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NEW CAROLINA INDUSTRIES
WELDON, NORTH CAROLINA

NIOSH INVESTIGATORS
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I. Summary

On November 3, 1980 the National Institute for Occupational Safety & Health (NIOSH) received a request from the International Ladies Garment Workers Union (ILGWU) for a health hazard evaluation at New Carolina Industries, Weldon, North Carolina. Workers at the plant are exposed to finishing chemicals in cloth that is cut and sewn into maternity wear. Two workers had become sick with respiratory problems that had been attributed to occupational exposure. Occupational exposure to formaldehyde was of particular concern. A medical and industrial hygiene study was carried out at the plant on December 8th and 9th, 1980.

Area and personal breathing zone air samples to measure formaldehyde concentrations, were obtained throughout the plant and 26 of the 127 employees were interviewed. Formaldehyde concentrations in general area and personal breathing zone samples throughout the plant were found to be less than the NIOSH recommended criterion of 1 ppm for 30 minute exposure. They ranged from less than 0.16 to 0.63 parts per million (ppm). One short-term continuous reading sample measured a concentration of 1.12 ppm. Even at these levels, workers experienced eye and upper respiratory irritation, especially when pressing garments and handling darker fabrics. Air within the building was recycled by the air conditioning system which did not actively draw in outside air.

On the basis of data obtained in this investigation NIOSH has determined that workers at New Carolina Industries are experiencing irritant symptoms of the eyes and respiratory tract from exposure to formaldehyde at low levels (0.16 - 1.12 ppm). The symptoms may be improved by increasing the exchange and circulation of air in the building. Formaldehyde is carcinogenic in rats exposed for long periods to levels of 6 and 15 ppm, and NIOSH has recently recommended that occupational exposures be reduced to the lowest feasible limit.

KEYWORDS: SIC 233, Formaldehyde, Garment Workers, Mucous membrane, Irritation.

II. Introduction

On November 3, 1980 the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Ladies Garment Workers Union (ILGWU) for an investigation of the exposures of garment workers at the New Carolina Industries factory in Weldon, North Carolina. Two workers from the cutting department had fallen ill with disabling chest symptoms attributed to exposure to formaldehyde and other finishing chemicals released from the cloth. Other workers had reported irritant respiratory symptoms, and there was concern that they may be at increased risk of respiratory disease. The union was also concerned that workers exposed at low levels may have an increased risk of cancer, because of recent reports that formaldehyde is carcinogenic in rats and mice.

III. Background

New Carolina Industries (est. 1959) is a jobbing company that produces maternity wear. Patterns are cut from cotton polyester fabrics and are assembled into garments at sewing machines. The workplace is a single-story open space of 33,000 square feet with a 14 ft. ceiling in which 127 employees (over 90% women) work during a single daytime shift.

IV. Process Description

Incoming rolls of finished fabric are unrolled into flat piles on long tables in the spreading area. Patterns are cut from the piles using hand-held reciprocating power scissors. The pattern pieces are sorted in the breakdown area and distributed for assembly by a production line of workers at sewing machines. Completed garments are trimmed, inspected, pressed, and stored prior to shipment. Several styles of garments are produced and, over a period, workers may be exposed to fabrics of different weight, color and cotton polyester composition.

V. Evaluation Criteria

Two primary sources of criteria for permissible exposure are used to assess the health significance of the concentrations of airborne substances: (1) NIOSH Recommended Occupational Health Standards; and (2) The occupational health standards promulgated by the U.S. Department of Labor (OSHA). For Formaldehyde these are (1) NIOSH: A ceiling value of 1 part per million (ppm) for a short period (30 minutes or less), and (2) OSHA: An 8 hour time weighed average (TWA) of 3 ppm.

Formaldehyde is a colorless flammable gas with a strong pungent odor. The first signs or symptoms noticed in exposure to formaldehyde (at concentrations ranging from 0.1 to 2 ppm) are burning of the eyes, tearing, and general irritation of the upper nasal passages. Higher exposures can produce coughing, tightening of the chest, a sense of pressure in the head and palpitations in the heart (1,2). Dermatitis following exposure to formaldehyde containing resins is a well recognized problem (1). Workers may develop redness and swelling of the skin of exposed surfaces.

VI. Methods and Results

NIOSH conducted industrial hygiene studies and medical interviews at the plant on December 8 and 9, 1980.

A. Industrial Hygiene

Area and personal breathing zone air/samples were obtained throughout the plant to measure formaldehyde concentrations.

