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MORGAN SHIRT COMPANY
MORGANTOWN, WEST VIRGINIA

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I. SUMMARY

On March 16, 1992, the Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health (NIOSH) received a request from Morgan Shirt Company to assess the potential respiratory effects as a result of handling and processing an imported fabric. The request was submitted by the manager of the facility. NIOSH was initially asked to determine the cause of worker complaints of upper respiratory problems and the acetic acid odor associated with a new fabric. NIOSH was later asked to expand the original request to address the manager's concerns of dust exposure in the cutting and sewing areas.

NIOSH investigators conducted initial and follow-up surveys at Morgan Shirt Company on March 16, April 2, and June 12. During the initial and subsequent follow-up industrial hygiene surveys, detector tube samples were collected for acetic acid and fabric samples were analyzed for latent volatile organics. On June 18, 1992 environmental samples were collected for dust, fibers, temperature, humidity, and noise in three areas of the facility. These areas were the cutting room, and the first and second levels of the main building.

The detector tube samples were less than the detection limit of 5 ppm for acetic acid. The bulk fabric samples indicated trace quantities of acetic acid and high molecular weight aldehydes were present only when the material was heated to 212°F.

From the air sampling for total nuisance dust, all of the concentrations monitored were well below OSHA and ACGIH standards. Fiber analysis indicated that the materials found were consistent with operations in a clothing manufacturing facility.

Area noise levels were obtained to determine the areas where workers had the greatest potential for overexposure. Once these workers were identified, personal dosimeters were used to measure their cumulative noise exposure. The workers identified were not found to be overexposed to noise during this survey.

Temperature and relative humidity maximums were 75±2°F and 68%, in the morning and 79±2°F and 63%, in the afternoon.

Based on the sampling results obtained during this HHE investigation at the Morgan Shirt Company, no overexposures to acetic acid, nuisance particulate or hazardous noise were determined. All personal and area exposures measured were below existing exposure criteria.

KEYWORDS: SIC (2321), nuisance dust, acetic acid, noise, shirt manufacturing, textile

II.INTRODUCTION/BACKGROUND

On March 16, 1992, the Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health (NIOSH) received a management request from Morgan Shirt Company, a manufacturer of shirts, to assess the

potential respiratory effects from handling and processing an imported fabric. NIOSH was initially asked to determine the cause of worker complaints of upper respiratory irritation from an acetic acid odor which was thoroght to be associated with a new fabric.

Bundles of the new fabric had recently been received from a supplier in India. Each bundle contained multiple rolls of fabric, with each roll wrapped in a layer of polypropylene and burlap for shipment. Upon arrival at the Morgan Shirt Company, the bundles were briefly stored in an unheated warehouse pending usage. A few bundles of this material were brought into the workplace for marking, coding, and patterning layout. Employees experienced upper respiratory irritation while working with this material. Symptoms of throat irritation, watering eyes, and chest tightness were reported in workers the morning following the day the material was brought to the worksite. Interviews with employees indicated that the material was brought to the workplace late in the afternoon, just about quitting time. Prior to leaving that day, the burlap was removed from the bundle, and a few rolls were unrolled on work tables. The next morning, employees noticed a "vinegar" odor in the building, followed by respiratory symptoms when they started marking and cutting the material.

Because of employee complaints, the plant manager immediately removed all the fabric from the building and placed it in a truck until the issue of the odor was resolved. Calls were then placed to NIOSH and to the fabric distributer to identify the cause of the vinegar odor. Representatives from the Ralph Loren Company and the fabric distributor suggested that the odors were off-gassing from the fabric because the material was packaged in India under 105^{o}F conditions, placed on an aircraft at much colder conditions and delivered to Morgantown, WV where conditions ranged from 50 to 60^{o}F. According to both textile representatives, once the material is opened and allowed to off-gas, the odors would diminish. It was also suggested, that all remaining bundles of material in the warehouse should be opened and allowed to off-gas.

NIOSH was later asked to expand the original request to address the manager's concerns of dust exposure in the cutting and sewing areas. The manager was concerned that concentrations during cutting and sewing operations may be sufficient to warrant respiratory protection. The plant manager reported that other facilities, similar to the Morgan Shirt Company, require employees to wear respiratory protection. Once at the plant, NIOSH investigators decided to sample for a potential noise health hazard.

III. PROCESS DESCRIPTION

The Morgan Shirt Company receives pre-cured, finished fabric from textile-finishing plants. The shirt fabric is treated at the textile-finishing plant with formaldehyde-based resins, which gives the fabric crease-resistant characteristics (permanent press). The resin treated fabric is then cured before it is received by Morgan Shirt Company.

