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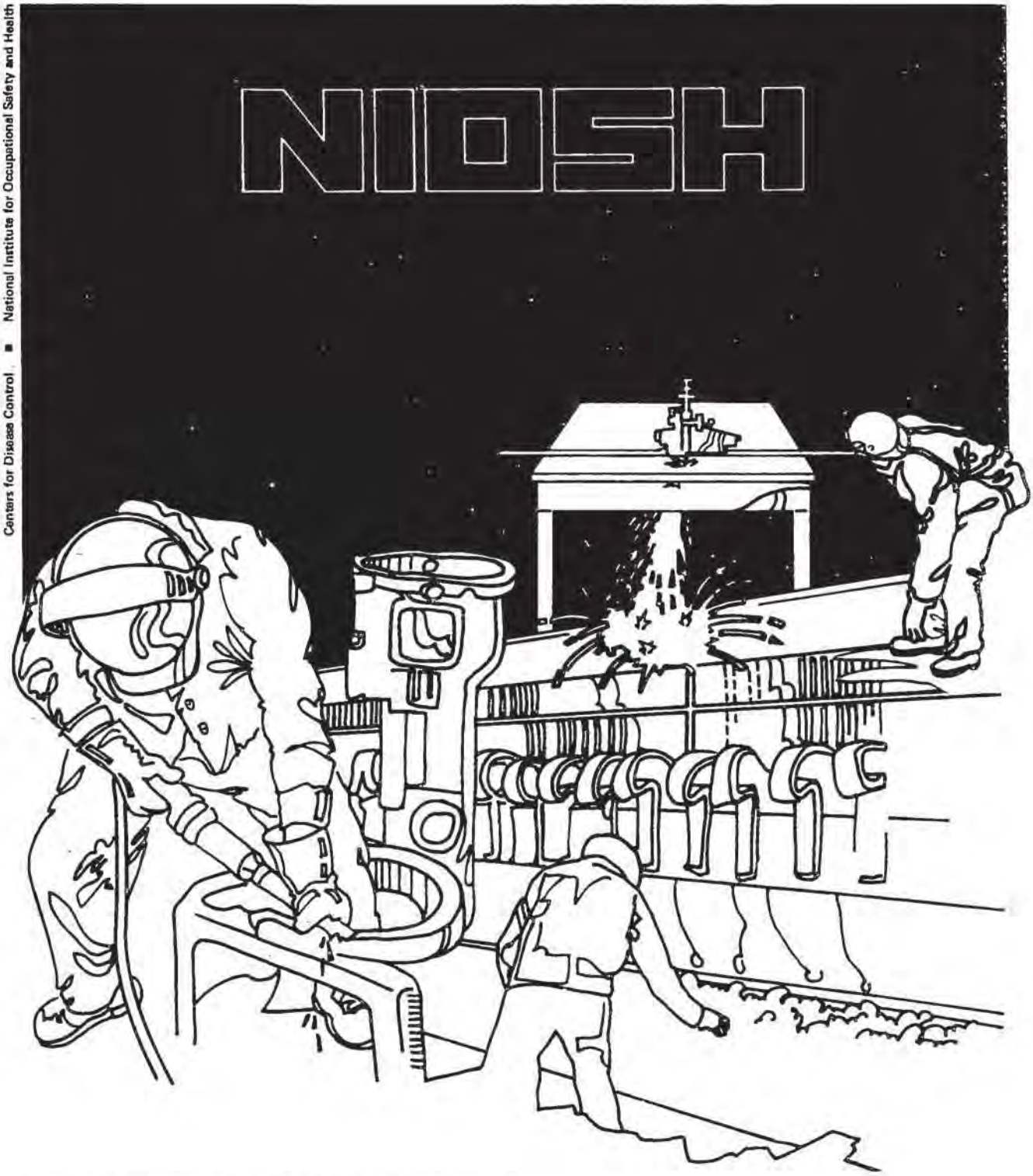

Health Hazard Evaluation Report

HETA 82-349-1332
WOOLRICH WOOLEN MILLS, INC.
WOOLRICH, PENNSYLVANIA

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.

