HETA 97–0119–2707
Victoria Vogue, Inc.
Bethlehem, Pennsylvania

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

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Health Hazard Evaluation Report 97–0119–2707
Victoria Vogue, Inc.
Bethlehem, Pennsylvania
September 1998

Calvin K. Cook, M.S.

SUMMARY

In February 1997, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request for a health hazard evaluation (HHE) from a group of employees at Victoria Vogue, Inc. in Bethlehem, Pennsylvania. The HHE request concerned employee health complaints that included skin rash, eye irritation, and difficulty breathing that were believed to be caused by occupational exposure to cotton dust during the production of velour materials and cosmetic powder puffs. Employees were also concerned about poor lighting while operating machinery in the Automatics department.

On August 4–5, 1997, a site visit was made by NIOSH investigators to conduct an industrial hygiene survey that included exposure monitoring on workers for cotton dust, a lighting survey to determine adequate illumination at workstations, and a general safety inspection of the weaving operation. A symptoms questionnaire was distributed to each employee to obtain baseline information and the prevalence of their health complaints.

Personal breathing–zone (PBZ) air sampling on nine workers, which measured the thoracic fraction of cotton dust, revealed 8–hour time–weighed average (TWA) concentrations that ranged from 0.08 milligrams per cubic meter (mg/m^3) of air to 0.38 mg/m^3. Although these concentrations were below the Occupational Safety and Health Administration's (OSHA) permissible exposure limit (PEL) of 0.75 mg/m^3 for cotton dust, one air sample exceeded the OSHA action level of 0.375 mg/m^3 and two others approached the action level. An area air sample collected at a weaving machine revealed a concentration of 0.33 mg/m^3. Additionally, 6 of the 10 air samples collected (including the area air sample using the vertical elutriator) exceeded the NIOSH Recommended Exposure Limit (REL) of 0.20 mg/m^3 as an 8–hour TWA. Safety and health deficiencies identified were lack of machine guarding at several weaving machines, inadequate lighting at workstations, and the absence of a written respiratory protection program.

Worker exposure to cotton dust exceeded the OSHA action level, indicating that the employer must initiate provisions of the OSHA Cotton Dust standard (29 CFR 1910.1043), including periodic exposure monitoring for cotton dust, medical surveillance, and employee training. Recommendations provided in this report include installing exhaust ventilation at weaving machines to control cotton dust emissions, addressing machine guarding deficiencies, improving work practices during cleaning, providing better lighting at workstations, and establishing and implementing a written respiratory protection program.

Keywords: SIC 2281 (Yarn Spinning Mills), weaving, cotton, cotton processing, cotton dust, velour, powder puffs, cosmetics, health effects, machine guarding, lighting, illumination.

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INTRODUCTION

In February 1997, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request to conduct a health hazard evaluation (HHE) at Victoria Vogue, Inc. in Bethlehem, Pennsylvania. Workers were concerned about their occupational exposures to cotton dust during weaving of velour material to produce cosmetic powder puffs. Employees reported symptoms of skin rash, eye irritation, and difficulty breathing that were believed to be caused by occupational exposure to cotton dust during the weaving operation. On August 4–5, 1997, a NIOSH site visit was made that included an industrial hygiene evaluation and distribution of a symptoms questionnaire.

BACKGROUND AND PROCESS DESCRIPTION

Victoria Vogue, Inc. is a world leader in the production of powder puff cosmetic applicators and other cosmetic accessories. The 75,000 square–foot Bethlehem facility employs approximately 190 workers. The departments of concern included the Looms, Automatics, and Rotary. Employees in these departments were machine operators, maintenance workers, and quality control personnel.

The Looms department consists of 11 weaving machines, 7 of which were in operation during the site visit. Spools of yarn (100% cotton, carded warp twisted) were woven into velour materials, then bleached (with a chlorine solution) or dyed. The Rotary and Automatics departments have a total of 31 rotary machines (19 manual, 12 automated) which are used to manufacture cosmetic powder puffs.

