettle Operator | 7 | 0 | - | 2 | 29 |
| Cotton Grinder Operators | 2 | 0 | - | 2 | 100 |
| Maintenance | 4 | 0 | - | 0 | - |
| Material Handler | 4 | 0 | - | 0 | - |
| Office/Administration | 13 | 1 | 8 | 0 | - |
| Other (Team Leaders, Lab Workers, etc.) | 13 | 0 | - | 2 | 15 |
| TOTAL | 74 | 22 | 30 | 23 | 31 |

Table C. Prevalence of symptoms among 74 participating workers, by smoking status, Claremont Flock Corporation, 2005.

| Symptom | All participants N=74 | | Smoking status Current N=18 | | Former N=23 | | Never N=33 | |
|---|---|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | % | Number | % |
| 3 or more episodes in the last 12 months | | | | | | | | |
| Nosebleeds | 7 | 9 | 1 | 6 | 3 | 13 | 3 | 9 |
| Throat irritation | 17 | 23 | 6 | 33 | 6 | 26 | 5 | 15 |
| Eye irritation | 8 | 11 | 2 | 11 | 2 | 9 | 4 | 12 |
| Sinus symptoms | 16 | 22 | 2 | 11 | 7 | 30 | 7 | 21 |
| Hay fever | 9 | 12 | 3 | 17 | 1 | 4 | 5 | 15 |
| Mucous membrane irritation* | 21 | 28 | 7 | 39 | 7 | 30 | 7 | 21 |
| Usual cough | 6 | 8 | 3 | 17 | 2 | 9 | 1 | 3 |
| Chronic cough | 7 | 9 | 2 | 11 | 3 | 13 | 2 | 6 |
| Usual phlegm | 10 | 14 | 3 | 17 | 2 | 9 | 5 | 15 |
| Chronic phlegm | 7 | 9 | 1 | 6 | 2 | 9 | 4 | 12 |
| Bronchitis-like symptoms† | 5 | 7 | 1 | 6 | 1 | 4 | 3 | 9 |
| Shortness of breath on slight hill (and no other reason for difficulty walking) | 9 | 12 | 4 | 22 | 2 | 9 | 3 | 9 |
| Shortness of breath walking on level (and no other reason for difficulty walking) | 4 | 5 | 2 | 11 | 0 | | 2 | 6 |
| Interstitial lung disease-like symptoms‡ | 4 | 5 | 1 | 6 | 1 | 4 | 2 | 6 |
| Wheeze apart from colds | 18 | 24 | 7 | 39 | 5 | 22 | 6 | 18 |
| Wheeze most of the time | 2 | 3 | 1 | 6 | 0 | | 1 | 3 |
| Wheeze with shortness of breath | 10 | 14 | 2 | 11 | 3 | 13 | 5 | 15 |
| Asthma-like symptoms§ | 12 | 16 | 3 | 17 | 3 | 13 | 6 | 18 |
| 3 or more episodes in the last 12 months | | | | | | | | |
| Fever | 8 | 11 | 4 | 22 | 1 | 4 | 3 | 9 |
| Aches | 11 | 15 | 2 | 11 | 3 | 13 | 6 | 18 |
| Systemic symptoms‖ | 17 | 23 | 5 | 28 | 4 | 17 | 8 | 24 |

*Defined as having three or more episodes of throat or eye irritation in the last 12 months
†Defined as having either usual or chronic cough *and* either usual or chronic phlegm
‡Defined as having either usual or chronic cough *and* shortness of breath on slight hill or shortness of breath while walking with a person of his/her own age on the level.
§Defined as having wheezing most of the time or wheeze with shortness of breath.
‖Defined as having three or more episodes of fever or flu-like achiness in the last 12 months.

Table D. Ratios of observed to expected number of participants with selected symptoms and medically diagnosed conditions Claremont Flock Corporation, 2005*.

| Symptom/Condition | Observed Number | Expected Number | Ratio (95% C.I.) |
|---|---|---|---|
| Chronic cough[†] | 7 | 4 | 1.6 (0.8 – 3.3) |
| Chronic phlegm[‡] | 7 | 5 | 1.6 (0.8 – 3.2) |
| Wheeze apart from cold[§] | 17 | 7 | 2.6 (1.6 – 4.2) |
| Shortness of breath[‖] | 11 | 11 | 1.0 (0.6 – 1.8) |
| Pneumonia[¶] | 3 | 1 | 3.0 (1.0 – 8.7) |
| Hay fever** | 8 | 8 | 1.1 (0.5 – 2.1) |
| Chronic bronchitis[††] | 2 | 3 | 0.8 (0.2 – 2.9) |

* 67 participating workers in comparison with NHANES III data, adjusted for gender, race, age, and smoking categories (7 workers were excluded due to selection of multiple race categories).
[†] Question 5c: "Do you usually cough like this on most days for three or more consecutive months during the year?"
[‡] Question 6c: "Do you bring up phlegm like this on most days for three or more consecutive months during the year?"
[§] Question 7a: "Does your chest sound wheezy or whistling occasionally apart from colds?"
[‖] Question 11a: "Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?"
[¶] Question 20a: "Have you ever been told by a doctor that you had pneumonia?"
** Question 22a: "Have you ever been told by a doctor that you had hay fever?"
[††] Question 23a: "Have you ever been told by a doctor that you had chronic bronchitis?"

Table E. Summary of selected results for the multivariate logistic modeling of common symptoms, Claremont Flock Corporation, 2005*.

| Outcome | Predictor | Covariate | Odds Ratio (95% C.I.) | Model Prediction & Interpretation |
|---|---|---|---|---|
| throat irritation | cleaning† | smoking | 3.5 (1.1 – 12.0) | A 12% occurrence of throat irritation for non-smoking workers who do not clean machines at least one hour per week; a 33% occurrence of throat irritation for non-smoking workers who clean machines at least one hour per week. |
| sinus irritation | Cumulative exposure† (1 mg-year per $m^3$) | race | 2.1 (1.1 – 4.7) | An 8% occurrence of sinus irritation for non-white workers with the minimum cumulative exposure; a 10% occurrence for non-whites with the median cumulative exposure, and a 20% occurrence for non-whites with cumulative exposures of 1.475 (the $90^{th}$ percentile). An 18% occurrence of sinus irritation for whites with the minimum cumulative exposure; a 23% occurrence for whites with the median cumulative exposure, and a 39% occurrence for whites with cumulative exposures of 1.475. |

*Due to the small number of cases for the various outcomes, the number of variables for the logistic models was restricted by first fitting the 'covariates only' model, which included smoking, age, tenure, and race.

†Statistically significant for $\alpha = 0.05$

Table F. Comparison of the 1998 and 2005 prevalences of symptoms among workers who participated in both the 1998 and 2005 surveys, Claremont Flock Corporation, 2005.

| Symptom | 1998 Survey N=31 | | 2005 Survey N=31 | |
|---|---|---|---|---|
| | Number | % | Number | % |
| 3 or more episodes in the last 12 months: | | | | |
| Nosebleeds | 2 | 6 | 2 | 6 |
| Throat irritation | 5 | 10 | 6 | 19 |
| Eye irritation | 3 | 16 | 1 | 3 |
| Sinus symptoms | 7 | 23 | 9 | 29 |
| Hay fever | 4 | 13 | 3 | 10 |
| Mucous membrane irritation* | 7 | 23 | 7 | 23 |
| Usual cough | 5 | 16 | 2 | 6 |
| Chronic cough | 7 | 23 | 3 | 10 |
| Usual phlegm | 6 | 19 | 3 | 10 |
| Chronic phlegm | 7 | 23 | 3 | 10 |
| Bronchitis-like symptoms† | 5 | 16 | 2 | 6 |
| Shortness of breath on slight hill (and no other reason for difficulty walking) | 6 | 19 | 3 | 10 |
| Shortness of breath walking on level (and no other reason for difficulty walking) | 0 | 0 | 3 | 10 |
| Interstitial lung disease-like symptoms‡ | 3 | 10 | 1 | 3 |
| Wheeze apart from colds | 6 | 19 | 10 | 32 |
| Wheeze most of the time | 0 | 0 | 1 | 3 |
| Wheeze with shortness of breath | 8 | 26 | 4 | 13 |
| Asthma-like symptoms§ | 8 | 26 | 5 | 16 |
| 3 or more episodes in the last 12 months: | | | | |
| Fever | 2 | 6 | 3 | 10 |
| Aches | 2 | 6 | 4 | 13 |
| Systemic symptoms‖ | 3 | 10 | 6 | 19 |

*Defined as having three or more episodes of throat or eye irritation in the last 12 months
†Defined as having either usual or chronic cough *and* either usual or chronic phlegm
‡Defined as having either usual or chronic cough *and* shortness of breath on slight hill or shortness of breath while walking with a person of his/her own age on the level.
§Defined as having wheezing most of the time or wheeze with shortness of breath.
‖Defined as having three or more episodes of fever or flu-like achiness in the last 12 months.

