This Health Hazard Evaluation (HHE) report and any recommendations made herein are for the specific facility evaluated and may not be universally applicable. Any recommendations made are not to be considered as final statements of NIOSH policy or of any agency or individual involved. Additional HHE reports are available at http://www.cdc.gov/niosh/hhe/reports

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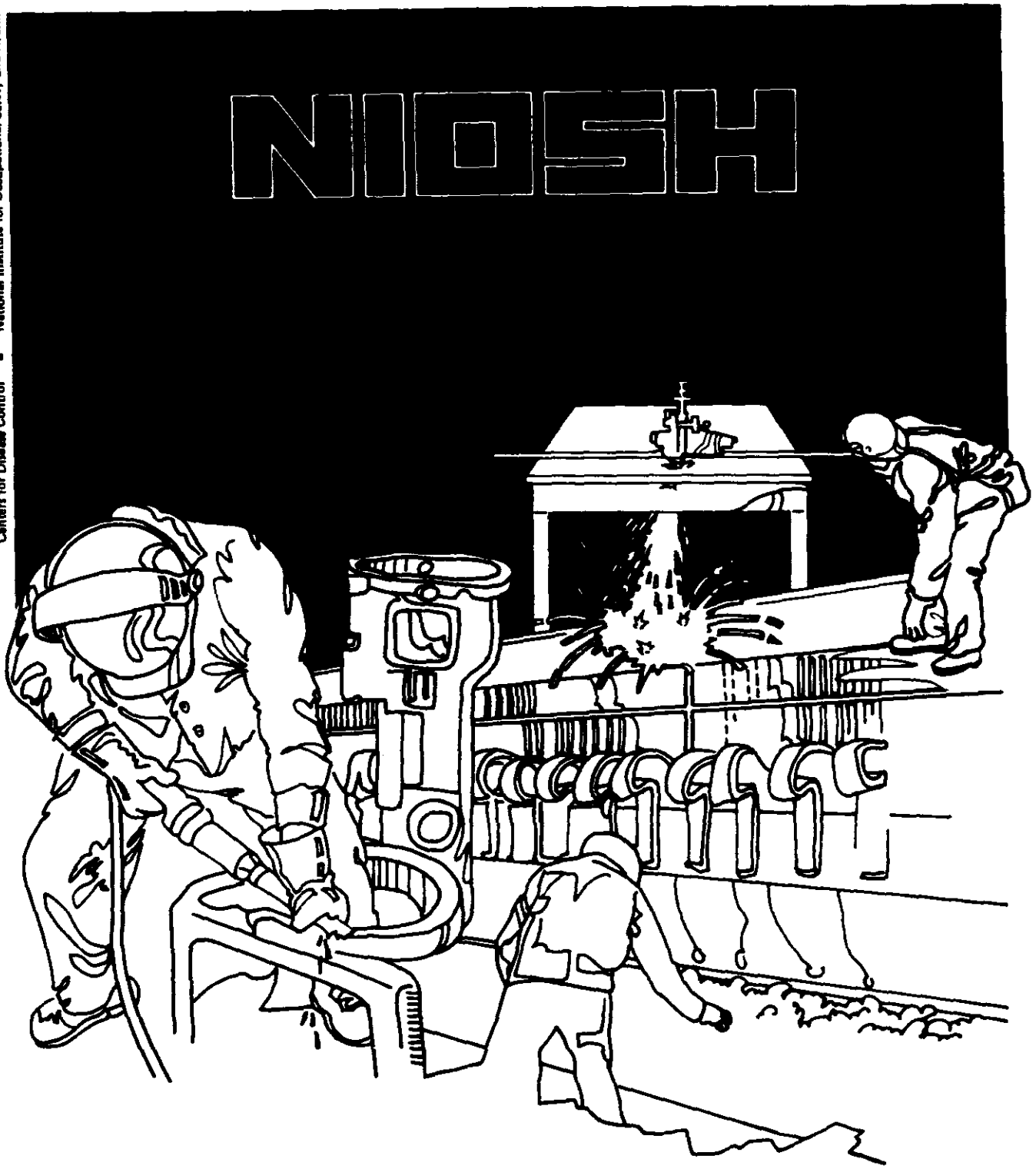

Health Hazard Evaluation Report

MHETA 88-230-1939
MORGAN SHIRT COMPANY
MORGANTOWN, WEST VIRGINIA

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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

