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DUTCH GIRL CLEANERS
SPRINGDALE, OHIO

NIOSH INVESTIGATORS:
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I. SUMMARY

On October 4, 1985, the National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance from the Health Commissioner of the City of Springdale, Ohio to investigate perchloroethylene odors from a commercial dry cleaners located in a small, enclosed shopping mall.

On October 25, 1985, NIOSH investigators conducted an initial environmental survey of Dutch Girl Cleaners, Springdale, Ohio to gather information on the dry cleaning process, work practices, and the heating, ventilation, and air-conditioning (HVAC) systems present in the building. On October 30, 1985, a follow-up visit was made to collect air samples for perchloroethylene from the following shopping center locations: Dutch Girl Cleaners; Thriftway employee training room; Thriftway stockroom; and enclosed pedestrian mall.

Sample analysis revealed perchloroethylene concentrations ranging from 79 to 135 milligrams per cubic meter (mg/M^3) for an 8-hour time-weighted average (TWA). The current Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) for perchloroethylene is $670 \text{ mg}/\text{M}^3$ for an 8-hour TWA. Because perchloroethylene has caused liver cancer in laboratory mice, NIOSH recommends that exposures be kept to the lowest feasible level and that perchloroethylene be handled in the workplace as if it were a human carcinogen.¹

General ventilation of Dutch Girl Cleaners is provided by a ceiling-mounted, 24-inch diameter, fan which exhausts air into a plenum formed by the suspended ceiling and the roof of the building. This plenum, shared by the Thriftway employee training room, Thriftway stock room and Dutch Girl Cleaners, accounts for the uniform distribution of perchloroethylene vapors in these areas.

On the basis of the data obtained in this investigation, it has been determined that a potential health hazard does exist from airborne exposure to perchloroethylene. Recommendations to improve the ventilation system are contained in Section VII of this report.

KEYWORDS: SIC 7216 (Commercial dry cleaners); tetrachloroethylene

II. INTRODUCTION

On October 4, 1985, the National Institute for Occupational Safety and Health (NIOSH) received a technical assistance request from the Health Commissioner, Springdale, Ohio. The Commissioner requested NIOSH to investigate several complaints, received by his department, concerning "odors" and "fumes" (perchloroethylene vapors) originating from Dutch Girl Cleaners, a small commercial cleaners located in the Thriftway Mini-Mall, Springdale, Ohio.

An initial walk-through survey of the cleaners and the mini-mall was performed on October 28, 1985, by NIOSH investigators. Accompanied by the Health Commissioner, the NIOSH investigators obtained information on the dry-to-dry cleaning process, the solvent recovery system, and the heating, ventilation, and air-conditioning (HVAC) systems servicing both the dry cleaners and the remainder of the building. The managers of both the cleaners and the adjacent Thriftway food store were interviewed to obtain a historical perspective on the odor complaints as well as information on work activities in the building. One Thriftway employee, who had experienced the periodic episodes of strong perchloroethylene odors, was also contacted.

During the follow-up survey on October 30, 1985, four full-shift area samples for perchloroethylene were collected at various locations in the mall. Using charcoal tubes, the air samples were obtained from the dry cleaning store, the Thriftway employee training room, a Thriftway storeroom and the pedestrian mall in front of the cleaners.

III. BACKGROUND

A. Chronology

Dutch Girl Cleaners, a small commercial dry cleaner situated in the Thriftway Mini-mall, Springdale, Ohio, is one of three located in the greater Cincinnati area. An occupant of the mall for approximately 5 years, Dutch Girl shares the building with a grocery, a bakery, and a drug store.

The Springdale Health Department requested technical assistance from NIOSH after receiving several complaints from both employees and customers of the mini-mall over the past year. These complaints described perchloroethylene odors detectable periodically in the grocery store, the Thriftway employee training room, and a Thriftway stockroom.