HETA 82-349-1332
JUNE 1983
WOOLRICH WOOLEN MILLS, INC.
WOOLRICH, PENNSYLVANIA

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I. SUMMARY

In October 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation at Woolrich Woolen Mills, in Woolrich, Pennsylvania. The request concerned an outbreak of skin rash among employees who sew shirts from formaldehyde resin-finished cotton material.

On August 10-12, 1982, NIOSH investigators conducted a medical and environmental survey. Full-shift breathing zone and general area air monitoring for formaldehyde exposure was conducted at the Woolrich plants for one day each, utilizing liquid media, solid sorbent, and direct-reading sampling devices. Airborne formaldehyde concentrations at the Avis plant averaged roughly 0.3 ppm, and 0.5 ppm at the Howard plant. No significant differences were detected between breathing zone and general area concentrations, nor between jobs within a plant at the same time of day. The OSHA standard for an 8-hour workday is 3 ppm, but NIOSH considers formaldehyde a suspect occupational carcinogen, and recommends that exposures be maintained at the minimum feasible level. No ethylene oxide was detected in four area samples, one at Avis, three at Howard.

In addition, a questionnaire survey of 120 employees was conducted to characterize the skin rash, to determine if there were any other health problems associated with formaldehyde exposures, and to collect exposure information. Questionnaire data showed that the incidence of skin rash and burning eyes increased simultaneously during the months between November 1981 and May 1982. Attack rates for the Avis plant were: burning eyes, 100%; burning throat, 46%; chest tightness, 1.5%; skin rash, 58%; and for the Howard plant burning eyes, 89%; burning throat, 72%; chest tightness, 37%; skin rashes, 44%.

NIOSH found that although atmospheric levels of formaldehyde were less than 0.5 ppm, skin rashes and burning eyes and throat occurred among Woolrich employees due to the combined effects of formaldehyde vapor exposure and contact with formaldehyde-containing materials. Recommendations for eliminating the problem are included in Section VIII of this report.

Key Words: SIC 2321, Formaldehyde, Skin rashes, Eye irritation, Throat irritation

II. INTRODUCTION/STATEMENT OF REQUEST

On August 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from Woolrich Woolen Mills, Woolrich, Pennsylvania. The request concerned an outbreak of skin rash among employees who sew shirts from formaldehyde resin-finished cotton material. On August 10-12, 1982, NIOSH conducted an industrial hygiene and medical survey at Woolrich's Avis and Howard manufacturing plants. A letter dated October 5, 1982, summarizing the August survey was sent to Woolrich. A second letter, sent October 28, 1982, discussed initial conclusions and preliminary recommendations.

III. BACKGROUND/PROCESS DESCRIPTION

Woolrich Woolen Mills owns five garment manufacturing plants, all located within a 50 mile radius of Woolrich, Pa. Two of these plants (Avis and Howard) are used to manufacture shirts from wool and chamois cotton material. The cotton is finished with a wrinkle-resistant formaldehyde resin prior to its receipt at Woolrich.

The Avis plant consists of one 14,500 ft^2 ground-level building and employs 170, predominantly female workers. Most of these employees are sewers who sew together shirts from pre-cut material pieces in assembly line fashion. The manufacturing area which contains a variety of different sewing machines occupies the majority of the floor space. Adjacent to this area are the enclosed press room and the enclosed receiving/storage areas. The offices and lunch room are located along the front of the building. The building has undergone expansion and has received additional heating and cooling capacity since being built in 1967. Currently, the ventilation system operates at 15,800 to 29,400 cubic feet per minute (CFM), depending on the heat or cooling load.

