IN-DEPTH SURVEY REPORT:

EXPOSURES DURING THE SPOTTING PROCEDURE IN A COMMERCIAL DRY CLEANER

at

Widmer's Dry Cleaning
Cincinnati, Ohio

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REPORT DATE
July 1995

REPORT NO
ECTB 201-13b

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Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Division of Physical Sciences and Engineering
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	August 29-31, 1994
SURVEY CONDUCTED BY	Amy Beasley Spencer Gary S Earnest Ronald J Kovein
EMPLOYER REPRESENTATIVES	Steve Carico, Manager John J Olmstead Jr , Owner
EMPLOYEE REPRESENTATIVES	No union
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EXECUTIVE SUMMARY

A study was conducted at Widmer's Dry Cleaning in Cincinnati, Ohio, to evaluate workers' exposures during the spotting procedure The existing engineering control in place for the spotting process was a small kitchen-type hood This hood was inadequate to remove the contaminated air, as evidenced by smoke tubes Air samples were collected on charcoal tubes Personal breathing zone (PBZ) long-term samples for the spotter and tagger were taken for perchloroethylene (perc), trichloroethylene, 2-butoxyethanol, and hexylene glycol Short-term PBZ samples were collected for perc, trichloroethylene, methyl isobutyl ketone (MIBK), and n-butyl acetate Area samples were collected only for perc and trichloroethylene All levels were below OSHA limits, and all concentrations of 2-butoxyethanol and hexylene glycol were nondetectable. Specific recommendations included exhaust of the spotting process to the outdoors, isolation of the spotting process during management's planned facility construction, proper use of personal protective equipment, and additional training for the spotter to reduce solvent usage and to achieve a more selective spotting procedure

INTRODUCTION

The Engineering Control Technology Branch (ECTB), Division of Physical Sciences and Engineering (DPSE), National Institute for Occupational Safety and Health (NIOSH), has undertaken a study of the dry cleaning industry to update a 1980 NIOSH engineering control study of the industry[1] and provide dry cleaners with recommendations for practical control measures based on current technology (see Appendix A) The focus of this in-depth study is to evaluate exposures during the spotting process

A walk-through evaluation was performed at Widmer's Dry Cleaners in Cincinnati, Ohio, in January 1993[2] to evaluate only the dry cleaning process. That evaluation revealed that the levels of perchloroethylene (perc) at the shop were within limits set by OSHA regulations In April 1994, Widmer's Dry Cleaners received a letter from OSHA documenting a complaint that employees were getting sick from perchloroethylene (perc) from the dry cleaning machines, and that there was inadequate ventilation.[3] Upon further discussion with the management of Widmer's, it seemed that there was much concern displayed by the employees in the clothing tag-in room where pre-spotting was performed In the previous walk-through of Widmer's, the spotting (both pre- and post-) were performed in a different location on the second floor The pre-spotting process was moved downstairs to the clothing tag-in area in February 1994 The employees in the tag-in room believed that they were being exposed to excessive amounts of perc and other chemicals used for pre-spotting The management requested that NIOSH researchers evaluate the pre-spotting process in the clothing tag-in room

This report describes the evaluation of the pre-spotting process conducted at Widmer's Dry Cleaners. The purpose of this study was to evaluate occupational health hazards associated with the use of various chemicals during the pre-spotting process

PLANT AND PROCESS DESCRIPTION

PLANT DESCRIPTION

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

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 The spotter usually works 8 hours per day, 40 hours per week Widmer's is able to clean approximately 1,100 lb of clothing per gallon of perc purchased Their three primary dry cleaning machines each use approximately 2 gal of PERC per week

The shop layout is shown in Figures 1 and 2 The clothing tag-in room where pre-spotting occurs is shown in Figure 3. The first floor is used for customer service, offices, marking and tagging, pre-spotting, dry cleaning, and storage The delivery vans are loaded and unloaded at the dock along Cinnamon Street The second floor is used for post-spotting, pressing, conventional laundry, and bagging An overhead conveyor system is used to transport clothing from the first to second floor