The Looms, Rotary, and Automatics departments were served by a common exhaust ventilation system ducted to a dust collection system using a cyclone and particulate air filters. In the Looms department the ventilation system essentially provided dilution ventilation. The general room air was removed by overhead exhaust grills located near ceiling level, filtered by the dust collection system, and then returned to the work space. Outside–air was delivered by supply–air fans near ceiling level. In the Automatics and Rotary departments each machine was equipped with direct exhaust ventilation designed to control dust emissions at the source. The total exhaust ventilation operated at about 20,000 cubic feet per minute (CFM).

EVALUATION METHODS

On August 4–5, 1997, an industrial hygiene survey was conducted that involved full–shift exposure monitoring on workers to assess their exposures to cotton dust. The plant's processes were visually evaluated to identify obvious safety hazards, and a lighting survey was performed to determine adequate illumination at workstations in the Automatics department. A symptoms questionnaire was distributed to each employee to obtain information and the prevalence of their health complaints.

Exposure Assessment

An air sampling strategy was devised to collect full–shift personal breathing–zone (PBZ) air samples on nine workers that would mimic the vertical elutriator by measuring the thoracic fraction of cotton dust. This was achieved by using four–stage personal Marple® cascade impactors with cut–points corresponding to aerodynamic–diameters ranging from 6 to 21 micrometers (μm). The dust collected by each impactor stage was multiplied by a factor to simulate the vertical elutriator penetration curve measured by Rubow et al.[1] The factors for the individual stages were: 0.00 for stage #1 (21 μm); 0.13 for stage #2 (15 μm); 0.37 for stage #3 (10 μm); and 0.77 for stage #4 (6 μm). The thoracic fraction was determined by summing the adjusted gravimetric results from each set of impactors. An example calculation is shown on the bottom of Table 1 of this report.

Each impactor stage had a pre–weighed polyvinyl chloride (PVC) filter to collect cotton particulates. Each set of Marple® impactors were connected to air sampling pumps that were pre– and post–calibrated at a flowrate of 1 liter per minute (lpm). An area air sample was collected near weaving machine #4, using a vertical elutriator connected to a high volume pump calibrated at a flowrate of 7.4 lpm.

Symptoms Questionnaire

Questionnaires were made available to all 60 employees present during the NIOSH site visit to obtain background and baseline information about their health complaints. For employees who were not present during the site visit, arrangements were made to grant them an opportunity to participate in the survey. The questionnaire asked if the employee had experienced symptoms associated with respiratory, skin, or eye–related ailments believed to be related to their work environment during the past year. The questionnaire also asked about the frequency of occurrence of symptoms reported. The final section of the questionnaire allowed employees to discuss other concerns about their health and work environment. Questionnaires were later analyzed to determine the prevalence of reported symptoms.

Other Safety and Health Issues

A general safety evaluation of the plant's processes and employee work practices was performed to identify obvious safety hazards. Documents and records were reviewed that included management's written Lockout/Tagout program, Occupational Safety and Health Administration (OSHA) Log and Summary of Injuries and Illnesses (OSHA 200 log) for the previous two years, and previous industrial hygiene survey reports.

A general lighting survey was done in the Automatics and Rotary departments to determine the adequacy of illumination to perform work tasks. Light levels were measured at each workstation with a hand–held Litemate® photometer (model 500) that gives readings in units of lux over the wavelength region from 380 to 760 nanometers (nm).

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employs environmental evaluation criteria for the 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 even though 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 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 Recommended Exposure Limits (RELs),[2] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs®),[3] and (3) the U.S. Department of Labor, OSHA Permissible Exposure Limits (PELs).[4] In July 1992, the 11th Circuit Court of Appeals vacated the 1989 OSHA PEL Air Contaminants Standard. OSHA is currently enforcing the 1971 standards which are listed as transitional values in the current Code of Federal Regulations; however,

some states operating their own OSHA approved job safety and health programs continue to enforce the 1989 limits. NIOSH encourages employers to follow the 1989 OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion. The OSHA PELs reflect the feasibility of controlling exposures in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard and that the OSHA PELs included in this report reflect the 1971 values.