The Howard plant consists of essentially the same manufacturing processes, housed in a slightly smaller building, with approximately 130 predominantly female workers. The lunch room is an open area located in front of the plant. Receiving/storage areas are located in the back of the plant. Ventilation consists of four heating/cooling systems located near the four corners of the building. The system operates from 10,000 to 15,200 CFM depending on the heat or cooling load.

The manufacturing processes at the Woolrich plants are typical of the garment industry in general, and are basically comprised of cutting (not normally conducted on a large scale at either the Avis or Howard plants), separating, jointing and sewing, inspection, and pressing. Ten thousand square yard lots of cotton material is received and cut at the Woolrich main plant before being sent to the Avis and Howard plants. Each lot of material produces approximately 4000 shirts once received

at the plant. Roughly five weeks are required for a particular lot to proceed through the manufacturing processes. Approximately 15,000 shirts are produced per week, and at a given time, 60-70,000 shirts may be in the plant undergoing one of the numerous processing operations. Thus, numerous lots of material may be present at any given time, with each shirt being handled by 30 to 40 employees. Woolrich uses three different finishing companies to apply the wrinkle resistant formaldehyde resin to their cotton material.

IV. METHODS AND MATERIALS

A. Environmental

Environmental monitoring was initiated at the Avis plant at the beginning of the first shift on August 11, 1982. Five personal breathing zone full-shift samples and six general area samples were collected for formaldehyde using both solid sorbent and liquid media collection devices. In addition, a direct reading instrument was used at various locations throughout the facility. Sampling and analytical difficulties encountered during previous NIOSH surveys involving formaldehyde necessitated the use of these multiple sampling devices. These difficulties involve the use of appropriate sampling and analytical methodologies when environments containing both "free" and "para" formaldehyde are evaluated. Analytical results of the solid sorbent and liquid media samples may not be exact, but should give a very close approximation of the actual airborne concentrations of formaldehyde. Laboratory research is currently being conducted to resolve this problem.

For each of the liquid media samples, 20 millimeters (cc) of sodium bisulfite ($NaSO_3$) solution was placed in small glass "impinger" vials, and air was drawn through the vials via battery operated pumps at a flow rate of 1.0 liter per minute for the duration of the shift. For personal samples, the vials were attached to the lapel of the worker to obtain "breathing zone" samples. General area samples were obtained at breathing zone height in appropriate locations throughout the facility. In most instances, solid sorbent samples were obtained in duplicate with the impinger samples. The solid sorbent sampling train consisted of 150 milligram (mg) Supelco XAD-2 chromosorb tubes attached to battery powered pumps operated at a flow rate of 50 cc/min. Sample analysis was conducted using NIOSH Method P&CAM 125 (1) for impinger samples (2 microgram limit of detection) and NIOSH Method P&CAM 354 (2) for the solid sorbent samples (5 microgram limit of detection).

A CEA 555 Ambient Air^R sampling instrument was used to obtain on-site measurements of formaldehyde concentrations. This instrument is capable of continuously sampling air and analyzing it for formaldehyde by a modified pararosaniline method. The CEA 555 was moved to various locations throughout both facilities during the day shifts, sampling particular locations for approximately one-half to one hour periods.

At the Howard facility, environmental sampling was conducted during the first shift of August 12, 1982, using the same sampling strategies for formaldehyde (same number of samples and method of acquisition) as was used at the Avis plant. The probe of the direct reading instrument was also placed in an air supply duct at the Howard plant to measure the formaldehyde content of the recirculated air.

Five samples, consisting of cloth and lint, were collected for determination of formaldehyde content. Also, due to its use as a finishing agent, four general area samples were collected for ethylene oxide (one at Avis, three at Howard). The samples were obtained using qazi-ketcham tubes attached to sampling pumps operated at 50 cc/min. Analysis was performed using NIOSH Method P&CAM S-286.(2) The limit of analytical detection was reported at 0.02 mg. ethylene oxide/tube.