MHETA 88-230-1939
DECEMBER 1988
MORGAN SHIRT COMPANY
MORGANTOWN, WEST VIRGINIA

NIOSH INVESTIGATOR:
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I. SUMMARY

On April 11, 1988, a representative of the Amalgamated Clothing and Textile Workers Union, Local 347 requested the Division of Respiratory Disease Studies (DRDS), National Institute for Occupational Safety and Health (NIOSH) to evaluate worker exposure to formaldehyde contained in the fabric used to make shirts at the Morgan Shirt Company in Morgantown, West Virginia. The request was initiated after two workers reported a dermatitis and one worker experienced difficulty breathing; both complaints were initially attributed to exposure to formaldehyde contained in the shirt fabric.

On April 28, 1988, a NIOSH representative conducted a walk-through survey of the facility and met with workers and company and union officials. During this initial meeting, the investigator learned that the "dermatitis" experienced by the workers, referred to in this request for evaluation, was actually due to bites from insects that infested the fabric during shipment and storage; and the worker with a single episode of difficulty breathing attributed her problem to a household insecticide that was sprayed in and around her work station to kill the insects in the fabric. Aside from the insect problem, the requester stated that the company had informed them that the shirt fabrics contained formaldehyde and they wanted NIOSH to conduct monitoring to evaluate their exposure to formaldehyde. The company officials also requested that the monitoring be performed.

An environmental survey was conducted in May 1988 to determine worker exposure to formaldehyde and a spot-cleaning compound (methyl chloroform). The results of the sampling indicated low level exposures. The range of the mean exposures for formaldehyde across all departments was 0.03 parts per million (ppm) to 0.14 ppm. Sampling for methyl chloroform vapors indicated time-weighted averages(TWA) of 30 to 50 ppm with short-term exposures ranging from 20 to 111 ppm. The levels of formaldehyde and methyl chloroform were well below the established criteria, and the levels of formaldehyde were within the range of typical residential formaldehyde exposure.

Based on the environmental results, employee interviews, and available toxicological information, it is concluded a health hazard did not exist at the time of this survey. Recommendations to aid in providing a safe and healthful work environment are presented in Section VII of this report.

KEYWORDS: (SIC 2321) formaldehyde, 1,1,1, - trichloroethane, methyl chloroform, shirt manufacturing

II. INTRODUCTION/BACKGROUND

In April 1988, the Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) from a representative of the Amalgamated Clothing and Textile Workers Union Local 347. The union representative submitted the request because some workers at the Morgan Shirt Factory located in Morgantown, West Virginia were concerned that they were being exposed to formaldehyde contained in the shirt fabric. The request stated that employees were experiencing dermatitis and one employee had "passed out". The requesters felt this was due to formaldehyde exposure.

On April 28, 1988, a NIOSH representative met with company officials, union officials, and some of the workers at the Morgan Shirt Company. During the meeting, the investigator learned that the dermatitis, experienced by the workers referred to in the HHE request, was actually due to insect bites. The insects had apparently gotten into the fabric during shipment and storage. As for the worker that "passed out", it was learned that on a particular day the worker did in fact have difficulty breathing and had to be taken out into the fresh air. This single episode was temporally related to use of a household insecticide sprayed in and around the employee's work station to kill the insects in the fabric.

Aside from the insect problem, the workers interviewed stated that they had been informed by the company that the shirt fabrics contained formaldehyde and they were concerned about their exposure. This was confirmed by the company official who stated that the company headquarters had already made arrangements for all of their factories to be evaluated for formaldehyde exposure. However, the Morgan Shirt Factory was not scheduled to be surveyed for several months and he too would like for NIOSH to conduct environmental monitoring in the Morgantown facility.

III. PROCESS DESCRIPTION

The Morgantown facility of the Manhattan Shirt Company receives pre-cured, finished fabric from a textile-finishing plant. The shirt fabric is treated at the textile-finishing plant with formaldehyde-based resins, which give the fabric crease-resistant characteristics (permanent press), and the resin treated fabric is cured before it is received by the Morgantown plant.

The first step in the process is the cutting of shirt parts from the fabric. In order to do this, many layers of fabric must first be spread out, one on top of another, on a long table. All of the layers are then cut simultaneously with hand-held saws ("cutters") or with dies. When a hand-held cutter is used to perform this step, a pattern is first laid over the top layer and the operator cuts according to this pattern.

