INDUSTRIAL HYGIENE REPORT
PERCHLOROETHYLENE

Fremont Laundry and Dry Cleaners
990 Villa Street
Mountain View, California 94040

SURVEY CONDUCTED BY:
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DATE OF SURVEY:
July 24, 1978

REPORT WRITTEN BY:
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Industrial Hygiene Section
Industry-wide Studies Branch
Division of Surveillance, Hazard Evaluations, and Field Studies
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Exposures to perchloroethylene (PCE) were studied in a dry cleaning facility (SIC-7216) in Mountain View, California. Air samples were collected using battery operated pumps and charcoal tubes. Employee exposure to airborne PCE concentrations in the dry cleaning area ranged from 21 to 30 parts per million. Sampling was incomplete due to a washing unit breakdown. The author concludes that PCE concentrations at this facility are well within the current standards. Since the carcinogenic potential of PCE has not been established, exposure to the compound should be limited as much as possible.

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PURPOSE OF SURVEY:	This survey is part of industrywide mortality and industrial hygiene studies of dry cleaning workers exposed to perchloroethylene. Current exposure levels of perchloroethylene were determined.
EMPLOYER REPRESENTATIVE:	Robert W. Austen President (415) 967-5707
EMPLOYEE REPRESENTATIVE:	No union.
STANDARD INDUSTRIAL CLASSIFICATION OF PLANT:	7216

ABSTRACT

An industrial hygiene survey of a California dry cleaning facility using perchloroethylene (PCE) was conducted in July 1978. Air samples were collected using battery operated pumps and charcoal tubes. Employee exposures to airborne concentrations in the dry cleaning area ranged from 21 to 30 ppm of PCE. However, due to the washing unit breaking down in the first hour, only three loads of clothing were cleaned, and sampling was terminated after six hours.

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 (dry cleaners) was initiated in response to a long-term study reported by the National Cancer Institute (NCI) in October 1977 demonstrating perchloroethylene (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 are unknown.

In January 1978, NIOSH recommended that PCE in the workplace be handled as if it were a human carcinogen (see Attachment I).[3] This was an interim recommendation, pending further study of the carcinogenic potential of PCE in the workplace. 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 WORKFORCE

Fremont Laundry & Dry Cleaners (formerly Austin's Linen & Garment) has been using PCE since it began dry cleaning in 1948, and has been at this location since 1964. The facility is housed in a building with dimensions of approximately 25 meters by 40 meters with a 10 meter high ceiling (see Attachment II). The dry cleaning area, which has partitions on two sides, is in the rear of the building adjacent to the loading dock. Currently about 225 to 450 kilograms (kg) of clothing are dry cleaned daily with about 114 liters of PCE consumed weekly. Although there are 20 fulltime employees working an 8-hour shift 5 days per week, only one employee (dry cleaner) is directly involved with dry cleaning, the remaining 19 work in the laundry area. The dry cleaner presses and spots as well as operates the demucker and cooker. A mechanic is briefly in the dry cleaning area as he performs one of his daily duties which is lubricating the facility's machinery.

DESCRIPTION OF PROCESS

Process equipment includes a 23 kg capacity washer and two 23 kg capacity dryers. Clothing is loaded into the washer, and agitated in PCE. After the PCE is drained, excess PCE adhering to the garments is extracted by centrifugal spinning and then drained. This washing-extracting cycle lasts about 10 minutes, after which the dry cleaner manually transfers the garments into one of the dryers. The transfer operation takes about 30 seconds and the clothes are dried for about 30 minutes. There are normally 10 to 20 washing-drying cycles per day. PCE drained following the washing-extracting cycle is piped to a solvent maintenance unit where the used solvent is demucked (filtered) and cooked (distilled). Each day prior to the first run, activated charcoal, diatomaceous silica, odor control, fabric softener, and PCE are added to the washer and drained to the cooker (still) which operates during the full shift reclaiming PCE for reuse. On Saturdays the filter is dried and dumped in the trash. All process equipment is vented through a charcoal adsorber and out through the roof. Bulk deliveries of PCE are made by truck when needed.