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 (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Cotton Dust

Occupational exposure to cotton dust has been associated with byssinosis (popularly called "brown lung"), a respiratory disease characterized by shortness of breath, chest tightness, and reduction in pulmonary function.[5,6] Other symptoms may include wheezing, cough, bronchial asthma, and bronchitis. Diagnosis is based on these symptoms because no particular exam or chest x–ray abnormalities are associated with byssinosis. It is assumed that progression of the disease occurs if duration of exposure to dust levels is sufficiently high and prolonged. Mild cases of byssinosis are probably reversible, but severe cases are irreversible.[5,6] Tobacco smoking may contribute to the severity of respiratory symptoms and increase the irreversibility of byssinosis. Workers may also develop eczema, conjunctivitis, and blepharitis (inflamation of the eyelids).[7]

Byssinosis is especially prevalent among cotton workers in the initial, very dusty operations where bales are broken open, blown, and carded.[4,7] A lower rate of the disease occurs in the spinning, winding, and twisting operations where the dust levels are lower. The lowest prevalence rate of byssinosis has been found among weavers, who experience the lowest dust exposure. However, weaver operators are known to suffer from outbreaks of *Weaver's* cough, an acute respiratory illness characterized by a dry cough.[5]

NIOSH recommends reducing exposures to cotton dust to the lowest feasible concentration to reduce the prevalence and severity of byssinosis;[2] the REL is less than 0.2 milligrams per cubic meter (mg/m^3) (as lint–free respirable cotton dust[1]). There are several PEL's for cotton dust, depending on the process involved. At the Victoria Vogue plant the PEL that applies to the weaving operations is $0.750\ mg/m^3$.[4] This exposure criteria for cotton dust is based on a mean concentration of lint–free, respirable cotton dust collected by a vertical elutriator or an equivalent method and averaged over an 8–hour period.

Industrial Lighting

Poor room or task lighting conditions in the workplace can lead to eye strain.[9] While the etiology of eye strain is detectable, it appears that the repeated occurrence is not likely to lead to any permanent eye damage. Workers over the age of 40 will probably encounter more symptoms of eye strain (headache, tired eyes, and irritation) since they require higher illumination levels to perform a similar job than do younger workers.[9] Recommended illumination levels are given by the Illumination Engineering Society (IES) North America. These levels vary according to the task demands of the worker. For the textile industry, illumination of 500 to 1000 lux is recommended for performance of visual tasks (finishing fabrics) of medium contrast or small size.[9]

[1] Lint–free respirable cotton dust means particles of cotton dust of approximately 10 micrometers or less in aerodynamic equivalent diameter.

RESULTS AND DISCUSSION

Cotton Dust Air Sampling

Air sampling results are presented in Table 1. PBZ air sampling on nine workers revealed 8–hour TWA concentrations that ranged from 0.08 mg/m^3 to 0.38 mg/m^3. Although these concentrations were below the OSHA PEL of 0.750 mg/m^3 specified for weaving and spinning operations, one air sample exceeded the OSHA action limit 0.375 mg/m^3 and two others (0.33 mg/m^3 and 0.36 mg/m^3) approached the action limit. The area air sample collected using the vertical elutriator measured 0.33 mg/m^3 of cotton dust near weaving machine #4. Additionally, 6 of the 10 air samples collected (including the area air sample using the vertical elutriator) exceeded the NIOSH REL of 0.20 mg/m^3 as an 8–hour TWA.

The air sampling method using cascade impactors is theoretically equivalent to the vertical elutriator method. Although replicate sampling comparing two methods was not done, the results were similar.

Symptoms Questionnaire

Questionnaire results are presented in Table 2. Fifty-five of approximately 60 employees returned questionnaires to NIOSH investigators (an approximate response rate of 92%). The most prevalent symptoms reported by the 55 respondents were cough, sneezing, and irritated eyelids. The first column of Table 2 shows the symptoms reported by workers. Columns two through five show the frequency of reported symptoms. Column six shows the percentage of employees who reported experiencing the respective symptom at work on the day of the survey. Columns seven through nine show the percentage of reported symptoms that either got worse, stayed the same, or got better when away from work (e.g., weekends, vacations). This later criterion has, in some industrial hygiene studies, been used to define a work–related symptom, but it is possible that a symptom which does not improve when away from the workplace could also be due to conditions at work.