(a) Work area samples were collected by drawing air at a rate of 1 litre per minute through a standard midget bubbler containing 20 milliliters (ml) of a 1% sodium bisulphite solution. The exposed solution is acidified with a chromotropic acid-sulpfuric acid solution to form a purple monocationic chromogen. The absorbance of this colored solution reflects the quantity of formaldehyde absorbed in the solution, and this is read on a spectophotometer. The lower limit of detection by this method is 0.1 micrograms per ml. (3). Similar samples were obtained during the same sampling period by drawing air through tubes containing impregnated charcoal. Air was drawn through Dupont B 4000 pumps set at a flow rate of 1 litre per minute. The sampling time for both sets of samples was approximately 1 hour.

(P) Personal breathing zone samples (BZ) were obtained using Dupont p-200 sampling pumps. Air was drawn through tubes containing impregnated charcoal at a rate of 200 cc per minute. The tubes, in plastic molders, were placed in the breathing zone for sample collection. The sampling time for each tube was approximately 4 hours. The tubes were analyzed for formaldehyde by ion chromatography (4).

Short-term continuous readings of levels were obtained on workers using a CEA Ambient air monitor. Results from this sampling represent the highest levels recorded over a 5-10 minute period of time. The samples were obtained from the breathing zones of workers and close to the fabric being sewn.

Area levels of formaldehyde were recorded in the storage area, blouse area, cutting and spreading area, pants department, and trimming and ironing areas. (Table 1) Levels ranged from 0.18 ppm. in the inspection and ironing areas to 0.35 ppm in the cutting/spreading areas and in the trimming department (mean level 0.25 ppm).

Personal breathing zone samples were obtained from 6 workers who were cutting fabric, sorting pieces, operating sewing machines, inspecting garments and moving throughout the plant ("floor girl") (Table 2). The 8 hour time weighted average (TWA) exposures of these workers ranged from less than 0.2 ppm in the cutting areas to 0.63 in the

inspection and ironing areas. The breathing zone samples (taken over 4 hours) recorded higher concentrations than the area samples (taken over 1 hour). The former are more likely to detect the rising fumes from heated fabric than the area samples and are a better representation of the respiratory exposure of the workers. The levels measured showed a good correlation between the charcoal tube and impinger measurement methods used (Table 1).

The short-term CEA readings of formaldehyde levels obtained in the work areas and in personal breathing zones ranged from 0.39 ppm to 1.12 ppm (Table 3). The NIOSH recommended criterion for exposure is a maxmimum of 1 ppm for periods of up to 30 minutes. The higher levels were found close to where shirts and pants were being sewn from dark fabric and in the area where the finished garments were pressed.

Measurements of temperature and humidity were also taken and the ventilation and air conditioning system was inspected. (Results table 4)

The heating, ventilation and air conditioning system of the work area consists of 8 units hung from the ceiling. These have outlet filters for particulates which are cleaned periodically. Air is recycled within the building and the only make-up air drawn into the building is through natural spaces around doors and windows. There are no air exhaust or supply vents.

B. Medical

Twenty six workers were interviewed; 4 male (cutters and spreaders) and 22 females (breakdown, sewing, ironing, "floor girl", and supervisor). The most frequent complaint was of eye irritation (15) associated with "sinus" irritation and congestion (6), and headaches (10). Those sewing and ironing the cloth complained of more severe symptoms, and dark colored fabrics were more troublesome. Symptoms were most noticeable on first entering the workplace in the morning and after weekends. There were complaints from all areas of dust in the air which caused occasional coughing and sneezing. Two workers had suffered skin irritation suggestive of formaldehyde sensitivity. Several workers complained of diesel truck fumes entering the workplace from the loading dock during refuse collection times in the mornings.

The two workers who were off work and incapacitated with pulmonary symptoms were interviewed. Both were involved in legal proceedings and were reluctant to disclose details of their illnesses. It was therefore not possible to evaluate whether their working conditions might have contributed to their illness.

VII. Discussion:

The levels of formaldehyde measured in this factory and the symptoms experienced by the workers are similar to findings in other garment manufacturing plants recently studied by NIOSH (NIOSH internal report 125.12, IWSB). Garment workers commonly experience irritation of the eyes and sinuses when exposed to formaldehyde concentrations of between 0.25-1.00 ppm. Symptoms are worse during the first hour of exposure and are less noticeable when the worker becomes acclimatized. Formaldehyde off-gases slowly from fabric treated with urea-formaldehyde resin and may accumulate to noticeable levels in closed spaces with poor ventilation. In this factory there may be such a build-up during weekends when the plant is inactive and the ventilation system shut down.

Recent research sponsored by the Chemical Industry Institute of Toxicology has shown that rats and mice have developed cancer of the nasal passages following 18 months exposure to formaldehyde in concentrations of 6 and 15 ppm (5). Because of these findings, NIOSH has issued a Current Intelligence Bulletin that recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen (6). An estimate of the risk of cancer in workers exposed to levels below the OSHA standard of 3 ppm has not yet been determined. Garment workers are commonly exposed to levels of less than 1 ppm and there is so far no convincing evidence that indicates increased cancer risk in other groups exposed to these levels (i.e., morticians, chemical workers, etc.) (7). NIOSH has recently initiated a cancer mortality study of garment workers to evaluate this risk.