After cutting, the shirt parts are assembled. Parts of the cuffs, collars, and fronts are assembled into complete pieces, then the major pieces, such as yokes, sleeves, collars, cuffs, and fronts, are assembled into complete shirts. Most of the various assembly operations require sewing with sewing machines appropriately modified for each type of operation. Some assembly operations (collar and cuff making) make use of heat to form or fuse together (in conjunction with a heat-sensitive adhesive) various parts.

The finished shirts are moved to the apparel press operation where conventional hand irons are used to press the shirts. The shirts are then packaged in bags and boxes for shipping.

The facility consists of three buildings -- a warehouse (storage) building, a building which houses pattern making and fabric cutting, and a third which has assembly and pressing/finishing on the first level; front making, collar and cuff making, and sleeve and back making are on the second level. Except for offices, there are no enclosed areas in the buildings.

The facility is not air-conditioned nor is there any local exhaust ventilation. General mechanical and dilution ventilation are used for comfort and exposure control. On the days of this survey most of the windows were closed and wall exhaust fans and large floor fans were not operational during the early morning hours due to the cool weather. From late morning (approximately 10:00 a.m.) throughout the remainder of the day, windows and doors were open, and the large wall exhaust fans and floor fans were operational.

IV. METHODS AND MATERIALS

The environmental evaluation was conducted May 10-12, 1988. Breathing zone samples for formaldehyde were collected using constant flow sampling pumps calibrated at a sampling rate of 1 liter per minute (lpm). The collection media was 20 milliliters (ml) of 1 percent sodium bisulfite solution in impingers. Sampling time was approximately 2-3 hours per sample and consecutive samples were obtained in order to determine the worker's full shift, time-weighted average exposure (TWA). The impinger samples were analyzed using visible absorption spectrophotometry per NIOSH Analytical Method 3500.[1]

During the initial visit to the facility on April 28, 1988, the NIOSH investigator observed an employee using a dry-cleaning agent (1,1,1,-trichloroethane) to remove soiled spots from the finished shirts. Therefore, during the evaluation on May 10-12, personal breathing zone samples were collected on the individuals working at the spot cleaning stations to determine their exposure to the chlorinated solvent. Full shift and short term samples for the solvents were collected using constant flow samplers calibrated at a sampling rate of 20 cubic centimeters (cc) per minute and 200 cc per minute. Activated charcoal was used as collection media. These samples were analyzed using gas chromatography per NIOSH Analytical Method 1003.[1]

Bulk samples of cloth were collected, enclosed in separate airtight bags and submitted for analysis of formaldehyde content. For analysis, an accurately weighted portion of each bulk was suspended in a wire mesh basket over 50 ml of distilled water in a reaction vessel. The vessels were capped and incubated at 50°C for 20 hours.[2] After cooling, an aliquot of each distilled water sample was analyzed for formaldehyde by NIOSH Method 3500.[1]

V. EVALUATION CRITERIA

Evaluation criteria are used as guidelines to assess the potential health effects of occupational exposures to substances and conditions found in the work environment. These criteria are generally established at levels that can be tolerated by most healthy workers occupationally exposed day after day for a working lifetime without adverse effects. Because of variation in individual susceptibility, a small percentage of workers may experience health problems or discomfort at exposure levels below these existing criteria. Consequently, it is important to understand that these evaluation criteria are guidelines, not absolute limits between safe and dangerous levels of 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 used by NIOSH investigators to assess occupational exposures are: 1) NIOSH recommended exposure limits (RELs), 2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor (OSHA) permissible exposure limits (PELs). Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the economic feasibility of controlling exposures in various industries where the agents are used; the NIOSH Recommended Exposure Limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease.

The exposure criteria are reported as: time-weighted average (TWA) exposure recommendations averaged over the full work shift; short-term exposure limit (STEL) recommendations for a 10-15 minute exposure period; and ceiling levels (C) not to be exceeded for any amount of time. These exposure criteria and standards are commonly reported as parts contaminant per million parts air (PPM), or milligrams of contaminant per cubic meter of air (mg/m^3).