PROCESS DESCRIPTION

Upon arrival, the garments are sent to the tagging room where they are tagged and logged on a computer-based tracking system The clothing is checked for stains and rips by the pre-spotter. The pre-spotter also uses a small bottle of perc in order to check for the colorfastness of garments before dry cleaning Garments with visible stains are pre-treated with various chemicals, and sorted into three bins whites, darks, and lights. Garments are also sorted by weight and finish The garments to be dry cleaned are loaded in one of three enclosed, dry-to-dry machines (Boewe® Model P546) These 46-lb machines are approximately 2 5 yr old and have some of the latest available control options Clothes are manually removed from the machine, loaded into a basket, then placed on a conveyor and transported to the second floor for pressing After each garment is pressed, it is wrapped in plastic, and stored for pickup or delivery

The Spotting Process

Two general categories of stains are water soluble and solvent soluble There are also two general categories of spotting chemicals "wet-side" chemicals that may contain water are used to remove water-soluble stains, and "dry-side" chemicals which do not contain water are used to remove solvent-soluble stains The spotting process has two components pre-spotting which involves the use of "dry-side" chemicals to remove or loosen solvent-soluble stains, and post-spotting which utilizes "wet-side" chemicals to remove water-soluble stains At Widmer's, pre-spotting involves very little use of tools, usually the solvent is simply squirted on the stain before the garments are sorted It was estimated that the pre-spotter treats approximately 2,500 garments per day.