Table G. Comparison of prevalences of symptoms in 1998 survey among current and former employees as of January 2005, Claremont Flock Corporation.

| Symptom | Current employee N=34 | | Former employee N=99 | |
|---|---|---|---|---|
| | Number | % | Number | % |
| 3 or more episodes in the last 12 months: | | | | |
| Nosebleeds | 2 | 6 | 10 | 10 |
| Throat irritation | 5 | 15 | 30 | 30 |
| Eye irritation | 3 | 9 | 18 | 18 |
| Sinus symptoms | 7 | 21 | 32 | 32 |
| Hay fever | 4 | 12 | 14 | 14 |
| Mucous membrane irritation* | 7 | 21 | 41 | 41 |
| Usual cough | 6 | 18 | 14 | 14 |
| Chronic cough | 7 | 21 | 15 | 15 |
| Usual phlegm | 7 | 21 | 17 | 17 |
| Chronic phlegm | 8 | 24 | 19 | 19 |
| Bronchitis-like symptoms† | 6 | 18 | 13 | 13 |
| Shortness of breath on slight hill (and no other reason for difficulty walking) | 6 | 18 | 19 | 19 |
| Shortness of breath walking on level (and no other reason for difficulty walking) | 0 | 0 | 3 | 3 |
| Interstitial lung disease-like symptoms‡ | 3 | 9 | 8 | 8 |
| Wheeze apart from colds | 6 | 18 | 19 | 19 |
| Wheeze most of the time | 0 | 0 | 2 | 2 |
| Wheeze with shortness of breath | 8 | 24 | 13 | 13 |
| Asthma-like symptoms§ | 8 | 24 | 14 | 14 |
| 3 or more episodes in the last 12 months: | | | | |
| Fever | 2 | 6 | 6 | 6 |
| Aches | 2 | 6 | 14 | 14 |
| Systemic symptoms‖ | 3 | 9 | 15 | 15 |

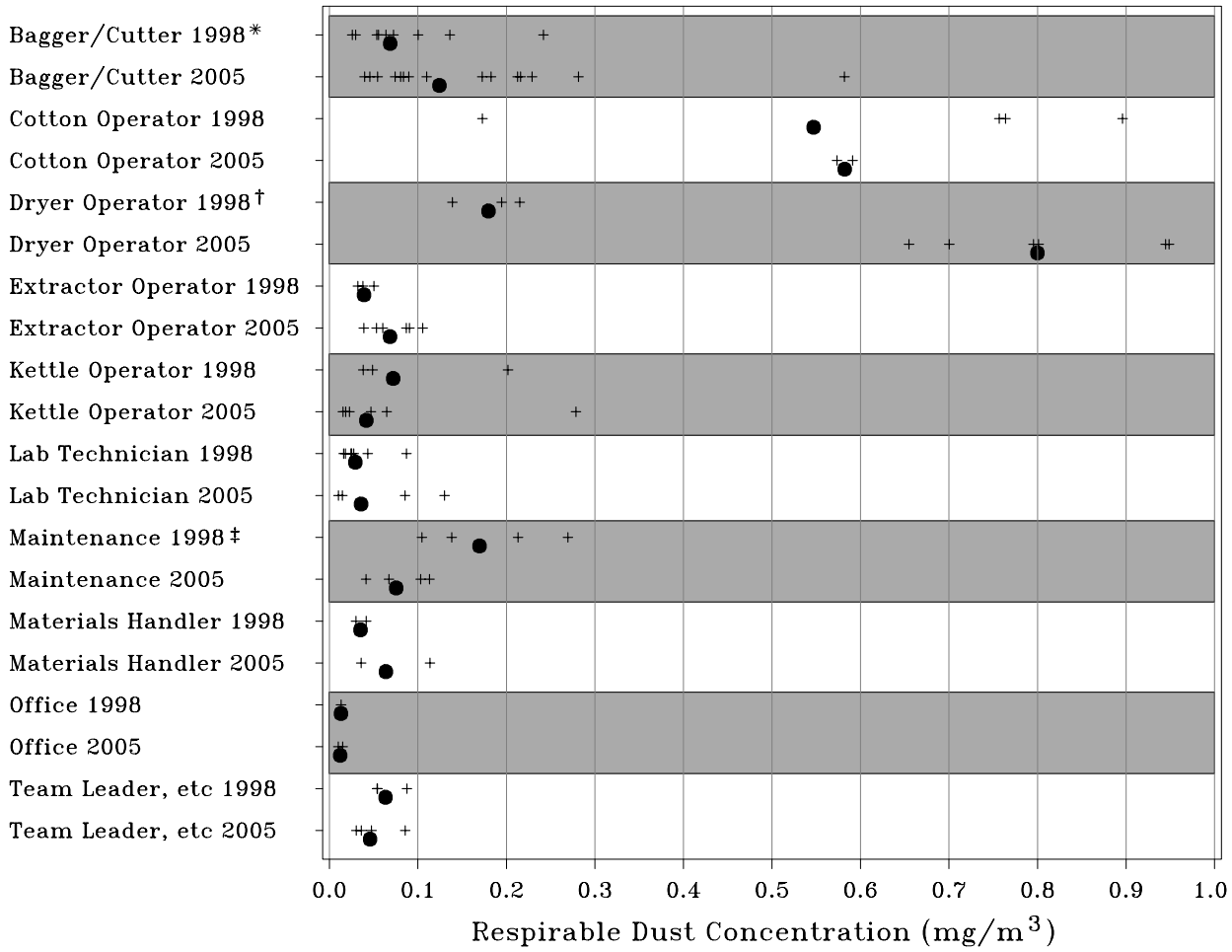
*Defined as having three or more episodes of throat or eye irritation in the last 12 months
†Defined as having either usual or chronic cough *and* either usual or chronic phlegm
‡Defined as having either usual or chronic cough *and* shortness of breath on slight hill or shortness of breath while walking with a person of his/her own age on the level.
§Defined as having wheezing most of the time or wheeze with shortness of breath.
‖Defined as having three or more episodes of fever or flu-like achiness in the last 12 months.

