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INDUSTRIAL HYGIENE REPORT
PERCHLOROETHYLENE

at

Janet Davis Cleaners
3645 West Maple Street (Birmingham)
Detroit, Michigan 48207

IWS-71.37

SURVEY CONDUCTED BY:
Dennis R. Roberts

DATE OF SURVEY:
May 18, 1979

REPORT WRITTEN BY:
Dennis R. Roberts

DATE OF REPORT:
July 15, 1980

Industrial Hygiene Section
Industry-wide Studies Branch
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2

ABSTRACT

An industrial hygiene survey of a Michigan dry cleaning facility using perchloroethylene (PCE) was conducted in May 1979. Air samples were collected using battery-operated pumps and charcoal tubes. The dry cleaner/spotter's average exposure to PCE was 19 ppm and his 5-minute peak exposures during clothing transfer ranged from 42 to 117 ppm. A 15-minute peak sample was 37 ppm.

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) is required under Section 20(a)7 of the Occupational Safety and Health Act of 1970 to conduct and publish industrywide studies of the effect of chronic or low level exposure to industrial materials, processes, and stresses on the potential for illness, disease, or loss of functional capacity in aging adults.¹ The industrywide study of workers using perchloroethylene (PCE) was initiated in response to a long-term study reported by the National Cancer Institute (NCI) in October 1977 demonstrating PCE to be carcinogenic in laboratory mice.² The results of this experiment were similar to those seen in studies with trichloroethylene, i.e., an increase in hepatocellular carcinoma in mice. Substances that cause cancer in experimental animals must be considered potentially capable of inducing cancer in man. Although a safe threshold limit for exposure to carcinogenic substances has not been shown, the probability of cancer development may be lessened by decreasing exposure. To date, the effects on humans from long-term low level exposure to PCE is unknown.

In January 1978, NIOSH recommended that PCE in the work place be handled as if it were a human carcinogen (see Attachment I). This was an interim recommendation, pending further study of the carcinogenic potential of PCE in the work place. This study will assess the health effects from exposure to PCE by analysis of cause specific mortality among an identified group of dry cleaning workers. A cause of death for each individual in the cohort will be determined retrospectively and the observed deaths will be compared to those expected based on a matched control population. The industrial hygiene evaluation at this facility will supplement the mortality study by documenting the extent of exposure to PCE and historic changes in dry cleaning techniques and work practices.

DESCRIPTION OF THE FACILITY AND WORK FORCE

Janet Davis Cleaners has been using PCE as a dry cleaning solvent since cleaning began at this Birmingham location in 1965. The facility is housed in a one-story building with dimensions of approximately 40 feet by 95 feet. About 25 gallons of PCE are consumed each week during the dry cleaning of about 3500 lbs of clothing. The work force of seventeen includes the dry cleaner/spotter, the spotter's helper, two counter and quick-clean operators, a silk finisher, a wool presser, an inspector, a seamstress, eight counter persons, and the manager.

DESCRIPTION OF PROCESS

Process equipment includes a 50 lb capacity washer and a 50 lb capacity dryer for the routine dry cleaning volume and a 25 lb capacity "dry-to-dry unit" (quick-clean) for processing fast pick-up orders. For fast

pick-up or quick-clean garments the clothing is loaded into the unit and agitated in PCE. After the PCE is drained, excess PCE adhering to the garments is extracted by centrifugal spinning and also drained. The dry-to-dry unit eliminates the need to transfer "wet" clothing from a washer unit into a dryer and as such only dry clothes are handled. PCE extracted following the washing cycle in the "dry-to-dry" unit is piped to a solvent maintenance system where filtering takes place. The filters are replaced after every 10,000 lbs of dry cleaning. There are about 50 cleaning cycles per week in the quick-clean unit.

For the routine dry cleaning the processing is performed in the separate washer and dryer system. The clothing is loaded into the washer, and agitated in PCE for 15 minutes. The PCE is drained and excess PCE adhering to the garments is extracted by centrifugal spinning for 5 minutes and also drained. The dry cleaner then manually transfers the clothes into the dryer. The transfer operation takes about a minute and the clothes are dried for 15 minutes, followed by a 5 minute cooling cycle. There are about 65 washing-drying cycles per week in this system. PCE extracted following the washing cycle is piped to a solvent maintenance system where demucking (filtering) and cooking (distilling) takes place. Backwashing of the filter and distilling the PCE for reuse is done about 3 times weekly or after every 1000 lbs of dry cleaning. All process equipment is vented through a charcoal adsorber. Bulk deliveries of PCE are made by truck when needed.

