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

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 76-29-322

COLUMBUS PRODUCTS CORPORATION
COLUMBUS, OHIO

AUGUST 1976

I. TOXICITY DETERMINATION

Exposures of employees to chemical agents at molding operations in the Wire Harness area are not believed to be toxic to employees under the conditions observed by the NIOSH Hazard Evaluation personnel during the survey dates of March 26 and May 12, 1976. Worker exposures to benzene, carbon monoxide, hydrogen chloride, and vinyl chloride were determined by personal and area air sampling. Complaints of dry throat and headaches in the Wire Harness area do not appear to be related to activities and materials used there. It is the opinion of the investigators that the reported symptoms can be explained by one or all of the following: an unidentified agent (chemical or physical), back drafting of contaminated outside air, or group hysteria. Recommendations are made in this report to re-evaluate the existing ventilation system.

This determination is based upon medical evaluation by interview, measurements of workplace concentrations of airborne chemicals, inspection of the work areas and materials used, and review of the current knowledge of the materials used.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Copies have been sent to:

a) Columbus Products Corporation, Columbus, Ohio
b) Authorized Representative of Employees
c) U.S. Department of Labor, Region V
d) NIOSH, Region V

For the purpose of informing the approximately seven "affected employees" the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) where affected employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from a representative of the Columbus Products Corporation concerning worker exposures at a polyvinyl chloride (PVC) molding operation in the Wire Harness area at Columbus Products Corporation, Columbus, Ohio. Workers in this area were reported to have experienced symptoms of dry mouth and headaches.

IV. HEALTH HAZARD EVALUATION

A. Evaluation Chronology/Background

The request for a Health Hazard Evaluation was submitted as suggested by an OSHA inspector. Air sampling by OSHA did not find significant levels of airborne contaminants and it was felt that further investigation of the health complaints should be performed.

On March 26, 1976, Industrial Hygienist Jack Geissert and Medical Officer John Herbert, M.D. (CDC - Atlanta) visited the Wire Harness area for the purpose of investigating the employee complaints and evaluating the PVC molding operation. A walk-through survey of the Wire Harness area was conducted by both investigators. Dr. Herbert at this time interviewed eleven workers assigned to the Wire Harness work area.

A follow-up industrial hygiene survey was conducted on May 12, 1976, and included air sampling, evaluation of work practices, and ventilation evaluation.

B. Process Description

This location of Columbus Products Corporation is involved in the production of refrigerators for home use. Most activities in the general plant deal with assembly of these units. The Wire Harness area is located on an upper level of the main assembly and materials handling area. Dimensions of the Wire Harness area are approximately 84 feet by 90 feet with a 12 foot ceiling. There are approximately seven employees (3 male) in the Wire Harness area with an average of two employees operating the gromet and terminal-insulator molds (40 hours/week). About three employees perform "hanking" operations (harness assembly), one employee is responsible for set up, while the remainder perform duties such as attaching wire terminals, etc. The thirteen gromet molds are operated as production needs dictate, with about two molds in operation at a given time. Similar temperatures and the same PVC formulation is used in all molds. About 50-100 pounds of PVC are used per day. The pelletized PVC is hopper fed into the mold and heated to 300-350^{o}F. The operator places a wire into the dye and the terminal insulator or harness gromet is molded. Portable fans are available and

commonly used by the mold operators. Several exhausting roof fans are located overhead and are used periodically. No other operations are conducted in this immediate area.

A list of components in the PVC molding formulation was provided by the supplier. The components are: PVC polymer, calcium carbonate, dibasic lead phthalate (stabilizer), epoxidized soybean oil (plasticizer), di-undecyl phthalate (plasticizer), and diisodecyl phthalate (plasticizer).

C. Evaluation Methods

1. Medical

On the day of the investigation, eleven persons working in the molding area were interviewed regarding their occupational history, symptoms experienced on the job, and aggravating or alleviating factors.