DESCRIPTION OF PAST EXPOSURES

Air samples for PCE have never previously been collected, and management had no idea how exposures to PCE have varied over the years. However, the process equipment and work practices used have not changed much, and since the current volume of dry cleaning has decreased from a peak of about 900 kg per day, the amount of PCE used and subsequently lost to the ambient air has probably decreased.

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. However, there is an agreement with a clinic to provide emergency or other medical care. A NIOSH-approved chemical-cartridge respirator is provided for the dry cleaning employee.

DESCRIPTION OF SURVEY METHODS

Personal air samples were collected in the breathing zone of the dry cleaner and mechanic using 150 milligram SKC, Inc.* activated charcoal tubes. Area samples were also collected in the vicinity of the washer and the solvent maintenance unit. The sampling pumps used were MDA*

* Mention of a manufacturer's name does not constitute a NIOSH endorsement.

Accuhalers which were calibrated at flow rates ranging from 20 to 40 milliliters per minute.

The air samples were analyzed using NIOSH Method Number P&CAM 127 or S335.[4] The samples were desorbed with 1 milliliter of carbon disulfide and analyzed for PCE by using a Hewlett-Packard* HP5130 or 5730 gas chromatograph with a flame ionization detector. A 3.7 meter 5% FFAP column was used at 100°C. No other significant unknown substances were observed in the analysis. A Turner* Model L9-1157 halide torch was used to detect sources of PCE leaks. Temperature and humidity measurements were made with an Environmental Tectonics Corporation* Model CP-147 Psychrometer.

RESULTS AND DISCUSSION

Only three loads of garments were dry cleaned before the washer was shut down and dismantled to replace a bearing. The results of air samples collected for PCE are reported in Table 1. During the 90 minutes of operation the dry cleaner's exposure was 28 parts PCE per million parts of air (ppm). An area sample collected near the washer indicated a PCE concentration of 25 ppm. Normally, the facility's mechanic would be in the dry cleaning area only long enough to lubricate the machinery. His exposure to PCE during the five hours spent repairing the washer was 21 ppm. This finding is reasonable even though the dry cleaning was stopped early in the shift because the PCE cooker continued to operate. The area samples collected near the cooker indicating 30 ppm of PCE substantiate the mechanic's exposure. Using the halide torch, leaks were readily detected around the viewing port of the PCE cooker. Temperatures and humidity readings are reported in Table 2. Dry bulb temperatures ranged from 21.1 to 27.2°C with the relative humidity varying between 55 and 65%.

CONCLUSIONS AND RECOMMENDATIONS

The current Occupational Safety and Health Administration (OSHA) standard[5] for occupational exposure to PCE was originally adopted in August 1971. The permissable eight-hour time-weighted average concentration of PCE is 100 ppm. The acceptable ceiling concentration is 200 ppm, not to exceed a maximum peak of 300 ppm for 5 minutes in any three-hour period. In July 1976 NIOSH recommended that no employees be exposed to PCE in excess of 50 ppm, determined as a time-weighted average for up to a 10-hour workday, 40 hour workweek, and also recommended that a ceiling concentration of 100 ppm as determined by 15-minute samples, twice daily, not be

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exceeded.[6] 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 limited sampling conducted on July 24, 1978 indicate that PCE concentrations are well within the 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. Enclosed as Attachment III is the NIOSH Recommended Standard for Occupational Exposure to Tetrachloroethylene (PCE). Recommendations in this attachment include:

1. Preplacement physical examinations.
2. Engineering controls such as exhaust ventilation (if warranted).
3. Respiratory protection for use during emergencies, such as spill cleanup.
4. Protective clothing to prevent skin contact (i.e. gloves, which are impervious to PCE, worn during transfer of garments).
5. Informing all employees as to the hazards, relevant symptoms, effects of overexposure to, and the precautions concerning the safe use and handling to PCE.
6. Storage containers, equipment, piping, and valves should be checked periodically for leakage and repaired as needed.

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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 January, 1976, GPO Stock No. 029-015-00051-1.

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.