DESCRIPTION OF PAST EXPOSURES

Air samples for PCE were collected by the Michigan Department of Health in 1978, but the results were not available. The dry cleaner/spotter felt that exposures to PCE had not varied much over the years since the same dry cleaning equipment has been used and the volume of business has remained fairly stable.

DESCRIPTION OF MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAMS

There are first aid supplies on the premises, but there is no one with formal first aid training. There is a routine maintenance program twice a year to inspect gaskets and seals and check for leaks. Respiratory protection is available for use during emergency situations; however, the respirator components are not NIOSH-approved.

DESCRIPTION OF SURVEY METHODS

Personal air samples were collected in the breathing zones of the dry cleaner/spotter, inspector, front counter and quick-cleaner operator, and pressers using 150 milligram SKC, Inc. activated charcoal tubes. Area samples were collected at the front counter, and in the dry cleaning

area. Peak samples were also collected in the breathing zone of the dry cleaner over five and fifteen minute periods. During this time, about a minute was spent loading and unloading the washer; the remainder of the time was spent doing spotting or hanging clothes. The sampling pumps used were MDA Accuhalers, which were calibrated at a flow rate of 20 milliliters per minute for personal and area samples and 100 milliliters per minute for peak samples. The air samples were analyzed using NIOSH Method Number P&CAM 127. The samples were desorbed with carbon disulfide and analyzed by a gas chromatograph equipped with a flame ionization detector. No other substances were observed in significant quantities in the analysis. A Turner Model L9-1157 halide torch was used to detect sources of PCE leaks. Temperature and relative humidity measurements were made with an Environmental Tectonics Corporation Model CP-147 Psychrometer. Ventilation air velocities were measured with an Alnor type 8100 velometer.

RESULTS AND DISCUSSION

The day of this survey was typical at this facility. Five loads were processed at the quick-clean station and in the routine cleaning area eight loads of clothing were dry cleaned with dry cleaning completed at 1:06 p.m. The results of air samples collected for PCE are reported in Table 1. During the 341 minutes of dry cleaning, the dry cleaner/spotter's average exposure was 19 parts of PCE per million parts of air (ppm). The average PCE exposures to two pressers during this time were 2.8 and 9.2 ppm and was 12 ppm for the dry cleaner/spotter's helper. The front counter and quick-clean operator's average PCE exposure was 13 ppm. Average PCE concentrations in the dry cleaning area and front counter were 10 and 20 ppm, respectively. The PCE concentrations of three 5-minute peak samples collected during garment transfer were 117, 75, and 42 ppm; a 15-minute peak sample was 37 ppm. The exhaust ventilation through the washer measured 150 feet per minute with the door open and there were leaks detected with the halide torch with the door closed. Temperature and relative humidity readings are reported in Table 2. Dry bulb temperatures ranged from 21.7 to 29.4 °C with the relative humidity varying between 25 and 40 percent.

CONCLUSIONS AND RECOMMENDATIONS

The current Occupational Safety and Health Administration (OSHA) standard for occupational exposure to PCE was originally adopted in August 1971. The permissible eight hour time-weighted average (TWA) concentration is 100 ppm. The acceptable ceiling concentration is 200 ppm, not to exceed a maximum peak of 300 ppm for 5 minutes in any 3-hour period. In July 1976, NIOSH recommended that no employees be exposed to PCE in excess of 50 ppm, determined as a TWA for up to a 10-hour day, 40-hour work week, and also recommended that a ceiling concentration of 100 ppm as determined by 15-minute samples, twice daily, not be exceeded. The OSHA standard or the NIOSH recommendation may not provide adequate protection from the potential carcinogenic effects because they

were selected to prevent toxic effects other than cancer (i.e. liver and kidney damage, irritation of the eyes and upper respiratory tract, central nervous system depression, etc.).

The results of the sampling conducted on May 18, 1979 indicate that exposures to PCE are well within current standards. However, since the question of PCE being a carcinogen has not as yet been answered, it is recommended that exposure to PCE be limited as much as possible. Also, all requirements of the Michigan Department of Public Health for Class IV Dry Cleaning Establishments should be followed.

