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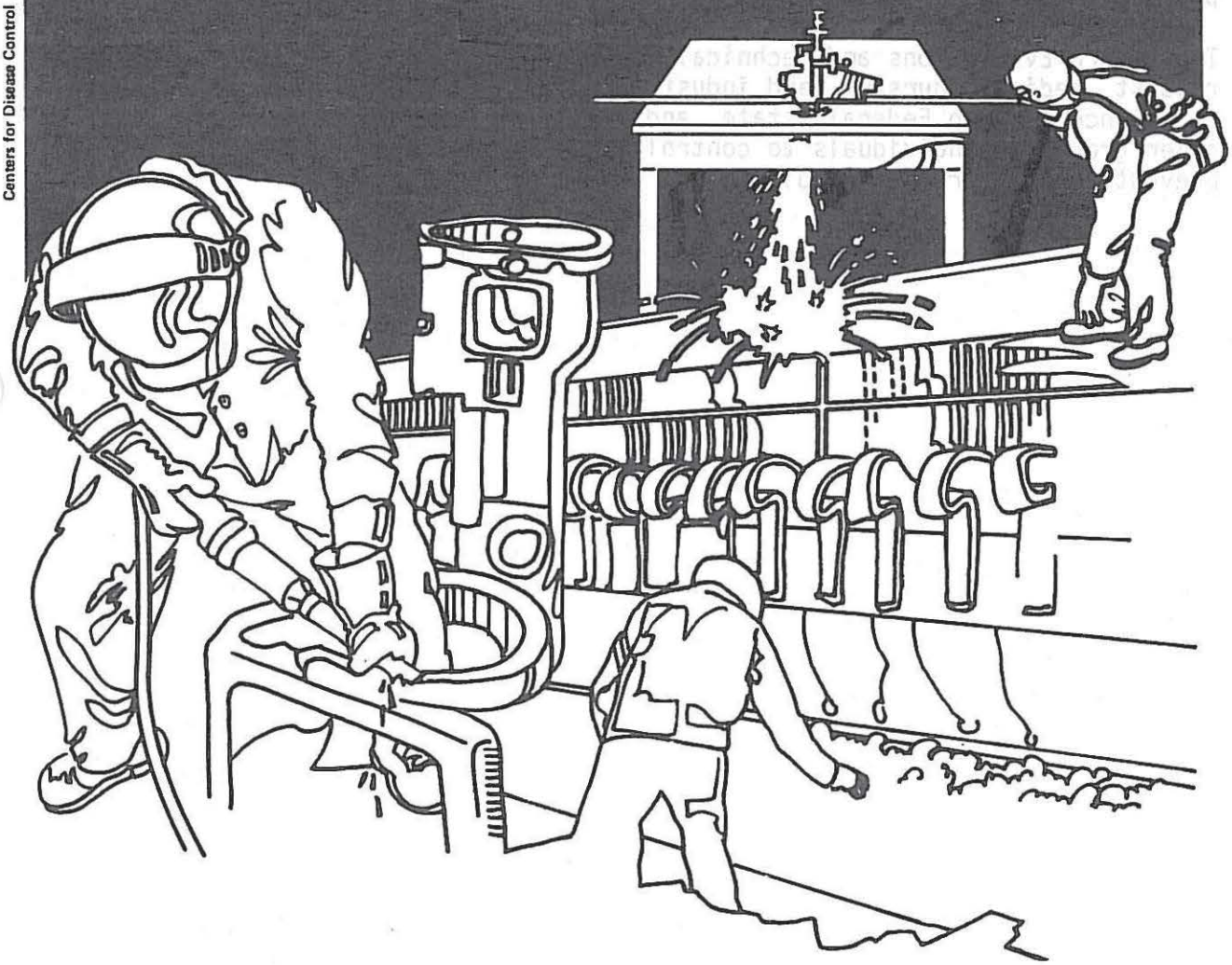

Health Hazard Evaluation Report

HHE 79-139-966
FULFLEX RUBBER COMPANY
BRISTOL, RHODE ISLAND

PREFACE

The Hazard Evaluations and Technical Assistance Branch of 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 Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative 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.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) 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.

HHE 79-139-966
Revised-June 1982
Fulflex Rubber Company
Bristol, Rhode Island

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I. SUMMARY

On August 28, 1979, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United Rubber Workers Union (URW), Local 474, to conduct a Health Hazard Evaluation at Fulflex Rubber Company, Bristol, Rhode Island. The URW expressed concern over a high prevalence of pulmonary disability, and recurrent rashes and nosebleeds among the workforce.

To determine if health complaints were related to exposures, NIOSH conducted site visits at the plant on November 6, 1979, and March 4-5, 1980. NIOSH industrial hygiene investigators obtained bulk, general, and personal (breathing-zone) samples to determine the presence and concentration of silica, asbestos, talc, nuisance dust, toluene, and nitrosamine contaminants in this work environment. Temperature, relative humidity, ventilation measurements, and a chemical inventory of ingredients added to red batch rubber were performed.

Analysis of nine bulk samples containing talc (range 20-100%) showed low levels of silica (1.3% for 100% Italian talc), and no asbestos. Other bulk samples showed a mixture of talc and other ingredients. Plant-wide, airborne dust samples (n = 35), both personal and general area, ranged from nondetectable to 1.2 milligrams per cubic meter (mg/M^3). Higher concentrations of dust were generally found in the rubber thread finishing areas. Nitrosomorpholine and nitrosodiethylamine were detected in heated rubber stock and ranged from 0.92 micrograms per cubic meter (ug/M^3) to 5.90 ug/M^3, and non-detectable to 0.30 ug/m^3, respectively. Relative humidity in the finishing area was lower (X = 23%) than the rubber milling area (X = 29%), and the outside (X = 55%). The hydrophilic properties of talc may account for this difference. Skin rashes, suspected by employees to be caused by a red pigment powder, may have been instead caused by an antioxidant. Ventilation was deficient on the first NIOSH survey. However, implementation of industrial hygiene recommendations for ventilation and engineering controls (Interim Report HE 79-139, February 1980) greatly improved environmental conditions by the second survey.

Medical interviews were conducted with a screening questionnaire of 74% (63/85) of the workers present on November 6, 1979. Based on results, a follow-up survey was scheduled in March, 1980, to perform pulmonary function tests, and X-rays for all active and retired Fulflex employees willing to participate. Ninety-one percent of the active employees and 29% of the retired employees participated (108 total).

Twenty-one percent of these workers were identified as having signs of pneumoconiosis, and another 22% had obstructive lung disease. The obstructive lung changes were significantly more common among smokers. Skin rashes were experienced significantly (p 0.05) more in the rubber milling area than in the finishing area, and nose bleeds (reported by 13 workers) are thought to be caused by irritation of the nose from dust and rubber fume exposure.

NIOSH medical findings which demonstrate evidence of respiratory impairment/decreased pulmonary function in a large percentage of rubber workers are believed due to past excessive exposures to airborne talc. Current talc exposures are below recommended criteria due to extensive improvements in ventilation and engineering controls, so hat a prospective health hazard of respiratory illness among new workers is unlikely. Company issued protective clothing, controlled handling of rubber additives, and routine cleaning and repair of ventilation equipment should decrease dermatological irritation of workers in this establishment. Further recommendations for control are found in Section VII of this report.