Table H. Comparison of prevalences of symptoms by hire date, Claremont Flock Corporation, 2005.

| Symptom | Hired prior to 11/1998 N=39 | | Hired after 11/1998 N=35 | |
|---|---|---|---|---|
| | Number | % | Number | % |
| 3 or more episodes in the last 12 months: | | | | |
| Nosebleeds | 3 | 8 | 4 | 11 |
| Throat irritation | 7 | 18 | 10 | 29 |
| Eye irritation | 2 | 5 | 6 | 17 |
| Sinus symptoms | 9 | 23 | 7 | 20 |
| Hay fever | 6 | 15 | 3 | 9 |
| Mucous membrane irritation* | 8 | 21 | 13 | 37 |
| Usual cough | 2 | 5 | 4 | 11 |
| Chronic cough | 3 | 8 | 4 | 11 |
| Usual phlegm | 3 | 8 | 7 | 20 |
| Chronic phlegm | 3 | 8 | 4 | 11 |
| Bronchitis-like symptoms† | 2 | 5 | 3 | 9 |
| Shortness of breath on slight hill (and no other reason for difficulty walking) | 3 | 8 | 6 | 17 |
| Shortness of breath walking on level (and no other reason for difficulty walking) | 3 | 8 | 1 | 3 |
| Interstitial lung disease-like symptoms‡ | 1 | 3 | 3 | 9 |
| Wheeze apart from colds | 10 | 26 | 8 | 23 |
| Wheeze most of the time | 1 | 3 | 1 | 3 |
| Wheeze with shortness of breath | 4 | 10 | 6 | 17 |
| Asthma-like symptoms§ | 5 | 13 | 7 | 20 |
| 3 or more episodes in the last 12 months: | | | | |
| Fever | 4 | 10 | 4 | 11 |
| Aches | 4 | 10 | 7 | 20 |
| Systemic symptoms‖ | 7 | 18 | 10 | 19 |

*Defined as having three or more episodes of throat or eye irritation in the last 12 months
†Defined as having either usual or chronic cough *and* either usual or chronic phlegm
‡Defined as having either usual or chronic cough *and* shortness of breath on slight hill or shortness of breath while walking with a person of his/her own age on the level.
§Defined as having wheezing most of the time or wheeze with shortness of breath.
‖Defined as having three or more episodes of fever or flu-like achiness in the last 12 months.

Figure 1. Job geometric means (plotting symbol = •) and individual worker geometric means (plotting symbol = +) for 8-hour personal respirable dust concentrations during production operations (cleaning tasks excluded) for the 1998 and 2005 surveys at the Leominster plant, Claremont Flock Corporation. Only area samples were collected from the offices. The cotton data from 1998 were obtained only from other Claremont Flock plants.




* P-value = 0.03 for comparison of 1998 and 2005 means.
† P-value = 0.003 for comparison of 1998 and 2005 means.
‡ P-value = 0.10 for comparison of 1998 and 2005 means.

Figure 2. Personal respirable dust concentrations for production and cleaning tasks for five bagger/cutter workers (identified as A – E) and two dryer workers (F – G), Claremont Flock Corporation, 2005. The solid vertical lines represent the job geometric mean levels for all production samples (i.e., the same geometric means displayed for the bagging/cutting and drying jobs in Figure 1).

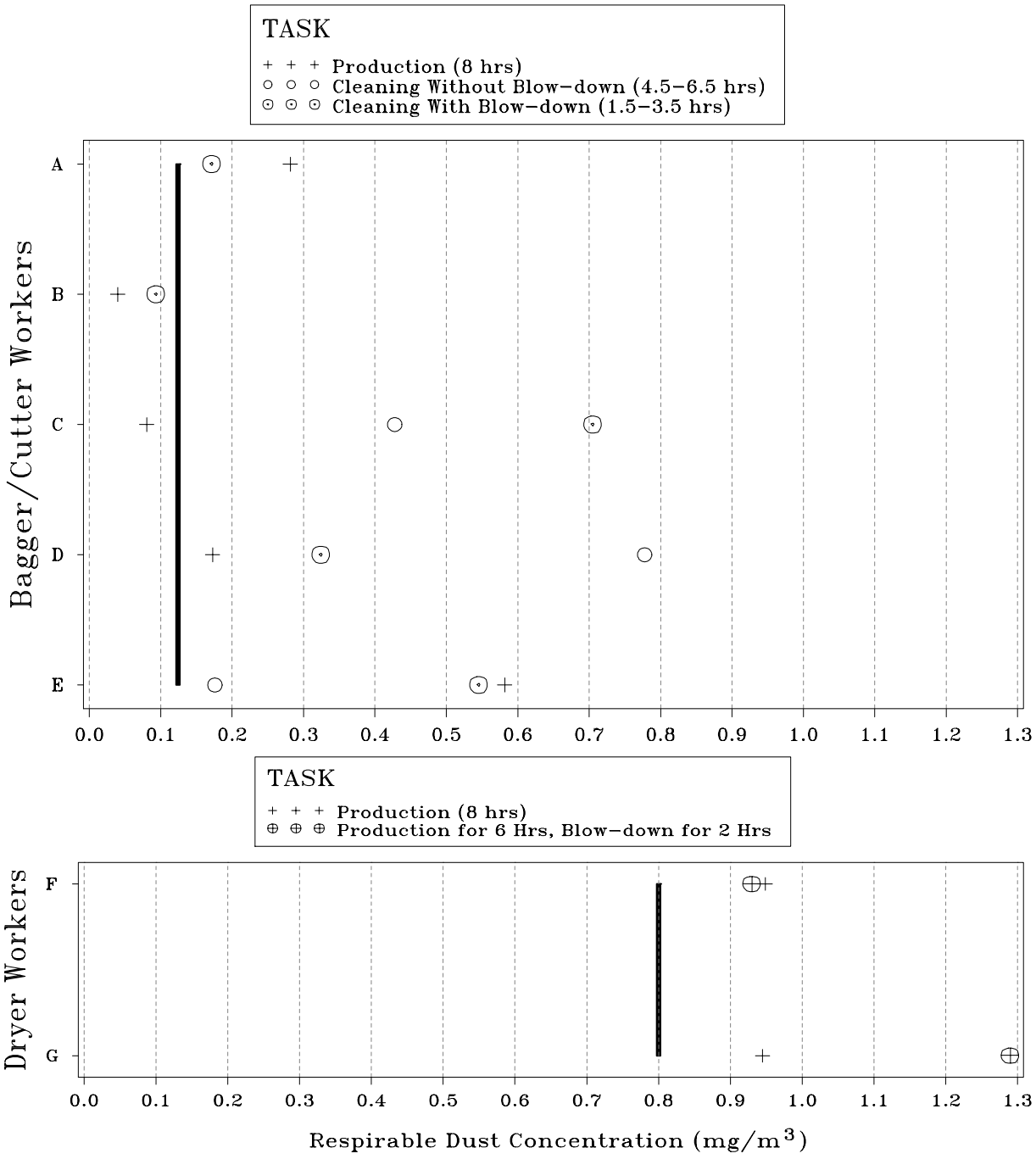
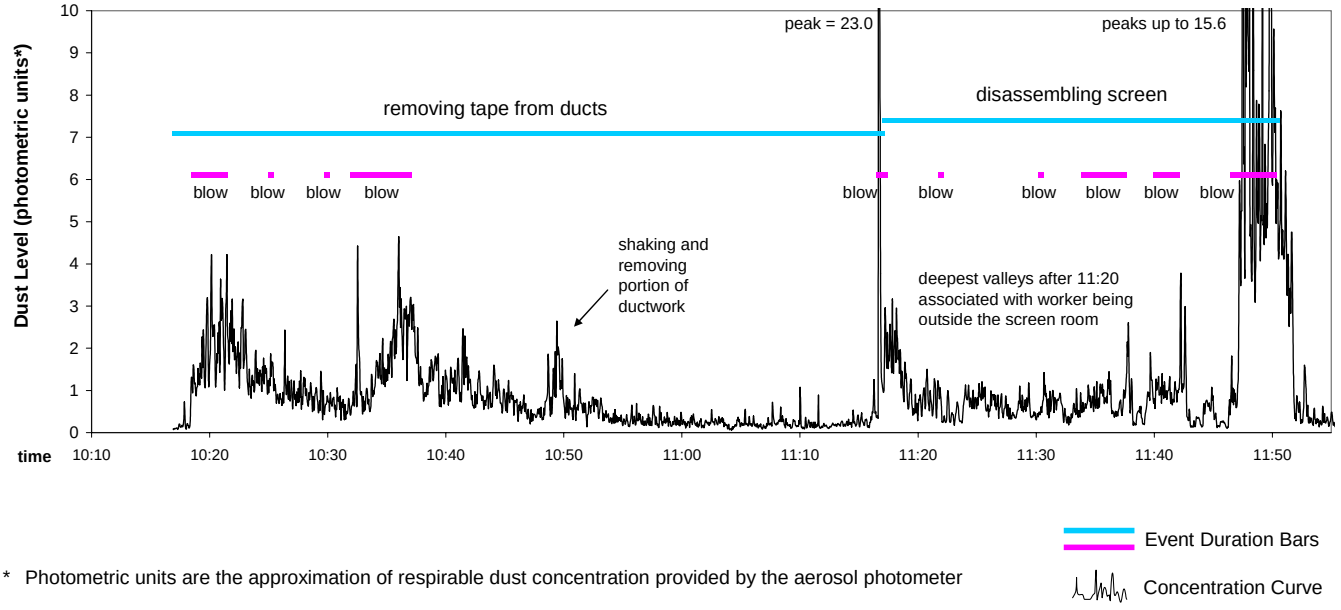
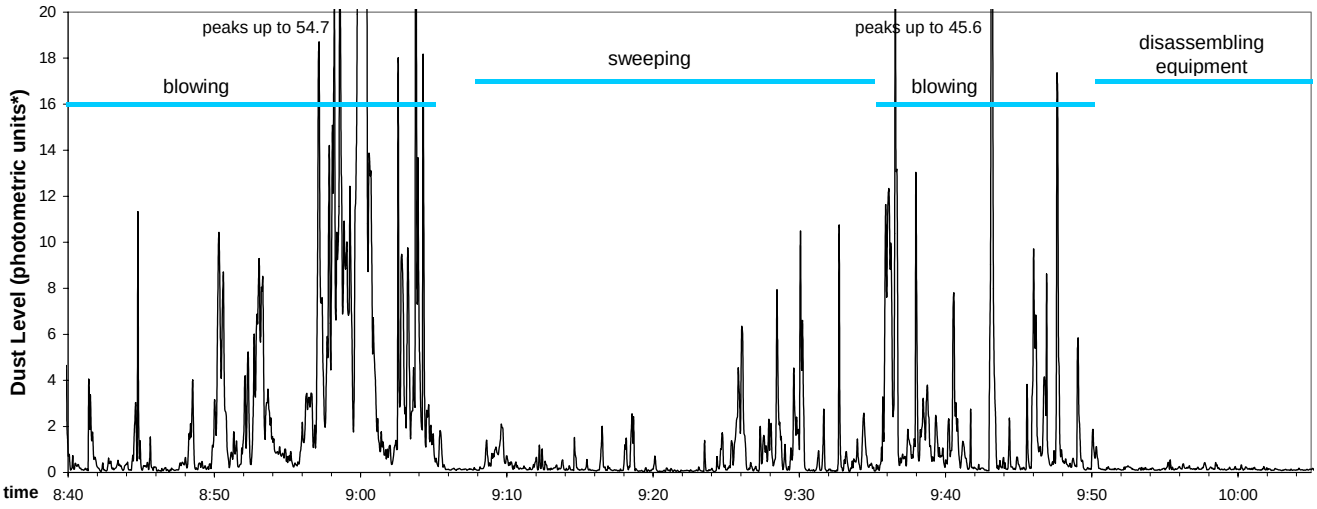


