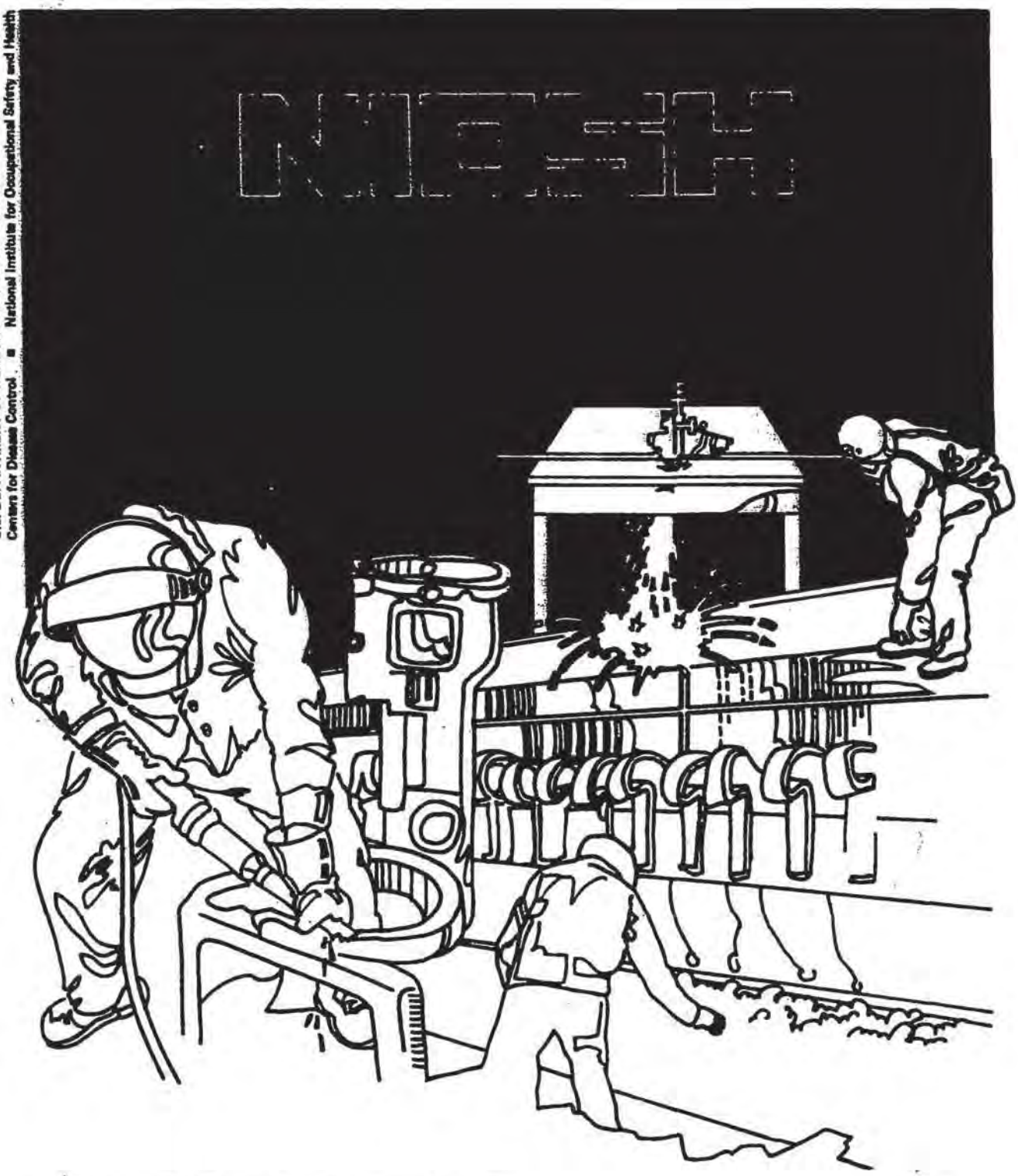
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 82-200-1233
TODD UNIFORM COMPANY
MAURY CITY, TENNESSEE

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 82-200-1233
NOVEMBER 1982
TODD UNIFORM COMPANY
MAURY CITY, TENNESSEE

NIOSH INVESTIGATORS:
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I. SUMMARY

On April 1, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation to investigate occupational exposures of approximately 60 workers employed at the Todd Uniform Company, Maury City, Tennessee. The requestors were concerned about worker exposure to formaldehyde and possibly other aldehydes during the handling and sewing of precured permanent press fabrics. The request listed problems with eye and nasal irritation, skin rashes, and respiratory problems, including asthma and bronchitis among the exposed workers.