KEYWORDS: SIC 3060 (Rubber Workers), talc, nitrosamines, antioxidants, pneumoconiosis, obstructive lung disease, smoking.

II. INTRODUCTION

On August 28, 1979, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United Rubber Workers Union, Local 474, for a Health Hazard Evaluation at the Fulflex Rubber Company, Bristol, Rhode Island. The request specified a high prevalence of pulmonary disability, rashes, and nosebleeds; the last two were thought to be associated with talc dust or the "red batch" rubber containing a red pigment.

On November 6, 1979, an opening conference was held with Fulflex management, United Rubber Workers Local 474 representatives, and NIOSH personnel, in which the nature and scope of the health hazard evaluation was explained. A walk-through survey of plant operations was conducted by company, union, and NIOSH personnel.

The initial environmental evaluation consisted of area air sampling for talc dust, charcoal tube sampling for volatile organics, thermosorb/N™ tube sampling for volatile nitrosamines, psychrometer measurements for humidity, and collection of bulk samples of various powders for asbestos and silica. A chemical inventory was also obtained and work practices observed.

The medical evaluation consisted of questionnaires and personal interviews with 63 of 68 employees present in the plant on November 6, 1979, to characterize the extent and nature of employee illness.

NIOSH distributed Interim Report #1 for this investigation in February 1980, following the initial visit. Interim recommendations centered on engineering controls, ventilation, and work practices to reduce employee exposure from talc dust and rubber batch additives.

III. BACKGROUND

The Fulflex Rubber Company in Bristol, Rhode Island, was founded in 1932. Its only product is rubber thread used in golf ball cases. This company has almost 90% of the world market for the manufacture of golf ball thread.

Fulflex Rubber has 89 current employees (54 males, 35 females); another 26 workers are laid off; and 108 are retirees. A large proportion of the workforce is of Portuguese extraction. Labor turnover is less than 1%, and most workers are close to retirement age. The work process is run in two shifts, and rubber thread production is generally similar for both shifts.

Steps for manufacturing golf ball thread and manpower needs for each production phase are as follows:

Receiving: raw materials enter the plant

Compounds Room:	various powders to be added to the rubber are weighed, mixed, and placed in paper bags for use by mill operators
Milling:	various rubber additives (antioxidants, colorants) are worked into the rubber
Calender:	rubber sheets are run through a calender and are then dusted with a mixture of talc, and other ingredients
Vulcanizing:	rubber is unwrapped by fabric and cured in a dry air oven
Strip Cutting:	rubber is cut into 4 strips
Splicing:	strips are glued together
Slitting:	strips are cut into fine thread
Tape Packing:	threads are combed and laid into containers
Shipping:	boxes are placed together, leave plant
Maintenance:	machinery repair

Workers in the receiving and shipping departments seem to have a fairly stable job assignment, whereas the other areas seem to have a fairly interchangeable workforce. Compounding, milling, calendering, vulcanizing, strip cutting, and maintenance being a male workforce; splicing, slitting, and tape packing being the predominantly female one.

The talc and other ingredients are consumed for the purpose of coating the rubber and keeping it from sticking together.

Rubber additives such as colorants, antioxidants, accelerators, and curing agents are manually added to rubber being milled at the mill rolls.

IV. METHODS AND MATERIALS

The first survey included: familiarization of the rubber thread production process, collection of talc bulk samples for silica and asbestos content, work station interviews concerning nosebleeds, temperature and humidity measurements in the finishing area, determination of solvent contaminants in the rubber splicing and gluing area, nitrosamine measurements during rubber milling, and evaluation of plant engineering controls and personal respiratory protection.

The second survey focused on personal exposure to talc dust, temperature and humidity, isolation of contaminants causing dermatitis, and evaluation of engineering controls to decrease airborne talc and rubber additive dusts through treated talc and oil mixing, and improved local exhaust ventilation in the finishing areas.

A. Environmental Equipment and Analyses

1. Initial Survey (November 6, 1979):

Bulk samples were collected from the tape packing machine, the thread machine tray, and settled dust from an overhead water sprinkler pipe, for silica and asbestos determinations. Analysis of these samples was experimental in design, and performed by NIOSH research chemists. The analyses were as follows:

Qualitative Analysis: A portion from each sample was rear-packed in an X-RD holder and analyzed qualitatively by X-ray diffraction (X-RD) from 8^{o} through 52^{o} 20 using copper X-ray radiation. The resulting diffraction patterns were compared to the pure patterns of three silica polymorphs - quartz, cristobalite, and tridymite.

Quantitative Analysis: A sample of 1-2 mg from each bulk sample was weighed, dispersed ultrasonically in isopropanol, deposited in 0.45 um silver membrane filter, dried, and analyzed by X-RD for the primary peaks of quartz and cristobalite.

General Airborne Dusts: Six general area air samples using preweighed filters and size selective samplers were used to monitor for respirable quartz, cristobalite, and polymorphs of free silica. Sampling pumps calibrated at 1.5 liters per minute (lpm) were set up in the rubber thread finishing areas (rubber slitting, packing, and shipping). NIOSH Method P & CAM 109[1] was used for airborne analyses with the following procedural modifications: 1) filters were dissolved in acetone in lieu of ashing them in a furnace; 2) a series of quartz and cristobalite standards for quantitation were prepared; and 3) sample material deposited on silver membrane filters was not washed.

Volatile Organics: Four process samples were taken for volatile organics using charcoal tubes and sampling pumps calibrated at 200 cubic centimeters per minute (cc/min) at rolling mills #1, 10, 11, and 12. Qualitative and quantitative analyses of these samples was by gas chromatograph and mass spectrometry (GC/MS).

Nitrosamines: Five process air samples were collected at the warm-up mills, feed mills, and calendering area for the presence of N-nitrosamine compounds. Sampling pumps calibrated at 3.0 liters per minute (lpm) with Thermosorb/N cartridges specific for nitrosamines. Analysis was by gas chromatograph, using a Thermo Energy Analyzer (TEA), and by High Performance Liquid Chromatography (HPLC). Details of nitrosamine analysis are in Appendix 1.

Psychrometer measurements (Model 556) for temperature and relative humidity were taken throughout the plant.

2. Environmental follow-up (March 4-5, 1980)

Thirty-five personal breathing-zone and general area air samples were collected to evaluate workers° exposure to talc dusts. Five personal samples were collected for organic solvents. Airborne dust was collected using calibrated sampling pumps at 1.5 lpm and connected to preweighed filters. Respirable dust samples were collected as personal breathing-zone samples from workers, while total dust samples were collected as general area samples. Selective (Cyclone) samplers were used in conjunction with preweighted filters for respirable samples. Samples for airborne solvents were collected with sampling pumps calibrated at 100 cc/min. Analysis for organic compounds was performed by NIOSH Method P & CAM 127.[2]

Six additional bulk samples were collected from different areas of the plant for asbestos and silica analyses. Polarized light microscopy and dispersion staining techniques were used for asbestos, and X-RD was performed for polymorphs of crystalline silica.