2. Thermal Degradation Products

A randomly selected bulk sample of the PVC molding material was obtained and evaluated to determine what products are evolved under operating conditions. The PVC material was heated through a temperature range of 25-315° C. with a Mettler DT-1 Thermo-analyzer and the weight losses were measured. Aliquots of the PVC material were put into a small oven and heated to 360°F. A steady stream of air was passed over the samples and the effluent vapors were collected using activated charcoal and fluorisil with subsequent gas chromatographic analysis.

3. Air Sampling

Benzene - Worker exposures to benzene were estimated by area air sampling. Benzene levels were measured by drawing air at 50 cc/minute through tubes containing activated charcoal collecting media. Analysis (carbon disulfide desorption and gas chromatography) was performed under contract by Utah Biomedical Test Laboratory. Drager colorimetric gas detector units were also used to measure benzene levels. These units are NIOSH certified and have an accuracy of 35 percent at one-half the exposure limit and an accuracy of 25 percent at one to five times the exposure limit.

Hydrogen Chloride - Worker exposures to hydrochloric acid mist were measured by bubbling air at 0.6 liters per minute through an impinger containing 0.5 N sodium acetate collecting media. The amount of hydrochloric acid was determined by the turbidimetric method. Drager colorimetric gas detector units were also used to measure levels of hydrochloric acid gas. These units are not certified for accuracy.

Vinyl Chloride - Worker exposures to vinyl chloride monomer were determined by personal air sampling. Vinyl chloride levels were measured by drawing air at 50 cc/minute through tubes containing activated charcoal collecting media with subsequent analysis (carbon disulfide desorption of the activated charcoal and gas chromatography), under contract by Utah Biomedical Test Laboratory.

The Century Organic Vapor Analyzer (Model OVA-98A) was used to detect the presence of airborne hydrocarbons. This instrument utilizes a flame ionization detector and will respond in a non-specific manner to hydrocarbons.

The worker's thermal environment was evaluated by obtaining the wet bulb, dry bulb and globe temperatures.

D. Evaluation Criteria

1. Toxic Effects

A review of the literature concerning health hazards associated with polyvinyl chloride (PVC) molding operations found few reports of health hazards. The most common health problems at these operations are upper respiratory irritation due to thermal decomposition of the molding materials, and skin irritation from the use of hydrocarbon cleaning solvents.

The emissions from heating or the combustion of PVC materials is dependent on the components of the formulation and the temperatures which are reached. Laboratory analysis by NIOSH of the volatile products from this PVC formulation indicated the presence of benzene and diisodecyl phthalate. Laboratory studies of pure PVC resin pyrolysis indicate that hydrogen chloride and benzene are the main volatile products.[1,2] Most PVC formulations are blended with plasticizers and stabilizers to give the PVC flexibility and inhibit thermal degradation. On thermal degradation, this PVC formulation would first emit the volatile plasticizers (phthalates and epoxidized soybean oil) with subsequent emission of hydrogen chloride and hydrocarbons, predominantly benzene. In most cases, employee exposures to benzene from PVC degradation would be controlled by the irritancy of the hydrogen chloride emissions. Studies in the meat wrapping industry[3,4,5] on the pyrolysis products of PVC film suggest that the smoke is primarily plasticizers with only minimal amounts of hydrogen chloride and other decomposition products of the PVC.

Much attention has recently been directed toward vinyl chloride in the work environment. Vinyl chloride exposures occur primarily in the production of vinyl chloride, in polymerization of vinyl chloride and the handling of freshly manufactured resin powder containing residual vinyl chloride. Trace concentrations of free vinyl chloride have been found at extrusion and molding operations during NIOSH studies at other plants utilizing PVC formulations.[6,7,8]

Vinyl chloride (the monomer from which PVC is made) is a carcinogenic agent. It is an etiological agent in the development of angiosarcoma of the liver (a rare form of liver cancer). As stated in NIOSH's Recommended Standard for Occupational Exposure to Vinyl Chloride[9], "there is probably no threshold for carcinogenesis although it is possible that with very low concentrations, the latency period might be extended beyond the life expectancy." In view of these considerations and NIOSH's inability to describe a safe exposure level as required in Section 20(a)(3) of the Occupational Safety and Health Act, the concept of a threshold limit for vinyl chloride gas in the atmosphere was rejected. As a result, the NIOSH recommended Standard

for Occupational Exposure to Vinyl Chloride states that exposure to vinyl chloride monomer should not exceed levels that are detectable by the recommended methods of sampling and analysis.