On June 1-3, 1982, NIOSH investigators conducted a combined environmental and medical evaluation at the facility. The industrial hygiene aspect of the evaluation involved the collection of personal and general area air samples for formaldehyde and general area air samples for longer chain (C_2-C_5) aldehydes, i.e. acetaldehyde, propionaldehyde, n-butyraldehyde, and n-valeraldehyde. "Fresh" and "stored" samples of four of the most widely used fabrics were also obtained and analyzed for residual formaldehyde content. The medical aspect of the evaluation included an interviewer-administered medical questionnaire and a limited physical exam.

Detectable levels of formaldehyde were measured in all of the air samples. Sixteen 8-hour TWA personal breathing zone samples averaged 0.26 ppm (range: 0.08 to 0.44 ppm). Twenty 30-minute duration samples averaged 0.40 ppm (range: 0.32 to 0.54 ppm). None of the 8-hour or 30-minute samples exceeded the OSHA or ACGIH exposure guidelines. NIOSH, however, recommends that worker exposure to formaldehyde be controlled to the lowest feasible level because it is a suspect human carcinogen. Measurements made prior to the workshift (following about 14 hours of inactivity in the plant) with the sole ventilation fan off showed that formaldehyde levels were generally no different from levels present during the shift. None of the other aldehydes were present in measurable concentrations. Latent formaldehyde was detected in two of the fabrics with the fresh samples having a slightly higher average formaldehyde content than the stored samples (334 ppm versus 200 ppm). All levels were below the lowest concentration (500 ppm) documented in the literature as giving rise to skin rashes among apparel wearers.

Fifty-six female production workers were evaluated by questionnaire and limited physical exam in order to detect toxic effects of formaldehyde. The questionnaire indicated symptoms of eye irritation in 44 workers (78.6%) in the two months prior to the NIOSH inspection. Twenty people (35.7%) had these symptoms more than twice a week. Nasal irritation (25.0%) and throat irritation (10.7%) were also described. Questionnaire results confirmed a pattern of respiratory symptoms in twenty-two (39.3%), but this was highly correlated with smoking. Asthma-like symptoms were described by five people, but in four cases the conditions preceded employment. Skin rashes were reported by eighteen people (32.1%). These were most frequently found on the forearms (14 people; 25%).

On physical exam, fourteen people had rashes. Eleven were of the contact dermatitis type, and possibly work related. Eleven people (19.6%) had mild to moderate inflammation of their conjunctiva (eye membranes) at the time of exam. The pattern of eye and skin symptoms was compatible with low-level formaldehyde exposure. There was no clear evidence of work-related asthma among workers.

Based on the environmental-medical data presented in this report, NIOSH concludes that employees at the Todd Uniform Company, Maury City, Tennessee, are exposed to formaldehyde at levels capable of producing eye and upper respiratory tract irritation and dermatitis. Recommendations to alleviate these conditions are provided in Section VIII of the report.

KEYWORDS: SIC 2328 (Men's, Youth's, and Boy's Furnishings, Work Clothing, and Allied Garments), formaldehyde, aldehydes, dermatitis, asthma, conjunctiva, upper respiratory tract irritation.

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970, NIOSH investigates the toxic effects of substances found in the workplace. On April 1, 1982, NIOSH received such a request from employees at Todd Uniform Company, Maury City, Tennessee. They were concerned that an apparently elevated occurrence of eye and nasal irritation, skin rashes, and respiratory problems, including asthma and bronchitis, among workers at the plant were related to exposure to chemicals on the job, specifically to formaldehyde used in precured permanent press fabrics.

On June 1-3, 1982, representatives from NIOSH conducted a site visit at Todd Uniform. The evaluation began with an opening conference with a walk-through inspection immediately following. Over the following two and one-half days, medical interviews and limited physical exams were conducted and industrial hygiene sampling was completed. A summary of the June evaluation was presented in Interim Report No. 1 dated July 1982. Results of the environmental portion of the evaluation were presented in Interim Report No. 2 dated August 1982.

