

WALK-THROUGH SURVEY REPORT:
PERCHLOROETHYLENE EXPOSURES IN COMMERCIAL DRY CLEANERS

at

Widmer's Dry Cleaning
Cincinnati, Ohio

REPORT WRITTEN BY:
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U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway - R5
Cincinnati, Ohio 45226

PLANT SURVEYED: Widmer's Dry Cleaning Specialists
2016 Madison Road
Cincinnati, Ohio 45208

SIC CODE: 7216

SURVEY DATE: January 13, 1993

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EMPLOYEE REPRESENTATIVES: No union

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DISCLAIMER

Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention.

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), located in the Centers for Disease Control and Prevention (CDC) under the Department of Health and Human Services (DHHS) (formerly the Department of Health, Education, and Welfare), was established by the Occupational Safety and Health Act of 1970. This legislation mandated NIOSH to conduct research and education programs separate from the standard setting and enforcement functions conducted by the Occupational Safety and Health Administration (OSHA) in the Department of Labor. An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards.

The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering has been given the lead within NIOSH to study and develop engineering controls and assess their impact on reducing occupational illness and injury. Since 1976, ECTB has conducted a large number of studies to evaluate engineering control technology based upon industry, process, or control technique. The objective of each of these studies has been to document and evaluate control techniques and to determine their effectiveness in reducing potential health hazards in an industry or at specific processes.

In the late 1970s and early 1980s, a NIOSH-sponsored engineering control technology study was conducted in the dry cleaning industry.¹ Since then, significant changes involving equipment, processes, and work practices have occurred within the industry. Many of these changes were initiated by new epidemiologic, toxicologic, and environmental data for the primary solvent, perchloroethylene (PERC). Some studies have shown that in addition to the numerous adverse health effects already known, there is evidence of carcinogenicity.^{2,3,4} In December of 1991, the Environmental Protection Agency began regulating perchloroethylene as a hazardous air pollutant under Section 112 of the Clean Air Act.⁵ This decision was based on environmental research, finding perchloroethylene to be a toxic air pollutant. The industry has responded with increased research into alternative solvents, a shift from transfer machines to closed-loop dry-to-dry machines, and innovations in vapor recovery equipment and other devices to reduce occupational exposures and environmental emissions.

Many of the exposure problems identified during studies in the late 1970s and early 1980s still exist because transfer equipment is still being used, many of the controls that have been developed are cost prohibitive, and work practices are inadequate. The OSHA Integrated Management Information System (IMIS) database, indicates that approximately 20 percent of samples taken at dry cleaning shops exceed 100 ppm.⁶ During a nationwide query of the OSHA State Consultation Programs in 1988, the dry cleaning industry was the second most mentioned small business needing occupational health hazard control technology research.⁷

For these reasons, ECTB has undertaken a study of dry cleaners to determine which engineering control recommendations from the 1980 NIOSH report are still valid. Additionally, during the course of this study, controls for other industry hazards, such as ergonomic hazards or exposure to spotting chemicals,

will be evaluated. During the initial phase of the study, literature will be reviewed to determine areas in need of research. Walk-through surveys then will be conducted to gain familiarity with the industry and determine locations for future in-depth studies. Next, in-depth surveys lasting several days will be performed during which quantitative data will be collected. Personal and area samples will be obtained, and real-time monitoring will be conducted. Detailed reports will be written to document all findings. These in-depth reports will be used to prepare technical reports and journal articles that summarize the findings concerning effective controls for occupational health hazards in the dry cleaning industry.

This report describes a walk-through survey conducted at Widmer's Dry Cleaners, located in Cincinnati, Ohio. The purpose of this survey was to qualitatively evaluate occupational health hazards with a focus on worker exposure to perchloroethylene.

PLANT AND PROCESS DESCRIPTION

PLANT DESCRIPTION

Widmer's Dry Cleaning is a large, commercial shop located in Cincinnati, Ohio. The main facility, where this survey was conducted, is a two-story building located on a corner lot, between Hyde Park and Walnut Hills. There are two satellite locations that pickup and drop off clothing for the main shop. Widmer's main shop has been located at its present site since approximately 1910. Most of the equipment at this shop is very modern.

Widmer's provides a home pickup and delivery service to its customers. Several half-ton panel vans are used to pickup and drop off clothing at the customer's residence and move clothing between the satellites and main shop. There are ten customer routes which service 80 percent of Widmer's customers.

The shop layout is shown in Figures 1 and 2. The first floor, where the main entrance is located, is used for customer service, offices, marking and tagging, dry cleaning, and storage. The delivery vans are loaded and unloaded at the dock along Cinnamon Street. The second floor is used for spotting, pressing, conventional laundry, and bagging. An overhead conveyor system is used to transport clothing from the first to second floor.

Widmer's is able to clean approximately 1,100 pounds of clothing per gallon of perchloroethylene purchased. Their three primary dry cleaning machines each use approximately 2 gallons of PERC per week. There are approximately 85 employees at the main facility, of which 60 percent are female. The shop is open for business from 7:00 a.m. to 6:30 p.m. Monday through Friday and 7:30 a.m. to 4:00 p.m. on Saturday. The average employee schedule is from 6:30 a.m. to 3:30 p.m., five days a week.