2. Environmental Evaluation Criteria

Airborne exposure limits intended to protect the health of workers have been recommended or promulgated by several sources. These limits are established at levels designed to protect workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime. For this investigation, the criteria used to assess the degree of health hazards to workers were selected from two sources:

a. NIOSH Recommended Standards - airborne exposure limits which NIOSH has recommended to OSHA for occupational health standards.

b. OSHA Standards - the air contaminant standards enforced by the U.S. Department of Labor as found in Federal Register, Vol. 39, 23540-23543, June 27, 1974.

The criteria used in this investigation to assess potential health hazards from airborne exposures are listed below:

Source	Substance	8-hour Time Weighted Average Concentrations
NIOSH Criteria Document	Benzene	30 mg/M^3[a]
NIOSH Criteria Document	Carbon Monoxide	35 ppm[b]
OSHA Standard	Hydrogen Chloride	7 mg/M^3

a - approximate milligrams of contaminant per cubic meter of air.

b - parts of carbon monoxide per million parts of contaminated air by volume.

NIOSH Recommended Standards are only recommended exposure limits whereas the OSHA Standards are those promulgated and enforced by the U.S. Department of Labor.

E. Results

1. Medical

Table I summarizes the pertinent points of the employee interviews. No physical examinations were conducted as none of the workers had residual effects, and no person was complaining of symptoms on the day of the interviews. As noted, symptoms were mainly dry mouth, eye and upper respiratory irritation associated with a subjective feeling of increased

"fumes" in the area. These symptoms were most severe when individuals operated the molding machine, however, they had been experienced elsewhere. Symptoms were apparently not related to duration of work, since all persons interviewed had experienced mild symptoms at one time during their work as a molder. No worker could precisely say how often they were bothered by the "fumes" with estimates ranging from several times a week to occasionally, once or twice a month, etc. Portable fans set so as to blow emissions away from the workers were reported to reduce the symptoms in several cases. Several individuals felt that these fumes were coming from the plating operation located directly below the molding operation, but on inquiry, none of the individuals involved in the plating operation ever complained of symptoms except on one occasion when the local exhaust ventilation on the plating tanks malfunctioned.

This facility maintains a dispensary staffed by a full-time nurse. The nurse stated that several complaints concerning this operation had been received around 1971, but that few workers from the Wire Harness area had visited the dispensary since. Review of OSHA Form 102 (Summary of Occupational Injuries and Illnesses) for 1975 disclosed no recorded occupational illnesses from the Wire Harness area.

2. Environmental

The initial walk-through survey of the Wire Harness area did not disclose or identify any hazardous working conditions. Working conditions were apparently normal and workers were not experiencing any of the reported symptoms. A return visit was planned at this time to conduct air sampling.

Laboratory analysis of the volatile emissions from the PVC molding material indicated the presence of benzene and diisodecyl phthalate. This material had a 0.3 percent weight loss when heated to about 400°F.

Results from air sampling on May 12, 1976 are presented in Tables II-V. The seven measurements performed with the Century Organic Vapor Analyzer in the Wire Harness area did not show worker breathing zone levels of hydrocarbons to be above outside ambient levels. These results do not indicate excessive exposure to these contaminants.

Psychrometric measurements were obtained to determine if the heat/humidity environment could be a contributing or causitive factor of the employee complaints of dry throat (Table VI). It does not appear that the temperatures or humidity would explain the dry throat symptomatology.

Visual inspection of the roof area suggested that contaminated air from the plating and coal-burning electric generating operations could backdraft through the ceiling vents. This could not be confirmed at the time of investigation. This facility is generally under negative pressure. This subject was discussed with members of the engineering staff who had apparently investigated the possibility of backdrafting in depth. Their investigations did not indicate that backdrafting was a problem. While this building's negative air pressure, combined with the physical proximity of the electric generating facility and variability in climatic conditions, could well provide the condition for backdrafting of contaminated outside air, it can not be determined if such a past event was the cause of worker complaints.