VIII. Conclusions

Workers of the New Carolina Industries plant are experiencing irritant symptoms when exposed to levels of formaldehyde of less than the recommended standard of 1 ppm. Although these levels are not acutely hazardous it would be prudent to employ engineering controls to reduce their exposure to the lowest feasible limit until the concerns about the effects of chronic exposures have been clarified.

IX. Recommendations

1) Local exhaust and general air supply systems should be designed to provide greater air exchange in the building. Operation of the ventilation system each day before the start of the work shift may reduce levels of formaldehyde that accumulate over night and on weekends. The formaldehyde levels may be reduced sufficiently by maintaining the building at a positive pressure with respect to the outside. This may obviate the need for installing costly local ventilation systems.

2) Arrangements for fabric delivery and refuse disposal should be changed so that truck diesel fumes do not enter the workplace through the loading dock entrance.

X. References:

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5. Swenberg J.A., W.D. Kerns, R.I. Mitchell, E.J. Gralla and K.L. Pavkov. Induction of squamous cell carcinomas of the rat nasal cavity by inhalation exposure to formaldehyde vapour. Cancer research 40:3398-3401 (1980)

6. Current Intelligence Bullentin Formaldhyde-Evidence of Carcinogenicity, Dec. 23rd 1980; NIOSH/OSHA, DHHS (NIOSH) Pub. 81-111

7. Report of CIIT conference on Formaldehyde toxicity; Nov. 20-21, 1980. In press.

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XII. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Technical Services, Publications Dissemination, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

Copies of this report have been sent to:

1. International Ladies Garment Workers Union
2. New Carolina Industries
3. OSHA Region IV
4. NIOSH Region IV

For the purposes of informing the approximately twenty six affected employees, copies of the report shall be posted by the employer in a prominent place accessible to the employees, for a period of 30 calender days.

Table 1
General Area Sample Results
Formaldehyde
New Carolina Industries
Weldon, N.C.
9 December, 1980

AREA	CHARCOAL TUBE-ppm*	IMPINGER-ppm*
Storage Area	0.24	0.26
Blouse Department	0.20	0.20
	0.26	0.24
	0.27	0.26
Cutting/Spreading	0.42	0.35
	0.20	0.19
Pants Department	0.20	0.23
Trimming Department	0.33	0.35
Inspection & Ironing	0.22	0.18

*ppm - Parts Per Million

NOTE: Charcoal Tube and Impinger samples were collected in a side-by-side sampling mode for approximately a 60 minute sampling duration.

Table 2
Personal T.W.A.* Sample Results
Formaldehyde - ppm**
New Carolina Industries, Weldon, N.C.
9 December, 1980

JOB CATEGORY	DAY RESULTS - PPM**	8 HR. TWA*-PPM**
Cutter/Spreader	0.16	
	0.28	0.20
" "	0.41	
	0.58	0.46
Breakdown	0.16	
	0.30	0.21
Safety Stitch	0.16	
	0.36	0.24
" "	0.18	
	0.30	0.22
Floor Girl	0.36	
	0.42	0.38
Side Seam Stitch	0.21	
	0.45	0.30
Inspection and Ironing	0.30	
	0.35	0.32
" "	0.51	
	0.84	0.63
" "	0.25	
	0.55	0.37

* TWA - Time Weighted Average
** PPM - Parts Per Million

NOTE: Individual day sample results were collected during approximately a four hour sampling duration.

Table 3
General Area and Breathing Zone Grab Sample Results
Formaldehyde - CEA Continuous Ambient Air Monitor
New Carolina Industries
Weldon, N. C.
9 Dec, 1980

Area	Time	Maximum levels detected per area Formaldehyde - ppm
Spreading & Cutting		
North End	10:00 AM	0.39
South End	10:20 AM	0.42
Middle of Table	10:35 AM	0.49
Middle Next to Wall	10:55 AM	0.62
Plant Sewing		
South End	11:10 AM	0.60
Middle of Room	11:25 AM	0.64
North End	12:25 PM	0.77
Middle Next to Dark Fabric	1:25 PM	0.97
Shirts and Blouses		
South End	1:35 PM	0.70
Middle Next to Dark Fabric	1:40 PM	1.12
North End	1:55 PM	0.88
Trimming & Pressing	2:10 PM	0.74
	2:30 PM	0.65

Table 4

Temperature and humidity measurements
by work area. New Carolina Industries
Dec. 9, 1980

Time	Temperature	Humidity	Area
12:47	22.7°C	40%	Loading Area
12:50	23	60%	Spreading/Cutting
12:52	23.5	60%	Pants
12:58	24	65%	Pants
1:17	25	65%	Shirt