Formaldehyde

Formaldehyde is an intense irritant of the upper respiratory passages. For this reason, systemic poisoning is unlikely since workers would be compelled to leave the exposure area before levels sufficient to cause systemic poisoning were reached. Acute exposure to formaldehyde can cause a variety of symptoms. The first symptoms noticed on exposure at concentrations ranging from 0.1 to 5 parts per million (ppm) are burning of the eyes,

tearing, and general irritation of the upper respiratory passages. Exposure on the order of 10 to 20 ppm are associated with coughing, tightness of the chest, a feeling of pressure in the head, and palpitation of the heart.[3]

The major effects of formaldehyde on the skin are the development of irritant dermatitis and the development of sensitization which leads to allergic contact dermatitis. NIOSH investigations conducted in the textile industry have concluded that airborne levels of formaldehyde of less than 1 ppm and cloth containing less than 750 ppm by weight of formaldehyde were associated with occupational dermatitis among the workers. The NIOSH studies have suggested that airborne concentration levels below 0.2 ppm might be needed to prevent dermal effects in the apparel industry.[4]

Currently, NIOSH recommends that, "formaldehyde be handled as a potential occupational carcinogen" based on studies in which laboratory rats exposed to formaldehyde vapor developed nasal cancer. Based on these studies and demonstrated mutagenic capabilities, NIOSH recommends the reduction of occupational exposure to "the lowest feasible limit".[3] The ACGIH recommends a 1 ppm TWA and a 2 ppm STEL. ACGIH also considers formaldehyde a suspected human carcinogen.[5] The OSHA standards which general industry is required by law to abide by has established a 1 ppm TWA and a 2 ppm STEL.[4]

1,1,1,- Trichloroethane (Methyl Chloroform)

Methyl Chloroform liquid and vapor are irritating to the eyes on contact. This effect is usually noted first in acute exposure cases. Mild conjunctivitis may develop but recovery is usually rapid. In controlled human exposures to 500 ppm no effects other than slight, transient eye irritation were noted. Exposure to 5,000 to 10,000 ppm may result in dizziness, incoordination, drowsiness, increased reaction time, and anesthesia. Repeated skin contact may produce a dry, scaly, and fissured dermatitis, due to the solvents defating properties.[6]

OSHA has established a Permissible Exposure Limit (PEL) of 350 ppm as a TWA.[6] The ACGIH recommends a TWA TLV of 350 ppm to prevent beginning anesthetic effects and objections to odor, and a STEL of 450 for protection against anesthesia.[5,7] NIOSH recommends that the 350 ppm concentration not be exceeded for any 15-minute period.[8]

VI. RESULTS

Formaldehyde

Individual TWA exposure results to formaldehyde according to job category within a department are listed in Table 1. Table 2 reflects the total number of samples for each job category within a department, the highest and lowest concentration observed in each department, the arithmetic mean and standard deviation, and 95% confidence limits.

Samples for which TWAs were computed were collected over a major portion of the normal work period. In all instances this was less than eight hours; however, a zero value was not assigned to the unsampled portion of the work shift in computing the TWA's because exposure was assumed to be consistent throughout the work shift.

Tables 1 and 2 illustrate that the formaldehyde TWA exposure levels during this survey were similar within job operations and across departments within the plant. The range of the mean exposures across all seven departments excluding the warehouse which is located away from the main plant, was very narrow, 0.03 ppm to 0.14 ppm. The pressing/finishing area had the lowest overall mean exposure level (0.03 ppm), and the workers in the pattern making/cutting building had the highest mean exposure (0.14 ppm). The one personal and two area samples collected in the warehouse indicated a mean level of 0.01 ppm.

Table 3 shows the levels of free formaldehyde found in the fabric samples collected during the survey. The John Henry 80% polyester/20% cotton fabric and the collar fusing material were the materials being used on the production floor at the time of the survey. The John Henry 80/20 material contained 93 ppm by weight of formaldehyde and the adhesive-coated collar fusing material contained 1440 ppm by weight. Formaldehyde was not detected in the other materials tested.

1,1,1,-Trichloroethane (Methyl Chloroform)

Exposure to organic vapors during the spot cleaning operations appeared to be low (Table 4). The full shift sample collected on one spot cleaner indicated a TWA of 21 ppm. Five short term samples (15 min/sample) collected on a second spot cleaner indicated short term exposures ranging from 20 ppm to 111 ppm with an overall shift average exposure of 58 ppm.