The dry cleaner occupies approximately 1400 square feet in the center section of the mini-mall. Two firewalls effectively divide the grocery store (east end) and the drug store (west end) from the middle section of the structure. A Thriftway employee training room and stockroom occupy the remaining two rooms in the building's middle section. Extending along the north side is an enclosed pedestrian walkway which also contains a small, independently run bakery.

Dutch Girl Cleaners utilizes a dry-to-dry perchloroethylene system (a single machine is used for washing, solvent extraction, and drying). Twin Permac R308 dry-to-dry units, manufactured by Bohler and Weber KG, are used at this location. Perchloroethylene usage is approximately 100 gallons per month. A solvent recovery system, using a steam regenerated charcoal bed, is connected to both dry-to-dry units and recovers approximately 2.5 gallons of solvent daily (76% recovery rate).

B. Heating, Ventilation, and Air Conditioning (HVAC) Systems.

Description.

Each of the three rooms in the middle section of the building is equipped with individual rooftop HVAC systems. The following summarizes these ventilation systems (excluding the independent HVAC systems supplying the grocery and drug stores):

- | | | |
|----|----------------------------------|--|
| 1) | Thriftway Employee Training Room | Natural gas-forced air HVAC; 1 horsepower (h.p.); 112,500 BTU Bonnet Capacity, Manufactured by the John Zink Company, Tulsa, OK. |
| 2) | Thriftway Stock Room | Same unit as above. |
| 3) | Dutch Girl Dry Cleaners | Natural gas-forced air HVAC; 1.5 h.p.; 168,750 BTU Bonnet Capacity; John Zink Company, Tulsa, OK. |
- Powair-X-Hauster Roof Ventilator; .17 h.p.; single phase.

According to the Dutch Girl manager the Powair-X-Hauster roof ventilator needed repair and the gas-fired, forced air HVAC system was used infrequently. In addition to these two systems, an exhaust fan had been installed in the suspended ceiling at the rear of the dry cleaners by the store manager. During both the initial and follow-up visits this fan was observed exhausting air from the dry cleaners into the plenum formed between the ceiling and roof.

A solvent recovery system, using a steam regenerated charcoal bed, had been installed 3 years ago on both dry-to-dry cleaning units. Capable of recovering up to 25 gallons of perchloroethylene per day, the system was currently salvaging 2.5 gallons per day. The system's exhaust vent, consisting of a 5 inch metal duct, had visible corrosion which permitted steam and solvent to escape into the work area during the recovery process.

IV. EVALUATION DESIGN

Area air samples were taken for perchloroethylene in the following four locations at the Thriftway Mini-mall:

- 1) Thriftway Employee Training Room
- 2) Dutch Girl Cleaners
- 3) Thriftway Stock Room
- 4) Pedestrian Aisle (in front of dry cleaners)

Perchloroethylene vapor was collected on SKC Lot No. 120 charcoal tubes connected to sampling pumps operating at approximately 0.1 liters per minute (lpm). The sampling period per charcoal tube was approximately 100 minutes (10 liters) and four samples were taken at each location. Total sample time and volume, per location, were approximately 400 minutes and 40 liters respectively.

Sample analysis was performed by gas chromatography with flame ionization detection (GC/FID) according to NIOSH Method S-335.² The limit of detection is 0.01 milligrams per cubic meter (mg/M³).

V. EVALUATION CRITERIA

A. Tetrachloroethylene

Tetrachloroethylene (more commonly known as perchloroethylene) is a clear, colorless, non-flammable liquid with an etheral odor detectable around 50 parts per million (ppm). Repeated contact may cause a dry, scaly, and fissured dermatitis with high concentrations producing eye and nose irritation. Acute exposure has caused effects on the central nervous system, mucous membranes, eyes, kidneys, liver, heart, lungs, and skin. Symptoms of overexposure include headache, dizziness, vertigo, and unconsciousness.⁵ While perchloroethylene can be metabolized and eliminated from the body, the process is relatively slow. The substance is deposited in body fat and the biologic half-life in man is estimated at six days.¹