DRY CLEANING TECHNOLOGY

Two types of machines are generally used in dry cleaning: transfer or dry-to-dry. Transfer machines are older, less expensive, and require manual transfer of solvent laden clothing between the washer and dryer. This is where the

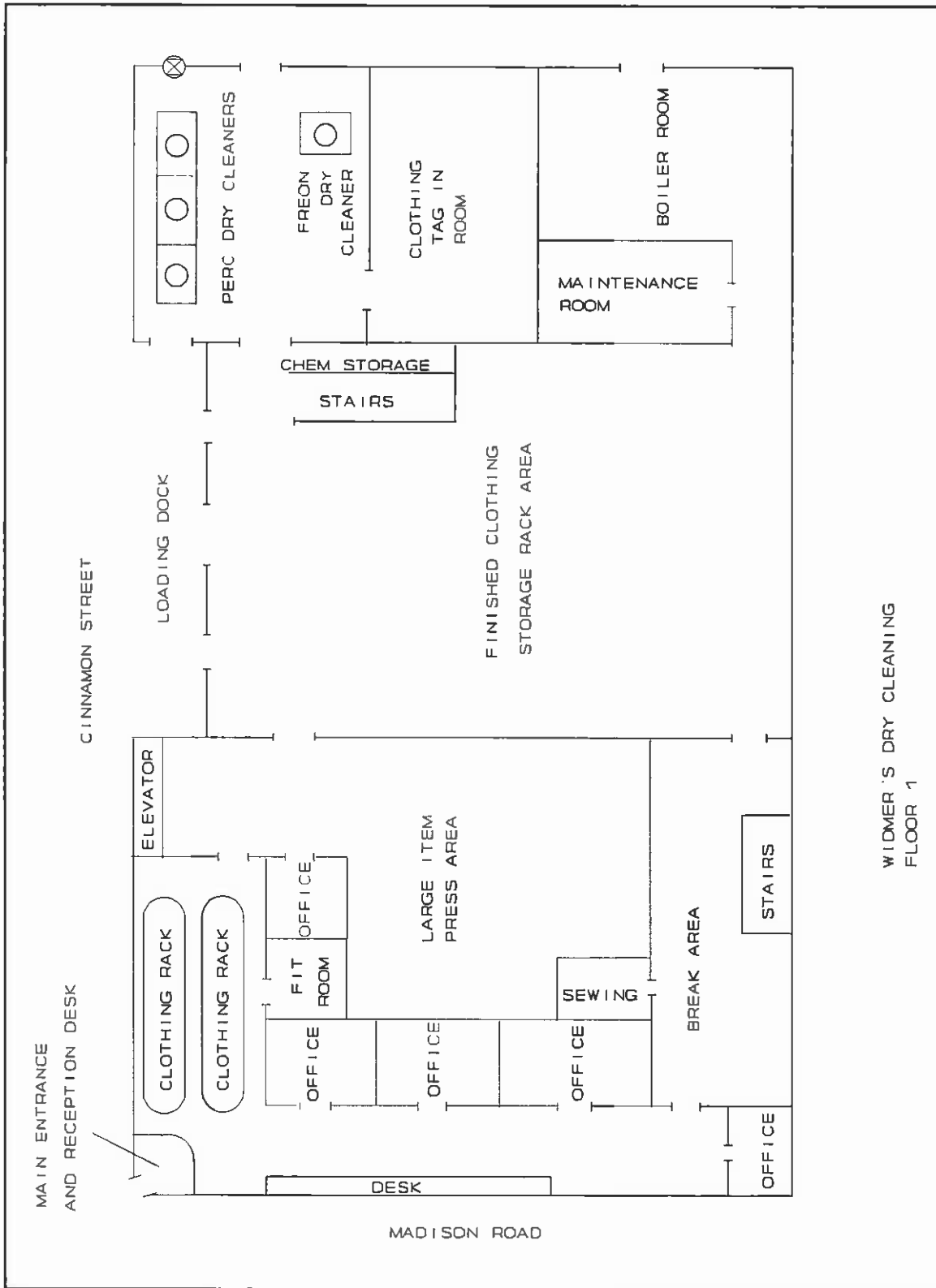


Figure 1 (Widmer's Dry Cleaning: Floor 1)