Figure 3. Real-time personal airborne dust measurements during cleaning of precision cutting range screen room, Claremont Flock Corporation, 2005.




* Photometric units are the approximation of respirable dust concentration provided by the aerosol photometer

Figure 4: Real-time personal airborne dust measurements during cleaning of precision cutting range, Claremont Flock Corporation, 2005.



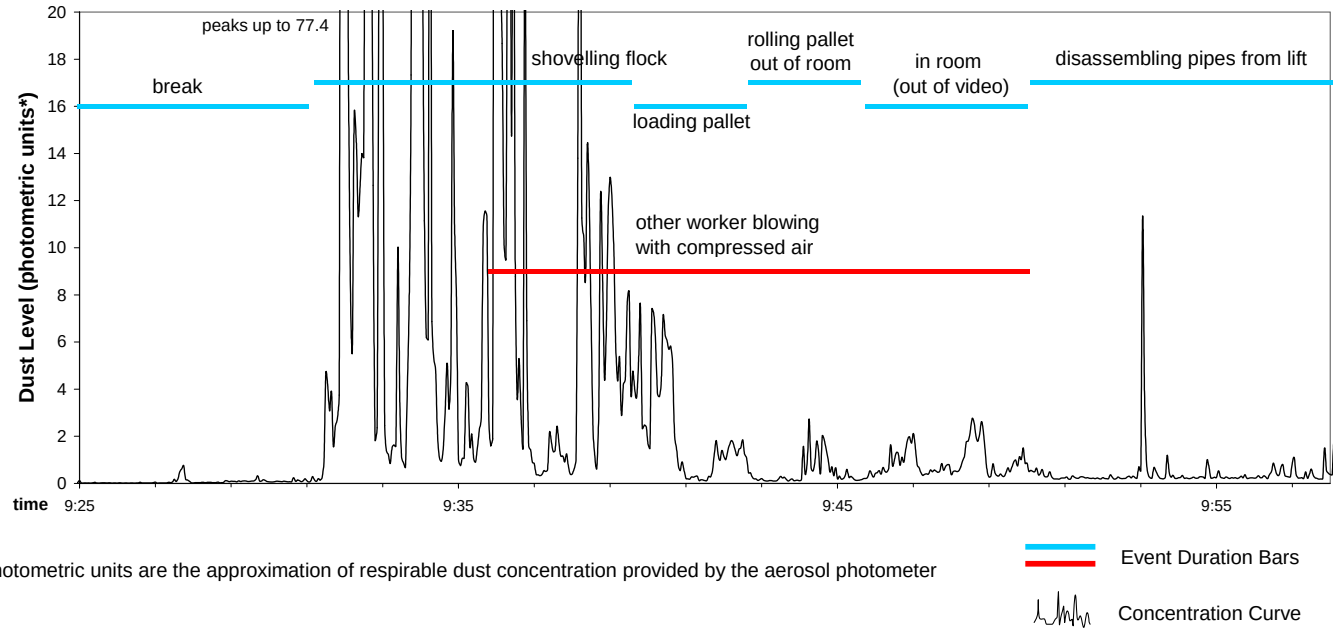

* Photometric units are the approximation of respirable dust concentration provided by the aerosol photometer

Event Duration

Concentration Curve

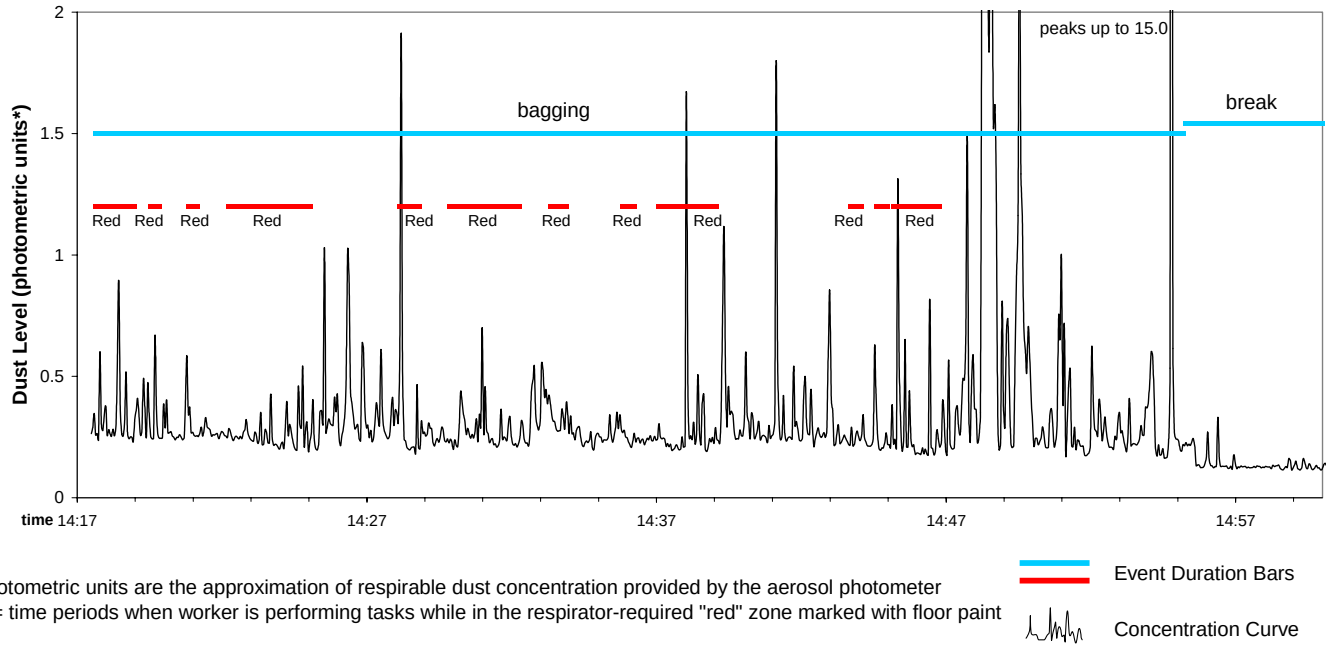
Figure 5: Precision cutting room during blow-down cleaning with compressed air, Claremont Flock Corporation, 2005.