Table 1. Perchloroethylene (PCE) Exposures at Fremont Laundry and Dry Cleaners (Mountain View, California) on 7/24/78

Sample	Sampling Time	Description	Concentration ppm
0101	0730-0900	Dry Cleaner	28
0106	0745-1310	Mechanic	21
0110	0740-0814	Area Adjacent to washer	25
0113A	0800-1052	Area adjacent to cooker	17
0113B	1052-1311	Area adjacent to cooker	46
		(TWA for 0113 = 30 ppm)	

TWA - Time-Weighted Average exposure for period of time sampled

Table 2. Temperature and Humidity Readings at Fremont Laundry and Dry Cleaners (Mountain View, California) on 7/24/78

Time	Temperature, °C		% Relative Humidity
	Dry Bulb	Wet Bulb	
0742	21.1	16.7	65
0847	23.9	18.3	59
1005	24.4	18.3	55
1040	23.9	18.3	59
1158	25.0	19.4	60
1255	26.1	20.0	58
1310	27.2	20.6	58

The Current Intelligence Bulletin is the primary product of the Current Intelligence System. The purpose of the Current Intelligence System is to promptly review, evaluate, and supplement new information received by NIOSH on occupational hazards that are either unrecognized or are greater than generally known.

As warranted by this evaluation, the information is capsulized and disseminated to NIOSH staff, other government agencies, and the occupational health community, including labor, industry, academia, and public interest groups. With respect to currently known hazard information this system also serves to advise appropriate members of the above groups of recently acquired specific knowledge which may have an impact on their programs or perception of the hazard. Above all, the Current Intelligence System is designed to protect the health of American workers and to allow them to work in the safest possible environment.

Synonyms

Ankilostin
Antisal 1
CAS 127-18-4
Didakene
Ethylene tetrachloride
Fedal-Un
Nema
Perclene
PerSec
NIOSH-RTECS KX38500
Tetracap
Tetrachlorethylene
Tetrachloroethene
Tetraguer
Tetraleno
Tetropil
Tetlen
1,1,2,2-Tetrachloroethylene

DHEW (NIOSH) Publication No. 78-112

TETRACHLOROETHYLENE (PERCHLOROETHYLENE)

The National Institute for Occupational Safety and Health (NIOSH) recommends that it is prudent to handle tetrachloroethylene (perchloroethylene) in the workplace as if it were a human carcinogen. The recommendation is based on a recent study by the National Cancer Institute (NCI) indicating that tetrachloroethylene causes liver cancer in laboratory mice (1). This Bulletin is to advise you of the findings of the NCI study, other pertinent data, their implications for occupational health, and precautions for handling tetrachloroethylene.

Animal studies are valuable in helping identify human carcinogens. Substances that cause cancer in experimental animals must be considered to pose a potential cancer risk in man. Safe levels of exposure to carcinogens have not been demonstrated, but the probability of cancer development is lowered with decreasing exposure to carcinogens. Thus NIOSH recommends that occupational exposure to tetrachloroethylene be minimized, and is providing suggested industrial hygiene practices. This is an interim recommendation, while the carcinogenic potential of tetrachloroethylene in the workplace is being further evaluated.

The current Occupational Safety and Health Administration (OSHA) standard for occupational exposure to tetrachloroethylene is 100 ppm, (8-hour time-weighted average). In July 1976 NIOSH (3) recommended an exposure limit of 50 ppm (time-weighted average for up to a 10-hour workday, 40-hour workweek). Neither of these levels may provide adequate protection from potential carcinogenic effects because they were selected to prevent toxic effects other than cancer.

Potential Occupational Exposures

Tetrachloroethylene is a volatile liquid with an odor detectable at about 50 ppm. It is a solvent widely used in dry cleaning, fabric finishing, metal degreasing, and other applications. NIOSH estimates that approximately 500,000 workers are currently at risk of exposure to tetrachloroethylene in the United States. Over 20,000 dry cleaning establishments and a large number of other industries manufacture or use this substance. About 700 million pounds of tetrachloroethylene are currently produced in the United States each year.