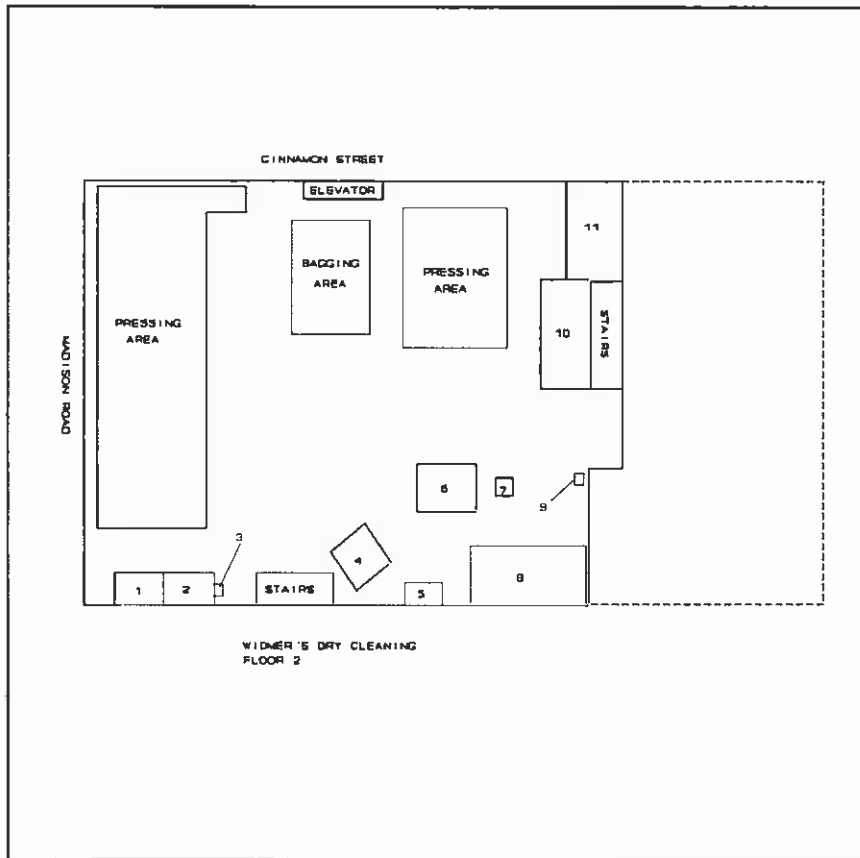


Figure 2 (Widmer's Dry Cleaning: Floor 2)

LEGEND FOR FIGURE 2	
1.	Men's Room
2.	Ladies' Room
3.	Water Fountain
4.	Italian Dry Cleaning Machine
5.	Conventional Laundry Machines
6.	Spotting Area
7.	Wind Whip
8.	Cissell Dryer
9.	Eye Wash
10.	Laundry Marking Area
11.	Conventional Laundry Machines

highest worker exposure occurs. Transfer machines process twice as much clothing as comparably sized dry-to-dry machines because the process time is half that of a dry-to-dry machine. Some owners of dry-to-dry machines reduce the cycle time to increase productivity. Unfortunately, this practice increases exposure due to residuals left in the clothing.⁸

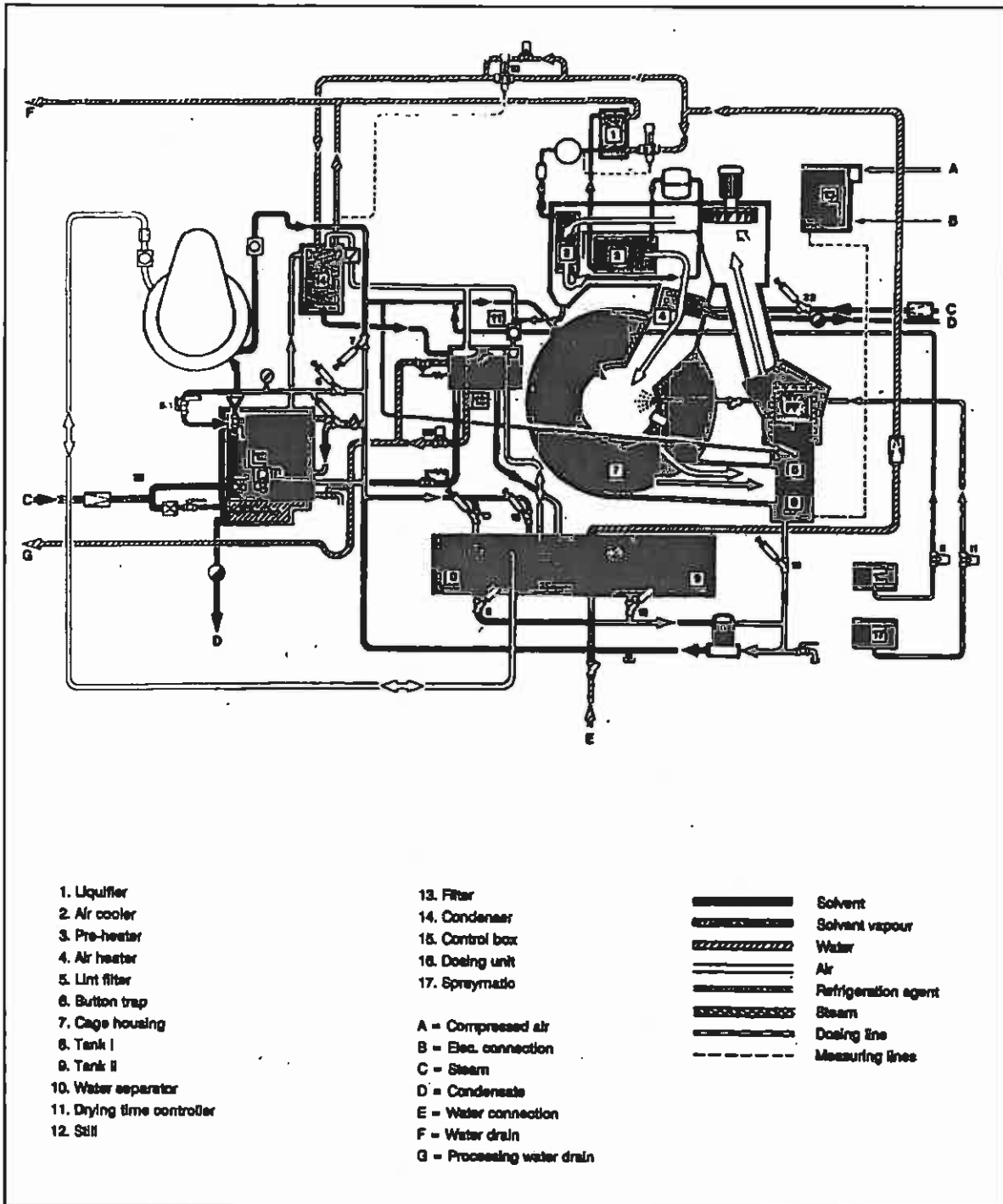
Because of the high exposures during transfer, transfer machines are no longer manufactured in the United States. Seventy percent of machines today are dry-to-dry machines using a one-step process that eliminates clothing transfer.⁹ Clothes enter and exit the machine dry. PERC exposure from dry-to-dry machines is considerably less than transfer machines. No federal or state regulations specifically require the use of dry-to-dry machines, but eliminating the transfer process is a significant step in reducing the level of occupational exposure to PERC. Most shops are moving or have moved to replace transfer machines with dry-to-dry machines because of the trend toward stricter regulations from both state and federal OSHA and the EPA.