Enclosed as Attachment III is the NIOSH Recommended Standard for Occupational Exposure to Tetrachloroethylene (PCE). Recommendations in this attachment as well as some of the Michigan Department of Public Health provisions include:

1. Preplacement physical examinations.
2. All dry cleaning machines and recovery units (dryer) should be equipped with a unit blower capable of providing an indraft velocity through the loading door of 100 feet per minute for each square foot of door opening. The blower should be ducted to a minimum point 5 feet above the roof of the building, and adjacent parapet walls or adjacent buildings. All dry cleaning systems should be installed so as to prevent escape of substantially any vapors into the atmosphere of the dry cleaning room.
3. Respiratory protection for use during emergencies, such as spill clean-up. A NIOSH-approved chemical cartridge respirator (see Attachment IV, NIOSH Certified Equipment List, DHEW (NIOSH) Pub. No. 79-107) should be obtained.
4. Protective clothing to prevent skin contact (i.e. gloves, which are impervious to PCE, worn during transfer of garments. An IAPA memorandum rates polyvinyl alcohol gloves as excellent for use with PCE).
5. Informing all employees as to the hazards, relevant symptoms, effects of overexposure to, and the precautions concerning the safe use and handling of PCE.
6. Storage containers, equipment, piping, and valves should be checked daily for leakage and repaired as needed such that no loss of solvent or solvent vapors may occur.
7. Recovered solvent should be piped directly to the base tank of the dry cleaning machine and all residues containing solvent should be disposed of so as not to create a health hazard or nuisance.

BIBLIOGRAPHY

1. Williams-Steiger Occupational Safety and Health Act of 1970, Public Law 91-596, 91st Congress, S.2193, December 29, 1970.
2. Bioassay of Tetrachloroethylene for Possible Carcinogenicity, DHEW Publication No. (NIH) 77-813, U.S. Department of Health, Education, and Welfare, Public Health Service, National Institute of Health, National Cancer Institute, October 1977.
3. Current Intelligence Bulletin 20, Tetrachloroethylene (perchloroethylene) DHEW (NIOSH) Publication No. 78-112. U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, January 1978.
4. NIOSH Manual of Analytical Methods, DHEW (NIOSH) Publication No. 77-157-A, C. U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, April 1977.
5. General Industry Standards, U.S. Department of Labor, Occupational Safety and Health Administration, OSHA 2206, Revised November 7, 1978, GPO Stock No. 029-015-00054-6.
6. Criteria for a recommended standard . . . Occupational Exposure to Tetrachloroethylene (perchloroethylene). HEW (NIOSH) Publication No. 76-185. U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, July 1976.
7. Technical Services Memorandum #8, Glove Selection Chart, Industrial Accident Prevention Association, Toronto, Canada.

Table 1

Perchloroethylene Exposures at Janet Davis Cleaners
(Birmingham) Detroit, Michigan on 5/18/79

Sampling Time	Sample Description	Concentration (ppm)
0725-1306	Dry Cleaner/Spotter	19
0731-1314	Presser (A)	2.8
0722-1302	Presser (B)	9.2
0800-1311	Front Counter and Quick-Clean Operator	13
0731-1306	Dry Cleaner/Spotter's Helper	12
0745-1318	Inspector	8.6
0739-1304	Area - Dry Cleaning Station	10
0759-1316	Area - Front Counter	20
0831-0836	Peak Sample During Transfer	117
1132-1137	Peak Sample During Transfer	75
1240-1245	Peak Sample During Transfer	42
	(Average of 5-minute peak samples is 78 ppm)	
1000-1015	Peak Sample During Transfer	37

Table 2

Temperature and Relative Humidity Readings at
Janet Davis Cleaners (Birmingham) Detroit, Michigan on 5/18/79

Time	Temperature, °C		% Relative Humidity
	Dry Bulb	Wet Bulb	
0800	21.7	13.9	40
0900	23.3	13.9	32
1000	23.3	13.9	32
1100	25.0	15.0	34
1200	26.7	15.6	30
1300	29.4	16.7	25

ATTACHMENT II
JANET DAVIS CLEANERS (BIRMINGHAM)
PLANT LAYOUT

