U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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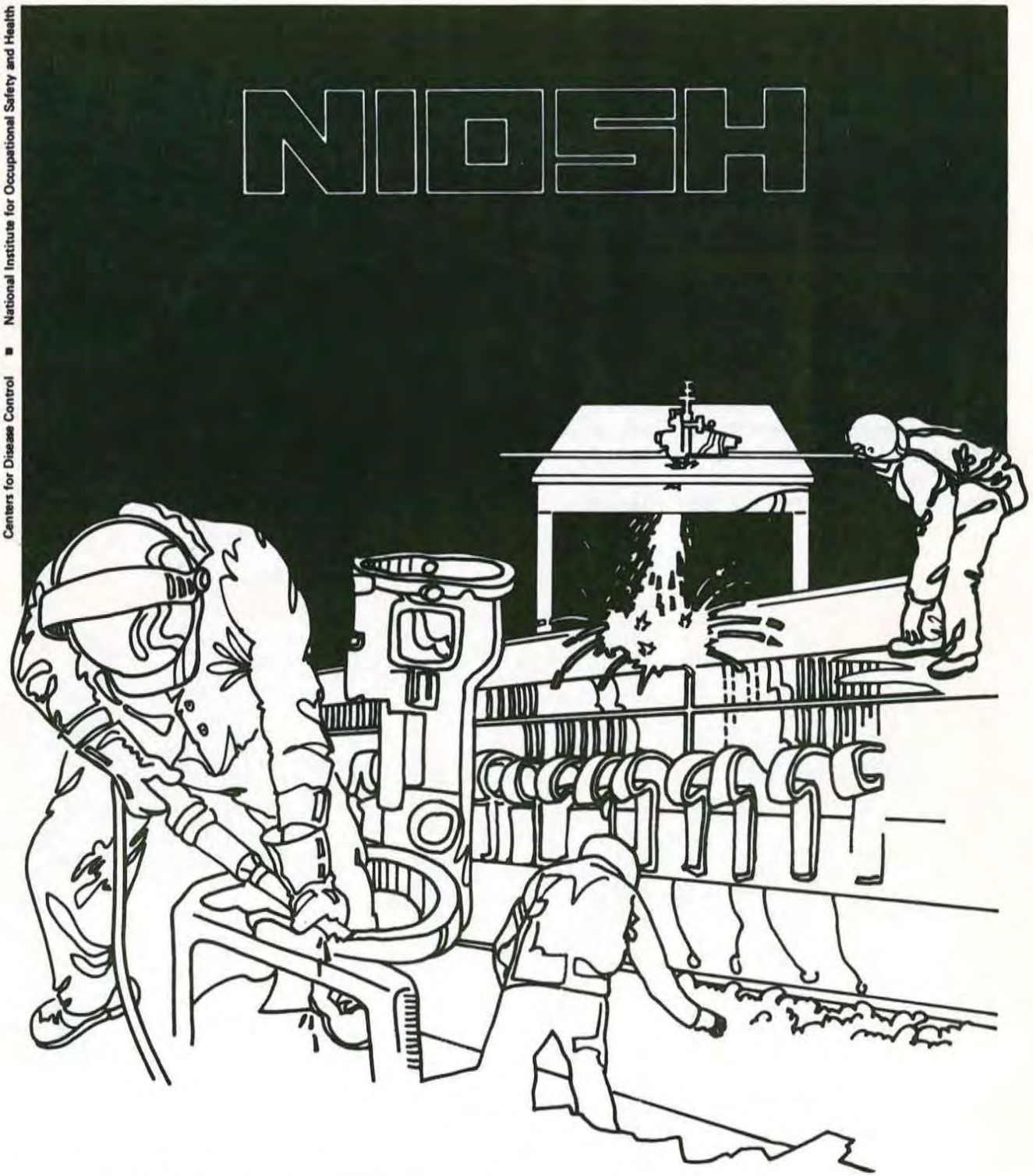
NIOSH