PROCESS DESCRIPTION

The majority of clothing which arrives at this facility is delivered by vans from customer routes or from the two satellite shops. A small portion comes from walk-in customers. Upon arrival, the clothing is sent to the tagging room where it is tagged and logged on a computer-based tracking system. Garments are inspected and sorted by weight, color, and finish. Garments with visible stains are sent to the second floor to be pretreated with various chemicals, prior to being washed. Some of the more common spotting chemicals include: trichloroethane, perchloroethylene, amyl acetate, petroleum naphtha, oxalic acid, acetic acid, dilute hydrofluoric acid, hydrogen peroxide, and aqueous ammonia. Each chemical is used in limited quantities.

Most of the garments are cleaned in one of the three, Boewe®, Model P546, enclosed, dry-to-dry machines. These 46-pound machines are approximately 2.5 years old and have some of the latest available control options. A piping diagram and function sequence can be seen in Figures 3 and 4. The machines run on a 32-minute cycle: a 2- to 3-minute prewash, an 8-minute wash, and a 21-minute drying cycle. Garments are washed in a PERC and detergent solution using a two bath process. This ensures cleaner solvent. After the prewash and wash cycle, PERC is drained from the machine's tank and excess PERC is extracted by centrifugal spinning. Each solvent bath is pumped through the filter prior to distillation. PERC is later returned for subsequent wash cycles.

During drying, air exiting the dryer passes through a carbon adsorber and refrigerated condenser to recover PERC vapors. The spin disc filtration system eliminates the need to handle and dispose of cartridges contaminated with PERC. Instead of cartridge filters requiring periodic maintenance, the spin disc system uses a fully automatic maintenance program. Clothes are manually removed from the machine and are loaded into a basket. The basket holds the garments temporarily until they can be placed on the conveyor and transported to the second floor for pressing. After each garment is pressed, it is sorted, wrapped in plastic, hung back on the rack, and stored for pickup or delivery. A local contractor delivers PERC on a regular basis. The

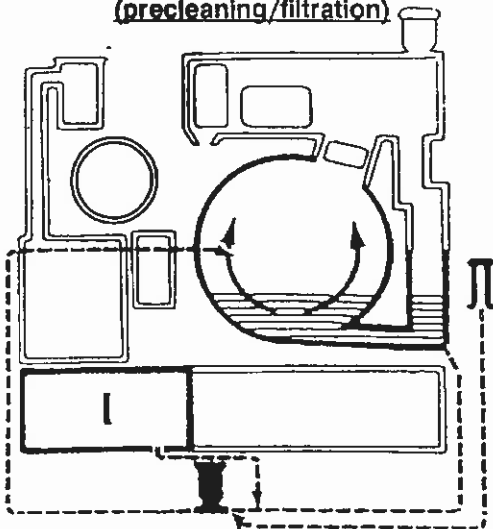


Piping Diagram

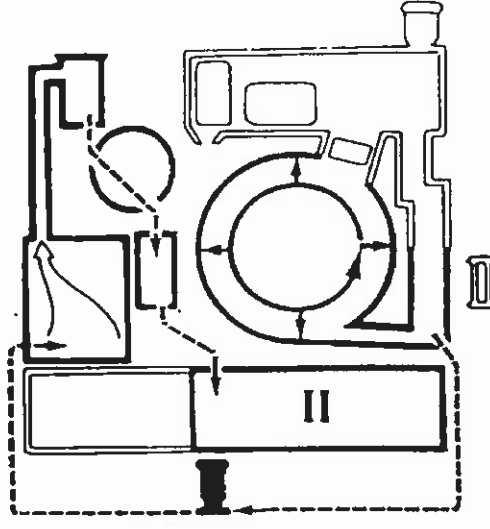
Figure 3

(Used with permission from Boewe Passat Corporation)
 Boewe Passat, P540, Instruction Manual, Augsburg, Germany