Ventilation measurements were taken at the 84" x 60" rolling mills using a Kurz Thermal Anemometer (Model 441). Psychrometer measurements were taken in different areas of the plant and compared with different production areas, and to the outside.

New ventilation controls constructed between the first and second NIOSH visits were evaluated, as well as an industrial vacuum purchased to control settled dust. Other controls such as oil dispersed in curing agent, and treated talc added to flocculate talc dust were also examined.

B. Medical

On November 6-7, 1979, NIOSH medical personnel conducted a preliminary investigation. Sixty-three workers (74%), were interviewed using a screening questionnaire. The results of these interviews indicated a very stable work population, with many of the workers close to retirement age. Labor turnover was approximately 1% per year.

A large proportion of the workforce is of Portuguese extraction, two-thirds are men. Male workers changed jobs within the following areas: compounding, milling, calendering, vulcanizing, and strip cutting; while female workers predominantly worked in: splicing, slitting, and tape packing. Receiving, shipping, and maintenance were usually stable assignments and were nearly exclusively male jobs. Based upon these preliminary interviews, there appeared to be an excess of respiratory problems, rashes, and nosebleeds among the employees.

Further information was supplied by the union in the form of medical records of retired or deceased employees. In four of these workers who had been with the company for 18-39 years, either an open lung biopsy or an autopsy had been performed: all had evidence of fibrosis; two with talc-like crystals, and two with silica.

The follow-up evaluation, conducted on March 4-5, 1980, was a cross-sectional study of the entire plant workforce, including as many retired employees as possible. This study consisted of an extensive questionnaire interview covering demographic data, occupational history, medical history, smoking habits, respiratory symptoms (adapted from the American Thoracic Society Questionnaire,[3] and a description of rashes and nosebleeds experienced during the year prior to interview. In addition, an objective assessment of the prevalence of respiratory disease was to be made by pulmonary function tests and chest X-rays for each worker interviewed.

Pulmonary function was measured with an Ohio Medical Model 840 dry rolling seal spirometer. A test was considered adequate for interpretation and use in the study only if there were three acceptable trials and the two best curves differed by no more than 5% with respect to forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1).[4]

The following criteria were used in the definition of chronic respiratory symptoms and lung disease:

cough:	yes to the question "Do you usually cough like this on most days for three consecutive months or more during the year?"
phlegm:	yes to the question "Do you bring up phlegm like this on most days for three consecutive months or more during the year?"
wheezing:	yes to the question "Does your chest ever sound wheezy or whistling when you have a cold/occasionally apart from colds?"
breathlessness:	yes to the question "Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill?"

obstructive lung disease: forced expiratory volume in one second (FEV_1) less than 80% of predicted norm; or ratio of FEV_1 and forced vital capacity (FVC) less than 70%.

restrictive lung disease: FVC less than 80% of predicted normal.

X-ray evidence of pneumoconiosis: chest X-ray with small rounded or irregular opacities with overall perfusion of 1/0 or greater; chest X-rays were read by a B-reader according to the UICC/Cincinnati Classification of the radiographic appearances of pneumoconioses.[5]

Smoking was considered a confounding variable for obstructive lung disease (and chronic cough and phlegm), but not for restrictive lung disease.

Pulmonary function test results from workers who had an upper respiratory infection ("cold") at the time of testing were not used in the analysis.

V. EVALUATION CRITERIA

The environmental evaluation criteria used in this report as related to airborne exposure to toxic substances are (1) NIOSH-recommended standards, (2) Threshold Limit Values (TLV's) of the American Conference of Governmental Industrial Hygienists (ACGIH), and (3) federal occupational health standards as promulgated by the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor (29 CFR 1910.1000).

Appropriate values are presented in the following table:

Substance	NIOSH Recommended Standard	ACGIH[a] TLV	OSHA[b] Standard
Nuisance Dust	-----	10 mg/M^3 5 mg/M^3	15 mg/M^3[c] (total) 5 mg/M^3 (respirable)
Talc (no fibers)	-----	2 mg/M^3[e] (respirable dust)	5 mg/M^3 (20 mppcf)
Toluene	375 mg/M^3 (100 ppm)[d]	375 mg/M^3 (100 ppm)	750 mg/M^3 (200 ppm)
Nitrosamines	F	----------	---------

a. American Conference of Governmental Industrial Hygienists Threshold Limit Values.
b. Occupational Safety and Health Administration Time-Weighted Average (TWA) Exposures for an 8-hour workday.
c. mg/M^3 = milligrams of substance per cubic meter of air.
d. ppm = parts of substance per million parts of air.
e. See notice of ACGIH Intended Changes for 1980.
F. No Environmental Criteria. However, nitrosamines are potent animal carcinogens and suspect human carcinogens. Therefore, exposure to these compounds should be kept as low as possible.

A. Toxicity of Talc:

The inhalation of significant amounts of commercial talc dust over an extended period of time can produce a symptomatic form of pneumoconiosis.[5-12] In addition to its occurrence in talc miners and millers, talc pneumoconiosis has been described occasionally in subjects exposed to the commercial product.[13,14] Talc workers and curing workers in the rubber industry have been shown to have increased respiratory morbidity.[15,16]

The clinical features of talc pneumoconiosis resemble those of asbestosis, but, in general, seem to take rather longer to develop. The subject is initially symptom-free, but as the disease progresses, cough and breathlessness develop, the latter being more prominent and consistent than the former.[11] The major clinical signs are diminished breath sounds, basilar crepitations, limited chest expansion, clubbing and cyanosis, the latter two features of the advanced case. Chronic bronchitis and emphysema are frequently associated with the disease, and death from cor pulmonale is the frequent cause of death.[6,11] The disease continues to progress slowly even in the absence of continued exposure to the dust.[7] Occasionally the disease may progress unusually rapidly, with death occurring within a few years of a very heavy exposure.

The initial radiographic appearance is an ill defined reticular and nodular lesion which appears preferentially in the mid zones. The nodules have a tendency to coalesce and progressive massive fibrosis may occur. The reticular lesions develop as a typical interstitial fibrosis and may involve the whole lung.

Studies of lung function have shown reduction in lung volume (FVC) and diffusing capacity in the advanced disease. Comparison of workers exposed over similar periods to fibrous and nonfibrous talc has shown little difference either clinically or in terms of lung function, though more individuals with restrictive disease are found among those exposed to fibrous forms.[17]

Macroscopic examination of the lungs shows fibrous pleural adhesions. Microscopically, in an early case, foreign body granulomata containing doubly refractile particles engulfed in macrophages may be found.[13] Interstitional fibrosis and hyperplasia of alveolar cells are seen as the disease progresses. In addition to particles of talc, asbestos bodies and fibers are usually visible. On the whole, the fibrous reaction to talc is less intense than that to silica.

