U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. HE 79-33-683

WELMETCO LTD.
SOUL CITY, NORTH CAROLINA

APRIL 1980

I. SUMMARY

On December 14, 1978, the National Institute for Occupational Safety and Health (NIOSH) received an employer request to investigate dermatitis problems which were stated to have affected approximately 45% of the work force who were employed as sewing machine operators or materials handlers in the manufacture of military duffel bags at Welmetco, Ltd., Soul City, North Carolina. It was suspected that the problem was caused by a government furnished cotton cloth (GFM Duck, Cotton, Federal Specification CCC-D-950D), which had been treated with a mildew inhibitor, 2,2'-methylene-bis (4-chlorophenol), (Synonym - dichlorophene or G-4).

In order to evaluate these complaints, NIOSH conducted an environmental and medical survey at the Soul City facility on January 15-16, 1979. Seven affected employees and 3 unaffected employees were interviewed by the NIOSH medical officer. Ten samples of the GFM were sent to the NIOSH laboratory for chemical analysis. GFM samples were also used to conduct skin irritation and sensitization studies on laboratory animals. Analysis of the GFM samples indicated that the % by weight of mildew inhibitor in the material (0.96% - 1.77%) was within the federal specifications (CCC-D-950D) requirement (1.1% - 1.9%). The pH of the samples ranged from 5.5 - 6.0, indicating slight acidity. The amount of dichlorophene which could be leached from the material, using distilled water or 0.9% sodium chloride solution, ranged from 1.5% - 12.1% and 2% - 12.3%, respectively. Other chemical compounds in the GFM capable of causing skin irritation or sensitization were not detected or could not be identified by the laboratory methods used. The amount of dichlorophene in the GFM samples tested was not of sufficient concentration to cause skin irritation or sensitization in the test animals. Although the laboratory and animal tests were non-conclusive as to the cause of the skin rash, several of the workers interviewed gave histories suggestive of allergic dermititis. A follow-up study on the previously affected employees was not possible because Welmetco closed down its Soul City operations shortly after NIOSH had concucted the initial visit to the plant.

Dichlorophene (G-4) is a known skin sensitizer. Information obtained from other users and suppliers of the WRMR GFM indicate that a potential skin dermatitis hazard does exist for workers who have constant direct skin contact with this material. This risk would likely increase during warm weather. Specific recommendations for dermatitis prevention, through use of protective clothing and adequate personal hygiene are discussed in detail on page 7 of this report. Laboratory and animal test results suggest that the water resistant/mildew resistant (WRMR) cotton duck used by Welmetco, Ltd., could be handled without danger to workers' health if suitable work practices are observed.

II. INTRODUCTION

On December 14, 1978, the President of Welmetco, Ltd., Melville, New York, requested a health hazard evaluation at the Welmetco sewing operations (SIC 2394) located at Soul Tech #1 in Soul City, North Carolina. The purpose of the investigation was to evaluate the cause of dermatitis which had affected about 45% of the sewing machine operators and material handlers working with a water resistant/mildew resistant cotton canvas material used in the manufacture of duffel bags for the U.S. Military. In response to this request a NIOSH medical officer and industrial hygienist conducted a survey of the facility on January 15-16, 1979.

III. BACKGROUND

Welmetco, Ltd., at Soul City, had contracts with the federal government for production of field packs and duffel bags for the military. The sewing operations started production in February 1978. The production rate for duffel bags never met the contract requirement for 18,000 bags per month. Production at that rate required 65 workers, but only 30-35 had been employed prior to August 24, 1978. On that date production on the duffel bags was discontinued because many of the workers were suffering from skin rash, resulting in job transfers or terminations of employment. No protective clothing was available, and other dermatitis control programs were not attempted. Production of duffel bags was never resumed. Maximum employment for both contracts (field packs and duffel bags) had been 80-85 workers. Most of the employees were women. At the time of the initial survey all employees were on lay off because heating in the building was inadquate for the cold January and February weather.