Health Hazard Evaluation Report

HETA 83-254-1393
UNITED UNIFORM MANUFACTURING
COMPANY OF MEMPHIS, INC.
MEMPHIS, 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 83-254-1393
December 1983
UNITED UNIFORM MANUFACTURING
COMPANY OF MEMPHIS, INC.
MEMPHIS, TENNESSEE

NIOSH INVESTIGATORS:
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I. SUMMARY

On April 28, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from Local 282 of the United Furniture Workers of America at The United Uniform Manufacturing Company of Memphis, Inc, Memphis, Tennessee. NIOSH was requested to evaluate the steam-pressing process in the manufacture of durable-press trousers. One of the steam-press operators complained of headaches, eye irritation, and sore throat. Exposure to formaldehyde was reported to occur during the post-curing of work uniform trousers made from fabrics pre-treated with a durable-press resin. Post-curing involves pressing trousers to the desired crease, then heating them in an oven which imparts a memory to the fabric.

On June 29, 1983, formaldehyde exposures to the press and curing oven operators were evaluated by four personal breathing zone, and five area 8-hour samples. Breathing zone formaldehyde concentrations ranged from 0.42 to 0.50 ppm (mean 0.46 ppm, SD±0.03). Area sample results were similar ranging from 0.34 to 0.53 ppm. None exceeded the 3 ppm 8-hour TWA OSHA standard. NIOSH recommends that formaldehyde exposure be kept to the lowest feasible level. Latent formaldehyde in a fabric sample was approximately 200 ppm. This latent formaldehyde is constantly off-gassing from the fabric exposing all of the uniform makers to low levels.

Health questionnaires were administered to two of the four workers in the post-curing area. One employee reported eye irritation, sore throat, coughing, and skin problems. Another reported headaches. The same interview was conducted during a concurrent hazard evaluation (HETA 83-205) with 64 other employees, mostly seamstresses. Eye irritation was reported by 44 employees, (69%), nose and throat irritation by 28 (44%), headache by 24 (38%), coughing by 21 (33%), sore throat by 15 (23%) and skin problems by 15 (23%). No exposure data was collected for these workers.

The environmental data collected at United Uniform Manufacturing Company of Memphis, Inc., Memphis TN, show that workers are exposed to low levels of formaldehyde. The reported symptoms of eye, respiratory, and skin irritation, and headache are compatible with these exposures. Since formaldehyde is a potential carcinogen and has irritant properties at low levels, controls to reduce exposure to the lowest feasible level are recommended. These include local ventilation, improved dilution ventilation, fabric isolation and dilution ventilation in storage areas.

KEYWORDS: SIC 2260 (Dyeing and Finishing Textiles), Formaldehyde, Post-Cured Resin.

II. INTRODUCTION

On April 28, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from an authorized representative of employees at United Uniform Manufacturing Company of Memphis, Incorporated, Memphis, Tennessee. The request concerned employee complaints of headache, burning sensation of the eyes, and sore throat. The requestor expressed concern that the steam press operators are exposed to formaldehyde during the post-curing of durable press fabrics. This request was sent as an ammendment to HETA 83-205, concerning potential ergonomics problems at the plant. The decision was made by NIOSH to give this request separate consideration. On June 28-30, 1983, NIOSH conducted concurrent industrial hygiene and medical surveys at the United Uniform plant for HETA 83-205 and HETA 83-254. This report addresses the investigation of HETA 83-254.

III. BACKGROUND

United Uniforms Manufacturing Company of Memphis, Inc., a subsidiary of Workwear Corporation, Cleveland, Ohio, is a maker of work uniforms. The plant employs around 125 people, predominantly female. At the time of this evaluation, one male worker and three female workers were involved with post-curing uniform pants. Shirt fabrics are pre-cured. The fabrics are pre-treated with a glyoxal-based resin system, dimethylol dihydroxyethylene urea (DMDHEU). Post-curing involves steam pressing the garment and then heating it in an oven. The post-curing procedure permits the trousers to retain their crease and recover from wrinkling due to washing.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

NIOSH collected personal breathing zone and area air samples on June 29, 1983, to evaluate workers' exposure to formaldehyde vapor during the steam-pressing and oven-curing of permanent press uniform pants. Three steam-press operators and one oven operator wore breathing zone monitors. Area formaldehyde monitors were attached to four of the operating presses, the curing oven, and a pole approximately fifteen feet from the presses.