Two-thirds of the domestically consumed tetrachloroethylene is used for dry cleaning and for the processing and finishing of textiles. Tetrachloroethylene is used by three-quarters of the dry cleaners in the United States because it is an excellent cleaner of most fabrics, is easily recycled, and is not flammable.

Metal cleaning accounts for approximately fifteen percent of the domestic consumption of tetrachloroethylene, where exposures can occur during degreasing and cold cleaning. Tetrachloroethylene also serves as a chemical

intermediate in the synthesis of trichlorotrifluoroethane (fluorocarbon 113), dichlorotetrafluoroethane (fluorocarbon 114), chloropentafluoroethane (fluorocarbon 115), and hexafluoroethane (fluorocarbon 116). Tetrachloroethylene exposures may also occur in extraction processes, during its use as an industrial solvent, as a heat exchange fluid, and as a drug in treatment of internal parasite infestations.

Laboratory Animal Studies for Carcinogenicity

The long term animal study reported by NCI demonstrates tetrachloroethylene to be carcinogenic in laboratory mice. In the study, B6C3F1 mice were force fed tetrachloroethylene for 78 weeks. Male mice were treated at two dose levels (536 or 1072 mg/kg/day) and female mice were treated at two different dose levels (386 or 772 mg/kg/day). A significant increase of hepatocellular carcinoma (liver cancer) was observed in both sexes of treated mice when compared with control animals. At both dose levels more than 50% of the male mice and 40% of the female mice (each from groups of approximately 50 animals) developed liver cancer. By comparison, cancer developed in 12% or less of the groups of untreated or vehicle-matched controls. This NCI report is the first definitive association of tetrachloroethylene with cancer. To relate some of the above information to the work environment, a 70 kg man breathing a typical 10 cu m/day (over an 8-hour work shift) of air contaminated with 100 ppm of tetrachloroethylene would have an inhalation exposure of about 100 mg/kg/day.

In the same NCI report, Osborne-Mendel rats showed no significant increase of liver cancer under the same experimental procedure. Because many of the rats died early in the study, this bioassay was considered inadequate for the carcinogenicity testing of tetrachloroethylene. However there was a high incidence of kidney damage observed in both the rats and mice treated with tetrachloroethylene.

A study by The Dow Chemical Company (2) found many tumors in Sprague-Dawley rats exposed by inhalation to 300 or 600 ppm tetrachloroethylene, but for most tumors there was no statistically significant difference in tumor incidence between exposed and control rats. Some tumors were found in higher incidence in control animals. The only tumor seen at higher incidence in exposed animals was adrenal pheochromocytoma in female rats at the lower exposure level only. Pheochromocytoma is a tumor which gives rise to high blood pressure and hyperglycemia due to release of adrenalin and noradrenalin into the blood. Increased mortality occurred in male rats exposed to 600 ppm tetrachloroethylene.

Section references: 1,2

Other Laboratory Animal Studies

The liver is a principal target organ of tetrachloroethylene exposure in

animals. Typical toxic effects are fatty liver, liver enlargement, and abnormal liver function tests. Tetrachloroethylene has also been shown to cause kidney damage in mice following intraperitoneal injection and in rats and rabbits following inhalation.

Neurophysiological effects of tetrachloroethylene are reflected in the distinct alterations of the electroencephalogram (EEG) in rats. Central nervous system (CNS) depression, including abnormal weakness, handling intolerance, intoxication, restlessness, irregular respiration, muscle incoordination, and unconsciousness have been observed in exposed animals.

Tetrachloroethylene has been shown to be a primary eye and skin irritant in rabbits. Other effects of tetrachloroethylene exposure in laboratory animals include lung damage (excessive fluid accumulation, inflammation, congestion, or hemorrhage), cardiac depression, decreased blood pressure, depressed respiration, decreased oxygen consumption, and depression in growth rate.

One study suggests the teratogenic potential of tetrachloroethylene. Fetal and maternal toxicity was observed in mice and rats exposed to tetrachloroethylene on days 615 of gestation. In this study a decrease in the maternal weight gain in rats, an increase in the relative weight of the liver in pregnant mice, an increase of fetal reabsorption in rats, a decrease in fetal body weight and an increase of subcutaneous edema in fetal mice, were all associated with exposure to tetrachloroethylene. Delayed ossification of skull bones and split sternebrae were possible teratogenic effects observed in mice.