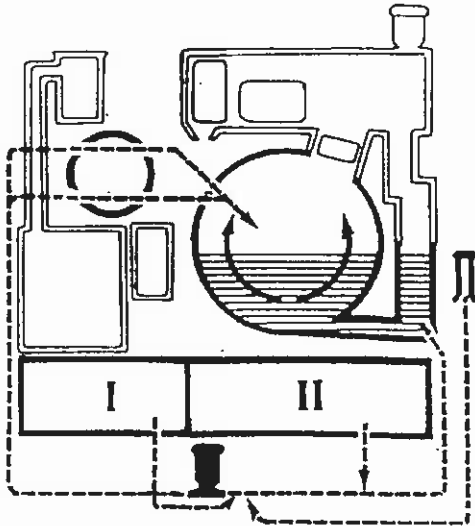
**8.1 Processing sequence/2-bath process
(precleaning/filtration)**



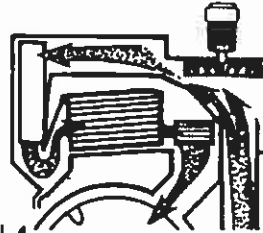
III. 1
Precleaning with solvent from tank I (work tank), low level, pump circuit, dosing.



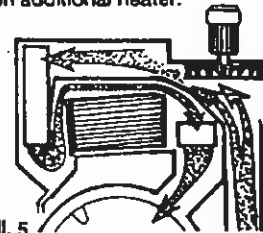
III. 2
Pumping and extracting to still; solvent evaporates in the still, condensing in the condenser, water is separated in the water separator, solvent drainage to clean rinse tank.



III. 3
Filtration with solvent from tank I, high level, replenishment from tank II if necessary, filter circuit, dosing, pumping and extraction to tank I.



III. 4
Drying in the preheater by making use of the refrigeration unit compression heat. If necessary, switch on additional heater.



III. 5
Decolorizing and cooling of garments.

Functional Sequence

Figure 4

(Used with permission from Boewe Passat Corporation)
Boewe Passat, P540, Instruction Manual, Augsburg, Germany

solvent is pumped directly into the machine's holding tank which eliminates employee handling. PERC used in the wash cycle is cleaned continuously by passing through the spin disc filtration system. In addition to filtration, distillation helps maintain solvent purity. The filters generally remove nonsoluble soils, while the still removes solubles. In addition to the three Boewe® machines, a Cleanline® machine in the same area uses CFC-113 to clean delicate or ornate clothing. A fifth, Italian, dry-to-dry, PERC machine is located on the second floor near the spotters. This machine is used on a limited basis for stain removal and will soon be replaced with a Boewe 30 lb dry-to-dry machine.

Ventilation in the dry cleaning room consists of a small, radial fan located near the floor, in the wall behind the machines. The air is exhausted outside the rear of the building. During the summer, there is a large garage door and small door which are opened to provide natural ventilation. On the second floor where the pressing occurs, the entire front and side of the building facing the streets has windows, some of which are opened year round. Numerous comfort fans are used in the pressing area to circulate air.

POTENTIAL HAZARDS

Exposure to PERC is the primary health hazard for workers in dry cleaning facilities today. PERC can enter the human body through both respiratory and dermal exposure. Symptoms associated with respiratory exposure include: depression of the central nervous system; damage to the liver and kidneys; impaired memory; confusion; dizziness; headache; drowsiness; and eye, nose, and throat irritation.⁹ Repeated dermal exposure may result in dry, scaly, and fissured dermatitis.¹⁰ Over the past 15 years, researchers have established a link between PERC exposure and cancer in animals. This link was discovered through studies conducted by the National Cancer Institute (1977), the National Institute for Occupational Safety and Health (1978), and the National Toxicology Program (1986). Other studies have shown an elevated risk of liver cancer in males who work in dry cleaning establishments.¹¹

Spotting involves the selective application of a wide variety of chemicals and steam to remove specific stains. Some of these chemicals that are used on a fairly regular basis include: trichloroethane, perchloroethylene, amyl acetate, petroleum naphtha, oxalic acid, acetic acid, dilute hydrofluoric acid, hydrogen peroxide, and aqueous ammonia. Individuals who perform the spotting process could be exposed to toxic chemicals through skin or eye contact or inhalation of vapors. Previous studies have indicated that inhalation exposures are minimized due to the limited quantities of chemicals and the intermittent nature and short duration of the task.¹ During personal sampling, an International Fabricare Institute study found PERC exposure levels many times lower than OSHA standards and some chemicals being used, below detection limits.¹² The primary hazard posed by chemicals used in the spotting process is skin damage resulting from chronic or acute exposure or injury to the eyes.

EVALUATION CRITERIA

The current OSHA permissible exposure limit (PEL) for perchloroethylene is 100 ppm, time-weighted average (TWA) exposure.¹³ OSHA had lowered the PEL to 25 ppm in 1989 under the Air Contaminants Standard.¹¹ In July 1992, the 11th Circuit Court of Appeals vacated this standard. OSHA is currently enforcing the 100 ppm standard; however, some states operating their own OSHA-approved job safety and health programs will continue to enforce the lower limits of 25 ppm. OSHA continues to encourage employers to follow the 25 ppm limit.¹⁴ NIOSH considers perchloroethylene to be a potential occupational carcinogen and recommends that exposure be reduced to the lowest feasible limit.¹⁵

CONTROLS

PRINCIPLES OF CONTROL

Occupational exposures can be controlled by the application of a number of well-known principles including engineering measures, work practices, and personal protection. Engineering measures are the preferred and most effective means of control. These include material substitution, process and equipment modification, isolation and automation, and local and general ventilation. Control measures also may include good work practices and personal hygiene, housekeeping, administrative controls, and use of personal protective equipment such as respirators, gloves, goggles, and aprons. Table 1 summarizes the spectrum of control measures.