VII. CONCLUSIONS/RECOMMENDATIONS

As a result of interviews with the workers, the NIOSH investigator determined that the "dermatitis" and difficulty breathing experienced by the workers referred to in the HHE request were a result of insect bites and the company's attempt to control the insects. It is recommended that in the future qualified pest control operators be contracted to eliminate any pest problem that may occur.

The requester's concern about exposure to formaldehyde was a result of the workers being informed by the company that some of the fabric used in the plant contained formaldehyde. The industrial hygiene survey demonstrated that the TWA exposure levels of formaldehyde were well below all applicable ACGIH TLV's and OSHA standards (1 ppm TWA and 2 ppm STEL). Also, the formaldehyde exposure at the time of the survey was well within the range of typical residential formaldehyde exposure (i.e. similar to conventional homes without urea formaldehyde foam insulation or particle board floors).[9]

It is very difficult to differentiate between formaldehyde contributed from various sources. Therefore, it is important to point out that practically all of the formaldehyde samples collected during this survey were exposed to cigarette smoke which contains as much as 40 ppm of formaldehyde by volume.[3] Several of the individuals that wore the samplers smoked and the nonsmoker samplers were exposed to cigarette smoke in the break areas located in the various departments.

These formaldehyde measurements were taken at only one point in time and may not reflect variations of exposure in the plant. The exposure range across departments within the plant appears to be very narrow, and the exposure among job categories within a department is similar. This similarity of exposure is probably a result of the limited dilution ventilation in the plant. Factors which could promote fluctuations in exposure levels are ambient temperatures, humidity, ventilation, type of fabric or resin system, and volume of stored materials or completed work. Every effort should be made to reduce and or eliminate workers' exposure to formaldehyde. Therefore, recommendations for accomplishing this include: obtaining information from textile mills on the concentration of relevant chemicals in the fabric; periodic personal monitoring with a reliable method to determine TWA exposures and peak variations in exposure levels; storage of fabric to allow for offgassing of formaldehyde to lessen irritation; good ventilation; and use of fabrics with the lowest concentrations of free formaldehyde compatible with standards of fabric quality.

Exposure levels of the spot-cleaning compound (methyl chloroform) were well below all NIOSH REL's, ACGIH TLV's, and OSHA standards. The levels measured refer only to vapor exposure and do not consider exposure due to skin absorption. The airborne levels measured do not indicate a requirement for local exhaust ventilation at the spot cleaning station but local exhaust ventilation would reduce worker exposure and remove the annoying odor of the cleaning solvent. Personal protective materials impervious to methyl chloroform should be provided for the hands of the individuals performing the spot-cleaning.

VIII. REFERENCES

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IX. AUTHORSHIP AND ACKNOWLEDGMENTS

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

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4. OSHA, Charleston, WV Area Office

5. NIOSH Regional Office

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

TABLE 1
Formaldehyde TWA Exposure

Morgan Shirt Company
Morgantown, West Virginia
MHETA 88-230

Date	Work Area	Job	Time (Min)	TWA(ppm)
May 10	Pressing/Finishing	Folder	319	0.04
	Pressing/Finishing	Examiner	319	0.03
	Pressing/Finishing	Boxer	316	0.02
	Pressing/Finishing	Bagger	310	0.03
	Pressing/Finishing	Presser	308	0.03
	Pressing/Finishing	Presser	303	0.01
	Pressing/Finishing	Service	306	0.04
	Pressing/Finishing	Presser	299	0.03
	Assembly I	Top Stitch	327	0.05
	Assembly I	Sn.-Close	327	0.02
	Assembly I	Examiner	324	0.03
	Assembly I	Sleeve 2	326	0.03
	Assembly I	Sleeve 2	325	0.05
	Assembly I	Sleeve 2	323	0.03
	Assembly I	Joiner	322	0.04
	Assembly I	Sleeve 1	323	0.05
	Assembly I	Pocket Setter	315	0.04
	Assembly II	Collar Closer	323	0.03
	Assembly II	Collar Closer	252	0.05
	Assembly II	Button Hole	314	0.09
	Assembly II	Final Exam	310	0.03
	Assembly II	Cuff Setter	250	0.04
	Assembly II	Final Exam	321	0.03
	Assembly II	Final Exam	312	0.04
	Assembly II	Cuff Setter	224	0.02
	Assembly II	Bottom Hem	300	0.02
	Assembly II	Bottom Hem	295	0.04
May 11	Collar/Cuff Making	Button Sewer	309	0.08
	Collar/Cuff Making	Service	313	0.08
	Collar/Cuff Making	Machine Op.	306	0.09
	Collar/Cuff Making	Collar Guager	297	0.13
	Collar/Cuff Making	Banding	301	0.13
	Collar/Cuff Making	Collar Turner	307	0.07
	Collar/Cuff Making	Button Hole	312	0.07
	Collar/Cuff Making	Cuff Guager	310	0.07
	Collar/Cuff Making	Cuff Runner	293	0.07
	Collar/Cuff Making	Collar Fusing	273	0.11