III. BACKGROUND

Todd Uniform Company markets and services washable industrial service apparel. The plant in Maury City is one of four company operated plants. It exclusively manufactures work shirts. All fabrics are received precut and precured. There is no storage capacity; fabrics are received daily from a sister plant. Shirts are assembled by seamstresses in a series of sewing operations organized on a piece work basis. Once completed, the shirts are inspected and packaged for shipment.

The plant has been in operation since April 1976 and employs 60 persons including 58 production workers. The non-production staff consists of an office manager and a clerical person. Job classifications for the production personnel include seamstresses (50), inspectors (5), and service operators (3). There are two maintenance mechanics--the only males employed at the facility.

The plant is located in a single-story building with interior dimensions of approximately 175' x 90' x 15'. All of the production activities are performed in an open work area of about 15,000 sq. ft.

Ventilation is provided by six thermostatically controlled combination heating/air conditioning units. These units are suspended from the ceiling and utilize existing plant air. A single wall fan is operated during work hours to provide air circulation in the plant.

At the time of this evaluation the major fabric-type was a 65% cotton/35% polyester and was manufactured by a major U.S. textile firm

-- The Milliken Corporation. The textile manufacturer indicated that the fabric is impregnated with a glyoxal-based resin. A polyethylene softener and carboxylated acrylic soil release agents are also present. According to the manufacturer, no flame retardants are used. The latent formaldehyde content in their fabrics is rated at less than 500 ppm per gram of fabric.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

During the 2-day survey, NIOSH collected personal and general area air samples for formaldehyde and general area samples for longer chain (C_2-C_5) aldehydes. Fabric samples were also obtained and analyzed for latent formaldehyde content.

NIOSH representatives measured worker exposure to formaldehyde by obtaining long-term (8-hour) and, for some operations, short-term (30-minute) duration air samples. The 8-hour samples were obtained from 16 sewing machine operators. The samples were collected using NIOSH method P&CAM 354.[1] This method specifies the use of sorbent tubes containing Chromosorb 102 impregnated with n-benzylethanolamine. Samples were collected at a flow rate of 20 cubic centimeters of air per minute (cc/min) and analyzed using a gas chromatograph equipped with a flame ionization detector. The limit of detection for this method was 6 micrograms per sample.

On June 2nd, five of eight sewing machine operators outfitted with the Chromosorb tubes also had additional 30-minute duration measurements taken randomly four times during the shift. These samples, placed on the operator's table within 2 to 3 feet of the operation, were taken to determine if there were any trends in the formaldehyde concentrations during the course of the workshift as a means of addressing the complaints of irritation reported by the workers. Measurements were taken at five specific sewing operations: hem front, crease and band, set collar, make collar and inspection. The first two operations were selected because formaldehyde levels were expected to be high due to the relative freshness of the fabric (hem front) or the use of heat (crease and band). The five operations were also chosen to best represent diverse points of the plant's lay-out. The samples were placed on the operators' table within two to three feet of the operator. Samples were collected at a flow rate of 1.5 liters per minute (Lpm) using NIOSH method P&CAM 125 with 1% sodium bisulfite as the impinger solution.[2] Samples were analyzed spectrophotometrically. The limit of detection for the analysis was 0.1 micrograms formaldehyde per milliliter of impinger solution.

Two long-term area samples, placed at representative locations in the workroom, were also collected and analyzed by the impinger method described above.

Detector tube measurements were also made to provide instantaneous estimates of airborne formaldehyde levels. These included pre-shift measurements on the morning of June 3, 1982, when the sole ventilation fan had been shut down during the night. This was done to determine whether there would be any accumulation of formaldehyde under such unusual conditions.

Because of the association of longer chain aldehydes with symptoms that are similar to those of formaldehyde, NIOSH collected four area samples for C_2-C_5 aldehydes which included analysis for acetaldehyde, propionaldehyde, n-butynaldehyde, and n-valeraldehyde., Two samples were obtained on June 2 at representrative locations in the work area with the remaining two samples collected at the same locations the following day. These samples were collected using a flow rate of 1.0 Lpm. and analyzed by gas chromatography using NIOSH method P&CAM 127 with modifications.[2] The limit of detection for all four analytes is 0.01 milligrams per milliliter of impinger solution.