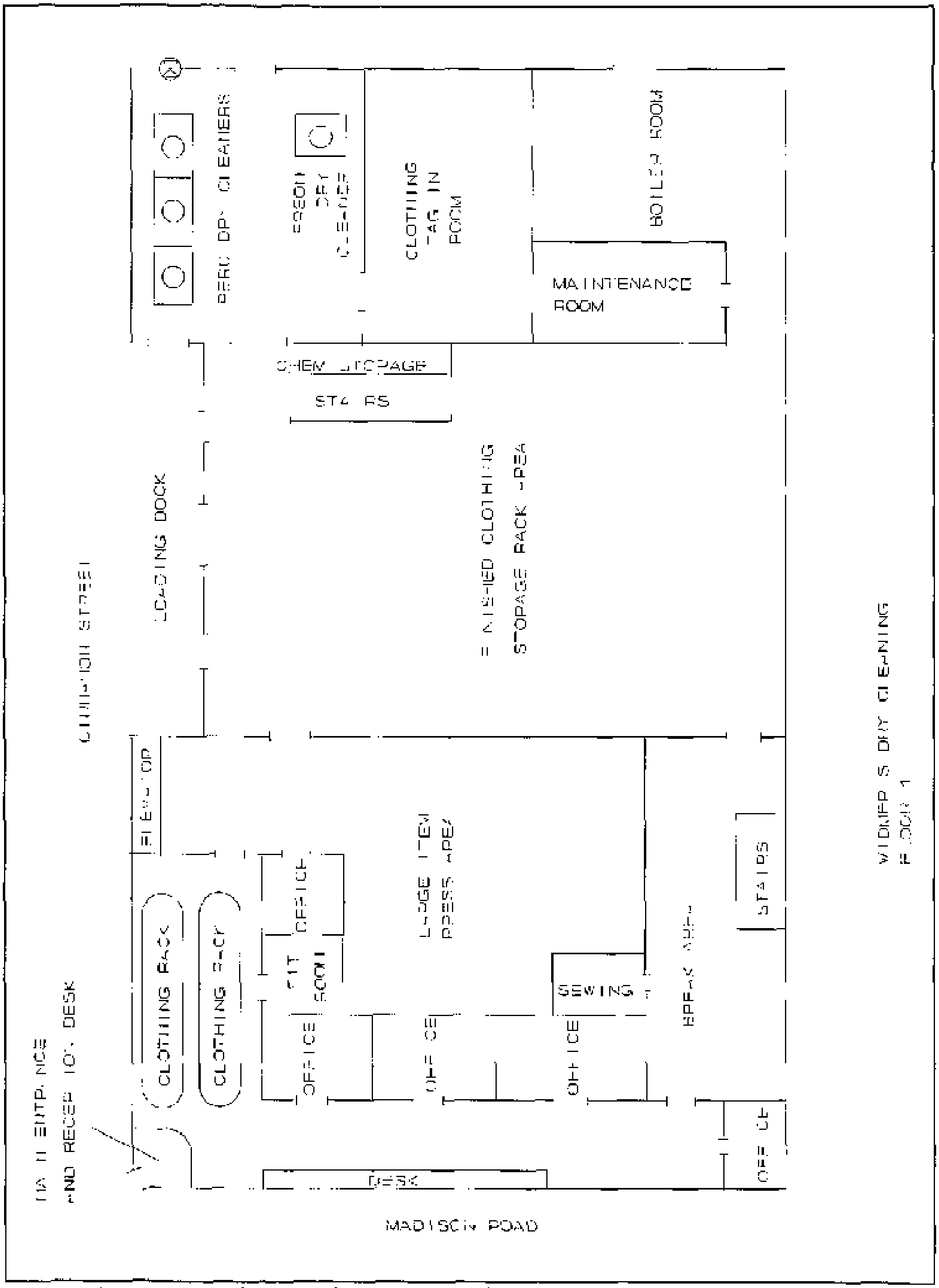

Figure 1 First floor Widmer's Dry Cleaning

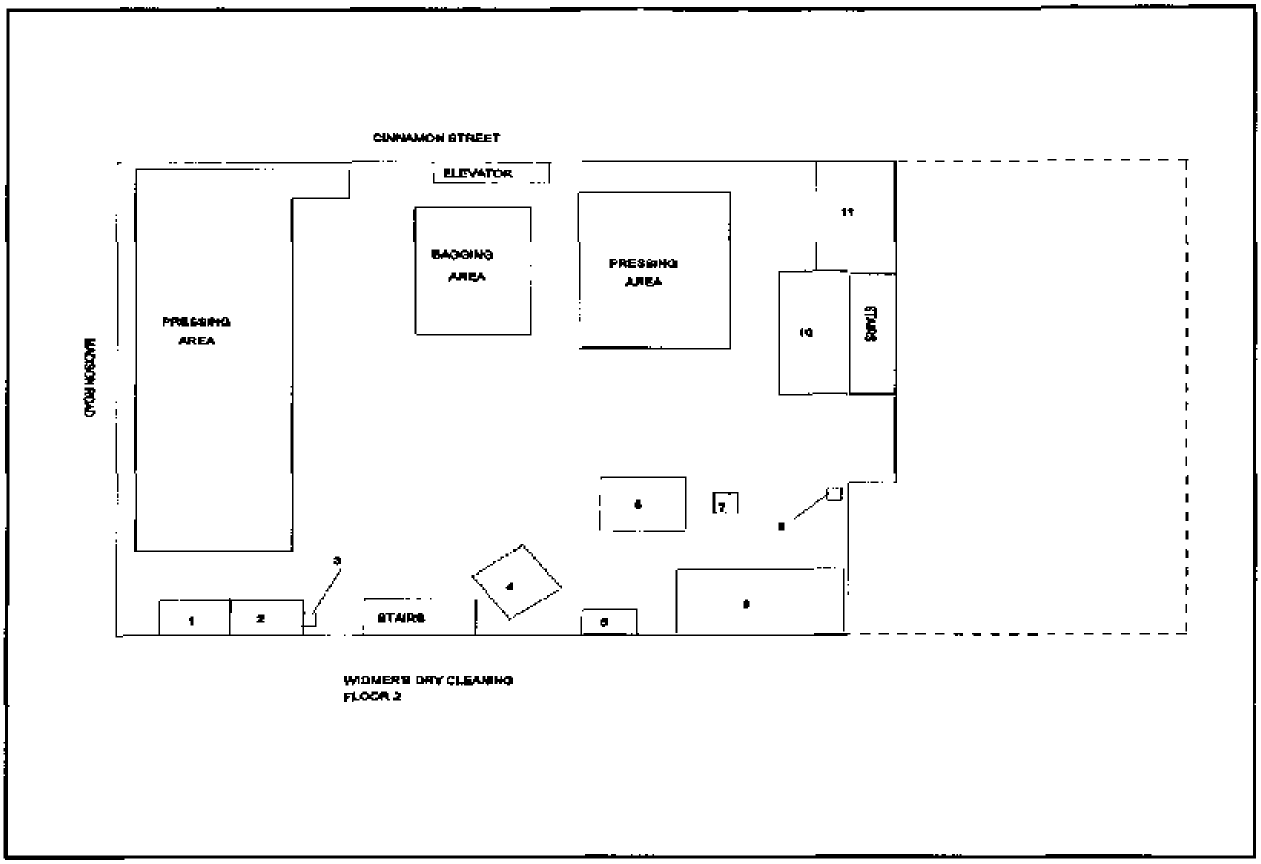

Figure 2. Second floor Widmer's Dry Cleaning

LEGEND FOR FIGURE 2

1 Men's Room
2 Ladies' Room
3 Water Fountain
4 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

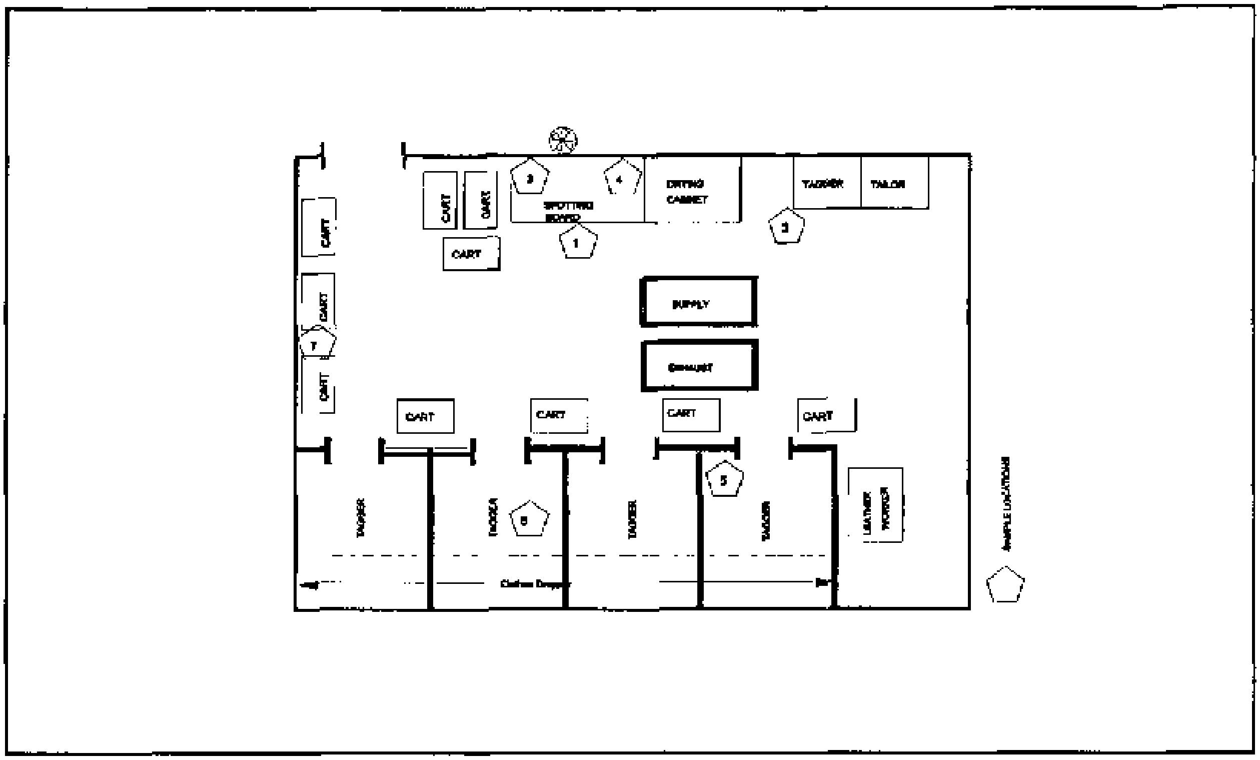

Figure 3 Clothing Tag-in Area where spotting occurs

Stains that were water-soluble which may further set during the dry cleaning process (rendering them more difficult or impossible to remove later) were sent upstairs to the post-spotting station for treatment before dry cleaning All other post-spotting was done after dry cleaning the garment Post-spotting was used when the stain was not visible before dry cleaning, or when the stain was not completely removed after pre-spotting and dry cleaning Post-spotting was much more time intensive, and involved the use of special equipment and tools It was performed on a spotting board equipped with pressurized air, steam, and water guns designed to flush the chemicals and stains from the garments. Small brushes, spatulas, and fingers were used to help remove the stain A foot-pedal actuated vacuum was used to capture the excess spotting chemicals, which were held in a storage reservoir until disposed of as hazardous waste The remainder of the report will focus on the pre-spotting portion of the stain removal process. For simplicity, the authors will refer to "pre-spotting" as "spotting" in the remainder of this paper

Four chemicals were used for spotting during the evaluation Pyratex®, Picrin®, Two-in-one®, and Wetspo® Pyratex® is primarily methyl isobutyl ketone (MIBK), n-butyl acetate, and 2-butoxyethanol Picrin® is primarily trichloroethylene Two-in-one® is a mixture of Picrin® and Streetex®, Streetex® is mostly hexylene glycol and diacetone alcohol Wetspo® is primarily composed of perc