All of the samples were collected using sorbent tubes connected to battery operated pumps. For personal monitoring the pump was on the worker's belt, and the sorbent tube was attached near the worker's "breathing zone". Area samples were placed at breathing zone height. Relative location of the personal and area samples are shown in Figure I.

The formaldehyde in air samples were collected and analyzed in accordance with NIOSH Method P&CAM 354.[1] This method specifies using sorbent tubes containing 180 mg of Chromosorb 102,® coated with N-benzylethamolamine. The sampling pumps were calibrated at 50 milliliters of air per minute (ml/min). The samples were desorbed with isooctane and analyzed using a gas chromatograph with a flame ionization detector. The limit of detection for this method was 1.0 microgram per sample.

Two area samples were also collected to determine the presence of other irritant organic hydrocarbons. One monitor was attached to a steam press, and another was on the curing oven. These samples were collected on sorbent tubes containing 150 mg of activated charcoal at a flow rate of 200 ml/min. The samples were desorbed with carbon disulfide, and analyzed by gas chromatography and mass spectrometry to identify the unknown compounds.

Four fabrics (blue, green, gray, and brown) were used for uniform pants. They were supplied by more than one fabric manufacturer. A sample of each was obtained by mail after the survey to determine latent formaldehyde content.

The fabric samples were analyzed for latent formaldehyde using a method developed by Burlington Industries.[2] A weighed portion of each fabric (about 1 gram) was suspended over water in a jar, and heated at 49°C for 20 hours. After addition of chromotropic acid, the solution was analyzed spectrophotometrically. The results were compared to a curve drawn using results from known formaldehyde concentrations. The limit of detection for this method was 150 parts per million (ppm) formaldehyde.

B. Medical

Confidential interviews with workers were conducted by NIOSH interviewers using a standardized questionnaire. Information collected included demographic variables, occupational history and medical symptoms associated with work.

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 primarily 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.

B. Formaldehyde

Skin contact with fabric containing free formaldehyde, and inhalation are the two mechanisms of formaldehyde exposure at textile finishing plants.

1. Effects on Skin

Skin rashes have been associated with exposure to free formaldehyde from resin systems used in the preparation of permanent press clothing[3-5]. 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-curing fabrics. 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 fabric formaldehyde concentrations of 0.05-0.075% (500-750 ppm free formaldehyde)[6].

2. Effects of the Respiratory System

Formaldehyde potentially affects the respiratory tract in two ways: as irritation of the nose, throat and upper airways and as airflow obstruction (asthma)[7]. 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. 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[8]. There is potentially a more serious problem concerning formaldehyde or formalin-induced occupational asthma[9]. 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.

Formaldehyde in wrinkle- and shrinkage-resistant fabrics was first reported to cause health problems in 1959. Bourne reported symptoms of burning, stinging eye, headaches, and nose and throat irritation in dress shop employees in Ohio[10]. Air sampling showed 0.13-0.45 ppm formaldehyde in the air. Samples of fabric contained 500-800 ppm formaldehyde in rayon fabric and 340 ppm formaldehyde in cotton fabric. In a 1966 study of a clothing store in California, complaints of eye irritation were reported. Air formaldehyde concentrations ranged from 0.9-3.3 ppm[11].

Studies of textile factories have reported similar findings. In 1966 a study was conducted at a textile factory in California where "perma-press" clothing was manufactured[12]. Workers complained of irritation to the eyes, nose and throat. Air formaldehyde concentrations ranged from 0.9-2.7 ppm. In a 1968 study of eight textile plants where fabric was treated with formaldehyde-containing resins, from 5-15% of the employees at each plant reported symptoms of mucous membrane and respiratory irritation[13]. Air formaldehyde concentrations ranged from 0-2.7 ppm with a mean of 0.68 ppm.