"Fresh" and "stored" cloth samples of four widely used fabrics including "gulf blue, navy blue, white leno, and suntan" were obtained to determine latent formaldehyde content. The samples were analyzed by a method developed by Burlington Industries.[3] Weighed portions of each sample (approximating 1 gram) were suspended over water in a jar and heated at 49°C for 20 hours. After additions of chromotropic acid, the solutions were analyzed spectrophotometrically. The samples were compared to a calibration curve based on known concentrations of formaldehyde. The limit of detection for the analytical method was 124 parts per million (ppm) formaldehyde per gram of sample.

B. Medical

The medical evaluation included an interviewer-administered medical questionnaire and an abbreviated physical exam. The questionnaire sought out routine demographic information, occupational history, and symptoms associated with exposure to formaldehyde. The physical exam consisted of a brief examination of the conjunctivae; of the nasal cavities; of exposed skin of the head and neck and arms; and chest auscultation.

V. EVALUATION CRITERIA

A. Environmental

Various criteria proposed by NIOSH, OSHA, and The American Conference of Governmental Industrial Hygienists (ACGIH) for airborne concentrations of chemicals measured in this evaluation are listed in Table I of this report for those substances with established levels. These criteria are the maximum concentrations of each substance to which most individuals can be exposed over an 8 to 10-hour workday, 40-hour work week, throughout an individual's normal worklife without adverse health effects. These limits have been derived from existing human and animal data and industrial experience. Of the criteria presented for each substance, those which are the most stringent, and thus afford the best health protection of the worker, will be applied for the purposes of this evaluation. Table I also lists the major health effects or sites of action of those chemicals. At the present time there are no established criteria for butyraldehyde or propionaldehyde.

B. Medical

A brief review of the known toxic effects of the hazardous substances to which Todd Uniform workers are potentially exposed follows:

FORMALDEHYDE---Contact with uncovered skin by fabric containing free formaldehyde and inhalation are the two mechanisms of exposure. The OSHA formaldehyde standard is based on a threshold for irritant and upper respiratory complaints: it does not address skin rashes (dermatitis).

a. Effects on skin.[9-12] Skin rashes have been associated with exposure to free formaldehyde from resin systems used in the preparation of permanent press clothing. Rashes are of the contact dermatitis type: that is, their appearance requires direct physical contact to skin. Among textile workers, symptoms are more commonly associated with post-cured fabrics, which have a higher level of free formaldehyde. Patch testing for sensitization has been generally unproductive because of the poor association between a positive patch test and skin symptoms. In population studies, rashes have been noted at formaldehyde concentrations of 0.05-0.075% (500-750 ppm free formaldehyde).

b. Effects on the respiratory system.[13-15] Formaldehyde potentially affects respiration in two ways: as irritation of the nose, throat and upper airways and as airflow obstruction and/or asthma. A moderate degree of eye irritation with mild tearing, and nose and throat irritation has been reported at

formaldehyde levels in the 0.1-0.5 ppm range. Free formaldehyde is detectable against background at about 0.01 ppm, with earliest detection of noxious effect at less than 0.05 ppm. There is a rapid adaptive effect with symptoms at low level of exposure decreasing or disappearing in about 15-20 minutes. In population studies, there is a linear increase in reported symptoms with increasing level of formaldehyde with general recognition of irritant effect at about 2-5 ppm. Despite the irritant effects, population and laboratory controlled studies have not indicated transient decreases in pulmonary function with formaldehyde exposure. There is potentially a more serious problem concerning formaldehyde or formalin induced occupational asthma. Several studies have shown that a small number of workers, usually with significant exposures to formalin, have been sensitized to formaldehyde. Any exposure to this group would constitute a potential hazard. For others, with obstructive lung disease or asthma, which is unrelated to formaldehyde, irritant levels could still pose a pulmonary stress.

c. Cancer. Recent reports of nasal cancers in rats have raised concerns about the carcinogenicity of formaldehyde related to human exposure. Therefore, at the present time, NIOSH recommends that worker exposure to formaldehyde be reduced to the lowest feasible level since it is a suspect human carcinogen.

OTHER ALDEHYDES---Other longer chain aldehydes, such as butyraldehyde propionaldehyde, and valeraldehyde have been described as contaminants of formaldehyde in permanent press resin preparations. Their described irritant effects are similar to those of formaldehyde, but less intense. No reports of cancer have been associated with these compounds.