3. Conclusions

In summary, exposure to chemical or other agents (as measured during this evaluation) do not explain worker complaints of dry throat and headaches. These symptoms appear to be mild, transient, and can probably be treated by fresh air and a cool drink. While worker complaints appear to be related to work at the molding machines, symptoms have been experienced in other areas of the Wire Harness area. Air sampling, observation of work practices, and investigation of the materials in use at this location indicate that excessive exposure to chemical agents did not occur on the days of this investigation. It is the opinion of the investigators that the reported symptoms can be explained by one or all of the following: an unidentified agent (chemical or physical), back drafting of contaminated outside air, or group hysteria.

V. RECOMMENDATIONS

1. Evaluate the possibility of contaminated outside air backdrafting into this building. Adequate make-up air is essential to good ventilation and will minimize the possiblity of such backdrafting. Design criteria for make-up air systems are available.[10] The positioning of the air exhaust and intake points should be evaluated and changed if indicated.[11]

2. Continue to provide molding machine operations with portable fans. Worker exposures to volatile emissions from the molding operations will be reduced by directing the air stream past the breathing zone and work area.

VI. REFERENCES

1. E.A. Boettner, et. al. "Analysis of the Volatile Combustion Products of Vinyl Plastics." Journal of Applied Polymer Science 13, 377-91, 1969.

2. S.L. Madorsky, Thermal Degradation of Organic Polymers. Interscience Publishers, N.Y., 1963 pp. 160-167.

3. Vandervort, R., Brooks, S., Health Hazard Evaluation Report 74-24, 92,95-246, December, 1976.

4. Van Houten, R.W., Cudworth, A.I., Irvine, C.H., "Evaluation and Reduction of Air Contaminants Produced by Thermal Cutting and Sealing of PVC Packaging Film." Am. Ind. Hyg. Assoc. J. 35:218-222 (April 1974).

5. Jaeger, R.J.; Hites, R.A. "Pyrolytic Evaporation of the Plasticizer from Polyvinyl Chloride Meat Wrapping Film," Bulletin of Environmental Contamination and Toxicology 11:45-48 (1974).

6. Okawa, M., HHE Report No. 74-96-173, NIOSH, February, 1975.

7. Straub, W., HHE Report No. 74-85-185, NIOSH, April, 1975.

8. Okawa, M., HHE Report No. 75-1-194, NIOSH, May 1975.

9. NIOSH Recommended Standard for Occupational Exposure to Vinyl Chloride, with excerpts from a March 11, 1974 memorandum from Marcus M. Key, Director, National Institute for Occupational Safety and Health to John H. Stender, Assistant Secretary of Labor, Occupational Safety and Health Administration transmitting the NIOSH recommendations.

10. American Conference of Governmental Industrial Hygienists "Industrial Ventilation. A Manual of Recommended Practice". Section 7, 14th Ed. (1976).

11. Clarke, J. H. "Air Flow Around Buildings." Heating, Piping and Air Conditioning, 39,5, May, 1967 pp. 145-154.

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Table I

Summary of Health Complaints Reported in the Wire Harness Area at

Columbus Products Corporation
Columbus, Ohio

March 26, 1976

Case #	Sex	Smoker	Years of Molding Exposure	Dry Mouth	Headache	Other Symptoms	General Comments
1	F	Yes	12	Yes	No	Dizziness, pulmonary congestion	Conditions better since 1971 Worse in cloudy weather.
2	F	Yes	2	Yes	Yes	Itching at mouth	Symptoms increased while on molding machine, but also present on other jobs.
3	F	Yes	10	Yes	Yes	Occasional eye irritation	Varied with the weather. Worse on molding.
4	M	No	6 mos.	No	No	Eye; drowsiness	Symptoms improved when fan set at molder.
5	M	No	4	No	No	Eye; cough; drowsiness	Noted symptoms increased with smell. No symptoms when in plating operation. Symptoms increased when standing over machine. Symptoms decreased with fan and sitting down.
6	F	No	10	Yes	No		Noted "coal gas" smell, increased in cloudy weather all over area. Has never operated molders.
7	F	No	4	No	Yes	Chest pain	Increased symptoms with rain, decreased by leaving area or fan at machine. "Coal gas" smell noted at machine and elsewhere.
8	F	No	8	Yes	No	Hoarse voice	Increased with cloudy, windy day. Symptoms decreases with fresh air, drink.
9	F	No	3 mos.	No	Yes	Dizziness	Foul odor.
10	F	No	10	Yes	No		Symptoms mild. Decreased with chewing gum.

