U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 75-90-236

RUSSELL CORPORATION
ALEXANDER CITY, ALABAMA

NOVEMBER 1975

I. TOXICITY DETERMINATION

It has been determined on the basis of environmental sampling that no health hazard existed from exposure to vinyl chloride resulting from the use of PVC based inks in the screen printing process at Plant #8 of the Russell Corporation. Worker exposures to vinyl chloride were characterized on June 18 and 19 by both area and personal air sampling. No detectable level of vinyl chloride was found in any case. The lower limit of detection for vinyl chloride using approved sampling and analytical methods is approximately 0.25 ppm. A screen cleaning process utilizing mineral spirits has caused skin problems following worker contact. Process changes and personal protective devices are discussed as a means of reducing skin problems in the screen cleaning process.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) Plant #8, Russell Corporation, Alexander City, Alabama
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region IV
d) NIOSH - Region IV

For the purposes of informing the approximately 116 "affected employees" this report shall be posted in a prominent place(s) readily accessible to workers for a period of at least 30 calendar days.

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 of Occupational Safety and Health (NIOSH) received such a request from the employer regarding exposure to polyvinyl chloride-based inks (with the trade name of "Plastisol") at Plant #8, Russell Corporation, Alexander City, Alabama.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

The Russell Corporation is involved in many aspects of textile production. Of the Russell Corporation's 15 plants in Alexander City, Plant #8 is primarily involved in the application of decorative lettering to garments. The majority of the lettering is done with a PVC-containing ink by the screen printing technique.

The PVC-containing inks are received and stored in 55 gallon drums in a storage room adjacent to the main work area. The inks are purchased with the pigments blended in. Workers periodically enter this storage area and transfer the ink from drums (under positive pressure) into trays to be used at the stenciling areas. The less frequently used non-PVC "textile dyes" are also stored in this area.

The screen printing of garments is performed both by hand and by automated machinery. Both types of screen printing involve similar processes: The application of the ink with a broad blade squeegee to a screen which is placed over a stencil and the garment by a "stenciler." Each stenciler is located along one of seven conveyor belts which carry the printed garments through a curing oven. Two of these conveyor belt-oven locations have automated screen printers which can print one garment every four seconds. The production on each conveyor belt-oven line varies because of the custom work performed. Each conveyor belt-oven has from three to five stencilers placing the stenciled garments on the conveyor belt at different rates. The conveyor belt carries the freshly stenciled garments through a curing oven at a temperature of 350°F. Following a garment's passage through the curing oven, it is folded and packaged by a "folder."

The curing ovens are ventilated by exhaust fans into the external environment. The area of the alleged hazard (120' x 176' x 15') is ventilated by eight 48" wall-mounted fans exhausting into the building and six 42" roof fans exhausting in the outside environment. Portable fans were available and utilized at most work stations for the purpose of personal comfort. Contaminant accumulation is expected to be minimal with existing ventilation.

Adjacent to the stenciling area is a screen washing area. The screens are washed manually by one worker on each shift. The screens are partially submerged in a 4' x 2' x 2' tub of mineral spirits and scrubbed with a brush to remove the residual ink. The washer is supplied with gloves and a protective apron.

During the periods of air sampling, June 18 and 19, production was considered to be normal on the first two shifts with 116 employees (supervisory and production) in the area of the alleged hazard. Fourteen workers were also working a third shift during the period of the initial investigation. A third shift is unusual and was discontinued after two weeks. Production associated with each curing oven is highly variable. This is because the stenciling is for custom order. Both PVC based and non-PVC based inks ("tex-dye") are used in stencilling on the automated conveyor-oven lines (ovens #7 and #8) and the conveyor-oven lines servicing the manual stenciling operations (ovens #1-#6).

B. Evaluation Design and Methods

On June 17-19, 1975, NIOSH industrial hygienists conducted an environmental investigation of the area containing the alleged hazard.

A walk through survey of the specified area was conducted on June 17. Representatives of the Russell Corporation and the employees accompanied the investigators and provided information concerning the screen printing process and areas of use of the alleged hazard. While conducting the walk through survey in the screen cleaning area, it was decided that a potential health hazard also existed from the use of mineral spirits.

Air sampling was conducted on June 18 and 19, 1975 during the day shift. Air sampling for vinyl chloride monomer included personal sampling of the potentially exposed workers, and area sampling in the areas where the PVC inks are stored and used. Personal air sampling of the "stencilers" and "folders" was conducted as it was felt that the potential for exposure to vinyl chloride was greatest among these workers. A total of 28 personal air samples were collected using charcoal tubes in series at the breathing zone of the workers. Twenty-four area air samples for vinyl chloride were collected. These areas of sampling included the ink storage room, stenciling area, and folding area. Sampling rates were approximately 50 cc/min. for at least 2.4 hours.