Figure 6: Real-time personal airborne dust measurements during cleaning of precision cutting range, Claremont Flock Corporation, 2005.



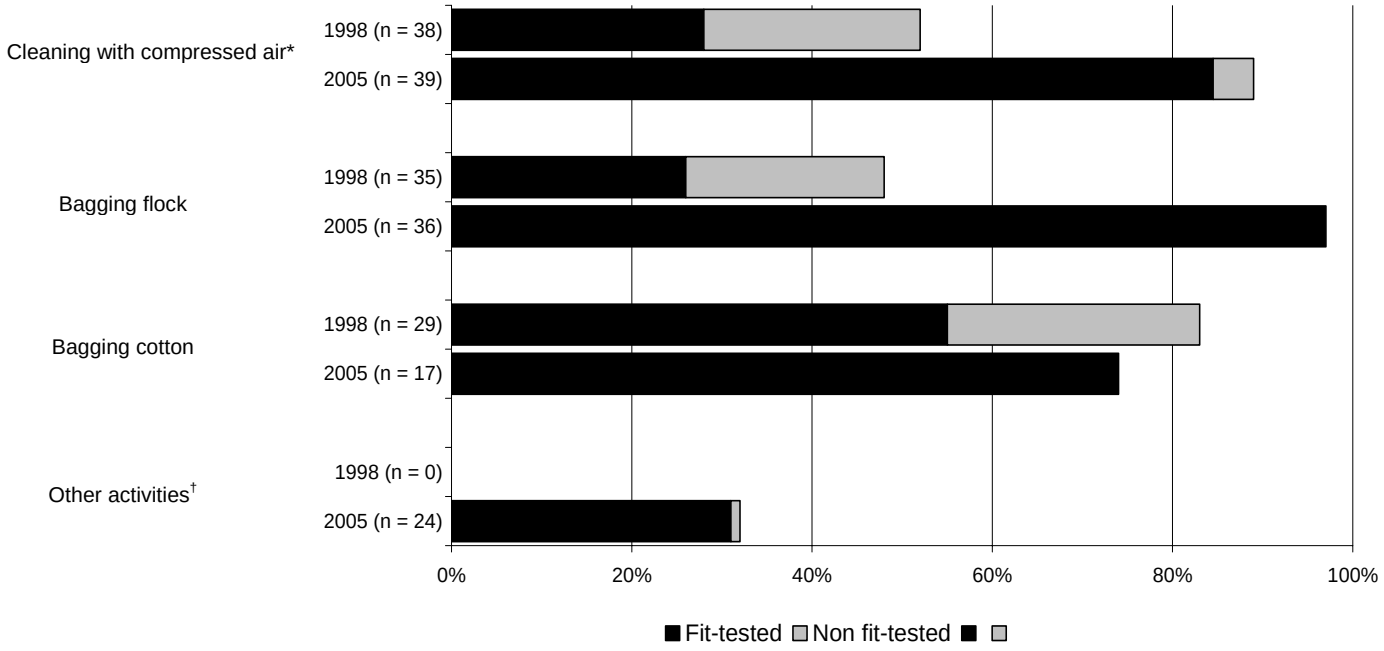

* Photometric units are the approximation of respirable dust concentration provided by the aerosol photometer

Figure 7. Real-time personal airborne dust measurements during bagging at a precision cutting range, Claremont Flock Corporation, 2005.



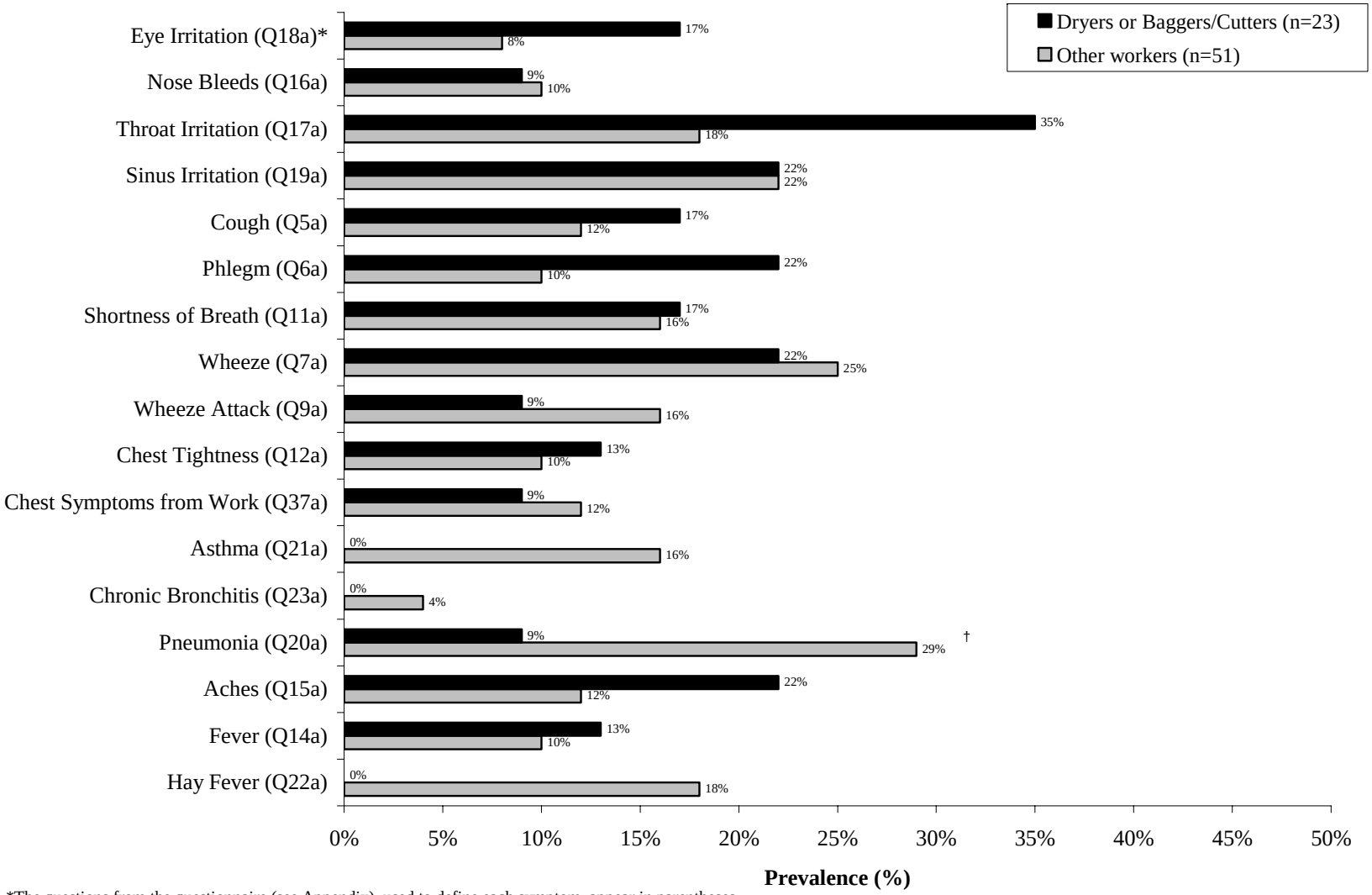

* Photometric units are the approximation of respirable dust concentration provided by the aerosol photometer
Red = time periods when worker is performing tasks while in the respirator-required "red" zone marked with floor paint

Figure 8. Percentage of employees that reported using respirator in the 1998 and 2005 surveys, by activity and fit-testing status, Claremont Flock Corporation.