Prevention of talc pneumoconiosis depends on the same measures of industrial hygiene as prevention of other pneumoconioses.[18]

B. Mixed Dust Pneumoconiosis:

In the mixed dust pneumoconioses the pathology depends to a large extent upon the relative proportion of free silica or quartz present in the airborne dust. Those with a quartz content of less than about 0.1% tend to develop small nodular areas in the lungs in almost direct proportion to the total amount of dust deposited, but little in the way of reticulin or collagen fibrosis, and very little emphysema. The pathological lesions more nearly resemble those found in coal miners.[19]

C. Rubber Itch:

Occupational dermatitis among rubber workers has been associated with a variety of chemicals: accelerators, acids, activators, adhesive removers, alkalis, antioxidants, benzol, chloroprene dimers, chromium pigments, curing agents, formaldehyde, heat, oils, plasticizers, resins, retarders, soaps, solvents, tar, turpentine, and zinc chloride.

Natural rubber latex rarely causes sensitization; however, synthetic rubber is a common sensitizer. Exposure to rubber accelerators and antioxidants is the most common cause of dermatitis among rubber workers such as compound mixers, calender, and mill operators.[20,21]

The causes of occupational dermatitis may be divided into primary irritants and allergic sensitizers. The difference between these is both matter of time and mode of action. Whenever there is difficulty in distinguishing between a primary irritant and an allergic reaction, a patch test, with a nonirritant concentration of the chemical(s) in question, may indicate whether the individual has become allergically sensitized to the chemical(s).

Once the cutaneous defenses have been broken down, from whatever cause, and contact dermatitis is present, the oozing or fissuring surface offers ideal conditions for superinfection.

Prolonged and excessive exposures to high humidity, friction, pressure, hyperhidrosis, and maceration may allow many usually nonirritating substances to produce inflammation. In addition, skin that is healed from an eczematous eruption may remain hyper-irritable for several months.

Protective clothing that prevents skin contact is generally very useful in preventing skin effects, especially if combined with regular meticulous skin cleansing. "Barrier creams" may be helpful if applied at least three to four times during the shift; however, they help protect against irritants only and do not prevent allergic reactions.

D. N-nitrosomorpholine (NMOR):

The acute toxic effects of animal exposure to NMOR are similar to those reported for N-nitrosodimethylamine (NDMA). The lethal dose producing 50% mortality (LD_{50}) in rats was 282 milligrams per kilogram of food (mg/kg) fed in a single oral dose.[22] NMOR has been found to be a mutagen by the microsomal mutagenicity assay (salmonella typhimurium 580 ug/plate).[23] Cytogenic analysis (rat cells) administered into the peritoneal cavity (250 mg/kg),[24] and 6g host-mediated assay (mouse/Salmonella typhurium 50 ug/kg).[24] In general, NMOR caused cancer of the liver and blood vessels in rats. No inhalation studies have been conducted to date on NMOR.

E. N-nitrosodiethylamine (NDEA):

Acute toxic effects of N-nitrosodiethylamine (NDEA) are similar to those of NMOR. The lethal dose for 50% of an experimental rat population (LD_{50}) is 216 mg/kg of food fed to rats in a single oral dose. NDEA causes cancer of the liver, nose, lung, and bronchi in rats.[25,26,27]

VI. RESULTS

A. Environmental

1. November 6, 1979:

Bulk samples collected from the tape packing machine, the thread machine tray, and the settled dust from a water sprinkler pipe, indicated little to no polymorphs of crystalline silica present. Quantitative analysis of these samples showed the quartz concentration in each sample to be less than 0.5%. However, these samples contained small amounts of fibrous talc with other silicate minerals. No asbestos was found in any of the bulk samples.

Five general area respirable samples were taken and analyzed for quartz, cristobalite, and total particulate weight. Both quartz and cristobalite were below the limit of detection (less than 0.03 mg/sample) for all five samples taken. The highest particulate (dust) exposure for this survey was the tape packer (1.2 mg/M^3).

Four process samples were taken for volatile organics at mill rolls #1, 10, 11, and 12. Qualitative analyses of these samples was by GC/MS. Only mill rolls #1 and 12 had detectable peaks of compounds with molecular weights of 126 and 141. The first compound was identified as methyl ethyl cyclohexane; the second compound could not be identified since no reference compound with a similar mass spectrum could be found.

Analysis of charcoal tubes for organics in the rubber thread gluing area showed trace amounts of toluene and some methyl ethyl cyclohexane.

Five Thermosorb/N process air samples were collected at the warm-up mills, feed mills, and calendering area for the presence of n-nitroso compounds. Two nitrosamine compounds were identified: nitrosomorpholine (NMOR) and nitrosodiethylamine (NDEA). Both nitrosamines are established animal carcinogens.[22] All samples were found to contain varying amounts of NMOR, and four of the five also contained NDEA. NMOR amounts ranged from 0.92 ug/m^3 to 5.9 ug/M^3, NDEA levels were somewhat lower, non-detectable ug/m^3 to 0.30 ug/M^3.

Psychrometer measurements were taken at some work stations in the plant. The relative humidity ranged from a low of 32% at the #3 slitting machine to 65% at the #10 mill roll. Generally, the areas where packers and slitters worked had lower humidity readings, while the rubber millers had higher humidity readings. This may be expected since the finishing areas use more talc (which performs like an astringent) than the milling areas.

2. March 4-5, 1980:

Environmental sampling in March 1980 showed that none of the workers at Fulflex Rubber were exposed to excessive amounts of talc dust during the NIOSH survey (Table I). The range of talc concentrations was from nondetectable at the bale cutter (where treated talc was used) to 1.2 mg/M^3 at one of the tape packing machines. The OSHA standard and ACGIH TLV for talc (containing no fibers) is 15 million particles per cubic foot or 2 mg/M^3 for respirable mineral dust.

Three bulk samples of settled dust, collected in March from support beams in the old Latex department, showed no detectable concentrations of asbestos.

Three personal samples for volatile organics in the rubber thread gluing and splicing area showed low levels of toluene ranging from 0.16 ppm to 0.46 ppm. The NIOSH environmental criterion for toluene is 100 ppm for an 8-hour time-weighted average (TWA).

One nitrosamine process sample collected at the pre-calender warm-up mill measured 2.34 ug/M^3 of n-nitrosomorpholine. This warm-up mill had no local exhaust ventilation.

Psychrometer measurements taken in various areas of the plant for temperature and humidity ranged from 69.5°F and 29% relative humidity in the 84" mixing mill area, to 76°F and 21% relative humidity in the tape packing area (x=23%). The temperature and humidity outside the plant on the day of sampling was 63.0°F and 55% relative humidity (Table II). The hydrophilic properties of talc may account for the lower relative humidity measurements, and, perhaps to workers° complaints of dry skin and nosebleeds, especially in the finishing area where liberal quantities of talc are used to coat rubber.

Ventilation:

Ventilation was vastly improved as a result of NIOSH recommendations in the finishing area between the first and second NIOSH surveys (see Appendix II). In the tape packing area where rubber thread is fed into 55-gallon drums, canopy exhausts above the drums were improved by increasing the flange area and thus increasing capture velocities of drum canopies. Face velocities ranged between 500 to 1,000 feet per minute (fpm) for most local exhaust canopies. However, in the 60" x 84" mill roll areas, local exhaust was still determined to be deficient. In general, the canopy opening face velocities ranged from 10-70 fpm. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that face velocities range from 50-500 fpm, depending on cross drafts. While volatilized contaminants from rubber may be exhausted, the larger particulates such as curing agents, accelerators, pigments, and antioxidants, which are manually added to the mill and mixed with natural and synthetic rubber, may not be sufficiently captured and removed by the hoods. In addition, the pre-calender warm-up mill had no exhaust ventilation. In light of the nitrosamine findings (2.3 ugM^3) at this mill, installation of local exhaust ventilation would be a prudent measure of contaminant control.