Air sampling for mineral spirits vapor was conducted during the first shifts of June 18 and 19, 1975. Two personal and two area samples were collected on charcoal tubes at a sampling rate of approximately 50 cc/min. for at least 3.6 hours.

Non-directed and directed medical questionnaires were administered to nine employees working in the area of alleged hazard. The OSHA Form 102 was reviewed.

C. Evaluation Criteria

Vinyl chloride (the monomer from which PVC is made) is considered a carcinogenic agent. It is suspected of being 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, "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 were 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.[1]

Acute exposures to high concentrations of petroleum naphthas, a generic name for a group of related compounds including mineral spirits, have been known to produce central nervous system depression. Effects ranging from headache, nausea, inebriation, and stupor to anesthesia and coma have been reported following single acute exposures. Nose, throat or eye irritation may be the first sign of potentially hazardous inhalation exposure. Mineral spirits are primary skin irritant. Prolonged or repeated contact will cause dehydration and defatting of the skin.[2,3] There is currently no federal standard for occupational exposure to mineral spirits. The American Conference of Governmental Industrial Hygienists has recommended an equation for computing threshold values for petroleum distillates for which no specific TLV exists.[4]

$$TLV = \frac{100}{\frac{\%\ Al}{3.6(200 - B.P.^{\circ}C) + 20} + \frac{\%\ Ar}{1.3(200 - B.P.^{\circ}C) + 10}} \text{ ppm}$$

% Al=% aliphatic
% AR=% aromatic
B.P. = boiling point in degrees centigrade

The mineral spirits in use at the Russell Corporation contain less than 8% aromatic hydrocarbons and have a boiling point of approximately 165° C. The computed TLV (assuming a molecular weight of 140) is approximately 744 mg/M^3.

D. Evaluation Results and Discussion

A summary of air sampling data and results for vinyl chloride is presented in Table I.

Twenty-eight personal breathing zone and twenty-four area samples were collected and analyzed for vinyl chloride. No vinyl chloride was detected in any of the samples. The limit of detection for vinyl chloride using approved sampling and analytical methods is approximately 0.25 ppm. Therefore, based on the criteria outlined in Part C, it was determined that no vinyl chloride hazard existed.

A summary of air sampling data and results for mineral spirits vapor is presented in Table II.

Personal breathing zone and area air sampling for mineral spirits vapor detected levels ranging from 137 mg/m^3 to 385 mg/m^3. Based on a lack of complaints of respiratory irritation by those working at the screen cleaning area, and air sampling, it was determined that no hazard existed from inhalation of mineral spirits vapor.

Both screen cleaners reported blistering of the skin following skin contact with the mineral spirits. While it was recognized by the workers that protective gloves would prevent this problem, conventional gloves attained poor worker acceptance because of perspiration accumulation. Subsequent to the NIOSH investigation, Russell Corporation representatives contacted NIOSH for assistance in solving the problem created by skin contact with the mineral spirits.

The solutions that have been considered include:

1) Substitution of the mineral spirits with a solvent which causes less skin irritation, without increasing other potential health hazards.

2) Automated cleaning processes which reduce worker contact with the cleaning solvent.

3) Use of cotton liner gloves, in conjunction with solvent-impervious gloves, as a means of achieving greater worker acceptance of gloves.

4) Accelerated usage of barrier creams formulated to resist organic solvents (when gloves are not in use or under other appropriate conditions). Examples of such products are:

(1) PLY 9 (Milburn Co., 3246 E. Woodbridge, Detroit, Michigan 48207)

(2) West No. 411 (West Chemical Products, 42-16 West St., Long Island City, New York)

(3) Fend S-2 (Mine Safety Appliances Co., Pittsburgh, Pa.)

(4) Kerodex 51 (Ayerst Laboratories, 685 Third Ave., New York, N. Y. 10017)

(5) MAN-O (MAN-O Products, 3710 Floral Ave., Cincinnati, Ohio 45207)

V. REFERENCES

1. NIOSH Recommended Standard for Occupational Exposure to Vinyl Chloride. 1974.

2. API Toxicological Review, Petroleum Naphthas, First Edition, American Petroleum Institute, 1969.

3. Browning, E: Toxicity and Metabolism of Industrial Solvents. London, Elsevier Publishing Company, 1965.

4. Threshold Limit Values for Chemical Substances in Workroom Air Adopted by American Conference of Governmental Industrial Hygienists for 1975.