* 1998 survey question: "Do you wear a mask or respirator when conducting a blowdown?"
2005 survey question: "Do you wear a mask or respirator when cleaning equipment with compressed air?"
† Question not asked in the 1998 survey.

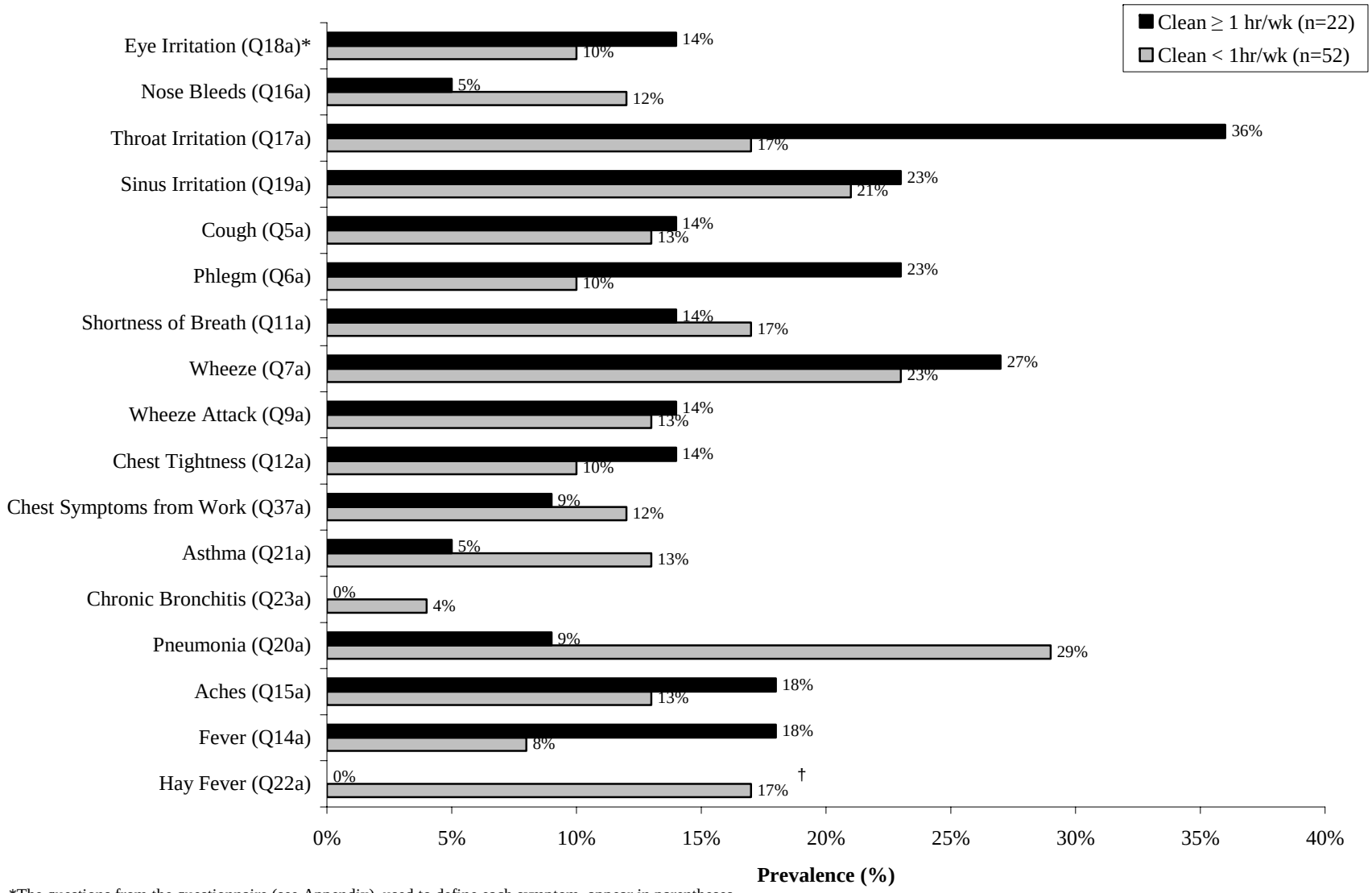
Figure 9. Prevalence of symptoms and physician-diagnosed conditions defined by type of job, Claremont Flock Corporation, 2005.




*The questions from the questionnaire (see Appendix), used to define each symptom, appear in parentheses

† Chi-square statistically significant at $\alpha = 0.05$.

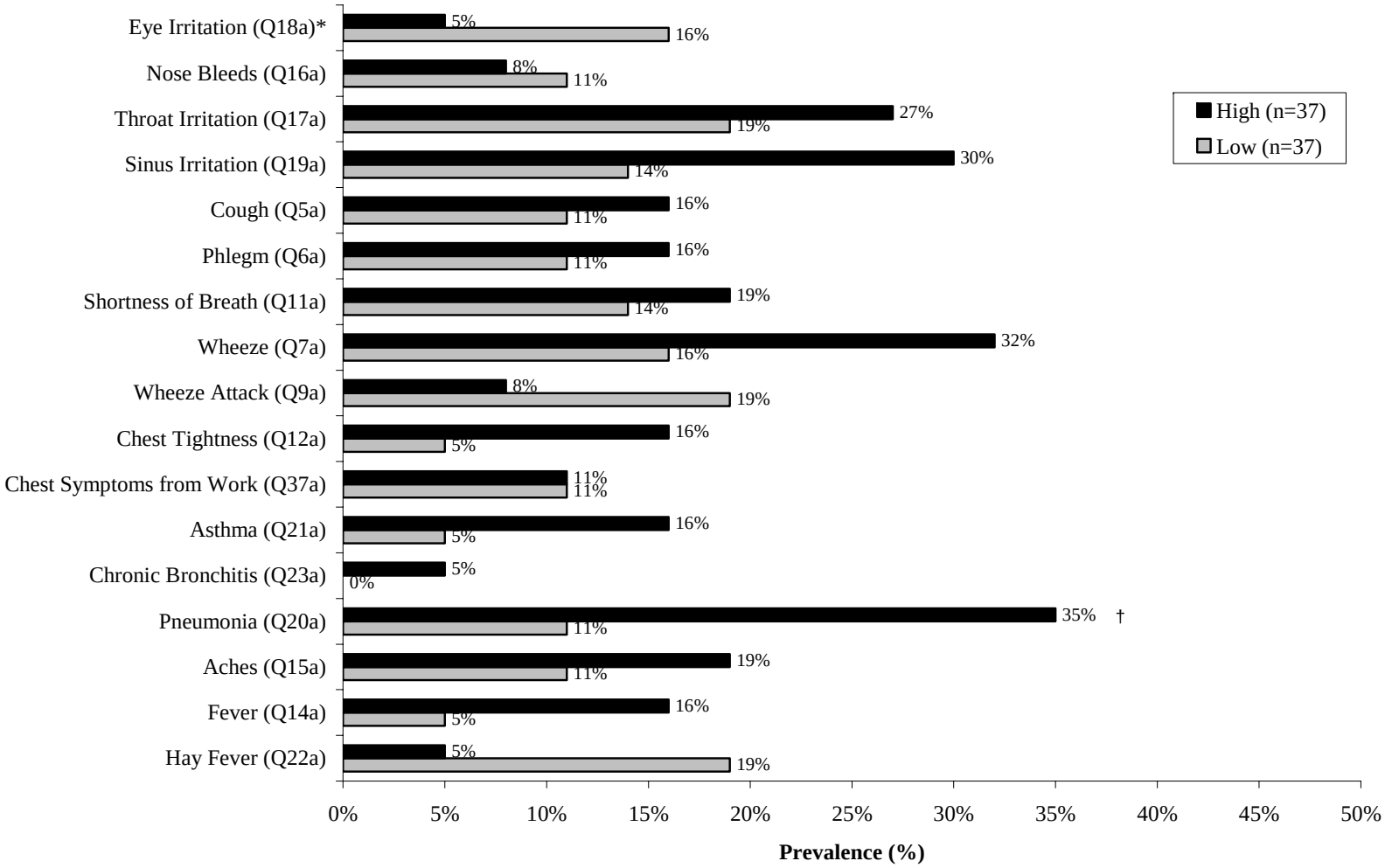
Figure 10. Prevalence of symptoms and physician-diagnosed conditions defined by cleaning status, Claremont Flock Corporation, 2005