The questionnaire also asked whether the respondent had ever been diagnosed with bronchial asthma, chronic bronchitis, or reduced pulmonary function by a doctor. Respondents reported four cases of bronchial asthma, four cases of chronic bronchitis, and two cases of reduced pulmonary function confirmed by a doctor. When a follow–up question asked whether the respiratory condition was first diagnosed during employment at Victoria Vogue, Inc. respondents reported two of the four cases of bronchial asthma, two of the four cases of chronic bronchitis, and none that were diagnosed while employed.

The final section of the questionnaire allowed employees to discuss other concerns about their health and work environment. Other reported symptoms (not listed in the questionnaire) believed to be caused by their work environment were sore throat and frequent eye infections. Some employees sometimes experienced ringing in the ears caused by noise levels generated by the foam processing operation. Other concerns about the work environment included the visual presence of "too much" cotton dust in the air and on work surfaces, ineffective ventilation, and poor lighting in the Automatics department.

Other Observations

None of the weaving machines in the Looms department were provided with local exhaust ventilation designed to capture cotton dust emissions at the point of generation. The existing ventilation merely provided dilution ventilation, which may not be effective in reducing worker exposures.

Workers in the Looms department used compress air to remove cotton dust from work surfaces. In accordance with the OSHA Cotton Dust Standard for work practices [CFR 1910.1043 (g) (1)], this method of cleaning is prohibited.[4]

Machine guarding deficiencies were discovered in the Looms department at weaving machines #1, #2, #9, and #10. Each of these four machines were missing a metal access panel that would prevent worker contact with internal moving machinery. It was reported by employees that the access panels were not replaced following maintenance and repairs on these machines.

A dye operator routinely wore an air–purifying respirator (with ammonia cartridges) for several minutes at a time to provide additional comfort and protection from chlorine gas exposure while loading and unloading velour materials for bleaching. Because the worker was allowed by management to *voluntarily* use the respirator at the work site, the OSHA Respiratory Protection standard (CFR 1910.134[c][2]) requires management to establish and implement those elements of a written respiratory protection program necessary to ensure that any employee using a respirator voluntarily is medically able to use that respirator, and that the respirator is cleaned, stored, and maintained so that its use does not present a health hazard to the user.[4]

The lighting survey revealed inadequate illumination in the Automatics department. Light measurements revealed illumination levels that ranged from 189 lux to 419 lux at workstations, which is below the IES's recommended range of 500 lux to 1000 lux illuminance for performance of visual tasks of medium contrast or small size objects for the textile industry.[9]

CONCLUSIONS AND RECOMMENDATIONS

1. Air monitoring performed during this evaluation revealed worker exposure to cotton dust in excess of the NIOSH REL and the OSHA Cotton Dust action level. The OSHA Cotton Dust standard states that, if initial air monitoring reveals worker exposure to be at or below the PEL for cotton dust, management is required to repeat exposure monitoring at least annually. In addition, management must provide at least annual medical surveillance for all workers exposed to cotton dust concentrations above the action level, and at least every two years for workers exposed to cotton dust at or below the action level. Management also must initiate an annual training program for all workers exposed to cotton dust to assure that they are informed about the acute and long term health hazards associated to cotton dust, and the measures (i.e., work practices) necessary to protect them from exposures in excess of the exposure limit.

2. Management should consider installing local exhaust ventilation at weaving machines, which could be ducted to the existing exhaust system that leads to the dust collector. If designed properly, such a system would be expected to significantly reduce workers' dust exposures. Other benefits would include reducing the potential for fire hazards caused by ignition of excess dust, and less cleanup of dust from work surfaces and equipment. A qualified industrial ventilation engineer should be consulted for optimum results. In the interim, a disposable respirator with a particulate filter could be provided to those workers experiencing respiratory ailments.

3. Machine guarding at weaving machines can be improved by ensuring that metal access panels are replaced immediately following maintenance and repair activities. Maintenance workers should be informed about this hazard and the potential for serious injury. This information could be included in the written standard operating procedures for maintenance and repairs of all machinery. Furthermore, line supervisors should be informed that they are responsible for recognizing and abating such a hazard, and enforcing safe work practices.

4. Because an employee was allowed to voluntarily use his own respirator, management must establish and implement certain elements of a written respiratory protection program necessary to ensure that the respirator does not pose harm

to the user. Elements of a written respiratory protection program *for employees using a respirator voluntarily* should include the following:

(a) medical evaluation to determine individual workers's ability to use a respirator and perform the work required; and

(b) procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators.