Skin Irritation:

A chemical inventory of rubber additives used in the compounding and milling was initiated on the first survey and completed on the second survey to isolate the agent(s) possibly responsible for skin irritation. Workers thought that red pigmented rubber was causing most of the irritation. By the process of elimination, the only differences between red batch rubber and tan rubber (which received few skin irritation complaints) was the red pigment and an antioxidant. Since antioxidants are, in general, moderate to severe skin irritants, we believe this antioxidant alone or in conjunction with the red pigment may be causing the skin irritation. Skin patch testing would be one way of testing this hypothesis.

Past Talc and Silica Exposure:

While NIOSH environmental dust results were low in general, the purpose was to provide recommendations to curb any development of respiratory disease

at this plant. NIOSH investigators examined the State OSHA files for measurements of past talc exposure. Only a few dust sample results were reported and only one total dust concentration at 18 mg/M^3 in 1978 was shown to exceed the OSHA total dust standard of 15 mg/M^3. No other information was available to NIOSH. Workers, however, reported conditions were sometimes so dusty the air looked hazy. The company claims to have never used talc containing asbestos.

B. Medical

Seventy-seven active employees (91%) and 34 retirees (29%) participated in the study. This, however, is little more than half of the total workforce (active and retired) at Fulflex (50.2%). A breakdown of study participation and demographic information is shown below.

Workforce of Fulflex Rubber Company in March 1980		Participants #	Participants %	# of Males	# of Females
Active Employees (73 production and 12 maintenance):	85	77	90.6	56	21
Laid-off Employees:	19				
Retired Employees:	117	34	29.1	21	13
Total:	221	111	50.2	77	34

Age and seniority distributions of the population under investigation are as follows:

	Active	
	Age (yrs.)	Seniority (yrs.)
median:	57	28
mean:	56.6	27.9
standard deviation:	7.8	7.6
range:	37-83	2-44

Fourty-five (43.7%) employees worked in the predominately male departments (compounding, milling, calendering, vulcanizing, and strip cutting), 37 (35.9%) in the predominately female departments (splicing, slitting, and tape packing), and 21 (20.4%) worked in receiving, shipping, or maintenance (see Table IV).

Male and female workers showed a similar prevalence of smoking. Current workers showed a higher prevalence of smoking (37.6%) than did the retired workers (20.6%).

Sex	% Smokers	Employment	% Smokers
Male	32.5	Active Workers	37.7
Female	32.4	Retired Workers	20.6
Both	32.4 (p 0.05)	Both	32.4 (p 0.05)

There is, however, a strikingly large proportion of ex-smokers among both active and retired male employees, this proportion being larger among retirees. There is no similar trend among both groups of females, probably because more than half of them are non-smokers or irregular smokers.

Males	% Ex-smokers	Females	% Ex-smokers
Active	42.8	Active	9.5
Retired	66.7	Retired	7.7
Both	x=49.4 (p 0.05)	Both	x=8.8 (p 0.05)

Respiratory symptoms were reported in the following frequencies:

Chronic cough:	17 (41.5%)
Phlegm:	22 (44.9%)
Breathlessness:	50 (45.1%)
Wheezing:	54 (49.5%)

For none of these symptoms could a significant association with sex, age, seniority, work area, or exposure type be detected. Smokers were more likely to have wheezing (p=0.048), but did not report chronic cough, phlegm, or breathlessness more often than ex-smokers or non-smokers, contrary to what might be expected (see Table V). Altogether, 83/111 workers (74.8%) reported one or more respiratory symptoms. For both sexes, all age groups, seniorities, work areas, exposure types, and smoking habits, reported rates of at least one symptom are high, but no significant differences or trends can be detected.

Thirty-one (32.3%) of 96 employees with a valid pulmonary function test showed signs of obstructive lung disease, six of them exhibiting a possible combination of obstructive and restrictive changes. One worker (1.0%) showed signs of restrictive lung disease. Obstructive changes appeared to be more common among smokers, as would be expected; no other association could be found (see Table VI).

Twenty-three (21.3%) of 108 employees with chest X-rays showed small to medium irregular or rounded opacities which are typical for talc or silica pneumoconiosis. Unaffected upper lung zones were more common than unaffected lower lung zones, a finding more suggestive of talc than silica. However, rounded opacities, which are more common, are more suggestive of silica than talc. Three additional workers showed pleural thickening only; these, however, were not included under the diagnosis, since there are many other causes of pleural calcification. Two workers with abnormal heart shape or size are likewise not included.

If the results of pulmonary function tests and chest X-rays are combined, 23 (21.3%) workers show signs of pneumoconiosis or restrictive lung disease, and 24 other workers (22.2%) have obstructive changes exclusively, these obstructive changes again being more common among smokers ($p=0.0458$).

Obstructive abnormalities are more common in the age groups 46-75 years (20.0-27.8%), whereas restrictive changes are prominent only in the 56-65 years age group (34.0%). This latter significant difference is probably explained by the fact that only 29.1% of the retired work population were included in the study, and furthermore, that death due to pneumoconiosis may have already occurred among the older employees, thus removing individuals with findings from the study population. No other associations or trends could be established.

Skin rashes, experienced at least once during the year prior to interview, occurred significantly more often in the predominately male work areas; otherwise no significant associations could be detected (see Table VIII). Of the 45 workers who experienced rashes, 10 reported one episode; 6 two episodes; 2 three episodes; 11 four or more episodes, and 16 said that they suffered from rashes continuously. Reported duration was from a couple of hours to several months.

Nosebleeds, experienced at least once at work during the year prior to interview, occurred significantly more often among people who also reported exposure to irritant fumes in addition to dust. No other significant associations could be detected. Of the 13 workers (15.3%) reporting nosebleeds, one reported two episodes; and 12 more than four episodes. Two of these workers with recurrent nosebleeds are hypertensive.

Conclusions

Analysis of bulk samples, and general and personal air samples for talc dusts during the NIOSH health hazard evaluation showed low silica content in company used talc, and low airborne concentrations of talc in all rubber manufacturing operations. Environmental data for past exposures to talc dusts before the NIOSH evaluation were not available, and State monitoring for airborne talc dust was very sparce. Interviews with workers, especially retired workers, described plant air conditions as "hazy" throughout the plant during high production periods. While environmental data are lacking, pulmonary function tests and chest x-rays indicate past airborne talc dust exposures to be of significant magnitude to have caused pneumoconiosis in one of every five workers included in our study. Obstructive lung disease, which was found in another 22% of the workers, was significantly more prevalent among smokers and ex-smokers.