3. Evidence of Carcinogenicity

Formaldehyde has induced a rare form of nasal cancer in both Fischer 344 rats and in B6C3F1 mice as reported in an ongoing study by the Chemical Industry Institute of Toxicology. In a second study by The New York University, formaldehyde appears to have induced the same type of cancer in Sprague-Dawley rats. Although humans and animals may differ in their susceptibility to specific chemical compounds, any substance that produces cancer in experimental animals should be considered a cancer risk to humans. Formaldehyde has also demonstrated mutagenic activity in several test systems. Although a substance cannot as yet be designated a potential occupational carcinogen based solely on results of mutagenicity tests, positive results in mutagenicity tests should be used as supporting evidence for identifying a potential occupational carcinogen.[14]

C. Exposure Criteria

In 1976 NIOSH recommended that occupational exposure to formaldehyde be limited to a concentration no greater than 1 ppm for any 30-minute sampling period.[15] This recommendation was based only on the consideration of irritant effects of formaldehyde. In 1979, evidence for the carcinogenic potential of formaldehyde became known, and in 1980, NIOSH issued a new criterion which considered formaldehyde a potential occupational carcinogen. NIOSH recommends that occupational exposure to formaldehyde be maintained at the lowest feasible level.[14]

The ACGIH designates formaldehyde as a industrial substance suspected of carcinogenic potential for man. The ACGIH recommends a 1 ppm ceiling limit to prevent serious or persistent adverse health effects.[16]

The OSHA formaldehyde standard is based on a threshold for irritant and upper respiratory complaints. The current OSHA standard requires that formaldehyde exposures be limited to an 8-hour TWA of 3 ppm, a ceiling level of 5 ppm, and an acceptable maximum peak above the ceiling level of 10 ppm for no more than a total of 30 minutes during an 8-hour work shift.[17]

VI. RESULTS AND DISCUSSION

A. Environmental

Breathing zone formaldehyde exposures for the press operators averaged 0.44 ppm, SD $\pm$ .02 (OSHA std. 3 ppm). The oven operator breathing zone exposure was 0.50 ppm (Table 1). Area formaldehyde sampling results ranged from 0.34 to 0.53 ppm and averaged 0.47 ppm, SD $\pm$ .07 (Table 2).

The breathing zone and area mean concentrations for the post-curing operation were not significantly different ($t=.2198$, $df=6$, $p> .4$). This indicates a lack of exposure control between the source (the presses and the curing-oven when the doors are open) and the workers breathing zone. It is known that under conditions of heat and high humidity, such as at the steam-presses and curing-oven, the release of formaldehyde from these pre-treated fabrics is increased[19]. The most efficient way to control the formaldehyde in the post-curing area would be local ventilation at the presses and the curing-oven door. The curing-oven interior is already vented during operation. Concentrations caused by fabric off-gassing can be handled by improved general ventilation using fresh outside air for dilution. This would enable the formaldehyde exposures to approach the lowest feasible level as recommended by NIOSH. At the time of the survey the heating/air conditioning system appeared to totally recircilate the indoor air (T=70°F, RH=50%).

Only trace amounts of other organics were found during analysis. The most abundant was 1,1,1-trichloroethane at 0.1 ppm, well below the NIOSH recommended standard of 350 ppm for a 15-minute period and the OSHA standard of an 8-hour TWA of 350 ppm. No source was indentified.

One of four fabric samples submitted for analysis showed detectable latent formaldehyde (limit of detection of the method, 150 ppm); the blue fabric had approximately 200 ppm latent formaldehyde. Interpretation of this result is difficult since the samples were forwarded to the investigators subsequent to the evaluation and the "freshness" of the samples is unknown. A previous NIOSH study has shown that there is a decrease in fabric latent formaldehyde levels when the fabric is aired.[18]

B. Medical

Two of the four employees in the post-curing area agreed to be interviewed regarding medical symptoms associated with formaldehyde exposure. These employees worked in the area where air samples were taken for formaldehyde. One employee reported eye irritation, sore throat, coughing and skin problems and another reported headaches.