Pyratex® is used for collar stains and grease, oil, ink, and paint stains; it is mainly used for tough stains on durable garments Picrin® is used to remove paints Two-in-one® is used for light oil and grease stains. Wetspo® is used for ink stains On an average day, the spotter used 48 oz of Pyratex®, 24 oz of Two-in-one®, 6 oz of Wetspo®, and 6 oz of Picrin® The spotter also used approximately 4 oz of perc per day to check for fabric colorfastness Some of the other common spotting chemicals used in other dry cleaners may include. amyl acetate, petroleum naphtha, oxalic acid, acetic acid, dilute hydrofluoric acid, hydrogen peroxide, and aqueous ammonia

The Clothing Tag-in Room: The Location of the Spotting Process

The clothing tag-in room is approximately 20 ft by 30 ft There is a door opening covered with thick plastic strips to keep in the heat or air conditioning In addition to the spotter, there are five to six other employees performing various tag-in or repair functions The spotting table was built by employees of Widmer's It is located against the wall, near the door opening, and is approximately 3 ft high on the front and is angled toward the worker at approximately 20 degrees The working surface of the table is approximately 3.5 ft wide and 2 5 ft long The top of the spotting table is constructed of nonporous laminated countertop surface, the rest of the table is made with wood covered with shellac to inhibit chemical saturation The spotting chemicals are kept in small plastic squeeze bottles for easy application On the right side of the table are holes in which the spotter places the solvent bottles and another hole to place his spotting brush Larger metal containers of the spotting chemicals are stored on a small shelf underneath the working