The duffel bags are made from government furnished material (GFM) cotton canvas (# 8 and # 10, cotton duck) which had been dyed olive drab and treated for water and mildew resistance. Rolls of material were unwrapped and unrolled, the pieces were cut out and then given to the sewing machine operators for assembly. All sewing machine operators were women. The field packs were made from nylon fabric and no dermatitis cases had been reported for workers handling this material.

The production area was not air conditioned, and the roof mounted exhaust fans were totally inadequate. To ventilate 47,000 sq. ft. of industrial space, only 2 fans, approximately 2 feet in diameter, had been installed. Additional ventilation was provided by opening the outside windows and doors.

Government specifications require that water repellents consist of aluminium or zirconium salts of carboxylic acid mixed with mineral or vegetable waxes applied in an aqueous or solvent solution. The mildew inhibitor must be a copper salt applied in an aqueous solution or 2,2' methylene-bis-(4 chlorophenol) (commonly called G-4) applied in an aqueous solution or water free solvent. The treatment was applied at the finishing mill which supplied the material. Most of the material in stock at Welmetco had been shipped from Reigel Textile Corp., Trion, Georgia or Martin Finishing Corp., Bridgeton, New Jersey. Both finishing mills had treated the material with G-4 mildew inhibitor. Due to the rising cost of copper, the copper salts treatment was no longer favored.

G-4 has been approved for use as a fabric anti-mildew agent for many years. The compound is applied in an aqueous solutions by mixing G-4 with sodium hydroxide to form a soluble G-4 sodium salt solution. The solution is applied by emerging the fabric into the solution and then feeding the fabric through squeeze rollers to remove the excess. The fabric is then acid washed to convert the soluble G-4 back to its insoluble form which binds the compound to the fibers. The fabric is then water rinsed and treated with the waterproofing solution. In some treating processes the water proofing solution is applied concurrently with the acid wash.

If the treatment chemicals are applied in a water free solvent, one method is to melt paraffin wax (for water proofing) in alcohol and dissolve G-4 in Stoddard solvent. The solvent and alcohol solutions are applied to one or both sides of the fabric with a roller running one side in the treating solutions and the other side against the surface of the fabric. The fabric is then fed over and under drying cans to evaporate the solvent and alcohol.

IV. METHODS AND MATERIALS

A. Environmental

Samples of materials, approximately 2 in. x 6 in., were cut from the ends of unused rolls of # 8 or # 10 GFM, Cotton Duck. Most of the rolls in storage at Welmetco were still wrapped in the paper and burlap packaging as shipped from the finishing mill. The samples of material were supplied from three different finishing mills; Sayles Biltmore Bleacheries, Inc. (1 sample), Martin Corp. (3 samples), and Riegel Textile Corp. (4 samples). Two samples were taken from a pile of precut pieces used for duffel bag chafing bands.

The ten samples of material were sent to the NIOSH Measurement Support Branch for testing and analysis to determine the amount of G-4 contained in the material. An attempt was made to analyze the samples by gas chromatography but initial work showed results would not be reliable. The samples were analyzed by Federal Test Method Standard No. 191 to determine the percent by weight of G-4 in the material. To determine if perspiration from increased the risk of dermatitis, tests were performed to see how much G-4 could be leached from the material with distilled water or with an isotonic (0.9%) sodium chloride solution. Wet samples of material were tested for pH to determine acidity/alkalinity.

Two samples of the material were also subjected to gas chromatograph (GC) analysis for identification of other chemical components. The samples were extracted with methylene chloride and acetone, respectively, and sonified. The extracts were analyzed by GC using a 12 ft 10% SP 2100 column, temperature programmed up to 300°C. Because the same components were detected in both sample extracts, only one sample was analyzed by GC/mass spectrophotometry (GC/MS).

B. Medical

During the initial survey 10 workers were interviewed by the medical officer. Seven reportedly had experienced problems with dermatitis. The workers gave histories suggestive of sensitization. Most of the problems occured during the warm weather when the workers were perspiring heavily.