VI. RESULTS AND DISCUSSION

A. Environmental

Formaldehyde air sampling results are presented in Table II. Detectable levels were measured in all of the air samples collected. The sixteen 8-hour TWA personal breathing zone samples averaged 0.26 ppm (range 0.08 to 0.44 ppm). The twenty 30-minute duration samples averaged 0.40 ppm (range 0.32 to 0.54 ppm). The two general area air samples measured identical levels of 0.5 ppm. These environmental levels are similar to those found in other fabric plants.[16] With respect to the 30 minute sample results, formaldehyde levels appear to increase during the workday from a range of 0.32 to 0.37 ppm in the early morning to a range of 0.39 to 0.52 ppm in the late afternoon. The results also show that the formaldehyde levels were fairly uniform throughout the plant. All of the samples were within the current OSHA standard of 3 ppm and the past NIOSH and current ACGIH TLV of 1 ppm, which were set to

prevent irritant symptoms. However, based on the elevated occurrence of nasal cancer in laboratory animals exposed to formaldehyde, NIOSH and ACGIH consider formaldehyde a suspect human carcinogen. NIOSH policy on human exposure to suspect carcinogens is to reduce the exposure to the lowest level possible.

To determine whether formaldehyde levels increased during the night (when the wall fan was off thus illustrating worst-case conditions), formaldehyde levels were measured prior to the workshift on June 3. Four measurements made using direct reading detector tubes showed that the formaldehyde levels were below 0.5 ppm, the lower limit of detection of the tube. Therefore, levels of formaldehyde appear to be no different at the beginning of the workshift than during the rest of the day.

General area air sampling results for acetaldehyde, propionaldehyde, butyraldehyde and valeraldehyde are presented in Table III. All four samples were below the analytical limit of detection of 0.01 mg/ml for all four analytes.

Latent formaldehyde measurement results are presented in Table IV. Two of the fabrics, gulf blue and navy blue, had detectable amounts of formaldehyde measured during the heating procedure described earlier in Section IV. For both blue fabrics, the fresh samples had slightly higher formaldehyde content: 329 ppm versus 255 ppm for the gulf blue and 339 ppm versus 146 ppm for the navy blue. These differences, although slight, are what one would expect i.e., the fresher the fabric the higher the latent formaldehyde content. These analyses were in agreement with the latent formaldehyde information provided by the textile manufacturer and were below the lowest concentration documented in the literature (500 ppm) as giving rise to skin rashes.[10]

B. Medical

Study Population

Fifty-six female workers were evaluated. This was 94.6% of the entire work force of 60 people. Of the remaining four people, two men were excluded to maintain sexual homogeneity, one refused to participate and one was absent. Forty-seven of the 56 workers were directly involved in cloth handling and fabrication. Of the remaining 9 people, 4 were inspectors, 3 were service operators, and the remaining two were an office manager and a clerical staff person. All, except the clerical staff, had direct exposure to cloth. Because of the absence of job differentiation regarding cloth handling and because environmental results did not detect area differences in airborne free formaldehyde levels, it was not possible to separate the workforce into categories with different exposures.

Symptoms

In Table V, the prevalence of irritant symptoms to the eyes, nose and throat are presented. The most common reported symptom was eye irritation, occurring in the two months prior to administration of the questionnaire. This was indicated by 44 of 56 workers (78.6%). Twenty people (35.7%) experienced these symptoms two or more times a week. Thirteen people were symptomatic on the day of the interview. There was an association between symptoms and time of day. Eighteen of the 44 symptomatic people associated their eye symptoms with the first 30 minutes of work. Nasal symptoms, including itchy and stuffy nose and frequent sneezing were reported by 14 people (25%). Although nasal irritation was less common than eye irritation, 12 people (21.4%) had an itchy or stuffy nose on the day of the interview. Throat symptoms were reported by 6 people (10.7%). This frequency heirarchy of eyes/nose/throat irritation is the general pattern in low level formaldehyde exposure.[5]