*The questions from the questionnaire (see Appendix), used to define each symptom, appear in parentheses

† Chi-square statistically significant at $\alpha = 0.05$.

Figure 11. Prevalence of symptoms and physician-diagnosed condition by cumulative exposure, Claremont Flock Corporation, 2005.




*The questions from the questionnaire (see Appendix), used to define each symptom, appear in parentheses
† Chi-square statistically significant at $\alpha = 0.05$.

# APPENDIX

QUESTIONNAIRE

ID Number: _____

HETA 2004 – 0186

Interviewer: _____ Interview Date: __ __ / __ __ / __ __ __ __
(Month) (Day) (Year)

Section I: Identification and Demographic Information

Name: _____ _____ ____
(Last name) (First name) (MI)

Address:_____
(Number, Street, and/or Rural Route)

_____ _____ _____
(City) (State) (Zip Code)

Home Telephone Number: ( ) _____ - _____

*If you were to move, is there someone who would know how to contact you?*

Name: _____ _____ ____
(Last name) (First name) (MI)

Relationship to you:_____

Address:_____
(Number, Street, and/or Rural Route)

_____ _____ _____
(City) (State) (Zip Code)

Home Telephone Number: ( ) _____ - _____

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

1. Date of Birth: __ __ / __ __ / __ __ __ __
(Month) (Day) (Year)

2. Sex: 1. ____ Male 2. ____ Female

3. Are you Spanish, Hispanic, or Latino? 1. ____Yes 0.____No.
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

4. Select one or more of the following categories to describe your race:

1. ___ White
2. ___ African-American or Black
3. ___ Asian
4. ___ American Indian or Alaska Native
5. ___ Native Hawaiian or Other Pacific Islander

Section II: Health Information

*I'm going to ask you some questions about your health. The answer to many of these questions will be "Yes" or "No." If you are in doubt about whether to answer "Yes" or "No," then please answer "No."*

COUGH

5a. 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 0. ___ No

*IF YES:*

5b. Do you usually cough as much as 4 to 6 times a day. 1. ___ Yes 0. ___ No

for 4 or more days out of the week?

5c. Do you usually cough like this on most days for 3 or more consecutive months during the year? 1. ___ Yes 0. ___ No

5d. In what year did you first notice this cough? __ __ __ __

PHLEGM

6a. 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 0. ___ No

*IF YES:*

6b. Do you usually bring up phlegm like this as much as twice a day, 4 or more days out the week? 1. ___ Yes 0. ___ No

6c. Do you bring up phlegm like this on most days for 3 or more consecutive months during the year? 1. ___ Yes 0. ___ No

6d. In what year did you first notice this phlegm? __ __ __ __

WHEEZING

7a. Does your chest sound wheezy or whistling occasionally apart from colds? 1. ___ Yes 0. ___ No

*IF YES:*

7b In what year did you start wheezing like this? __ __ __ __

.

8a. Does your chest sound wheezy or whistling most of the time? 1. ___ Yes 0. ___ No

*IF YES:*

8b In what year did you start wheezing like this? __ __ __ __

.

ATTACKS OF WHEEZING

9a. Have you ever had an attack of wheezing that has made you feel short of breath? 1. ___ Yes 0. ___ No

*IF YES:*

9b. In what year did you first have an attack of wheezing with shortness of breath? __ __ __ __

9c. Have you ever required medicine or treatment for the(se) attack(s)? 1. ___ Yes 0. ___ No

BREATHLESSNESS

10a. Do you have any nerve, muscle, bone problems or heart trouble that makes walking difficult for you? 1. ___ Yes 0. ___ No

*IF YES, ask for description of difficulty:*

10b._____

11a. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill? 1. ___ Yes 0. ___ No

*IF YES:*

11b. Do you have to walk slower than people of your own age on the level because of shortness of breath? 1. ___ Yes 0. ___ No

11c. In what year did you first notice this shortness of breath? __ __ __ __

CHEST TIGHTNESS

12a. Have you ever woken up with a feeling of tightness in your chest? 1. ___ Yes 0. ___ No

*IF YES:*

12b. During the last 12 months, have you woken up with a feeling of chest tightness? 1. ___ Yes 0. ___ No

13a. Have you ever had to change your job, job duties, or work area at this plant because of breathing difficulties? 1. ___ Yes 0. ___ No

*IF YES:*

13b. What month and year did you change your job, job duties, or work area? __ __ / __ __ __ __
(Month) (Year)

13c. Describe your job, job duties, and/or work area before the change:

_____

13d. Describe your job, job duties, and/or work area after the change:

_____

13e. Were your breathing problems after the change:
1. ___ Better
2. ___ The Same
3. ___ Worse

SYSTEMIC SYMPTOMS

FEVER

14a. In the last 12 months, have you had 3 or more episodes, of fever? 1. ___ Yes 0. ___ No

IF YES:

14b. In what year did you first notice fevers like this? __ __ __ __
(Year)

14c. 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

ACHES

15a. In the last 12 months, have you had 3 or more episodes of flu-like achiness or aches all over your body? 1. ___ Yes 0. ___ No

IF YES:

15b. In what year did you first notice aches like this? __ __ __ __ (Year)

15c. 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

D. IRRITANT SYMPTOMS

NOSE

16a. In the last 12 months, have you had 3 or more nosebleeds? 1. ___ Yes 0. ___ No

IF YES:

16b. In what year did you first notice these nosebleeds? __ __ __ __ (Year)

16c. 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

THROAT

17a. In the last 12 months, have you had 3 or more episodes of throat irritation, soreness, or tickle? 1. ___ Yes 0. ___ No

IF YES:

17b. In what year did you first notice throat irritations like this? __ __ __ __ (Year)

17c. 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

EYES

18a. In the last 12 months, have you had 3 or more episodes of eye irritation? 1. ___ Yes 0. ___ No

IF YES:

18b. In what year did you first notice these episodes of eye irritation? __ __ __ __ (Year)

18c. 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

SINUS

19a. In the last 12 months, have you had 3 or more episodes of sinus fullness, drainage, or sinus pain? 1. ___ Yes 0. ___ No

IF YES:

19b. In what year did you first notice these sinus symptoms? __ __ __ __ (Year)

19c. 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

RESPIRATORY ILLNESSES

PNEUMONIA

20a. Have you ever been told by a doctor that you had pneumonia? 1. ___ Yes 0. ___ No

IF YES:

20b. In what year did you last have pneumonia? __ __ __ __ (Year)

20c. How many episodes of pneumonia have you had in the last year? _____ episodes

ASTHMA

21a. Has a doctor ever told you that you have asthma? 1. ___ Yes 0. ___ No

IF YES:

21b. At what age were you first told that you had asthma? __ __ (Age in years)

21c. Do you still have asthma? 1. ___ Yes 0. ___ No

IF NO:

18d. At what age did your asthma stop? __ __ (Age in years)

HAY FEVER

22a. Has a doctor ever told you that you have hay fever? 1. ___ Yes 0. ___ No

IF YES:

22b. At what age were you first told you had hay fever? __ __ (Age in years)

22c. Do you still have symptoms of hay fever? 1. ___ Yes 0. ___ No

IF NO:

22d. At what age did you stop having hay fever symptoms? __ __ (Age in years)

CHRONIC BRONCHITIS

23a. Has a doctor ever told you that you had chronic bronchitis? 1. ___ Yes 0. ___ No

IF YES:

23b. At what age were you first told you had chronic bronchitis? __ __ (Age in years)

23c. Do you still have symptoms of chronic bronchitis? 1. ___ Yes 0. ___ No

IF NO:

23d. At what age did you stop having chronic bronchitis symptoms? __ __ (Age in years)

Section III: Work History at Claremont Flock Co.