Environmental measurements during the NIOSH evaluation have shown that all airborne talc dust levels were below OSHA standards and ACGIH TLV criteria, and that further respiratory impairment due to current exposures is unlikely under these conditions. However, current workers, who were not found to have penumoconiosis now, may still develop this disease even though current exposures are well controlled. Likewise, workers, who were found to have penumoconiosis now, may still have progression of their disease even without further exposure to talc.

VII. RECOMMENDATIONS

1. Although significant improvements have been made in both general and local exhaust systems, a make-up air system has not been developed; thus putting the building under negative pressure and decreasing the efficiency in which contaminants are removed. Therefore, it is recommended that a make-up air system should be installed to improve the efficiency of removal of contaminants.

2. Humidity should be increased in the finishing area to balance the effects of dusts absorbing air moisture, and to decrease the drying out of workers' skin.

3. Improved local exhaust ventilation should be installed in the compounding area, especially where the batch ingredients are weighed out and bagged.

4. Flange of canopy hood should be extended to the back of mill rolls.

5. The capture velocity of mill roll local exhaust system 1) increasing fan speed, 2) larger fan motors, and/or 3) fan pitch.

6. Local exhaust should be installed at the pre-calender warm-up mill.

7. Local exhaust for talc dust should be installed at the post-calender rubber rolls.

8. The antioxidant should be investigated as a skin irritant in rubber mill roll workers.

9. Oil blended sifting is recommended rather than the curing agent system to decrease dust levels.

10. Local exhaust ventilation is needed for sifting antioxidants, coloring agents and curing agents.

11. More effective ventilation is needed for tumbler.

12. The respirator program should be upgraded during the interim for airborne dusts until effective ventilation can be installed or upgraded.

13. When mixing or compounding, mill room door should be closed to allow effective capture of central room ventilation.

14. A training program should be established for compounders where the uses and limitations of respirators, protective clothing, and personal hygiene are stressed.

15. Make-up air system will help exhaust systems work more effectively, and should over the long run help decrease energy costs.

16. Routine maintenance and cleaning of dusts from ductwork of rolling mill hood ventilators should be done on a semi-annual basis.

17. Protective clothing and barrier creams should be used to decrease dermatitis, and infection may be avoided by thorough cleansing and medical treatment where indicated.

18. A medical screening program should be initiated at the plant to monitor the current workforce. This screening should include regular medical examinations, chest x-rays, and pulmonary function testing. Preferably, this screening should be done by a physician familiar with occupational pulmonary disease. For workers found to have respiratory changes, a careful individual decision needs to be made as to whether they can continue to work under present environmental conditions at the plant. This assessment should include as considerations: their present medical status, their current level of disability, and the prognosis for progression of their disease a disability given their current occupational exposures.

VIII. REFERENCES

1. NIOSH Manual of Analytical Methods Vol. 1 (P & CAM 109). Quartz.

2. NIOSH Manual of Analytical Methods, Vol. 1 (P & CAM 127). Organics.

3. Ferris, B.G.: Respiratory Disease. Epidemiology Standardization Project, Respiratory Disease 118(6):1-120, 1978.

4. Horvath Jr., E.P.: Pulmonary Function Testing in Occupational Medicine, Navy Environmental Health Center, Technical Manual 77-1 Department of the Navy, Revised 1979.

5. UICC Committee, UICC/Cincinnati Classification of the Radiographic Appearances of Pneumoconioses, Chest 58:57-67, 1970.

6. Porro, F.W., J.B. Patton, A.A. Hobbs: Pneumoconiosis in Talc Industry, Amer. J. Roentgen 47:507 and 24, 1942.

7. Kleinfeld, M., J. Messite, I.R. Tabershaw: Talc Pneumoconiosis, AMA Arch. Ind. Health 12:66, 1955.

8. Seeler, A.O., J.S. Grybowsky, H.E. MacMahon: Talc Pneumoconiosis, AMA Arch. Ind. Health 12:66, 1955.

9. Kleinfeld, M., J. Messite, O. Kooyman et al: Pulmonary Ventilatory Function in Talcosis of Lung, Dis. Chest 46:592-98, 1964.

10. Kleinfeld, M., J. Messite, R. Swencicki et al: Lung Function Changes in Talc Pneumoconiosis, J. Occup. Med. 7:12-17, 1965.

11. Kleinfeld, M., J. Messite, J. Shapiro et al: Effect of Talc Dust Inhalation on Lung Function, Arch. Environ. Health 10:431-37, 1965.

12. Miller, A., A.S. Teirstein, M.E. Bader et al: Talc Pneumoconiosis. Significance of Sublight Microscopic Mineral Particles, Am. J. Med. 50:395-402, 1971.

13. Moskowitz, R.L.: Talc Pneumoconiosis: A Treated Case, Chest 58:37-41, 1970.

14. Nam, K., D.R. Gracey: Pulmonary Talcosis from Cosmetic Talcum Powder, J.A.M.A. 221:492, 1972.

15. Fine, L.J., J.M. Peters, W.A. Burgess et al: Studies of Respiratory Morbidity in Rubber Workers: 1. Prevalence of Respiratory Symptoms in Curing Workers, Arch. Environ. Health 31:5-9, 1976.

16. Fine, L.J., J.M. Peters, W.A. Burgess et al: Studies of Respiratory Morbidity in Rubber Workers: 4. Respiratory Morbidity in Talc Workers, Arch. Environ. Health 31:195-200, 1976.

17. Seaton, A.: Silicate Pneumoconioses, in Morgan and Seaton (Eds.) Occupational Lung Disease, W.S. Saunders Company, Philadelphia, PA, 1975, pp. 112-123.

18. Criteria for a Recommended Standard...Occupational Exposure to Crystalline Silica, DHEW (NIOSH) Publication No. 75-120 (reprinted 1979).

19. Occupational Diseases: A Guide to Their Recognition. DHEW (NIOSH) Publication No. 77-181, p. 115, 1977.

20. Gall, L.E.: Results of Patch Testing with Rubber Antioxidants and Accelerators, J. Invest. Dermatol. 29:105, 1957.

21. Wilson, R.H., E.H. Planak, W.E. McCormick: Allergy in the Rubber Industry, Ind. Med. Surg. 28:209, 1959.

22. Druckery, H., Pruessman, S. Ivankovic, and D. Schmahl: "Carcinogenic Effects of 65 Different N-Nitroso Compounds on BD-Rats." Z. Krebsforsch, 69(103), 1967.

23. Mutation Research, Vol. 59, p. 61, 1979.

24. Mutation Research, Vol. 48, p. 337, 1977.

25. Pruessman, R.: Toxicity of Nitrite and N-Nitroso Compounds, in Proceedings of International Symposium of Nitrite Meat Producers. Center for Agricultural Publishing and Documentation, Wageingen, 1974.

26. Herrold, K.M.: "Introduction of Olfactory Neuroepithelial Tumors in Syrian Hamsters by Diethylnitrosamine." Cancer 17:114-121, 1964.

27. Dontenwill, W., V. Hohr: "Carcinoma of the Respiratory Tract and Bronchi of Hamsters with N-Nitrosodiethylamine." Z. Krebsforsch 64:305-12, 1961.