The National Cancer Institute (NCI), in a long term animal study, has demonstrated that perchloroethylene, administered by gavage, causes hepatocellular carcinoma (liver cancer) in laboratory mice of both sexes.⁶ In a NIOSH retrospective cohort mortality study of 1,690 dry cleaner workers having potential exposure to perchloroethylene, no deaths due to liver cancer were observed.⁷ NIOSH considers substances that cause cancer in experimental animals, however, to also pose a potential cancer risk in man. While safe levels of exposure to carcinogens have not been demonstrated, the probability of developing cancer is lowered with decreasing exposure to carcinogens. In this light, NIOSH recommends that occupational exposure to perchloroethylene be minimized while its carcinogenic potential in the workplace is further evaluated.

B. Environmental

The primary air contamination criteria considered in this study, shown in Table I, were: 1) NIOSH Current Intelligence Bulletin 20 on Tetrachloroethylene (perchloroethylene), 2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV*s)⁴, 3) the U.S. Department of Labor General Industry Standards³, and 4) the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62-1981, Ventilation for Acceptable Indoor Air Quality. The first three sources provide environmental limits based on airborne concentrations to which employees may be occupationally exposed in the workplace up to 10 hours a day, 40 hours per week without adverse health effects. Because of wide variations in individual susceptibility, a small percentage of employees may experience discomfort from perchloroethylene at concentrations at or below these recommended limits. The ASHRAE guidelines specify indoor air quality and minimum ventilation rates which should be acceptable to human occupants and not impair health.

Table I

EVALUATION CRITERIA

SOURCE	PERCHLOROETHYLENE (mg/M ³) ^a	
	8-HOUR TWA	STEL/CEILING LIMIT ^b
NIOSH	c	c
ACGIH	1,340 (STEL)	335
OSHA	1,340 (CEILING)	670
ASHRAE	-	d

- a) Milligrams of perchloroethylene per cubic meter of air.
- b) Short-term exposure limit (STEL) is the maximum allowable concentration to which employees can be exposed during a period of up to 15 minutes. No more than four excursions, with at least 60 minutes between exposure periods, are permitted each day. The ceiling limit, as used by OSHA, is the permissible exposure level for one 15 minute period.
- c) NIOSH recommends that exposures be minimized and concentrations maintained at the lowest feasible level.
- d) Assuming continuous exposure to the general population, the concentration of any contaminant should not exceed 1/10 of the OSHA limit used in industry.

NIOSH Recommendations and ACGIH TLV*s, based on more recent information, are often lower than the corresponding OSHA standard, which, in some instances, may be required to consider the feasibility of controlling exposures in various industries where the agents are used. NIOSH recommendations, by contrast, are based primarily on concerns relating to prevention of occupational disease. Thus, the current OSHA standard for occupational exposure to perchloroethylene (670 mg/M³, 8-hour TWA) may not provide adequate protection from potential carcinogenic effects since the limit was selected to prevent toxic effects other than cancer.¹ In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted, however, that industry is legally required to meet those levels specified by an OSHA standard.

VI. RESULTS

Table II summarizes the results of the four area air samples taken in the Thriftway Mini-mall. Results of analysis for airborne levels of perchloroethylene, expressed as 8-hour time-weighted averages, were: Dutch Girl Cleaners, 135 mg/M³; Thriftway Employee Training Room, 126 mg/M³; Thriftway stockroom, 134 mg/M³; Pedestrian Aisle, 79 mg/M³. Although these concentrations are below the OSHA 8-hour TWA standard of 670 mg/M³, NIOSH recommends that exposure to perchloroethylene, due to its carcinogenic potential, be kept to the lowest feasible level.

Perchloroethylene concentrations measured in the non-industrial areas of the building (employee training room, stock room and the public mall area) exceeded the indoor air quality guideline suggested by ASHRAE.