Respiratory symptoms are summarized in Table VI. Eighteen people (32.1%) had had significant episodes of coughing within the past year. Two people, one of them a smoker, had symptoms consistent with a clinical history of chronic bronchitis. Since beginning work at Todd, eight people had been diagnosed as having a respiratory disease: three had pneumonia, one had asthma, and four had bronchitis. In general, respiratory symptoms were highly, correlated with smoking (Table VII). Because the simple dichotomy of smoker/non-smoker does not differentiate between different degrees of smoking and does not take into account individuals who may have discontinued smoking in the recent past, Todd workers are compared in Table VIII on the basis of average pack year consumption. A pack year is a simple multiple of the average number of packs smoked per day and the number of years smoked. Symptom (+) was indicated when chronic bronchitis, symptoms suggestive of asthma or symptomatic shortness of breath were present. It was also indicated in the presence of at least two of the following symptoms: cough, wheeze, mild shortness of breath. Twenty-two people (39.3%) were symptomatic (+) and 34 (61.7%) were symptom-free (-). The symptomatic (+) workers had a more frequent history of smoking. Because of the association of formaldehyde with the development of occupational asthma, symptoms of episodic severe wheezing and shortness of breath were investigated in detail. Five workers had such symptoms, but in at least four of the cases, the symptoms preceded employment. These low numbers obviated more detailed investigation. Although two of the five workers are smokers, all five had previous occupational exposure in other textile firms. Therefore, industrial exposure as a precipitating or exacerbating factor cannot be excluded.

In summary, there was no explicit pattern of lower respiratory disease. However, such symptoms were significantly related to a history of smoking. There were a number of cases with asthma-like symptoms; association with occupational exposure is complicated by the small number of people involved.

Skin problems of brief duration and moderate severity were another frequent complaint. (Table IX). Eighteen people (32.1%) reported skin problems over the past 6 months. The frequency of reported episodes of rash in the past six months was as follows: three people had one episode only; nine people had two to five episodes; and four people had five or more episodes. The most frequent location was the exposed forearm, which was reported by 14 people. Navy blue cloth was the only material frequently cited for its association with rash.

Physical Examination.

Fourteen people had skin rashes noted on physical exam. Three of these were chronic or infectious lesions which bore no relationship to contact dermatitis. Four people had rashes located on the volar forearms, five people had rashes on the neck and upper chest, one had a rash on the forehead, and one had a rash on the chest and forearms. On nasal exam, one individual had polyps with opacification; no other lesions were noted. Eleven people (19.6%) had mild to moderate inflammation of their conjunctivae at the time of exam.

VII. CONCLUSIONS

Symptoms consistent with low level formaldehyde exposure including irritation of eyes, nose and throat, and skin rashes were found in significant numbers in the Todd workforce. Environmental levels of free formaldehyde were below the current OSHA and ACGIH exposure limits; there is evidence in the literature that the mild irritative symptoms seen among the workers at Todd occur at levels approximating 0.5 ppm. Environmental monitoring did not identify usually high concentrations of formaldehyde in any particular area in the plant in the early morning following shutdown of the wall fan, or in any specific types of cloth. The prevalence of early morning irritative symptoms with subsequent accommodation has been observed in several controlled studies,[13] and may explain the increase prevalence of early morning symptom reporting in absence of relatively high environmental levels. The medical evaluation did not demonstrate a pattern of serious respiratory disease associated with work, but this must be qualified by the prevalence of smoking, the small size of the workforce, and the high proportion of prior employment in other textile facilities.

The principal hazards of formaldehyde exposure are of two types: (1) irritation and (2) the long term risk of cancer. NIOSH recommends that formaldehyde be treated as a suspect human carcinogen based on the occurrence of nasal cancer in laboratory animals exposed to it. Although current levels of formaldehyde are below those generally associated with respiratory disease the unresolved issue of cancer and the presence of mild irritant symptoms underlines the need for improvements in ventilation to minimize worker exposures.

VIII. RECOMMENDATIONS

1. Dilution ventilation incorporating at least 15% fresh (outdoor) air should be provided to the plant as a means of reducing worker exposure to formaldehyde.

2. A barrier cream should be provided to those workers with skin irritation and/or skin rashes on the neck and chest. Long sleeves should be worn for those workers with arm irritation.