Section references: 3,5,6,7,8,13

Human Toxicity

Clinical evidence accumulated over the years clearly demonstrates that tetrachloroethylene is toxic to the liver and kidneys in humans. Liver impairment has been noted in cases of exposure to tetrachloroethylene as evidenced by abnormal liver function tests. Also, toxic chemical hepatitis, and enlargement of the liver and spleen have been associated with exposure to tetrachloroethylene. Tetrachloroethylene vapor is irritating to the eyes and upper respiratory tract, and may cause frontal sinus congestion and headache. Direct contact with skin can cause burns, blistering, and erythema due to the "degreasing" effect of tetrachloroethylene on the skin. Over a period of time this can result in extreme skin dryness with cracking and associated infection.

Altered physiological and behavioral responses observed in subjects exposed to tetrachloroethylene include vague nonspecific complaints generally attributed to CNS depression. These symptoms include vertigo, impaired memory, confusion, fatigue, drowsiness, irritability, loss of appetite, nausea

and vomiting. Motor coordination following tetrachloroethylene exposure requires additional mental effort, which along with memory impairment and fatigue have important implications for worker safety. Various disturbances of the peripheral nervous system such as tremors and numbness have also been associated with exposure to tetrachloroethylene. Excessive absorption of tetrachloroethylene can cause severe depression of the CNS leading to coma; ultimately death may occur from respiratory paralysis or circulatory failure.

Tetrachloroethylene is most commonly absorbed through the lungs and can be absorbed from the intestines if ingested. The skin is a less important absorption site. Physical exercise can significantly increase the amount of tetrachloroethylene absorbed through the lungs because of greater respiration and increased blood flow.

Metabolism and elimination of tetrachloroethylene is relatively slow. It is deposited in body fat and the biologic halflife of tetrachloroethylene in man is estimated at six days.

Section references: 3,4,8,9,10,11,12,14

NIOSH Action on Tetrachloroethylene

1. NIOSH has contracted for a retrospective mortality study of persons employed in dry cleaning establishments where there had been exposure to tetrachloroethylene. The contract will be monitored by the Biometry Section of the NIOSH Industry-wide Studies Branch.

2. The NIOSH Industrial Hygiene Section of the Industry-wide Studies Branch plans an industrial hygiene assessment of dry cleaning workers exposed to tetrachloroethylene.

3. The NIOSH Behavioral and Motivational Factors Branch is undertaking a tetrachloroethylene behavioral teratology study. The study results should be available in late 1978.

4. NIOSH has contracted for a control technology assessment of the dry cleaning industry. The contract will be monitored by the NIOSH Control Technology Research Branch.

5. NIOSH will coordinate research on tetrachloroethylene with the National Cancer Institute (NCI) which is also examining the mortality experience of persons employed in dry cleaning establishments.

6. NIOSH has contracted for a study to evaluate the potential teratogenicity and the mutagenicity of tetrachloroethylene. This contract will be monitored by the NIOSH Experimental Toxicology Branch.

7. Currently available NIOSH publications on tetrachloroethylene include:

a) Criteria for a recommended standard....Occupational Exposure to Tetrachloroethylene (Perchloroethylene). HEW Publication No. (NIOSH) 76-185.

b) Health and Safety Guide for Laundries and Dry Cleaners. HEW Publication No. (NIOSH) 75-151.

c) Effects of Perchloroethylene/Drug Interaction on Behavior and Neurological Function HEW Publication No. (NIOSH) 77-191.

d) A Behavioral and Neurological Evaluation of Dry Cleaners Exposed Perchloroethylene. HEW Publication No. (NIOSH) 77-214.