surface of the table Soon after the spotting was moved into the tag-in room, the tag-in workers started to complain about the odor. The management installed a small kitchen exhaust hood (Broan Microtek Systems IV®, Model 88,000C) above the spotting station to reduce inhalation hazards from the spotting chemicals The hood exhausted into the adjacent room, the dry cleaning room The tag-in workers did not believe this improved the odors. The hood was mounted on the wall, approximately 6 ft high; this was approximately 3 ft from the spotting table surface At the face of the hood, the average velocity was approximately 170 ft per min (fpm) At a distance of 6 in below the face, there was a negligible amount of air movement due to the hood The hood was also tested with smoke tubes, there was no air movement near the work surface.

The clothing tag-in room had a dedicated air handling unit The supply and exhaust were located in the middle of the room, side by side The supply protruded from the ceiling and had three registers a circular register at the bottom, and two rectangular registers on the sides, directed toward the back of the room towards the wall where the spotter was located Smoke tube testing surprisingly showed that there was very little entrainment of the supply air into the exhaust in the room since they were located beside each other. However, there was some swirling of air up under the circular supply The workers in the back of the room reported that they sometimes cover the air register supplying air to the back of the room because "it is too much wind " Examination of the air handling unit located on the roof showed that it was in good condition However, the outside air intakes were closed, thereby allowing no fresh air intake to enter the tag-in room, there was 100 percent recirculation of air.