IX. REFERENCES

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Requestors
2. Todd Uniform Company, Maury City, Tennessee
3. NIOSH, Region IV
4. OSHA, Region IV

For the purpose of informing the 60 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

Summary of Exposure Limits and Health Effects for Substances
Measured at Todd Uniform Company

Todd Uniform
Maury City, Tennessee
HETA 82-200

Substance	Evaluation Criteria* (ppm) NIOSH**	OSHA***	ACGIH****	Primary Health Effects	Reference
Formaldehyde	See text (Section V)	3 5 Ceiling 10 Acceptable max peak above ceiling for 30 minutes	1 (C)	Eye, Respiratory Tract Irritant	7
Acetaldehyde	-	200	100	Eye, Mucous Membrane Irritant	7
Valeraldehyde	-	-	50	Eye, Skin Irritant	8

(C) - Ceiling concentration, exposures should not exceed this level.
* Limits are 8-hour time-weighted averages
** See Reference 4
*** See Reference 5
**** See Reference 6

TABLE II

Personal and General Area Sampling Results for Formaldehyde

Todd Uniform
Maury City, Tennessee
HETA 82-200

June 2-3, 1982

Date	Job Classification	Location	Sampling Duration	Sample Volume (liters)	Formaldehyde Concentration (ppm)
6-2-82	Hem Front	Machine 122	0802-1600	10.2	0.15
6-2-82	Hem Front	Machine 122	0858-0913	45	0.32
6-2-82	Hem Front	Machine 122	1039-1054	45	0.38
6-2-82	Hem Front	Machine 122	1215-1230	45	0.32
6-2-82	Hem Front	Machine 122	1430-1445	45	0.39
6-2-82	Make Collars	Machine 124	0750-1530	9.8	0.24
6-2-82	Make Collars	Machine 124	0857-0912	45	0.35
6-2-82	Make Collars	Machine 124	1045-1100	45	0.45
6-2-82	Make Collars	Machine 124	1215-1230	45	0.38
6-2-82	Make Collars	Machine 124	1430-1445	45	0.44
6-2-82	Crease & Band	Machine 127	0750-1530	10.7	0.23
6-2-82	Crease & Band	Machine 127	0854-0909	45	0.35
6-2-82	Crease & Band	Machine 127	1054-1109	45	0.35
6-2-82	Crease & Band	Machine 127	1215-1230	45	0.40
6-2-82	Crease & Band	Machine 127	1430-1445	45	0.45
6-2-82	Set Collar	Machine 67	0740-1530	8.7	0.19
6-2-82	Set Collar	Machine 67	0852-0907	45	0.37
6-2-82	Set Collar	Machine 67	1140-1155	45	0.35
6-2-82	Set Collar	Machine 67	1215-1230	45	0.42
6-2-82	Set Collar	Machine 67	1430-1445	45	0.54
6-2-82	QC Inspector	QC Station 1	0926-1600	10.5	0.23
6-2-82	QC Inspector	QC Station 1	0849-0904	45	0.35
6-2-82	QC Inspector	QC Station 1	1042-1057	45	0.40
6-2-82	QC Inspector	QC Station 1	1215-1230	45	0.43
6-2-82	QC Inspector	QC Station 1	1430-1445	45	0.52

(continued)

TABLE II (continued)

Date	Job Classification	Location	Sampling Duration	Sample Volume (liters)	Formaldehyde Concentration (ppm)
6-2-82	Band Sandwich	Machine 128	0745-1600	12.5	0.26
6-3-82	Crease & Band	Machine 126	0743-1530	11.5	0.28
6-2-82	Side Seaming	Machine 401	0730-1530	9.5	0.08
6-3-82	Make Collars	Machine 125	0738-1531	10.5	0.39
6-2-82	Set Collar	Machine 40	0800-1600	11.0	0.44
6-3-82	Hem Front	Machine 122	0751-1545	7.4	0.22
6-3-82	Pocket Setter	Machine 119	0735-1530	11.1	0.37
6-3-82	Tail Hem	Machine 001	0759-1500	9.1	0.09
6-3-82	Sew Buttons	Machine 47	0757-1536	10.4	0.15
6-3-82	Set Pockets	Machine 48	0809-1620	7.8	0.41
6-3-82	QC Inspector	QC Station 3	0751-1605	9.6	0.42
6-3-82	*	Machine 104	0830-1616	699	0.50
6-3-82	*	Machine 086	0830-1617	700	0.50