Edward J. Baier
Deputy Director

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SUGGESTED PROCEDURES FOR MINIMIZING EMPLOYEE EXPOSURE TO TETRACHLOROETHYLENE (PERCHLOROETHYLENE)

CONTROL OF OVEREXPOSURES

NIOSH recommends that it is prudent to handle tetrachloroethylene in the workplace as if it were a human carcinogen and that occupational exposure to tetrachloroethylene be minimized. Exposure to tetrachloroethylene should be limited to as few employees as possible, while minimizing workplace exposure levels. The area in which it is used should be restricted to those employees necessary to the process or operation. Furthermore, consideration should be given to isolating the tetrachloroethylene exposure area so that adjacent workers are not also exposed.

1. Exposure monitoring

The NIOSH Occupational Exposure Sampling Strategy Manual, NIOSH publication #77-173, may be helpful in developing efficient programs to monitor employee exposures to tetrachloroethylene. The manual discusses determination of the need for exposure measurements, selection of appropriate employees for sampling, and selection of sampling times.

Employee exposure measurement samples can be obtained and analyzed using the guidelines in NIOSH method #P&CAM 127 in the second edition of the NIOSH Manual of Analytical Methods, NIOSH publication #77-157. Exposure measurements should consist of 8-hour TWA exposure estimates calculated from personal or breathing zone samples (air that would most nearly represent that inhaled by the employees).

2. Engineering controls

Engineering and work practice controls should be used to minimize employee exposure to tetrachloroethylene.

To ensure that ventilation equipment is working properly, it is advised that effectiveness be checked at least every three months (e.g., air velocity, static pressure or air volume). System effectiveness should also be checked within five days of any change in production, process, or control which might result in significant increases in airborne exposures to tetrachloroethylene.

3. Respiratory protection

Exposure to tetrachloroethylene should not be controlled with the use of respirators except:

During the time period necessary to install or implement engineering or work practice controls; or

In work situations in which engineering and work practice controls are technically not feasible; or

To supplement engineering and work practice controls when such controls fail to adequately control exposure to tetrachloroethylene; or

For operations which require entry into tanks or closed vessels; or

In emergencies.

Respirators should be approved by the National Institute for Occupational Safety and Health (NIOSH) or by the Mining Enforcement and Safety Administration (MESA). Refer to NIOSH Certified Equipment, December 15, 1975, NIOSH publication #76-145 and Cumulative Supplement June 1977, NIOSH Certified Equipment, NIOSH Publication #77-195. The use of face-seal coverlets or socks with any respirator voids NIOSH/MESA approvals.

Quantitative faceseal fit test equipment (such as sodium chloride or PDOP) should be used. Refer to A Guide to Industrial Respiratory Protection, NIOSH publication #76-189 for guidelines on appropriate respiratory protection programs.

Where respirators are used under the preceding guidelines, NIOSH recommends that for routine use the employer provide either a) Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode (30 CFR 11.70(a)) or b) A combination respirator which includes a Type-C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or positive pressure mode (30 CFR 11.70(b)). For firefighting, the employer should provide a) Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode (30 CFR 11.70(a)). For escape the employer should provide a) Any gas mask providing protection against organic vapors (30 CFR 11.90) or b) Any escape self-contained breathing apparatus (30 CFR 11.70(a)).

PERSONAL PROTECTIVE EQUIPMENT

Employers should provide impervious, gloves, face shields (8-inch minimum) and other appropriate clothing necessary to prevent repeated or prolonged skin contact with liquid tetrachloroethylene.

Employers should see that employee clothing wet with liquid tetrachloroethylene is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of tetrachloroethylene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the tetrachloroethylene, the employer should inform the person

performing the operation of the hazardous properties of tetrachloroethylene including the fact that it is a possible human carcinogen.

Employers should see that permeable clothing which becomes contaminated with liquid tetrachloroethylene be removed promptly and not reworn until the tetrachloroethylene is removed from the clothing.

PERSONAL HYGIENE

Employers should see that employees who handle liquid tetrachloroethylene wash their hands thoroughly with soap or mild detergent before eating, smoking, or using toilet facilities.

Employers should see that employees whose skin becomes contaminated with liquid tetrachloroethylene promptly wash or shower with soap and mild detergent and water to remove any tetrachloroethylene from the skin.

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ATTACHMENT II

PLANT LAYOUT FREMONT LAUNDRY & DRY CLEANERS