VII. DISCUSSION AND CONCLUSIONS

General ventilation of the dry cleaner is achieved solely by the use of an "attic" type exhaust fan mounted in the ceiling at the rear of the store. Purchased at a local department store and installed by the Dutch Girl manager during the past summer to remove heat generated by equipment, the 24 inch diameter fan is not ducted to the outside. Instead, exhaust air is vented into the plenum formed by the suspended ceiling and the roof. This overhead space is shared by the employee training room, a stock room, and the dry cleaner. As expected, area samples for perchloroethylene from these three areas were very similar (8-hour TWA range 126-135 mg/m³).

A low-cubic feet per minute (CFM) duct, floor mounted near the perchloroethylene absorber/recovery unit, is designed to collect the heavier than air solvent vapors. It is questionable whether the density of the perchloroethylene/air mixture is sufficiently great to permit a floor mounted system to work effectively. It was also observed that the exhaust duct, downstream of the absorber blower, was badly corroded, allowing solvent vapor to reenter the room air.

Two additional ventilation systems present in the dry cleaners were not functioning during this survey. A roof mounted ventilating fan, manufactured by Powair-X-Hauster, needed repair and had not run for several months. The second device, a roof HVAC unit, was operational but not routinely used by the dry cleaner manager.

The ceiling fan, which vents exhaust air from the cleaners into the plenum space, is the predominant reason for the uniformly high levels of perchloroethylene in adjacent areas of the building. Compounding the problem is the absence, through neglect and non-use, of additional ventilation for the various dry cleaning operations.

Because of inadequate ventilation, a potential health hazard does exist from airborne exposure to perchloroethylene. This solvent, because of its potential carcinogenicity, should be handled in the work area as if it were a human carcinogen and exposures maintained at lowest feasible levels. The current OSHA standard for occupational exposure to perchloroethylene (670 mg/M³, 8-hour TWA) may not provide adequate protection from potential carcinogenic effects because this level was selected to prevent toxic effects other than cancer.¹

VIII. RECOMMENDATIONS

1. Use of the ceiling fan, located in the rear of the dry cleaners, should be discontinued until such time as the exhaust air can be vented outside the building and not recirculated into the plenum.
2. The roof ventilator (manufactured by Powair-X-Hauster) should be repaired and operated during working hours.
3. The dry cleaners HVAC unit (manufactured by John Zink and Co.) should be operated during working hours.
4. Corroded sections of the vent from the perchloroethylene absorber bed should be replaced. In addition, the vent should exhaust through the roof and be free from further obstructions and leaks.
5. Development of a maintenance check list is recommended for the ventilation systems and the perchloroethylene recovery unit.

IX. REFERENCES

1. National Institute for Occupational Safety and Health. Current Intelligence Bulletin, Tetrachloroethylene (Perchloroethylene) #20. Cincinnati, Ohio: National Institute for Occupational Safety and Health, January 20, 1978. (DHEW Publication No. (NIOSH) 79-146).
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X.

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1. Springdale Health Department
2. Dutch Girl Cleaners
3. Thriftway Food-Drug
4. NIOSH, Region V
5. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE II

Results of Environmental Air Samples for Perchloroethylene

Thriftway Mini-Mall
Springdale, Ohio
HETA 86-005

October 30, 1985

Perchloroethylene

Air Sample Location	Sample Volume (liters)	Sample Period	Concentration 8-Hour TWA ^a (mg/M ³) ^b
Thriftway Training Room (top of video monitor)	41.8	0835-1511	126
Dry Cleaners (rear of store)	38.8	0840-1526	135
Thriftway Storeroom (west wall)	40.5	0845-1530	134
Pedestrian Aisle (in front of cleaners)	41.8	0850-1532	79

Evaluation Criteria:

NIOSH	c
OSHA Permissible Exposure Limit	670
ACGIH Threshold Limit Value	335
ASHRAE Indoor Air Quality Guideline	d

a. Time-Weighted Average.

b. Milligrams per cubic meter of air.

c. Maintain levels of perchloroethylene as low as possible to minimize employee exposure.

d. Assuming continuous exposure to the general population, the concentration of any contaminant should not exceed 1/10 of the OSHA limit used in industry.