Evaluation Criteria: See Section IV

* Area samples

TABLE III

Concentrations of Acetaldehyde, Propionaldehyde, n-Butyraldehyde, and n-Valeradehyde in Area Samples

Todd Uniform
Maury City, Tennessee
HETA 82-200

June 2-3, 1982

Date	Location	Sample Duration	Sample Volume (liters)	Airborne Concentration (ppm)			
				Acetaldehyde	Propionaldehyde	n-Butyraldehyde	n-Valeraldehyde
6-2-82	Machine 86	0825-1616	466	ND	ND	ND	ND
6-3-82	Machine 86	0825-1616	466	ND	ND	ND	ND
6-2-82	Machine 104	0830-1616	465	ND	ND	ND	ND
6-3-82	Machine 104	0830-1320	290	ND	ND	ND	ND
Evaluation Criteria:				100	-	-	50

Laboratory Limit of Detection - 0.01 mg/ml for all four analytes.

ND - Nothing Detected

TABLE IV

Latent Formaldehyde Content in Fresh and Stored Fabric Samples

Todd Uniform
Maury City, Tennessee
HETA 82-200

June 2-3, 1982

Sample Description	Latent Formaldehyde Content (ppm)
Gulf Blue, Fresh	329
Gulf Blue, Stored	255
Navy Blue, Fresh	339
Navy Blue Stored	146
White Leno, Fresh	<LOD
White Leno, Stored	<LOD
Suntan, Fresh	<LOD
Suntan, Stored	<LOD
Limit of Detection (LOD):	124

TABLE V

Eye, Nose, and Throat Symptoms

Todd Uniform
Maury City, Tennessee
HETA 82-200

June 2-3, 1982

Symptom	Number	Percent With Symptom
Symptoms Present at Time of Exam		
Itchy nose	12	21.4
Burning eyes	13	23.2
Symptoms Occurring Over Past 2 Months		
Eye irritation	44	78.6
Eye irritation 2 or more times per week	20	35.7
Throat irritation	6	10.7
Nasal symptoms	14	25.0

Total Number of People Interviewed - 56

TABLE VI

Respiratory Symptoms

Todd Uniform
Maury City, Tennessee
HETA 82-200

June 2-3, 1982

Symptom	Number	Percent With Symptom
Symptoms Present at the Time of Interview		
Cough or phlegm - (cold)	5	8.9
Chest tightness	4	7.1
Chronic Conditions		
Cough	18	32.1
Chronic bronchitis	2	3.6
Medical treatment for bronchitis during employment	4	7.1
Shortness of breath	26	46.4
Symptomatic shortness of breath	11	19.6

Total Number of People Interviewed - 56

TABLE VII

Respiratory Symptoms Analyzed by Smoking History

Todd Uniform
Maury City, Tennessee
HETA 82-200

June 2-3, 1982

	Shortness of Breath	No Shortness of Breath
Ever smoked	7	16
Never smoked	4	29
	11	45

Relative Risk* = 2.51

	Cough	No Cough
Current smoker	10	7
Non-smoker	8	31
	18	38

Relative Risk* = 2.87

	Wheeze	No Wheeze
Current smoker	7	9
Non-smoker	10	30
	17	39

Relative Risk* = 1.75

Total Number of People Interviewed - 56

* The relative risk (RR) measures the likelihood of having a symptom, such as coughing, given a risk such as smoking. In other words, the prevalence of a symptom in smokers is compared to the prevalence of that symptom in non-smokers. A RR of 1 means a smoker is no more likely to have a certain symptom than a non-smoker. A RR of 10 means that the likelihood of the symptom in a smoker is ten times greater than in a non-smoker.

TABLE VIII

Respiratory Symptoms and Smoking History

Todd Uniform
Maury City, Tennessee
HETA 82-200

June 2-3, 1982

	With Symptom (+)	Without Symptom (-)
Number of Workers	22	34
Average Number of Pack Years	13.0	3.6
Standard Deviation	15.8	7.8

Student's T-Test - $p < 0.005$

Total Number of People Interviewed - 56

TABLE IX

Skin Problems

Todd Uniform
Maury City, Tennessee
HETA 82-200

June 2-3, 1982

Symptom	Number	Percent With Rash
Rash in last 6 months	18	32.1
Location		
Face	5	8.9
Arms	14	25.0
Chest	7	12.5

Total Number of People Interviewed - 56