Interviews were conducted in association with concurrent hazard evaluation (HETA 83-205), with 64 other employees who handled fabric while sewing. These workers are exposed to the latent formaldehyde in the pre-treated fabrics. Eye irritation was reported by 44 (69%) of them, nose and throat irritation by 28 (44%), headache by 24 (38%), coughing by 21 (33%), sore throat by 15 (24%), skin problems by 15 (24%) and difficulty swallowing by 13 (24%). No air samples were collected to relate to these symptoms.

VII. CONCLUSIONS

These symptoms were compatible with exposure to low levels of formaldehyde. Environmental concentrations of formaldehyde in the trouser post-curing area were found to range from 0.42 to 0.50 ppm (mean = 0.44 ppm). Employees in the rest of the plant are also exposed to formaldehyde through skin contact with durable-press resin-treated fabrics, and by breathing formaldehyde which off-gasses from these fabrics. These exposures were not quantitied.

Irritation of the eyes, respiratory tract and skin, and headaches were occuring among workers at United Uniform. These symptoms were compatible with exposure to low levels of formaldehyde.

VIII. RECOMMENDATIONS

1. Engineering efforts should be made to reduce the formaldehyde levels. The most efficient manner to control formaldehyde exposure is to implement local exhaust at the presses and curing-oven door in the post-cure area. General ventilation could be improved by providing fresh air dilution in the entire shop to reduce ambient formaldehyde levels. A ventilation expert should be contacted for advice concerning these matters.

2. In a past study involving DMDHEU resin systems, NIOSH has shown a correlation between the age of the treated fabric and latent formaldehyde content.[18] Bolts of fabric should be stored in a ventilated area prior to use in sewing operations to reduce the potential for worker exposure to formaldehyde vapor. Consideration also should be given to airing the fabric off the bolt during storage.[13]

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. 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 NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. United Uniform Manufacturing Company of Memphis, Incorporated, Memphis, Tennessee
2. Local 282, United Furniture Workers of America, AFL-CIO, Memphis, Tennessee
3. United Furniture Workers of America, AFL-CIO, Nashville,Tennessee
4. NIOSH, Region IV
5. OSHA, Region IV

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.

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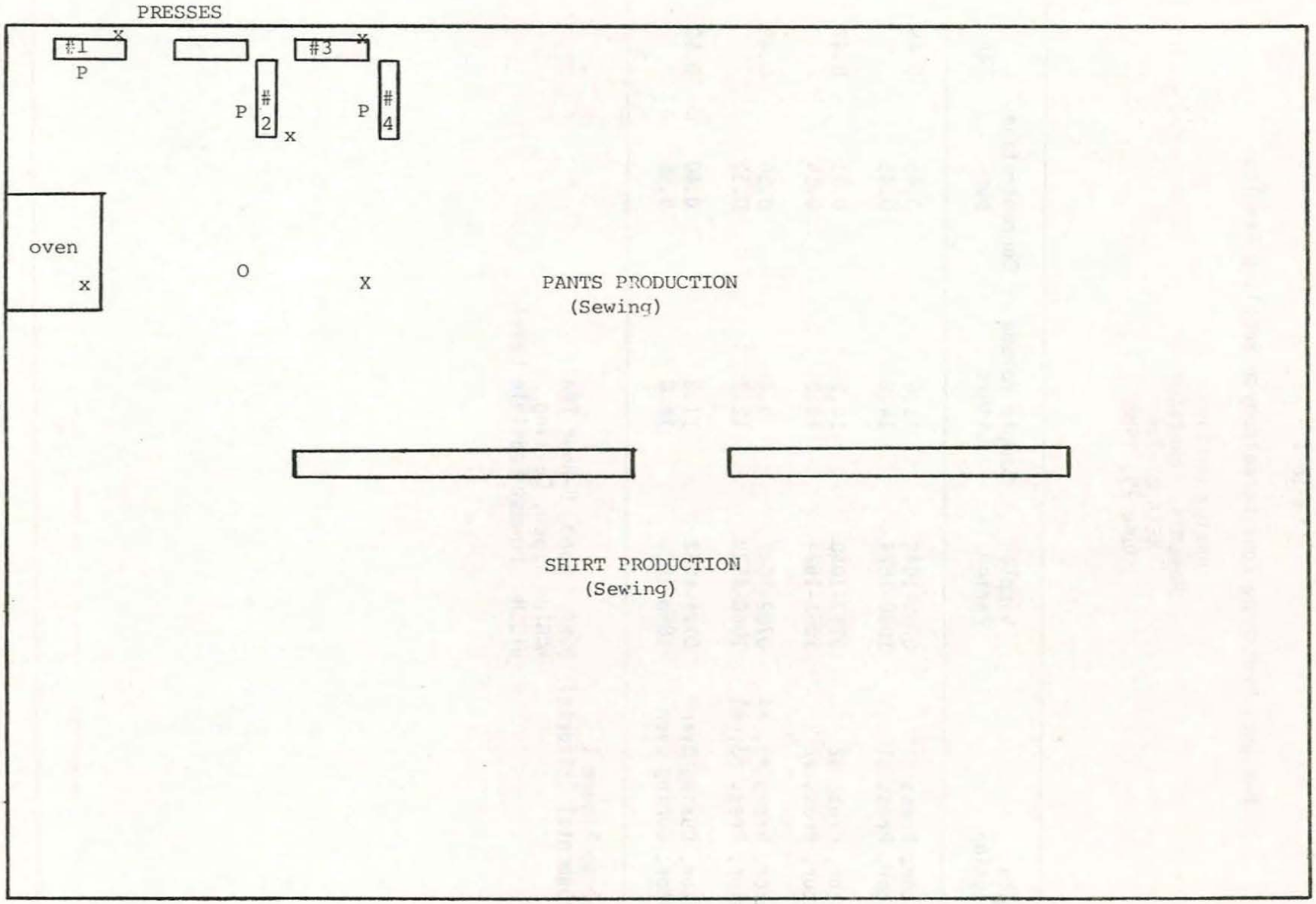
FIGURE I PRODUCTION AREA - UNITED UNIFORM, MEMPHIS, TENNESSE