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Copies of this report have been sent to:

1. Fulflex Rubber Company
2. United Rubber Workers, Local 474
3. U.S. Department of Labor (OSHA), Region I
4. NIOSH, Region I

For the purpose of informing the "89 affected employees," the employer shall promptly "post" this report for a period of 30 calendar days in a prominent location near where employees work.

TABLE I

Environmental Sampling for Talc
Fulflex Rubber Company
Bristol, Rhode Island
HE 79-139

March 4-5, 1980

Date	Sample Location	Sample Type	Sample Volume (liters)	Sampling Time	Talc Results (mg/M^3)
3/4	Tape Packing Machine Loc. 1	P*	525	7:49-10:50&11:41-14:30	0.63
3/4	Tape Packing Machine Loc. 2	P	513	7:54-10:51&11:55-14:40	0.78
3/4	Slitting Machine Loc. 3	P	540	7:58-10:00&10:42-14:40	0.24
3/4	Slitting Machine Loc. 2	P	519	8:00- 9:23&10:17-14:40	0.44
3/4	Slitting Machine Loc. 1	P	531	8:04- 9:22&10:04-14:40	0.75
3/4	Tape Packing Machine Loc. 4	P	514	8:08-10:00&10:49-14:40	0.27
3/4	Tape Packing Machine Loc. 5	P	495	8:13-10:00&10:57-14:40	0.28
3/4	Strip Cutting Machine Loc. 2	P	514	8:17-14:00	0.17
3/4	Stripper Operator	P	555	8:32-14:42	0.18
3/4	Wrapping Machine Operator	P	540	8:37-14:37	0.59
3/4	Strip Cutting Loc. 2	P	430	8:52-13:45	0.67
3/4	Bale Cutter	P	465	16:18-18:30	N.D.
3/4	Slitting Machine Loc. 3	P	612	15:40-22:08	0.38
3/4	Tape Packing Machine Loc. 1	P	577	15:50-22:15	0.47
3/4	Tape Packing Machine Loc. 2	P	490	16:00-22:12	0.67
3/4	Tape Packing Machine Loc. 3	P	541	16:05-22:06	0.37
3/4	Calender Inspector	P	475	16:11-21:58	0.84
3/4	Bale Cutter	P	198	18:50-22:00	0.10
3/4	Calender Operator	P	472	16:20-22:00	0.27
3/4	Stripper Machine Operator	P	459	16:53-22:01	0.37
3/5	Tape Packing Machine Loc. 2	P	540	7:35-14:25	1.20
3/5	Slitting Machine Loc. 2	G.A.**	514	7:43-14:26	0.45
3/5	Slitting Machine Loc. 3	P	516	7:44-14:28	0.31
3/5	Tape Packing Machine Loc. 4	P	516	7:47-14:31	0.52
3/5	Tape Packing Machine Loc. 3	P	514	7:49-14:32	1.03
3/5	Tape Packing Machine Loc. 5	P	513	7:52-14:35	1.20
3/5	Strip Cutting Machine Loc. 1	P	504	7:57-14:33	0.61
3/5	Rubber Wrapper/Vulcanization	P	474	8:23-14:39	0.15
3/5	Bale Cutter	P	378	10:25-14:37	0.08

*P = Personal sample **G.A. = General area sample Loc. = Location number

TABLE II

Psychrometer Measurements

Fulflex Rubber Company
Bristol, Rhode Island
HE 79-139

March 4, 1980

Time	Location	Wet Bulb (°F)	Dry Bulb (°F)	Percent Relative Humidity
10:35am	Tape Packing Machine Loc. 1	52.5	72.5	24
10:40am	Rubber Splicing Area	52.5	72.5	24
10:45am	Slitting Machine Loc. 3	52.5	73.0	23
10:50am	Slitting Machine Loc. 1	54.0	75.0	24
10:55am	Tape Packing Machine Loc. 4	55.0	75.0	25
11:00am	Tape Packing Machine Loc. 3	54.0	76.0	21
11:05am	Tape Packing Machine Loc. 5	54.0	75.0	24
11:10am	Strip Cutting Machine Loc. 2	52.5	75.0	19
11:15am	Stripping Machine	54.0	76.0	21
11:20am	Calender Machine	54.0	76.0	21
11:25am	Mill Roll Loc. 2	55.0	75.0	25
11:30am	Mixing Mill Area Loc. 1	52.0	69.5	29
11:40am	Outside	54.0	63.0	55

TABLE III

Nitrosamine Results (Process Sample)

Fulflex Rubber Company
Bristol, Rhode Island
HE 79-139

Date	Location	Sampling Time	NMOR[1] (ug/M^3)*	NDEA[2] (ug/M^3)	Comments
11/6/80	Mix Mill Loc. 2	13:20-15:33	2.00	0.12	Mixed Batch Rubber
11/6/80	Mix Mill Loc. 1	13:19-15:32	5.04	0.06	Mixed Batch Rubber
11/6/80	Warm up Mill	13:21-15:28	0.92	0.06	Curing Agent Blend Added
11/6/80	Mix Mill Loc. 3	13:23-15:30	5.88	0.30	Master Batch
11/6/80	Rubber Calender	13:18-15:25	3.41	N.D.**	Final Mix (red batch)
'4-5/81	Feed Mill	8:05-14:44	2.34	N.D.	Tan Rubber

1. NMOR = N-nitrosomorpholine
2. NDEA = N-nitrosodiethylene
* ug/M^3 = Micrograms of substance per cubic meter of air
** N.D. = Nondetectable

TABLE IV

Distribution of Participating Workers Among Different Work Areas

Fulflex Rubber Company
Bristol, Rhode Island
HE 79-139

Work Area	Number of Active Workers		Number of Retired Workers		Number of Active & Retired Workers Combined		
	Males	Females	Males	Females	Males (%)	Females (%)	Total (%)
Compounding, milling, calendering, vulcanizing, strip cutting	32	0	13	0	45 (100.0)	0 (0.0)	45 (43.7)
Splicing, slitting, tape packing	6	21	1	9	7 (18.9)	30 (81.1)	37 (35.9)
Receiving, shipping, maintenance	18	0	3	0	21 (100.0)	0 (0.0)	21 (20.4)
All areas	56	21	17	9	73	30	103*(100.0)

*Eight retired workers did not specify their job categories.

TABLE V

Respiratory Symptoms Reported By Active And Retired Employees

Fulflex Rubber Company
Bristol, Rhode Island
HE 79-139

Variable		Cough			Phlegm			Breathlessness			Wheezing		
		n	%	p	n	%	p	n	%	p	n	%	p
Sex:	Male	13	44.8	.53	15	41.7	.26	32	41.6	.27	36	48.0	.63
	Female	4	33.3		7	53.9		18	52.9		18	52.9	
Age (yrs.):													
	36-45	2	100.0	.13	1	100.0	.94	2	40.0	.74	2	40.0	.74
	46-55	6	30.0		10	41.7		21	51.2		22	53.7	
	56-65	9	52.9		9	47.4		22	41.5		26	51.0	
	66-75	0	0.0		2	40.0		4	36.4		4	36.4	
	75	0	0.0		0	0.0		0	0.0		0	0.0	
Seniority (yrs.):													
	25	5	41.7	.95	7	50.0	.93	14	41.2	.55	14	41.2	.21
	25	12	42.7		15	44.1		36	47.4		40	54.1	
Work Area:													
	Compounding, Milling, Calendering, Vulcanizing, strip cutting	11	61.1	.30	10	47.6	.69	18	40.0	.50	25	56.8	.22
	Splicing, Slitting, Tape Packing	4	30.8		8	53.3		19	51.4		21	56.8	
	Receiving, Shipping, Maintenance	2	28.6		3	30.0		11	52.4		7	35.0	

TABLE V, Cont'd.