B. Medical

1. Skin Rash

The NIOSH medical investigators administered a questionnaire designed to characterize the skin rash problem and to determine if any other health problems typically associated with formaldehyde exposures existed at Woolrich. The questionnaire addressed work and medical history as well as current health status. Ninety questionnaires were administered at Woolrich to a randomly selected group of the employees. Then an additional 30 were administered to volunteers who had a skin rash but were not included in the randomly selected population.

2. Other Information

The company supplied information on type, amounts, and finishers for all material sewed at both the Avis and Howard plants during the past year. The major portion of the reported skin rash outbreak occurred during this time period. Contact was made with material finishers to inform them about the situation at Woolrich and to collect information on their resin application process. In addition Woolrich provided records on "free formaldehyde" tests conducted on material samples from each of the three finishers used to apply the formaldehyde resin.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical

agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH recommended standards, by contrast, are based solely on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Exposure to formaldehyde concentrations as low as 0.1 parts formaldehyde per million parts of air (ppm) have been associated with irritation of the eyes, nose, throat and respiratory tract.(3) Its odor is detectable at less than 1 ppm, and at 4-5 ppm lacrimation and burning of the nose and throat occur. At concentrations greater than 10 ppm, difficulty in breathing, intolerable burning of nose and throat and substernal chest discomfort occur. These

symptoms may persist for several hours after high exposures have terminated. Two types of dermatitis can result from formaldehyde exposure: irritant and allergic sensitization. Allergic sensitization to formaldehyde may occur following repeated exposure. There are individual differences in susceptibility to formaldehyde sensitization. The duration of exposure and the exposure level needed to cause sensitization are variable. However, once an employee is sensitized, recurrence of the effect can result from extremely low levels of formaldehyde exposure. The current OSHA standard, intended to protect workers against irritant effects, is 3.0 ppm (3.6 mg/m^3) as an eight-hour time weighted average (TWA), 6.1 mg/m^3 as a 30 minute ceiling limit, and 12.3 mg/m^3 for a maximum peak exposure limit. Recently, studies by the Chemical Industry Institute of Toxicology and New York University(4) have shown that formaldehyde induces nasal cancer in rats and mice. Based on these animal studies NIOSH currently considers formaldehyde as a potential carcinogen and recommends that occupational exposure be reduced to as low as feasible.(6)

VI. RESULTS AND DISCUSSION

A. Environmental

Only one of the solid sorbent samples obtained at the Avis plant was reported above the analytical limit of detection (5 micrograms/sample, or about 0.2 mg/m^3, air volume adjusted). This sample, obtained from an employee's breathing zone while sewing collars, was reported at 0.29 ppm. The liquid media samples were generally reported to contain less formaldehyde than the solid sorbent samples. As indicated in the liquid media analytical method (NIOSH P & CAM 125), negative interferences are possible when solvent vapors are present in the sampled air. This may have been the case in this garment facility, because substances such as polyvinyl alcohol are used as sizing agents and ethylene glycol as lubricants. All samples collected via the liquid media sampling method were above the limit of detection. Personal samples(5) ranged from 0.11 to 0.27 ppm, averaging 0.17 ppm, while area samples(6) ranged from 0.12 to 0.18 ppm, averaging 0.14 ppm. Table I presents analytical results of the liquid media samples obtained from the Avis plant.

The direct reading instrument was moved to various locations throughout the facility during the shift. No differences were detected betweeen general area and breathing zone airborne concentrations. With this instrument, formaldehyde concentrations were shown to range from 0.12 to 0.53, with an overall average of 0.34 ppm. Table II presents airborne concentrations of formaldehyde measured with the CEA 555 at the Avis plant. The time intervals presented in the table represent stationary positions of the instrument.