The shirt manufacturing process consists of several steps. Initially, various shirt components are cut from the fabric. This requires many layers of fabric to be spread out and stacked one on top of another on a long table. These layers are then simultaneously cut with hand-held saws ("cutters") or with dies. When a hand-held cutter is used in this step, a pattern is first laid over the top layer and the operator cuts according to this pattern.

After cutting, the shirts are assembled. Initially the cuffs, collars, and fronts are assembled into complete pieces. 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. Finally, the shirts are packaged in bags and boxes for shipping.

The facility consists of three buildings: 1) a warehouse (storage); 2) a building which houses pattern making and fabric cutting; and 3) a main building which has assembly and pressing/finishing on the first level and front, collar and cuff, sleeve and back making 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.

IV. EVALUATION METHODS

First Survey

On March 16 and April 2, 1992 an initial and follow-up survey was conducted at Morgan Shirt Company. Detector tube samples for acetic acid were collected during both surveys.

Dräger direct reading short-term colorimetric detector tubes (Catalog #67 22101) were used to measure acetic acid concentrations in the cutting-room and storage truck. Sampling conducted in the cutting room was accomplished near the suspected fabric, near the cutting operations, and from inside sealed fabric

bundles. Samples collected in the storage truck were taken directly inside randomly selected bundles. Detector tube results, although not as sensitive as other analytical techniques, do provide good screening results to direct future follow-up sampling needs. Accuracy range for detector tubes are

generally between 15-25% of the actual concentration with a limit of detection (LOD) of 5 parts per milliom (ppm). On April 2, 1992, bulk samples of unpacked fabric and burlap were collected and submitted for analysis of latent volatile organic compounds.

Second Survey

On June 18, 1992, a follow-up survey was performed in three areas of Morgan Shirt Company. At the time of the survey, most of the windows were opened and wall and large floor fans were operating during the early morning and afternoon due to the warm weather. This survey consisted of air sampling for total nuisance dust (area and personal breathing zone), and fiber characterization (area open-face sampling). In addition, noise levels (area and personal), temperature, and relative humidity were monitored in the facility.

Total Nuisance Dust

Five personal breathing zone air samples were collected on employees engaged in fabric cutting operations. Eight area air samples were collected in the main building on levels one and two. Also, two area samples for fiber characterization were collected in these areas.

Total dust samples were collected using NIOSH Method 0500.[1] In this method, air is drawn into a tared polyvinyl chloride (PVC) filter [37-millimeter (mm) diameter, 5 micron (um) pore size] at a flow rate of 2.0 liters per minute (lpm) using a calibrated battery powered sampling pump. Determination of the weight of the dust deposited on each sample was made by weighing the samples on an electrobalance and subtracting the initial tare weight (before sampling). The instrumental precision is 0.01 milligrams (mg) per weighing. The following equation was used to determine the concentration (Conc) of total nuisance dust, in milligrams per cubic meter, mg/m^3:

$$Conc = \frac{(W_2 - W_1) + B}{V} * 10^3, mg/m^3$$

where: W_1 = tare weight of filter before sampling (mg)
W_2 = weight of filter after sampling (mg)
B = mean change in field blank filter weights, mg (+/-)
V = total volume sampled, liters

Fibers

Area air samples for fibers were collected on open-face cellulose ester filters housed in a 25 mm conductive cowl filter cassette. Air was drawn through the filters using personal sampling pumps at a calibrated flow rate of 2.0 lpm. Samples were analyzed according to NIOSH Method 7400, using a stereoscope at 45X magnification, polarized light microscope at 200X, and a phase contrast microscope.[2] Fiber sampling was collected at different time intervals. These intervals were approximately 60 and 720 minutes.

Noise

Noise levels associated with cutting and sewing operations were measured in three areas (cutting room, and first and second floor of the main building) in the morning and afternoon. Area noise levels were monitored, followed by personal noise dosimeters on sewing machine operators having the greatest potential for exceeding OSHA's noise standard.

Area sound level measurements were made using a GenRad 1982 Precision Sound-Level Meter and Analyzer. All measurements were made on the A-scale, with slow response. Personal noise samples were made with GenRad Type 1954-9710 Personal Noise Dosimeter. The calibration of both instruments was checked just prior to use according to the manufacturer's procedure.