VI. AUTHORSHIPS AND ACKNOWLEDGMENTS

Report Prepared By : Jack O. Geissert
Industrial Hygienist
Hazard Evaluation Services Branch
Cincinnati, Ohio

Originating Office : Jerome P. Flesch, Chief
Hazard Evaluation Services Branch
Cincinnati, Ohio

Acknowledgments

Analytical Laboratory Services: Joe Lebrizzi
David E. Rushing
Agricultural Research Analytical Laboratory Program
Western Area Occupational Health Laboratory
Salt Lake City, Utah

Environmental Evaluation: John R. Kominsky
Industrial Hygienist
Hazard Evaluation Services Branch
Cincinnati, Ohio

Table I: Results of Environmental Sampling for Vinyl Chloride on June 18-19, 1975

Sample Number	Type	Location/Job	Sample Duration (hr.)	Sample Volume (liters)	Vinyl Chloride Environmental Concentration (ppm)
1	Area	Oven Outlet #5	3.5	14.5	N.D.*
2	"	Oven Outlet #7	3.1	7.8	N.D.
3	"	Oven Outlet #7	3.5	10.5	N.D.
5	"	Oven Inlet #7	3.2	10.3	N.D.
6	"	Oven Inlet #3	3.6	13.0	N.D.
7	Personal	#7 Folder	3.6	13.4	N.D.
8	"	#3 Folder	3.8	13.3	N.D.
9	"	#8 Folder	3.6	12.0	N.D.
10	"	#5 Stenciler	3.5	12.9	N.D.
11	"	#5 Folder	3.5	11.9	N.D.
12	"	#1 Stenciler	2.8	12.5	N.D.
13	"	#7 Stenciler	3.5	10.6	N.D.
14	"	#8 L. Stenciler	3.6	11.4	N.D.
15	Area	Oven Inlet #8	3.4	8.9	N.D.
17	"	Oven Inlet #5	3.5	12.4	N.D.
18	"	Oven Inlet #7	3.2	4.3	N.D.
19	"	Oven Outlet #5	4.6	10.6	N.D.
20	"	Oven Outlet #3	2.5	9.3	N.D.
21	"	Oven Inlet #5	4.1	5.8	N.D.
22	"	Oven Inlet #7	3.0	9.6	N.D.
23	Personal	#7 Stenciler	3.0	10.1	N.D.
24	"	#3 Folder	2.9	10.0	N.D.
25	"	#1 Stenciler	2.6	8.4	N.D.

* N.D. None Detected with a lower limit of detection, utilizing approved sampling and analytic techniques, at approximately 0.25 ppm.

Table I: Results of Environmental Sampling for Vinyl Chloride (page 2)

Sample Number	Type	Location/Job	Sample Duration (hr.)	Sample Volume (liters)	Vinyl Chloride Environmental Concentration (ppm)
26	Personal	#8 Stenciler	3.0	9.4	N.D.
27	"	#5 Stenciler	3.1	10.9	N.D.
30	"	#8 Stenciler	3.0	10.1	N.D.
31	"	#5 Folder	3.2	10.6	N.D.
32	"	#7 Folder	3.1	11.8	N.D.
33	Area	Oven Inlet #8	2.4	6.5	N.D.
40	"	Oven Inlet #5	4.2	15.0	N.D.
41	"	Oven Inlet #8	4.3	16.9	N.D.
42	"	Oven Outlet #3	4.4	13.5	N.D.
43	Personal	#1 Stenciler	4.7	14.8	N.D.
44	"	#3 Folder	4.7	16.6	N.D.
45	"	#8 L. Stenciler	3.8	11.5	N.D.
46	Area	Oven Outlet #7	3.5	9.5	N.D.
47	Personal	#5 Stenciler	4.5	16.4	N.D.
48	"	#7 Folder	4.0	13.5	N.D.
49	Area	Oven Outlet #5	>2.5?	12.3	N.D.
50	Personal	#5 Folder	4.7	15.2	N.D.
51	"	#7 Stenciler	3.6	12.0	N.D.
52	"	#8 R. Stenciler	4.1	11.8	N.D.
53	Area	Oven Inlet #7	3.1	11.5	N.D.
54	Personal	#8 Stenciler	4.0	6.8	N.D.
55	"	#7 Stenciler	2.6	7.6	N.D.
56	"	#8 Stenciler	2.5	7.0	N.D.
57	Area	PVC Storage Room	4.2	14.9	N.D.

Table I: Results of Environmental Sampling for Vinyl Chloride (page 3)

Sample Number	Type	Location/Job	Sample Duration (hr.)	Sample Volume (liters)	Vinyl Chloride Environmental Concentration (ppm)
58	Area	Oven Outlet #7	2.4	7.0	N.D.
59	Personal	#7 Folder	2.4	7.5	N.D.
60	Area	Oven Outlet #5	2.4	8.2	N.D.
61	"	PVC Storage Room	4.2	11.7	N.D.
62	"	Oven Inlet #7	2.8	10.3	N.D.

Table II: Results of Environmental Sampling for Mineral Spirits on June 18-19, 1975

Sample Number	Type	Location/Job	Sample Duration (hr.)	Sample Volume (liters)	Mineral Spirits Environmental Concentration (mg/m^3)
4	Personal	Screen Cleaner	3.6	28.6	385
16	Area	Screen Cleaning	3.6	13.6	149
28	"	Screen Cleaning	5.0	5.8	336
29	Personal	Screen Cleaner	3.4	9.05	137