As indicated in Table II, concentrations increased with time, indicating a general buildup of free formaldehyde during the shift. This is further indicated by measurements obtained at the Collar Finishing location in the morning (09:02-10:37) and the afternoon (13:49-14:07), with concentrations averaging 0.36 ppm and 0.44 ppm, respectively. No particular job was associated with relatively higher formaldehyde concentrations, and exposures apparently result from the cumulative release of formaldehyde from all the operations.

One full-shift area sample obtained for measurement of exposure to ethylene oxide was below the analytical limit of detection (less than 1 milligram/cubic meter (mg./M^3) air volume adjusted).

Concentrations of formaldehyde in five personal, full shift breathing zone samples at the Howard plant ranged from less than 0.19 to 0.57 ppm. Area samples ranged from 0.13 to 0.55 ppm. Table III presents the analytical results for the liquid media and solid sorbent samples.

Table IV presents a summary of the measurements obtained with the direct reading instrument. The direct reading instrument was used to measure breathing zone airborne formaldehyde concentrations at numerous locations. However, as was the case at the Avis plant, no instances were observed where "area" vs. "personal" monitoring significantly differed. This is probably due to the abundance of partially finished garments stored in areas throughout the facilities. Thus, formaldehyde is being generated in a uniform manner at most locations. Results also indicate that supply air is as heavily laden with formaldehyde as general plant air. Also, as seen from the direct reading instrument summary data, airborne formaldehyde concentrations tended to increase with time at both plants. This suggests that the ventilation systems are merely circulating formaldehyde laden air, without reducing concentration.

A suede cloth sample identified as associated with the reported skin rash outbreak among employees at the Avis plant (I.D.# Pa 821) showed a formaldehyde content of 421 ppm (this material is no longer used). This level was 3-4 times higher than the formaldehyde content of the other two cloth samples obtained at the Avis plant. One of these cloth samples, reported as having a formaldehyde content of 136 ppm (I.D.# Pa 910), was obtained from a storage bin from the floor area. During environmental sampling, the probe of the direct reading instrument was placed directly into the material, and the instrument registered a formaldehyde concentration of greater than 1 ppm (off scale). It is reasonable to assume that the cloth material with the higher content (Pa 821) resulted in greater airborne concentrations of formaldehyde, and may explain the significantly higher airborne formaldehyde concentrations previously measured by an investigator from the Occupational Safety and Health Administration during the use of

this material. Levi Strauss, a major manufacturer of cotton cloth material, recommends that latent formaldehyde levels be kept below 200 ppm.

Lint samples collected from table surfaces showed nearly identical formaldehyde content to that of the cloth material (138 ppm). This demonstrates that a significant source of employee exposure is inhalation and skin contact with the lint and dust containing formaldehyde.

B. Medical

Evaluation of the incidence and reports of skin rash and burning eyes indicated that most cases had their onset between November 1981 and May 1982. Cases of skin rash and burning eyes increased simultaneously at both plants during this time period. All employees interviewed at the Howard plant reported burning eyes at some time in the last year; burning throat was reported by 46% of the interviewees; chest tightness by 1.5%; and skin rash by 58%. Attack rates for the Avis plant were similar: burning eyes, 89%; burning throat, 72%; chest tightness, 37%; and skin rashes, 44%.

Most employees indicated that the severity of symptoms varied from day to day, depending on weather conditions, plant ventilation, and especially the particular batch and color of material being handled. However, the same colors did not always appear to cause a problem, but colors which were problematic seemed to most often come from the same finisher.

Interview data indicate that several employees at Woolrich have possible allergic sensitization to formaldehyde, based on their descriptions of the symptoms. Several employees indicated that skin rashes developed on exposed skin after repeated contact with material.

As the skin rash problem increased, Woolrich began to conduct free formaldehyde tests on material samples from each of the three finishers. The tests showed that one finisher, the one whose material was most often identified as the cause of the skin rash, consistently supplied material with higher formaldehyde levels than the other two, ranging from about 200 ppm, to over 500 ppm which is above the 200 ppm limit currently recommended by one garment manumanufacturer. Material finishers indicated that the free formaldehyde content of the material can vary greatly from day to day depending on the care and control maintained during the finishing process.