TABLE 1 ¹⁶		
METHODS OF CONTROL		
SOURCE	PATHWAY	RECEIVER
Material substitution	Housekeeping	Training and education
Process change	General exhaust ventilation (Roof fans)	Worker rotation
Process enclosure	Dilution ventilation (Supplied air)	Worker enclosure
Process isolation	Increase worker/ source distance	Personal monitoring
Wet methods	Continuous area monitoring	Personal protective equipment
Local ventilation	Maintenance programs	Maintenance programs
Maintenance programs		

Each of these approaches must be considered when developing a comprehensive, effective control strategy; however, their optimum application varies from case to case. Built-in design modifications are the preferred method of control because they generally are not dependent on human behavior. Additionally, monitoring and maintenance of controls, and education and commitment of both workers and management are important ingredients of a successful control system.

ENGINEERING CONTROLS FOR DRY CLEANING

At dry cleaning facilities, substitution and local exhaust ventilation appear to be the most effective and realistic control approaches for reducing perchloroethylene exposure. Substitution of the process, equipment, and material has been looked at extensively in dry cleaning. Process and equipment substitution has been very successful while material substitution has been unsuccessful.

The most significant change involving process/equipment substitution was the introduction of dry-to-dry machines. This change eliminated exposures from the transfer operation. Anytime a process can be made more continuous, the less hazardous it is likely to be. Closed-loop systems have reduced exposures from venting contaminated air. In addition, solvent recovery equipment such as carbon absorbers and refrigerated condensers have reduced vented PERC emissions. Substitution of the material, PERC, has been tried for some time with little or no success. Many substitute solvents have been tried, but each has its own set of problems.

Isolation of both equipment and material from the worker is being used in some dry cleaners today. Isolation is the term to describe placing a physical or time barrier between the hazard and the workers that may be injured. Many facilities no longer store large quantities of solvent on the premises. Instead, they have a supplier deliver it as needed. It is difficult to isolate dry cleaning machines in small shops. Larger shops have more space which provides greater flexibility for isolating high exposure processes. Operators spend much of the day at the machine. Consequently, the operator will have greater exposure to PERC than other workers. In order to be effective, process isolation must be used in conjunction with good local and general ventilation.

Local ventilation is considered the "classic method" of control and attempts to capture contaminant before escaping into the environment. National Fire Protection Association codes for the dry cleaning industry recommend dry cleaning machines with an integral exhaust system having a door face velocity of 100 fpm. This has become a widely accepted practice in the industry.^{1,17} This face velocity will help to prevent solvent vapors from escaping into the shop by providing a draft of clean air to pass over the items being removed from the machine. The integral exhaust system is activated by a door interlocking switch. An alternative to this is placing a ventilation shroud outside the machine door with an airflow capacity in cfm not less than 100 times the door opening area in square feet.¹⁸

Local exhaust ventilation is effective because it captures solvent vapors where they are most concentrated, at the source. This prevents vapors from reaching the worker's breathing zone, as well as reducing diffusion throughout the plant. Local exhaust ventilation can be improved with a number of measures. Hood modifications such as placing a flange on a slotted hood to reduce interference and turbulence is helpful. Isolating the capture area from strong air drafts is another effective measure.¹⁹

General ventilation adds fresh air or removes general plant air to keep contaminant concentrations below a specified level. Replacement air enters naturally through windows and doors or through large fans in the ceiling or walls. Fans should pull fresh air through the cleaning area and draw vapors away from the workers prior to exhaust. This reduces movement of contaminated air into other areas of the shop. Emergency ventilation systems are needed to handle spills and leaks.

ENGINEERING CONTROLS AT WIDMER'S

The three Boewe® machines currently in use are Model 546, closed-loop, dry-to-dry machines with advanced engineering features designed to comply with European regulations. Boewe Passat is a well known, German corporation that is the largest manufacturer of dry cleaning equipment in the world. Boewe Passat has done a considerable amount of research and development to reduce perchloroethylene emissions. Some of the prominent features of their machines that help to reduce PERC exposure include:

- spin disc filters that eliminate the need to change filters
- significant reduction of emissions from the button trap and lint filter
- process controls in the drying sequence to reduce garment residuals
- controls to reduce PERC emissions from still residue
- a device for reducing solvent emissions when filling the tank

Process isolation is used in this shop to aid in containing emissions. Most dry cleaning is performed in a room at the rear of the building that is physically separated from other areas of the shop. Isolation helps prevent solvent vapors from escaping and moving throughout other areas of the shop.