Temperature and Relative Humidity

Temperature and relative humidity (RH) were measured in the morning and afternoon using Vaisala Senior Systems HM 34 Relative Humidity and Temperature Meter. The instrument accuracy is between $\pm$2% RH (0-90%) and $\pm$0.5 ^{o}F.

V. EVALUATION CRITERIA AND TOXICOLOGY

Environmental evaluation criteria are used to assess a number of chemical and physical agents that may pose workplace hazards. These criteria are intended to suggest levels of exposure that most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. However, workers may experience adverse health effects due to pre-existing medical conditions, individual susceptibilities, and/or hypersensitivities.

There may also be hazards that produce adverse health effects although occupational exposures are controlled at the level set by the criterion. These

hazardous substances can additively react with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects. Also, some substances are absorbed by direct contact with the skin and mucous membranes; thereby, potentially increasing the overall exposure. Finally, evaluation criteria may be updated 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, NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. The OSHA standards 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 short-term exposure (10-15 minute), and ceiling levels (C) not to be exceeded at any time.

Acetic Acid

Acetic acid is widely used in dyes, rubber, pharmaceuticals, food preserving, textile, and laundry industries. Acetic acid vapor may produce irritation of the eyes, nose, throat, and lungs. Inhalation of concentrated vapors may cause serious damage to the lining membranes of the nose, throat, and lungs. Contact with concentrated acetic acid may cause severe damage to the skin and severe eye damage, which may result in loss of sight. Repeated or prolonged exposure to acetic acid may cause darkening, irritation of the skin, erosion of the exposed front teeth, and chronic inflammation of the nose, throat, and bronchi. Bronchopneumonia and pulmonary edema may develop following acute overexposure.[3]

The OSHA PEL, ACGIH TLV, and NIOSH REL for occupational exposure to acetic acid is 10 ppm for an 8-hour TWA. It is interesting to note that the odor threshold for acetic acid is in the range of 1 ppm, or 1/10th of the exposure criteria.

Total Nuisance Dust

Nuisance dusts have a long history of producing slight adverse effect on the lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control.[4] Nuisance dusts are chemicals/or substances present in inhaled air in a solid or liquid particle form, thus constituting an aerosol. Nuisance particles can be an irritant to the eyes, nose, throat, and lungs. Primary health concern is

given to solid materials that are small enough to enter the alveoli. OSHA's PEL for total dust is 15 mg/m^3 TWA. The ACGIH TLV for total nuisance dust is 10 mg/m^3(TWA).[5] These standards are for dust which contains no asbestos and less than 1% free silica. NIOSH does not have a REL for exposure to nuisance dust.

Noise

Overexposure to noise may cause temporary or permanent hearing loss. The degree of damage depends primarily upon the intensity of the noise and the duration of the exposure. Chronic noise exposure above 90 dB(A) causes hearing loss in a portion of the exposed population according to epidemiologic and laboratory evidence.

The OSHA standard for occupational exposure to noise [29 Code of Federal Regulation (CFR) Part 1910.95] specifies a maximum PEL of 90 dB(A)-slow response for a duration of 8 hours per day.[6] Both NIOSH, in its Criteria for a Recommended Standard, and the ACGIH propose an exposure limit of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard. Both of these criteria also use a 5 db time/intensity trading relationship in calculating exposure limits.

Time-weighted average noise limits as a function of exposure duration are listed below.

Duration of Exposure (hrs/day)	Sound Level dB(A)	
	NIOSH / ACGIH	OSHA
16	80	
8	85	90
4	90	95
2	95	100
1	100	105
0.5	105	110
0.25	110	115

***No exposure to continuous or intermittent in excess of 115 dB(A).**
****Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.**

The OSHA regulation has an additional action level (AL) of 85 dB(A) above which an employer shall administer a continuing, effective hearing conservation program. The program must include monitoring, employee notification, observation, audiometric testing, use of hearing protectors, training, and record keeping. All of these stipulations are included in 29 CFR 1910.95, paragraphs (c) through (o).

When workers are exposed to noise levels in excess of OSHA PEL; feasible engineering or administrative controls must be implemented to reduce the worker's exposure levels. Also, a continuing, effective hearing conservation program must also be implemented.

VI. RESULTS AND DISCUSSION

Acetic Acid

Acetic acid concentrations were below the limit of detection of 5 ppm on all detector tube samples. As previously noted, acetic acid has an odor threshold of 1 ppm, or 1/10th the exposure criteria. Odors may be completely harmless, but they have some significance as an index of air contamination. Disagreeable, though harmless, odors may cause so much discomfort that employees will refuse to work in their presence.