Data on type, amount, and finisher for material entering the plant was analyzed, but no association between the skin rash outbreak and any of these variables could be established.

VII. CONCLUSIONS

It appears that the skin rash outbreak among Woolrich Howard and Avis plant employees was caused by the combined effect of contact with formaldehyde-containing material and exposure to formaldehyde vapor. There are several reasons to support this conclusion:

1. Similar skin rash problems have been associated with working with formaldehyde resin-treated material in the past.

2. Environmental monitoring has documented airborne levels of formaldehyde vapor of about 0.11 to 0.60 ppm in both plants. These levels have been associated with burning eyes and skin rashes in past surveys.

3. Employees who had close contact with material (the sewers) experienced the highest incidence of skin rash.

4. Burning eyes, a classic symptom of formaldehyde exposure, increased in severity during the skin rash outbreak.

Several employees exhibited symptoms of allergic sensitization to formaldehyde. These individuals will not be able to work in areas containing even small amounts of formaldehyde.

Interviews indicated that skin rashes, respiratory irritation and especially burning eyes have been a chronic problem in the past, with reccuring episodes, but that in the time period between November 1981 and May 1982 the problem was particularly severe. There are probably two main reasons for the this: (1) material containing unusually high free formaldehyde, and (2) inadequate ventilation.

Apparently the ventilation system is not bringing in enough fresh air to maintain low formaldehyde levels during the day. In addition the physical handling of the material causes an increase liberation of free formaldehyde. There are two environmental observations that support these statements: (1) direct reading measurements for formaldehyde showed that there was no difference between supply air and general room air formaldehyde levels, and (2) environmental sampling demonstrated a steady increase over time in atmospheric formaldehyde concentration between morning and afternoon.

In light of recent evidence on formaldehyde carcinogenicity, and considering the major problem of its acute irritant effects, material finishers and garment manufacturers have a responsibility to work together to reduce employee exposure to formaldehyde. In a letter dated April 14, 1983, Woolrich accepted recommendations made by NIOSH in a letter of October 28, 1982. They stated that their finishers were working to reduce free formaldehyde and that current test data showed that levels were averaging below 150 ppm in material at Woolrich.

NIOSH supplied Woolrich with copies of the latest literature on formaldehyde finishing research, and requested Woolrich to send each of it's finishers a copy.

VIII. RECOMMENDATIONS

1. Woolrich should continue to monitor the free formaldehyde content of incoming material and encourage finishers to continue work on lowering formaldehyde content by maintaining proper control during the finishing process, by researching new lower or non-formaldehyde finishing techniques.

2. Employees exhibiting symptoms of formaldehyde allergic sensitization should be moved to a job where there is no formaldehyde exposure.

3. Exposed employees should wear long sleeve garments and long pants to reduce skin exposure. In some situations lab coats could be used to reduce exposure.

4. The raw materials (cotton cloth) should be allowed to "off-gas" in an isolated area prior to the production process.

5. Although a thorough ventilation survey was not performed during the NIOSH evaluation, an increase of outside air as "make up" would probably decrease levels of airborne formaldehyde.

IX. REFERENCES

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4. Kerns, W.D.: Long-Term Inhalation Toxicity and Carcinogen- icity Studies of Formaldehyde in Rats and Mice. Presented at the Third CIIT Conference on Toxicology, Nov. 20-21, 1980, Raleigh, North Carolina.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Woolrich Woolen Mills
2. NIOSH, Region III
3. OSHA, Region III

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I.
LIQUID MEDIA ANALYTICAL RESULTS FOR FORMALDEHYDE: AVIS PLANT
WOOLRICH WOOLEN MILLS
WOOLRICH, PA.
AUGUST 10-12, 1982