*I am now going to ask you questions about your current job at Claremont Flock.*

24. What is your current department? _____

25. What is your current job title? _____

26. What shift do you usually work?
1. ___ Day
2. ___ Night
3 ___ Rotate shifts

27. During an average week, how many hours do you usually work? _____ Hours per week

28. During an average week, how many days do you usually work? _____ Days per week

29a. Do you ever work in an area where flock is processed? 1. ___ Yes 0. ___ No

*IF YES:*

29b. During an average week, how many hours do you work in areas where flock is processed? _____ Hours per week

30a. Do you ever clean equipment with compressed air (blowdowns)? 1. ___ Yes 0. ___ No

*IF YES:*

30b. During an average week, how many times do you clean equipment with compressed air? _____ Times per week

30c. During an average cleaning session, how long do you spend cleaning equipment with compressed air (in minutes)? _____ Minutes Per cleaning session

30d. Do you wear a mask or respirator when cleaning equipment with compressed air? 1. ___ Yes 0. ___ No

*IF YES:*

30e. Do you wear a mask or respirator:
1. ___ During all cleanings?
2. ___ During most cleanings?
3. ___ During some cleanings?

30f. Which type of mask or respirator do you wear? (See Diagram)
1. ___ Single strap
2. ___ 2-strap
3. ___ Half face piece
4. ___ Full face piece
5. ___ PAPR
6. ___ SCBA
7. ___ Other

*Describe:*_____

30g. Were you fit tested for this respirator? 1. ___ Yes 0. ___ No

31a. During an average week, how many times is equipment cleaned with compressed air near your work area that you don't directly conduct? _____ Times per week

IF NOT = 0:

31b. Do you wear a mask or respirator when cleanings of equipment with compressed air are occurring? 1. ___ Yes 0. ___ No

*IF YES:*

31c. Do you wear a mask or respirator:
1. ___ During all cleanings?
2. ___ During most cleanings?
3. ___ During some cleanings?

31d. Which type of mask or respirator do you wear? (See Diagram)
1. ___ Single strap
2. ___ 2-strap
3. ___ Half face piece
4. ___ Full face piece
5. ___ PAPR
6. ___ SCBA
7. ___ Other

*Describe:*_____

31e. Were you fit tested for this respirator? 1. ___ Yes 0. ___ No

BAGGING FLOCK

32a. In the last 12 months, have you spent any time bagging flock (not cotton flock)? 1. ___ Yes 0. ___ No

IF YES:

32b. In an average shift, how many hours do you spend bagging flock? ___ ___ hours in a shift

32c. Do you wear a mask or respirator while you are bagging flock? 1. ___ Yes 0. ___ No

*IF YES:*

32d. Do you wear a mask or respirator:
1. ___ During all bagging?
2. ___ During most bagging?
3. ___ During some bagging?

32e. Which type of mask or respirator do you wear? (See Diagram)
1. ___ Single strap
2. ___ 2-strap
3. ___ Half face piece
4. ___ Full face piece
5. ___ PAPR
6. ___ SCBA
7. ___ Other

*Describe:*_____

32f. Were you fit tested for this respirator? 1. ___ Yes 0. ___ No

BAGGING COTTON

33a. In the last 12 months, have you spent any time bagging cotton? 1. ___ Yes 0. ___ No

*IF YES:*

33b. In an average shift, how many hours do you spend bagging cotton __ __ hours in a shift

33c. Do you wear a mask or respirator while you are bagging cotton? 1. ___ Yes 0. ___ No

*IF YES:*

33d. Do you wear a mask or respirator:
1. ___ During all bagging?
2. ___ During most bagging?
3. ___ During some bagging?

33e. Which type of mask or respirator do you wear? (See Diagram)
1. ___ Single strap
2. ___ 2-strap
3. ___ Half face piece
4. ___ Full face piece
5. ___ PAPR
6. ___ SCBA
7. ___ Other

*Describe:*_____

33f. Were you fit tested for this respirator? 1. ___ Yes 0. ___ No

34. Do you ever clean equipment with a vacuum cleaner? 1. ___ Yes 0. ___ No

35. Do you ever clean your clothes with compressed air at work? 1. ___ Yes 0. ___ No

36a. Do you ever wear a mask or respirator during your regular work activities, other than when cleaning with compressed air or bagging flock or cotton? 1. ___ Yes 0. ___ No

*IF YES:*

36b. What percent of the time do you wear a mask or respirator when performing your regular work activities? _____ Percent

36c. Which type of mask or respirator do you wear? (See Diagram)
1. ___ Single strap
2. ___ 2-strap
3. ___ Half face piece
4. ___ Full face piece
5. ___ PAPR
6. ___ SCBA
7. ___ Other

*Describe:*_____

36d. Were you fit tested for this respirator? 1. ___ Yes 0. ___ No

37a. Have you noticed material(s) at work that cause you to have chest symptoms such as cough, phlegm, wheezing, attacks of wheezing, or shortness of breath? 1. ___ Yes 0. ___ No

*IF YES*, describe the material(s) and associated chest symptom(s):

| | MATERIAL | CHEST SYMPTOM |
|---|---|---|
| 37b1. | _____ | _____ |
| 37b2. | _____ | _____ |
| 37b3. | _____ | _____ |
| 37b4. | _____ | _____ |

38. *I'm now going to ask you to list all the jobs that you have held at Claremont Flock Co. We will begin with your current job and work back through time.*

| | Job Title | Department | Start Date Month/Year | End Date Month/Year |
|---|---|---|---|---|
| A | | | | |
| B | | | | |
| C | | | | |
| D | | | | |
| E | | | | |
| F | | | | |
| G | | | | |
| H | | | | |
| I | | | | |
| J | | | | |

Section V - Cigarette Smoking History

*I'm now going to ask you a few questions about tobacco use.*

39a. Have you ever smoked cigarettes regularly? 1. ___ Yes
0. ___ No
(*YES if smoked 100 cigarettes or more in your entire life; 100 cigarettes = 5 packs.*)

*If YES:*

39b. How old were you when you first started smoking cigarettes regularly? _____ Years old

39c. On average, for the entire time that you smoked, how many cigarettes did you smoke per day? (*20 cigarettes = 1 pack*) _____ Cigarettes per day

39d. Do you still smoke cigarettes (as of 1 month ago)? 1. ___ Yes
0. ___ No

*If NO:*

39e. How old were you when you stopped smoking cigarettes regularly? _____ Years old

*Thank you for participating in this survey!*

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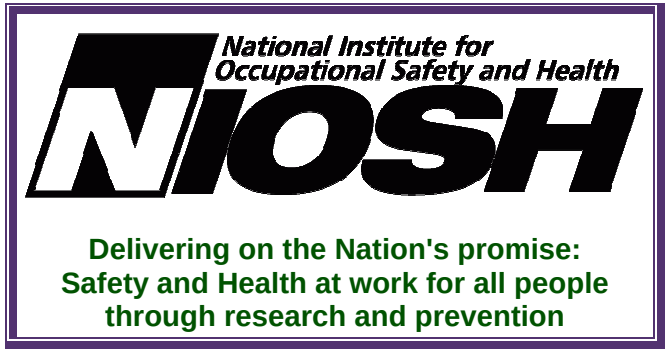


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