TABLE 1 (cont)
Formaldehyde TWA Exposure

Morgan Shirt Company
Morgantown, West Virginia
MHETA 88-230

Date	Work Area	Job	Time (Min)	TWA(ppm)
	Front Making	Top Center	308	0.05
	Front Making	Top Center	319	0.10
	Front Making	Button Hole	299	0.08
	Front Making	Button Sew	316	0.04
	Front Making	Pair-up	314	0.08
	Sleeve/Back Making	Hathaway Facing	316	0.05
	Sleeve/Back Making	Hathaway Facing	313	0.08
	Sleeve/Back Making	Pleat Sleeve	302	0.06
	Sleeve/Back Making	Label Set	291	0.05
	Sleeve/Back Making	Label Sew	302	0.09
	Sleeve/Back Making	Yoke Set	286	0.09
	Sleeve/Back Making	Yoke Set	295	0.10
May 12	Cutting Room	Marker	366	0.13
	Cutting Room	Die Cutter	363	0.14
	Cutting Room	Cutter	361	0.21
	Cutting Room	Pinner	359	0.12
	Cutting Room	Stamper	355	0.14
	Cutting Room	Spreader	314	0.13
	Cutting Room	Pinner	357	0.14
	Warehouse	Packer	298	0.01
	Warehouse	Area	299	0.01
	Warehouse	Area	304	0.01

TWA - Time Weighted Average
ppm - Parts per Million

TABLE 2
Formaldehyde TWA* Exposure (ppm)**

Morgan Shirt Company
Morgantown, West Virginia
MHETA 88-230

Area	Number of Samples	Approx. Number Workers	Range High	Range Low	Mean	Standard Deviation	95% Lower Confidence Limit	95% Upper Confidence Limit
All	59	165	0.21	0.01	0.06	0.04	0.050	0.069
Pressing/Finishing	8	20	0.04	0.01	0.03	0.01	0.023	0.036
Assembly I	9	20	0.05	0.02	0.04	0.01	0.037	0.043
Assembly II	10	37	0.09	0.02	0.04	0.02	0.027	0.052
Collar/Cuff Making	10	22	0.13	0.07	0.09	0.02	0.077	0.102
Front Making	5	28	0.10	0.04	0.07	0.02	0.052	0.087
Sleeve/Back Making	7	15	0.10	0.05	0.07	0.02	0.055	0.084
Cutting Room	7	22	0.21	0.12	0.14	0.03	0.117	0.162
Warehouse	3 (1 personal, 2 Area)	1	0.01	0.01	0.01			

* TWA - Time Weighted Average
** ppm - Parts per Million

TABLE 3
Formaldehyde in Fabric

Morgan Shirt Company
Morgantown, West Virginia
MHETA 88-230

Fabric Type	Formaldehyde Concentration ppm* by weight
Polo 10 oz Denim	ND**
John Henry 80% Polyester/20% Cotton	93.0
Polo 100% Cotton	ND
Polo 7 oz Denim	ND
Collar Fusing Material	1440

*ppm - Parts per million
**ND - None Detected. The Limit of Detection was 30 µg/sample

TABLE 4
Methyl Chloroform Exposure

Morgan Shirt Company
Morgantown, West Virginia
MHETA 88-230

Date	Work Area	Job	Time	Concentration (ppm)
5/10	Pressing/Finishing	Cleaner	8:59a.m. - 3:05p.m.	31
	Pressing/Finishing	Cleaner	9:45a.m. - 10:00a.m.	20
			10:32a.m. - 10:47a.m.	33
			10:54a.m. - 11:09a.m.	45
			1:37p.m. - 1:52p.m.	81
			2:12p.m. - 2:27p.m.	111