SAMPLE TYPE	DURATION	CONCENTRATION (ppm)	LOCATION
Personal	07:31-15:07	0.20	Sewing buttons
Personal	07:38-15:11	0.12	Sewing pockets
Personal	07:44-15:17	0.11	Sewing pockets
Personal	07:56-15:26	0.27	Sewing collars
Personal	10:00-15:06	0.16	Sep. fronts from backs
Area	08:59-15:45	0.12	Auto. cutter
Area	08:50-15:45	0.12	Central front area
Area	08:43-15:45	0.18	Sleeves
Area	08:46-15:45	0.16	Southwest area
Area	08:35-15:45	0.15	Inspection
Area	08:39-15-45	0.12	Press room

TABLE II.
CEA 555 FORMALDEHYDE MEASUREMENTS: AVIS PLANT
WOOLRICH WOOLEN MILLS
WOOLRICH, PA.
AUGUST 10-12, 1982

DURATION	RANGE (ppm)	AVERAGE (ppm)	LOCATION
07:17-08:05	0.12-0.22	0.18	Inspection
08:05-08:29	0.19-0.22	0.20	Marking for Pockets
08:29-09:02	0.19-0.21	0.20	Small Parts
09:02-10:37	0.21-0.42	0.36	Collar Finishers
10:37-10:52	0.35-0.42	0.38	Collar Finisher*
10:52-11:20	0.36-0.38	0.37	Steam Room
11:20-11:35	0.38-0.39	0.39	Sewing Sleeves
11:35-12:00	0.30-0.36	0.33	Small Parts
12:58-13:32	0.47-0.53	0.50	Sewing Backs
13:32-13:49	0.40-0.53	0.45	Cuffs & Pockets
13:49-14:07	0.39-0.47	0.44	Collar Finishers
14:07-14:24	0.49-0.50	0.49	Button Facing

*Breathing Zone Sample

TABLE III
RESULTS OF SOLID SORBENT AND LIQUID MEDIA SAMPLES: HOWARD PLANT
WOOLRICH WOOLEN MILLS
WOOLRICH, PA.
AUGUST 10-12, 1982

SAMPLE TYPE	DURATION	CONCENTRATION (ppm)		LOCATION
		Liquid media	Solid sorbent	
Personal	07:01-15 05	0.29	0.48	Small parts
Personal	07:10-15 00	0.30	LT0.19	Cuffs
Personal	07:23-15 07	0.33	0.57	Sleeves
Personal	07:15-15 13	-Impinger spill-	0.42	Sleeves
Personal	07:07-15 10	0.34	0.44	Small parts
Area	07:50-15 40	0.36	0.23	Central area
Area	08:02 15 34	0.20	0.47	Cuffs
Area	07:44 15 30	0.35	0.55	N.W.floor area
Area	07:55 15 38	0.25	0.47	S.E. floor area
Area	07:36 15 29	0.36	0.20	Cuffs
Area	07:59 15 35	0.13	0.25	Press room

TABLE IV.
CEA 555 FORMALDEHYDE MEASUREMENTS: HOWARD PLANT
WOOLRICH WOOLEN MILLS
WOOLRICH, PA.
AUGUST 10-12, 1982

DURATION	RANGE(ppm)	AVERAGE(ppm)	OPERATION
07:30-08:06	0.24-0.43	0.35	Seperating small parts
08:06-08:31	0.43-0.45	0.44	Sewing fronts
08:31-09:20	0.50-0.64	0.58	Sewing sleeves
09:24-10:24	0.60-0.67	0.62	Sewing collars
10:24-10:38	0.55-0.60	0.57	Sewing sleeves
10:38-10:55	0.31-0.43	0.35	Steam room
11:10-12:04	0.57-0.76	0.64	Sewing fronts
12:04-13:05	0.45-0.70	0.49	Sewing fronts
13:05-14:20	0.55-0.70	0.65	Fronts to backs