A sample of the GFM, Cotton Duck was sent to the NIOSH Experimental Toxicology Branch for characterization of its irritant and sensitization potential.

1. Skin Irritation Study

The skin irritation study was conducted on male albino rabbits using a 3/4 x 3/4 inch piece of the GFM under a 1 x 1 inch gauze patch. The samples were tested both dry and wet with a saline solution. The dry and wet GFM samples were applied to separate intact and abraded skin test sites on each of 6 male albino rabbits. All test sites were covered by patches for 24 hours. The sites were observed at 24 and 72 hours following application.

2. Skin Sensitization Study

Skin sensitization studies were also performed using the same patch method with both dry and wet samples on guinea pigs. For each test site, the GFM was administered under a gauze patch to 10 male albino guinea pigs for 9 treatments over a 3 week period.

Controls were treated with only a dry or a saline wetted gauze patch (no GFM under the patch). After a 2-week rest period, a challenge patch was administered follwing the same method as described above, to both groups, i.e. 10 test animals and 5 controls, in each study.

V. EVALUATION CRITERIA

The Federal Specification for Dyeing and Aftertreating Processes for Cotton Cloths, CCC-D-950D, dated March 2, 1972, specifies the minimum and maximum amounts of mildew inhibitor to be applied to the cloth. If the finishing mill elects to use dichlorphene, the cloth must contain not less than 1.1 nor more than 1.9 percent of inhibitor on total weight of finished cloth as determined when tested by Federal Test Method 191. Dichlorophene has been identified as a skin sensitizer [1,2]. A 0.2% aqueous solution is recommended as the appropriate test strength to distinguish people who are sensitized to G-4 from people who are not sensitized. This suggests that a concentration greater than 0.2% would be required to cause dermititis in non-sensitized people. The amount required in a sensitized individual would depend greatly on the degree of hypersensitivity. Dichlorophene is also a photosensitizer[2], meaning that people exposed to sunlight are more susceptible to allergic reactions from skin contact with dichlorphene.

VI. RESULTS

A. Environmental (cloth sample analysis)

The percent by weight of dichlorophene or G-4 in each sample was found to be within the limits required by Federal Specifications CCC-D-950D, i.e., 1.1 - 1.9%. The average concentration for all ten samples was 1.3% dichlorophene, and the highest amount detected in any sample was 1.77%. The pH of the cloth ranged from 5.6 - 6, which is within the normal pH range of the skin, i.e., 4.5 - 6[3]. Extraction of the cloth with water or isotonic saline solutions (0.9% sodium chloride solution) did indicate that a small percentage of the G-4, approximately 1-12%, could be leached from the material. A summary of the results of the laboratory analysis of the cloth samples is presented in Table 1.

The GC/MS analysis of one of the samples (sample # 8) identified paraffin-type alkanes, probably straight chain alkanes, in the C_{21}-C_{28} range. These compounds are not highly toxic or hazardous and were not unexpected considering that vegetable or mineral waxes are components of the water resistance treatment.

B. Medical (animals test results)

1. Skin Irritation Study

The laboratory studies using male albino rabbits showed no irritation from contact of intact and abraded skin with dry material, and no reaction with intact skin from wet material. Abraded skin was slightly irritated in 2 of the 6 rabbits after 24 hours, but was no longer irritated after 72 hours. A slight yellow-brown staining of the skin was observed on all test animals.

2. Skin Sensitization Study

None of the guinea pigs tested showed sensitization when tested dry or when wetted with a saline solution. The material did produce a slight yellowing of the skin on approximatly half of the test animals.