POTENTIAL HAZARDS

Spotting involves the selective application of a wide variety of chemicals and steam to remove specific stains Individuals who perform the spotting process may be exposed to toxic chemicals through skin or eye contact or inhalation of vapors The primary hazards posed by chemicals used in the spotting process is skin damage resulting from chronic or acute exposure, or injury to the eyes, however, chemicals that readily vaporize and have a high toxicity could also pose a risk from inhalation Vapor pressure, toxicity, ventilation, and the manner and frequency of use, and air concentration should all be considered when assessing the risk from inhalation For a more detailed discussion about potential chemical hazards during the spotting process, refer to Appendix B.

EVALUATION CRITERIA

NIOSH considers perchloroethylene to be a potential occupational carcinogen and recommends that exposure be reduced to the lowest feasible limit.[4] The current OSHA permissible exposure limit (PEL) for perchloroethylene is 100 ppm, 8-hr time-weighted average (TWA) exposure, perc has a Short-Term Exposure Limit (STEL) of 200 ppm [5] OSHA had lowered the PEL to 25 ppm in 1989 under the Air Contaminants Standard [6] 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 [7]

Trichloroethylene has a TWA of 100 ppm, and a STEL of 200 pm,[5] NIOSH recommends a TWA of 25 ppm [8] For 2-butoxyethanol, the OSHA TWA is 50 ppm and the NIOSH TWA is 5 ppm [8] For hexylene glycol, NIOSH recommends a ceiling of 25 ppm.[8] For MIBK, the OSHA TWA is 50 ppm, and the STEL is 75 ppm [5] For n-butyl acetate, both NIOSH and OSHA have a TWA of 150 ppm, and the STEL is 200 ppm [8,5]

RESULTS

INDUSTRIAL HYGIENE SAMPLING

The samplıng methodology ıs descrıbed ın Appendıx C. Aır samplıng was conducted for two days to evaluate the tagger and spotters' personal breathıng zones (PBZ) for perc, trıchloroethylene, 2-butoxyethanol, hexylene glycol, MIBK, and n-butyl acetate Addıtıonally, five locatıons were sampled to obtaın area concentratıons of perc and trıchloroethylene. Samplıng results are shown ın Appendıx D as TWA concentratıons For the results that were reported as nondetectable (ND), the lımıt of detectıon (LOD) was used ın Tables 1, 2, and 3 to obtaın the most conservatıve value for concentratıon. The LOD was reported as 0 01 mg/sample for all the chemıcals sampled For the results that were reported below the lımıt of quantıtation (LOQ), the reported values were used The LOQ was reported as 0 033 mg/sample for all the chemıcals sampled

The long-term PBZ samples were collected for an average tıme of 115 mın No 2-butoxyethanol or hexylene glycol was detected ın the PBZ samples The spotter's TWA exposures of perc and trıchlorethylene for days one and two were, respectıvely, 5 40 ppm and 12 31 ppm, for the tagger, the exposures were 2.64 ppm and 9 50 ppm Average PBZ exposures are shown ın Table 1 Durıng day one for the PBZ samples, the samplıng pump was ınadvertently not turned on, therefore, only three samples were taken for the tagger

Table 1 --Eıght-Hour PBZ Exposures

Worker	Day	n	Perc TWA (ppm)	Perc Range (ppm)	Trıchlorethylene TWA (ppm)	Trıchlorethylene Range (ppm)	2-Butoxy-ethanol (ppm)	Hexylene glycol (ppm)	Total Sample Tıme (mın)
Spotter	1	4	5 40	2 44-8 73	2 37	0 55-4 48	<0 09	<0 09	472
Tagger	1	3	2 64	ND-4 46	0 30	ND-0 47	-	-	360
Spotter	2	4	12 31	4 73-24 07	3 11	0 80-9 08	< 034	<0 09	436
Tagger	2	4	9 50	4 69-13 48	1 46	0 62-2 88	-	-	444

For the four chemıcals that have a STEL, short-term PBZ samples were taken The average exposures (tıme-weıghted) are shown ın Table 2. Area samples were taken for perc and trıchloroethylene, and average exposures (tıme-weıghted) are shown ın Table 3