OBSERVATIONS

Widmer's management is a member or has been involved in a variety of professional organizations such as International Fabricare Association, Ohio Cleaner's Association, Varsity International, and Sanitone. Widmer's considers themselves to be a leader in the industry and has taken measures to remain in this position. One step taken by Widmers was to invest in three modern Boewe Passat machines 2.5 years ago. This has saved the company approximately \$22,000 the first year by reducing the quantities of solvent used and corresponding solvent expenses. Another important benefit of

reducing solvent useage is a reduction in emissions and related occupational exposures.

Disposal of water separator residue was a problem at this shop. Contaminated water from the separator was boiled off in an open container outside the building. This was unknowingly done under an air intake vent. This could have resulted in contaminated vapors being returned to the building if elevated levels of PERC were present.

General maintenance and housekeeping appeared to be good. The shop was neat and orderly and regular maintenance was performed. Routine maintenance was performed on all the machines. There was not a significant leakage problem probably because the equipment was only a few years old. One small leak was found. This leak was on a small piece of plastic tubing that was part of an optional component added to the machine after purchase.

Modern equipment is more resistant to leakage of solvent than its predecessor. As systems age, leaks can compound resulting in excessive exposures. A halide torch leak detector was available at this shop. Additionally, a passive monitoring badge for determining PERC exposure levels had been used in the past; however, when the new equipment was purchased, the badge was no longer used because exposures were significantly reduced.

PERSONAL PROTECTIVE EQUIPMENT

Use of personal protective equipment at this facility is one area which needs improvement. Personal protective equipment is particularly important for the spotters who use a wide variety of hazardous chemicals. There was no written program or policy concerning the use of personal protective equipment. Workers and management seemed unconcerned with its usage. Both gloves and respirators were available; but they were not being used. The gloves were made of natural rubber, and the respirator was a single-use variety.

RESULTS

INDUSTRIAL HYGIENE SAMPLING

Personal sampling was conducted on three workers. Two of the workers were in the dry cleaning room where most of the dry cleaning occurs. The operator was responsible for loading and unloading the machine, and the other worker was hanging clothing on the conveyor that transports clothing to the second floor. The third worker, in the spotting area of the second floor, operated the dry cleaning machine used by the spotters.

PERC vapors were collected on SKC® lot number 120 charcoal tubes connected to sampling pumps operated at approximately 0.2 liters per minute (lpm). Sampling was conducted for approximately 90 minutes. Analysis of samples was performed using gas chromatography with flame ionization detection (GC/FID) in accordance with NIOSH Method 1003. The limit of detection was 0.25 milligrams per cubic meter (mg/m³). Results of the personal sampling are shown in Table 2.

Table 2. Personal sampling results.			
Area	Operator	Hanger	Spotter
Conc. (ppm)	20.5	7.81	3.9
Note: (ppm, 90 minute TWA)			

In addition to the personal sampling conducted, Draeger® perchloroethylene 2a detector tubes were used to determine approximate levels of PERC in different areas of the shop and identify emission sources and operations with potential for exposure. These tubes had a measuring range between 2 and 300 ppm. Detector tubes consist of a glass tube containing an inert carrier impregnated with a reagent. The ends of the tube are broken and the tube connected to a hand-operated bellows pump. Workplace air is pulled through the tube and the contaminant reacts with the reagent. The concentration is determined by the length of color change. These measurements were used to identify areas or operations causing potential exposure. These tubes were used to provide a relative reading. Error is typically between 10 and 25 percent.²⁰ Detector tube measurements are listed in Table 3.

Table 3. Detector Tube Measurements.				
Area	Machine 1 Door	Machine 2 Door	Machine 3 Door	Area
Conc. (ppm)	10	8	5	8
Note: These are single, instantaneous measurements used to identify areas or operations causing potential exposure; they may not reflect actual exposures measured by long-term sampling techniques.				

VENTILATION MEASUREMENTS

Little local ventilation was provided on the Boewe® machines used in this shop. Airflow measurements near the door of each machine averaged around 8 feet per minute. Boewe® designs their machines so that PERC concentration inside the cylinder should be very low when the door is opened. This makes local exhaust ventilation unnecessary.

General ventilation appeared adequate. The dry cleaning room had a small axial fan located in the wall, near the floor, behind the machines to remove vapors from the room. The face velocity was approximately 400 ft/min. Smoke tubes indicated that it was doing a good job removing vapors that were originating from behind the machine. The garage door and rear exit door were

well placed to provide fresh air flow when opened during the summer months. On the second floor, where most of the pressing occurs, there were many windows and fans for circulating fresh air. No local ventilation was provided for the machine in the spotting area.

CONCLUSIONS AND RECOMMENDATIONS

Widmer's Dry Cleaning appeared to have controls capable of maintaining (8-hour TWA) exposure levels below 25 ppm, which is the level that OSHA encourages dry cleaners to follow. NIOSH recommends controlling PERC to the lowest feasible limit. The highest level of exposure measured was 20.5 ppm, (90 min TWA) for the machine operator. The operator is expected to have the highest exposure levels, and this value would probably be lower if measured during a full eight hour shift. These levels could be due to inefficient operation of the vapor recovery system. According to the International Fabricare Institute, there are four factors which could result in ineffective solvent recovery during the dry cycle.²¹ They include:

- poor maintenance
- inefficient cooling coils
- improper load size
- improper length of the dry cycle

Widmer's recovery could probably be improved by better maintenance or more effective cooling coil performance. Background levels of PERC in the dry cleaning room were approximately 8 ppm. These levels could be due to factors such as an inefficient recovery system, minor emissions from the machine components, or ventilation and work practices.