SAMPLE LOCATION

P - Press Operator

O - Oven Operator

X - Area Sample

Table 1

Personal Breathing Zone Formaldehyde Sampling Results

United Uniform
Memphis, Tennessee
HETA 83-254
June 29, 1983

Sample Description	Sample Period	Sample Volume Liters	Concentration ppm	TWA
Operator, Press #1*	0706-1049	11.6	0.46	0.45
Operator, Press #1	1050-1524	14.2	0.45	
Operator, Press #2	0713-1050	10.2	0.71	0.42
Operator, Press #2	1051-1524	13.0	0.19	
Operator, Press #3, #4	0702-1047	9.4	0.36	0.45
Operator, Press #3, #4	1048-1523	12.2	0.52	
Operator, Curing Oven	0711-1052	11.3	0.40	0.50
Operator, Curing Oven	1053-1526	14.0	0.58	

*Refer to Figure I
Environmental Criteria: OSHA 3ppm, 8-Hour TWA
ACGIH 1ppm, Ceiling
NIOSH Lowest Feasible Level

Table 2

Area Formaldehyde Sampling Results

United Uniform
Memphis, Tennessee
HETA 83-254
June 29, 1983

Sample Description	Sample Period	Sample Volume Liters	Concentration ppm	TWA
Press #1*	0714-1104	10.4	0.43	0.49
Press #1	1105-1527	11.5	0.55	
Press #2	0717-1107	12.5	0.51	0.53
Press #2	1108-1527	14.9	0.55	
Press #3	0718-1109	11.5	0.31	0.34
Press #3	1110-1527	12.6	0.36	
Curing Oven	0729-1112	10.9	0.49	0.50
Curing Oven	1113-1529	12.4	0.51	
Support Pole (approximately 15' from Press #4)	0726-1532	23.4	0.47	0.47

*Refer to Figure I

Environmental Criteria:

OSHA	3ppm, 8-Hour TWA
ACGIH	1ppm, Ceiling
NIOSH	Lowest Feasible Level

DEPARTMENT OF HEALTH AND HUMAN SERVICES
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