The program should be updated as necessary to reflect changes in workplace conditions that affect respirator use.

5. Selection of an appropriate respirator is an important element of protecting the dye operator's exposure to chlorine gas. The half–face respirator with ammonia cartridges may provide some protection against chlorine gas exposure, however, a full–face respirator with acid gas cartridges is a more appropriate respirator. Respirators and cartridges should only be used for those specific chemical compounds for which they have been approved or recommended. A full–face respirator is recommended due to the irritative effects of chlorine gas to the eyes, and for cases of accidental splash to the face and eyes.

6. Cleaning of work surfaces, floors, equipment, and clothing with compressed air should be prohibited. Whenever feasible, cleaning should be performed with a vacuum or with methods designed to minimize dispersal of dust.

7. Lighting levels provided in the Automatics department should be further increased to ensure adequate illumination for the performance of job tasks. One option may be to provide task lamps at workstations of workers who have complaints of poor lighting. A qualified lighting engineer should be consulted to ensure best results.

8. Based on questionnaire responses, full–shift noise dosimetry measurements should be made on employees working near the foam processing operation. Measurement results will determine whether acoustical controls or noise attenuating devices (ear plugs or muffs) are necessary to ensure hearing protection.

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Table 1
Air Sampling Results for Cotton Dust
Victoria Vogue, Inc.
Bethlehem, Pennsylvania
August 5, 1997

Sample Location	Sampling Time (minutes)	Sample Flow Rate (liters per minute)	Sample Volume (liters)	Cotton Dust Concentration (expressed in mg/m^3)
Weaver	477	1	477	0.16 †
Maintenance worker	467	1	467	**0.32***
Maintenance worker	430	1	430	0.08
Rotary operator	475	1	475	0.08
Automatics operator	470	1	470	**0.22***
Automatics operator	485	1	485	0.12
Quality Control worker	477	1	477	**0.36***
Roof leader	517	1	517	**0.27***
Shift dyer operator	283	1	283	**0.38***
Vertical elutriator area sample	442	7.4	3,271	**0.33***
Minimum Detectable Concentration (MDC)				0.01
Minimum Quantifiable Concentration (MQC)				0.08
Exposure Criteria (expressed in mg/m^3) for Weaving Operation				
NIOSH Recommended Exposure Limit (REL)				<0.20
OSHA Permissible Exposure Limit (PEL)				0.75
OSHA Action Level (½ the OSHA PEL)				0.375

* = exceeded the NIOSH REL

† Example calculation: ∑(Gravimetric weight)(Penetration factor) ÷ volume of air sampled;

	Gravimetric weight		Penetration Factor		
stage 1	0.898 mg	x	0.00	=	0.000 mg
stage 2	0.194 mg	x	0.13	=	0.025 mg
stage 3	0.048 mg	x	0.37	=	0.018 mg
stage 4	0.042 mg	x	0.77	=	0.032 mg

Total = 0.075 mg ÷ 0.477 M^3 = 0.160 mg/m^3

Table 2
Questionnaire Results
Victoria Vogue, Inc.
Bethlehem, Pennsylvania
August 5, 1997

SYMPTOMS experienced at work in the past month.	Not in past month	1–3 days in past month	1–3 days *per wk* in past month	Every or almost every workday	On the day of the NIOSH survey	Percentage of respondents (n=55) who experienced symptoms that either got worse, stayed same, or got better when away from work (e.g., weekends, holidays).		
						Got Worse	Stayed Same	Got Better
chest tightness	72%	9%	4%	15%	13%	0%	11%	16%
cough	49%	18%	13%	20%	33%	0%	22%	24%
wheezing	78%	5%	4%	13%	11%	0%	9%	11%
difficulty breathing	72%	11%	7%	9%	13%	0%	11%	13%
sneezing	42%	20%	13%	25%	29%	2%	25%	31%
eczema	85%	2%	2%	11%	11%	0%	13%	0%
conjunctivitis	76%	7%	4%	13%	15%	0%	13%	11%
irritated eyelids	49%	22%	11%	18%	27%	2%	11%	25%

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or visit the NIOSH Homepage at:
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