Respiratory Symptoms Reported By Active And Retired Employees

Fulflex Rubber Company
Bristol, Rhode Island
HE 79-139

Variable	Cough			Phlegm			Breathlessness			Wheezing		
	n	%	p	n	%	p	n	%	p	n	%	p
Exposure:												
Dust	8	36.4	.48	12	42.9	.45	33	47.8	.85	33	48.5	.68
Dust & Fumes	8	50.0		9	50.0		17	46.0		19	52.8	
Smoking:												
Smoker	7	36.8	.50	8	44.4	1.0	20	55.6	.29	23	65.7	.048
Ex-Smoker	3	37.5		8	50.0		17	41.5		15	37.5	
Non- or Irregular Smoker	7	50.0		6	40.0		13	38.2		16	47.1	
Total	17	41.5*		22	44.9		50	45.1*		54	49.5*	

p = Level of significance by Chi Square test.

* = Percentage of employees reporting symptoms, out of all workers interviewed; all other percentages give the proportion of males, females, of a certain age group etc. with a certain symptom.

TABLE VI

Pulmonary Function Test Results

Fulflex Rubber Company
Bristol, Rhode Island
HE 79-133

	Pulmonary Function Test Results[1]			
	Obstructive		Restrictive	
	n	%	n	%
Sex:				
Male	24	37.5	1	1.6
Female	7	21.9	0	0.0
Seniority(years)				
≤ 25	5	18.5	0	0.0
> 25	25	36.8	1	1.5
Work Area				
Compounding, Milling Vulcanizing, Calendering strip cutting	16	40.0	0	0.0
Splicing, Slitting Tape Packing	7	21.9	1	3.1
Receiving, Shipping Maintenance	4	25.0	0	0.0
Exposure				
Dust	19	31.7	1	1.7
Dust & fumes	11	33.3	0	0.0
Smoking				
Current	17	54.8	1	3.2
Ex-smoker	10	30.3	0	0.0
Non-smoker	4	12.5	0	0.0

1 - Based on 96 employees

Table VII

Chest X-Ray Results

Fulflex Rubber Company
Bristol, Rhode Island
HE 79-133

		Chest X-Ray Pneumoconiosis[1] n	%
Sex			
	Male	14	18.4
	Female	9	28.1
Seniority(years)			
	≤ 25	6	17.7
	> 25	17	23.3
Work Area			
	Compounding, Milling Vulcanizing Strip Cutting	7	15.6
	Splicing, Slitting Tape Packing	10	28.6
	Receiving, Shipping Maintenance	4	20.0
Exposure			
	Dust	17	25.4
	Dust & Fumes	5	14.0
Smoking			
	Current	10	28.6
	Ex-smoker	8	20.0
	Non-smoker	5	15.2

1 - Based on 108 employees with valid chest x-rays.

TABLE VIII

Distribution of Skin Rashes (one or more) Among Active Employees

Fulflex Rubber Company
Bristol, Rhode Island
HE 79-139

Variable		Affected Employees n	%	Level of Significance (Chi Square)
Sex:	Male	32	66.7	.7024
	Female	13	61.9	
Age (yrs.):				
36-45		2	50.0	.4297
46-55		19	63.3	
56-65		24	70.6	
66-75		0	0.0	
75		0	0.0	
Seniority (yrs.):				
25≤		11	61.1	.5963
25>		34	68.0	
Work Area:				
Compounding, Milling, Calendering, Vulcanizing, Strip Cutting		24	82.8	.0286
Splicing, Slitting, Tape Packing		16	61.5	
Receiving, Shipping, Maintenance		5	41.7	
Exposure:				
Dust		22	59.5	.1028
Dust & Fumes		22	78.6	
Total		45	65.2*	

* Only 69 employees answered the question; these 45 workers represent 51.9% of the interviewed active workforce.

APPENDIX 1

Description of the Analytical Methods for N-Nitrosamines

Fulflex Rubber Company
Bristol, Rhode Island
HE 79-139

1. ThermoSorb/N Air Sample Cartridges:

ThermoSorb/N cartridges have been shown to be capable of both retaining a wide variety of N-nitrosamines and to be artifact resistant. These cartridges were supplied to NIOSH by New England Institute for Life Sciences (NEILS). When they were received for analysis they were eluted by backflushing the cartridges with acetone. Studies have shown that the first 1.0 ml of acetone quantitatively elutes all of the N-nitrosamines that were tested. The acetone eluate from these cartridges were (without further sample preparation) then examined by GC-TEA and HPLC-TEA.

2. Analysis by GC-TEA:

The GC-TEA conditions used for the detection of volatile nitrosamines was that described by Fine and Rounbehler.* A 14' x 1/8" stainless steel column packed with 5% Carbowax 20M containing 2% NaOH on Chromosorb HP (80-100 mesh) was operated at 175° with argon gas as the carrier at a flow rate of 15 ml/min. A TEA, which is a nitrosamine specific detector, was used as the detector with dry ice/ethanol as the cold trap.

3. Analysis by HPLC-TEA:

HPLC-TEA was constructed by sequentially connecting a high pressure pump (Altex model 110), an injector (Waters model U6K), a uPorasil column (Waters), and a TEA. The operation of HPLC-TEA has been described by Fine, et al. The samples were confirmed using a solvent system of 4% acetone in isooctane.

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*Fine, D.H., Rounbehler, D.P., Trace Analysis of Volatile N-nitroso compounds by combined gas chromatography & thermal energy analysis, J. of Chromatography 109, 271, 1975.

APPENDIX 2

Dust Control Improvements

Fulflex Rubber Company
Bristol, Rhode Island
HE 79-139

The following are the exhaust fans which have been installed and/or put into regular everyday use since NIOSH's first visit to Fulflex Rubber Company in November, 1979:

A. Single End Packers -

1. Exhaust hoods over thread feed area.
2. Enclosure over thread feeding device.
3. Window and/or roof general area - exhaust fans.
4. On-machine tamping has been eliminated.
5. Screen mesh tampers.
6. Operator station changed to reduce exposure.

Location	Location	Size	Blades	RPM	HP	CFM
Single End Packer						
Loc. 1	Window	16"	8	1725	1/4	2400
Loc. 2	Window	16"	8	1725	1/4	2400
Loc. 3	Wall	24"	2	1750	1/4	4200
Loc. 4	Wall	24"	6	1140	1/4	4500
Loc. 5	Wall	24"	6	1140	1/4	4500
Loc. 5	Wall	24"	6	1140	1/4	4500
Slitter Window- Loc. 3		16"	8	1825	1/4	2400
Strip Cutting Area	Roof	30"	6	1167	7-1/2	15,000

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