One practice which could become a problem was allowing still runoff to remain exposed to the atmosphere until it cools. Boewe® machines are designed to significantly reduce levels of PERC in the still residue. If the still is not functioning as designed, elevated exposures could result from the still runoff. Still residue should cool in the still before being removed.

Several additional measures which might help contain vapors would be to further enclose the dry cleaning room by placing a doorway between the cleaning room and storage area. Additionally, the machine near the spotting area could be moved to the cleaning room to help with containment of any leak. General ventilation in the dry cleaning room appeared to be adequate. The ability to open the outside doors during the warmer months would increase the level of fresh air circulated. Improvement could be made by increased ventilation around the machine on the second floor.

Proper maintenance can be instrumental to reducing leakage. Leaks are more easily seen if proper maintenance and housekeeping is performed. Lint buildup is a real problem in many dry cleaners. If lint accumulates on the floor and around equipment, leaks are more difficult to locate. Gaskets prone to deterioration must be inspected and replaced on a regular basis. Several

devices can aid in leak detection. These include: the halide torch, photoionization detector, and pocket dosimeters. An in-line static pressure gauge could warn the operator that a leak exists. Passive exposure monitoring devices cannot be used to aid in leak detection, but should be used periodically to alert management when an exposure problem may exist.

Personal protective equipment should be routinely used by all of the spotters who are using hazardous chemicals. Use of personal protective equipment (PPE) at this shop was not in accordance with Federal Regulation 29 CFR 1910.134 because there was no established program. In addition to the measures mentioned earlier, occupational exposure could be further reduced through the proper use of PPE. PPE does nothing to reduce or eliminate the source of the hazard and must be used properly to be effective.

Because NIOSH has classified PERC as a potential occupational carcinogen, the following two types of respirators are recommended: a self-contained breathing apparatus (SCBA) with full facepiece operated in pressure demand or positive pressure mode, or a supplied-air respirator (SAR) operated in pressure demand or positive pressure mode with auxiliary SCBA. The auxiliary SCBA must be of sufficient duration to permit escape to safety if the air supply is interrupted.²²

Though not recommended by NIOSH because PERC is a potential occupational carcinogen, the currently used respirators (half-mask facepiece with organic vapor cartridges), may be used for short-term exposures to low levels of perchloroethylene. At a minimum, the cartridges must be changed prior to breakthrough (approximately 130 minutes based on room concentrations).²³ Regular cartridge changes are important because the odor threshold of PERC is 27 ppm. This low odor threshold will prevent the worker from smelling PERC until significant breakthrough and exposure has occurred.²⁴

Where employees must wear respirators, an appropriate respiratory protection program in accordance with 29 CFR 1910.134 must be instituted. This Federal regulation contains provisions for:

- a written standard operating procedure;
- respirator selection based upon hazards;
- instruction and training of the user concerning the proper use and limitations of respirators;
- regular cleaning, disinfection, and proper storage;
- medical review of the health and condition of the respirator user; and
- use of certified respirators which have been designed according to standards established by competent authorities.²⁵

Gloves, aprons, and goggles should be used to reduce exposure to hazardous chemicals such as perchloroethylene. Gloves and aprons provide limited dermal

protection and should be made of solvent resistant materials such as viton fluoroelastomer, polyvinyl alcohol or unsupported nitrile. When deciding on a specific glove to use, factors such as permeation, durability, dexterity, and cost should be considered. Research by The Dow Chemical Company found viton and polyvinyl alcohol to have a perchloroethylene breakthrough time in excess of eight hours.²⁶ A 1987 study showed that unsupported nitrile was impervious to perchloroethylene after a two hour challenge period.²⁷ Some of the drawbacks associated with these materials are that viton is expensive, polyvinyl alcohol significantly reduces dexterity, and unsupported nitrile has a higher permeation rate. Whenever swelling or softening of the gloves or seepage of perchloroethylene into the glove is observed, the gloves should be replaced.

Chemical splash goggles should be worn to prevent eye injury when workers are using hazardous chemicals. Accidental contamination of the eye could result in minor irritation or complete loss of vision. Use of chemical splash goggles is particularly important in the spotting area at this shop where a wide variety of toxic chemicals were being used to remove stains. Additionally, the eye wash station which is located near the spotting area could provide prompt eye irrigation in the event it is needed. If chemical contamination of the eye does occur, prompt irrigation for at least fifteen minutes can play a deciding role in limiting the extent of damage.

Generally speaking, controls at this facility appeared above average for the industry. Control methods discussed in previous sections of the report could aid in reducing exposure levels. Based upon the information gathered during this walk-through, Widmer's Dry Cleaners is a shop where an in-depth study would be of value. Areas which would be useful to examine in greater detail at this shop include: hazards and controls for the spotting process, efficiency of the vapor recovery system, real-time analysis of manual tasks, residual emissions, fault tree analysis of the operation, and ergonomic hazards. A decision concerning a possible in-depth survey at this facility will be made following the completion of all walk-through surveys and finalization of the study protocol.

REFERENCES

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