VII. DISCUSSION AND CONCLUSIONS

The concentration of G-4 in the material was not sufficient to cause irritation or sensitization in the test animals. Based on the results of the animal tests and information from the literature, NIOSH has determined this water resistant/mildew resistant material can be handled safely with minimum risk of dermatitis, provided suitable work practices are observed. Direct skin contact with the material should, however, be minimized, especially during warm humid weather. The effect of rubbing one piece of treated material across the skin, hour after hour, might result in an accumulation of G-4 on the skin sufficient to trigger a sensitization with subsequent allergic dermatitis. Although the data is not conclusive, it appears that a number of workers at Welmetco had become sensitized to G-4.

Two other companies that had previously manufactured duffel bags from this material were contacted by NIOSH to determine if their workers had experienced problems with dermatitis. One of the companies had not produced duffel bags for over 10 years. Supervisors could not recall any "excess" problems. The other company had stopped producting duffel bags at least 5 years ago. Prior to that time they had produced an estimated 10-12 million bags. During their production, they did have some problems with skin rash. Out of 250 employees (approximately 90% female), it was reported that about 10-15 cases of dermatitis occurred each year. The rash was more of a problem during warm and humid weather. The rash appeared under the arm, on the forearms, and occasionally on the face. The dermatitis was controlled by having the workers wash their hands and arms with a special kerosene based soap and by requiring the workers to wear long-sleeve clothing or by providing special cotton sleeves that could be worn by workers wearing short-sleeve clothing.

VIII. RECOMMENDATIONS

Since it appears that some contractors working with the WRMR Cotton Duck have experienced problems with dermatitis, the Defense Personnel Support Center must ensure that all current and future contractors are warned of the hazard. Direct skin contact with the material should be minimized through the use of protective gloves and long sleeve clothing for those workers who constantly handle the WRMR material. The work area should be air-conditioned to reduce heat and humidity during the summer. Employees should wash thoroughly, their face, arms, and hands at least twice during their work shift. Workers who experience dermatitis should seek immediate medical attention. Workers who become sensitized should no longer be exposed to the material.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. DISTRIBUTION AND AVAILABILITY

Copies of this Determination report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After ninety (90) days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati, Ohio address.

Copies of this report have been sent to:

a) Welmetco Ltd.
b) U.S. Department of Labor, Region IV
c) NIOSH Region IV
d) North Carolina Department of Labor
e) North Carolina Department of Human Resources
f) Defense Personnel Support Center

XI. REFERENCES

1. Fisher, Contact Dermatitis, Lea & Febiger, Second Edition, page 375, 1973.

2. Adams, Occupational Contact Dermatitis, J.B. Lippincott Co., page 224, 1969.

3. The Industrial Environment its Evaluation and Control, Department of Health Education and Welfare, USPHS, CDC, NIOSH, page 505, 1973.

TABLE 1
Welmetco Ltd.
Soul City, North Carolina

Analysis of cloth Samples for Mildew Inhibitor
2,2-Methylene bis, (4-chlorophenol)
(Dichlorophene)

June 21, 1979

Sample No.	Type Material	Lot No.	Roll No.	Finisher	% by weight
1	# 8 duck	9	1207	Martin	0.96
2	# 8 duck	5	531	Martin	1.77
3	# 10 duck	2	431	Martin	1.39
4	# 8 duck	3	Unknown	Sayles	1.54
5	# 10 duck	1	339	Reigel	1.42
6	# 10 duck	13	5294	Reigel	1.12
7	# 10 duck	5	2050	Reigel	1.08
8	# 10 duck	2	790	Reigel	1.17
9	Chafing band	N/A	N/A	Unknown	1.34
10	Chafing band	N/A	N/A	Unknown	1.38

pH of Samples = 5.5 - 6.0

% dichlorophene leached from samples:

with distilled water = 1.5% - 12.1%
with 0.9% sodium chloride solution = 2.0% - 12.3%

Note: All roll samples were taken from new unused rolls, which were wrapped in heavy paper inside a burlap outer cover. Samples 9 & 10 were taken from a pile of cut pieces, sample # 9 from within the pile, and sample # 10 from top of the pile. All samples were placed in sealed glass vials for shipping to the NIOSH laboratory.