Bulk samples of fabric submitted for analysis of latent volatile organic compounds showed that trace quantities of acetic acid and high molecular weight aldehydes were present only when the material was heated to 212^{o}F.

Total Nuisance Dust

The data from the area and personal breathing zone air sampling are

shown in Tables 1, 2, and 3. Table 1 gives the concentration of total nuisance dust in the main building on the second floor. These values ranged from 0.07 to 0.35 mg/m^3, TWA, over the period sampled. Table 2 gives the concentration of the dust collected in the main building on the first floor. These values ranged from 0.09 to 0.19 mg/m^3, TWA, over the period sampled. Table 3 gives the personal breathing zone sampling concentrations of the cutting room. These values ranged from 0.16 to 0.24 mg/m^3, TWA, over the period sampled.

All of the nuisance dust concentrations measured in the three different areas were below the ACGIH and OSHA standards of 10 and 15 mg/m^3, respectively.

Noise

The use of the sound-level meter helped to identify those areas where workers had the greatest potential for overexposure to noise. The maximum noise levels in these areas varied from 90 to 96 dB(A).

The noise dosimetry results from the workers who were suspected to have high noise levels were below exposure criteria. These workers were: 1) the three sewing machine operators on the second floor, of the main building, who made button holes (located in the fronts section); 2) one of the sleeves and back sewing machine operators located on the second floor of the main building; and 3) a sewing machine operator in Assembly I on the first floor of the main building. Their noise exposure levels were 76.0, 78.6 and 78.8 dB(A) TWA, respectively. These levels are below the NIOSH and ACGIH exposure limits, 85 dB(A), TWA. They are also below OSHA's 85 dB(A) action level and PEL of 90 dB(A).

Fiber

The fiber analysis from the cutting room and first and second floor of the main building disclosed that there were no fibers found that were considered inconsistent with operations at Morgan Shirt Company. Also, no count was attempted because there was no fiber present that was regulated by count.

VII. CONCLUSIONS

Since April 28, 1992, the time in which the bulk sample analysis results were verbally reported to the manager, most all of the fabric had been cut, assembled and shipped with no additional employee complaints. It is possible that from the time the fabric was first received from India, to the time the HHE request was made and all subsequent samples were collected, sufficient time may have elapsed for the fabric to off-gas while sitting in the warehouse.

Based on the sampling results obtained during this HHE investigation at the Morgan Shirt Company, no overexposure to acetic acid, nuisance particulate or excess noise were determined. All exposure levels measured were below existing exposure criteria. Based upon the information obtained during this evaluation, no health hazard was found

to exist at the Morgan Shirt Company.

VIII. REFERENCES

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Morgan Shirt Company
2. Ms. Peggy Wisner, ACTWU Local 347
3. OSHA, Region III

In accordance with the Code of Federal Regulations, Title 42, Part 85, this report is to be posted in a prominent location accessible to all employees for a period of 30 days from receipt.

Table 1.
Area Nuisance Dust Sampling Results
Morgan Shirt Company-Main Building Second Floor
Morgantown, West Virginia
June 18, 1992
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Location	Total Volume (m^3)	Concentration (mg/m^3)
Fronts	0.83	0.18
Fronts	0.83	0.14
Sleeves/Backs	0.83	0.09
Sleeves/Backs	0.83	0.09
Sleeves/Backs	0.82	0.07
Cuffs	0.82	0.12
Collars	0.82	0.35
Cuffs/Near Office	0.82	0.09

Table 2.
Area Nuisance Dust Sampling Results
Morgan Shirt Company-Main Building First Floor
Morgantown, West Virginia
June 18, 1992
HETA 92-208

Location	Total Volume (m^3)	Concentration (mg/m^3)
Assembly I	0.83	0.11
Assembly I	0.83	0.09
Assembly I	0.83	0.19
Assembly I	0.80	0.09
Assembly II & III	0.78	0.17
Shipping	0.78	0.14
Pressing	0.77	0.15

Table 3.
Personal Nuisance Dust Sampling Results
Morgan Shirt Company-Cutting Room
Morgantown, West Virginia
June 18, 1992
HETA 92-208

Job Description	Total Volume (m^3)	Concentration (mg/m^3)
Hand Held Cutter	0.86	0.22
Band Saw Cutter	0.85	0.24
Lining Sample Cutter	0.85	0.20
Cutter/Not Stationary	0.84	0.18
Pinner	0.84	0.16