Table II

Summary of Air Sampling for Benzene* at

Columbus Products Corporation
Columbus, Ohio

May 12, 1976

Person/Location	Sample Method	Sample Period	Concentration of Benzene
Near Mold Operator #1	Charcoal Tube	0738-1440	N.D.**
Near Mold Operator #2	Charcoal Tube	0732-1415	N.D.
Mold Operator #1	Detector Tube	1135	N.D.
Mold Operator #2	Detector Tube	0950	N.D.

* OSHA Standard - 30 mg/M^3 as measured by an 8-hour time weighted average sample, 150 mg/M3 during and 10 minute period.

**N.D. - None detected where the lower limit of detection (by the charcoal tube method) is 0.01 mg per sample and the sample volumes were about 18.5 liters, (by the detector tube method) is 48 mg/M^3.

Table III

Summary of Air Sampling for Carbon Monoxide* at

Columbus Products Corporation
Columbus, Ohio

May 12, 1976

Location	Sample Period	Concentrations of Carbon Monoxide
Mold Operator #1	1135	3 ppm **
Mold Operator #2	0950	3 ppm

* OSHA Standard - 50 ppm as measured by an 8-hour time weighted average sample.

**ppm - Parts of carbon monoxide per million parts of contaminated air by volume.

Table IV

Summary of Air Sampling for Hydrogen Chloride* at

Columbus Products Corporation
Columbus, Ohio

May 12, 1976

Person/Location	Sample Method	Sample Period	Concentrations of Hydrogen Chloride
Mold Operator #1	Impinger	0714-1045, 1124-1427	N.D.**
Mold Operator #2	Impinger	0707-1045, 1124-1420	0.07 mg/M^3***
Near Mold Operator #1	Impinger	0801-1440	0.19 mg/M^3
Near Mold Operator #2	Impinger	0809-1415	0.11 mg/M^3
Hankin Station	Impinger	1220-1440	0.11 mg/M^3
Mold Operator #1	Detector Tube	1135	N.D.
Mold Operator #2	Detector Tube	0950	N.D.

* OSHA Standard - 7 mg/M^3

** N.D. - None detected where the lower limit of sensitivity by the impinger method was about 0.02 mg/M^3, and 1.5 mg/M^3 by the detector tube method.

***mg/M^3 - milligrams of hydrogen chloride per cubic meter of air.

Table V

Summary of Air Sampling for Vinyl Chloride Monomer

Columbus Products Corporation
Columbus, Ohio

May 12, 1976

Person	Sample Period	Concentration of Vinyl Chloride
Set-up	0753-1410	N.D.*
Hankin Operator #2	0742-1035, 1121-1414	N.D.
Mold Operator #1	0714-1427	N.D.
Mold Operator #2	0707-1045, 1124-1420	N.D.

* N.D. - None detected where the analytic lower limit of sensitivity is 0.001 milligrams per sample and sample volumes ranged from 17.1 to 20.8 liters.

Table VI

Summary of Psychrometric Measurements at

Columbus Products Corporation
Columbus, Ohio

May 12, 1976

Location	Time	Dry Bulb Temperature (°F)	Globe Temperature (°F)	Wet Bulb Temperature (°F)	Relative Humidity
Mold Operator #2	0849	72	74	57	40
Mold Operator #1	0924	72	75	57	40
Mold Operator #1	1127	77	80	59	35
Mold Operator #2	1201	78	80	61	40
Harness Assembly	1326	80	84	63	40