Table 2 --Spotter's PBZ Time-Weighed Average Short-Term Exposures

Day	n	Perc (ppm) Avg	Perc (ppm) Range	Trichloroethylene Avg	Trichloroethylene Range	MIBK (ppm) Avg	MIBK (ppm) Range	n-Butyl Acetate (ppm) Avg	n-Butyl Acetate (ppm) Range	Sample Time (min)
1	27	5 87	ND-16 93	2 21	ND-9 16	1 39	ND-2 44	1 89	ND-3 52	15 3
2	25	6 65	ND-38 70	1 40	ND-5 13	1 65	ND-4 20	2 28	ND-5 69	16 9

Table 3 --Time-Weighed Average Area Sample Concentrations

Area	Location (Figure 3)	Day	n	Perc TWA (ppm)	Perc Range (ppm)	Trichlorethylene TWA (ppm)	Trichlorethylene Range (ppm)	Total Sample Time (min)
Back	#2	1	4	5 30	2 98-9 00	1 49	0 46-2 56	484
Table	#3	1	4	5 26	2 83-8 80	1 53	0 46-2 56	484
Above	#4	1	4	4 83	2 74-8 25	1 77	0 71-2 89	484
Tag stn	#5	1	4	5 15	2 79-8 93	1 32	0 43-2 19	488
Door	#7	1	4	5 58	3 11-9 71	1 10	0 39-1 87	488
Back	#2	2	4	6 95	3 67-11 91	1 30	0 86-2 11	480
Table	#3	2	4	12 91	3 93-25 43	3 45	0 90-8 82	480
Above	#4	2	4	7 27	3 81-11 80	1 79	1 19-2 40	480
Tag stn	#5	2	4	12 43	3 05-24 88	2 82	0 73-7 59	480
Door	#7	2	4	11 72	4 05-24 19	2 13	0 28-5 85	480

Since the spotter is exposed to multiple solvents, the additive effects of the multiple solvents should be examined. To evaluate whether the total solvent exposure is excessive, a combined exposure, C_E, is calculated using the following equation

$$C_E = C_1/T_1 + C_2/T_2 + \quad + C_n/T_n$$

Where. C_n = Exposure to an individual contaminant (ppm)
L_n = The OSHA TWA for the individual contaminant (ppm)

If the value of C_E is less than 1, the combined exposure is believed to be acceptable When using this calculation for the data collected in this study, the OSHA TWA for each chemical was used when available For hexylene glycol, no OSHA TWA was available, therefore, the NIOSH ceiling of 25 ppm was used The highest percentage of the TLV calculated for the mixture was 0 10, during day 2 for the tagger, who was tested for perc and trichloroethylene exposures

REAL-TIME MONITORING

Video recording and real-time monitoring were performed during the spotting procedure Since the air sampling results showed such low concentrations of various chemicals, the real-time data was evaluated qualitatively. The real-time sampling data was gathered over a basket beside the spotting table where garments are placed after they are spotted The excess solvent in the garments continued to off-gas into the tag-in room, as qualitatively evidenced by the real-time instrumentation As expected, the relative concentration of solvents above the basket peaked when a garment with solvents on it was placed in the basket There also appeared to be a cumulative effect, as the level of garments increased in the basket, the overall background level of solvents also seemed to increase, as shown in Figure 4

DISCUSSION

CONTROLS FOR THE SPOTTING PROCESS

During the spotting process, it appeared that there was an excess of spotting solvents applied. There was little close examination of the type of stain before a seemingly excess of solvents was poured on the garment by the spotter However, lack of stain examination perceived by the authors could actually be due to the experience of the spotter, perhaps little inspection is required to determine the necessary treatment However, using the solvents more sparingly could reduce the off-gassing of the excess solvent during spotting, and also when they are placed in the baskets beside the spotting table.

Local exhaust ventilation appears to be the most effective and realistic control approaches for reducing solvent exposures during the spotting process Another control is isolation. Isolation refers to placing a physical or time barrier between the hazard and the workers Isolation of both the process and chemicals from the worker is being used in some dry cleaning shops today Many facilities no longer store large quantities of solvent on the premises Instead, they have a supplier deliver it as needed, or have outside storage It is often difficult to isolate the spotting procedure in small shops such as Widmer's due to space constraints

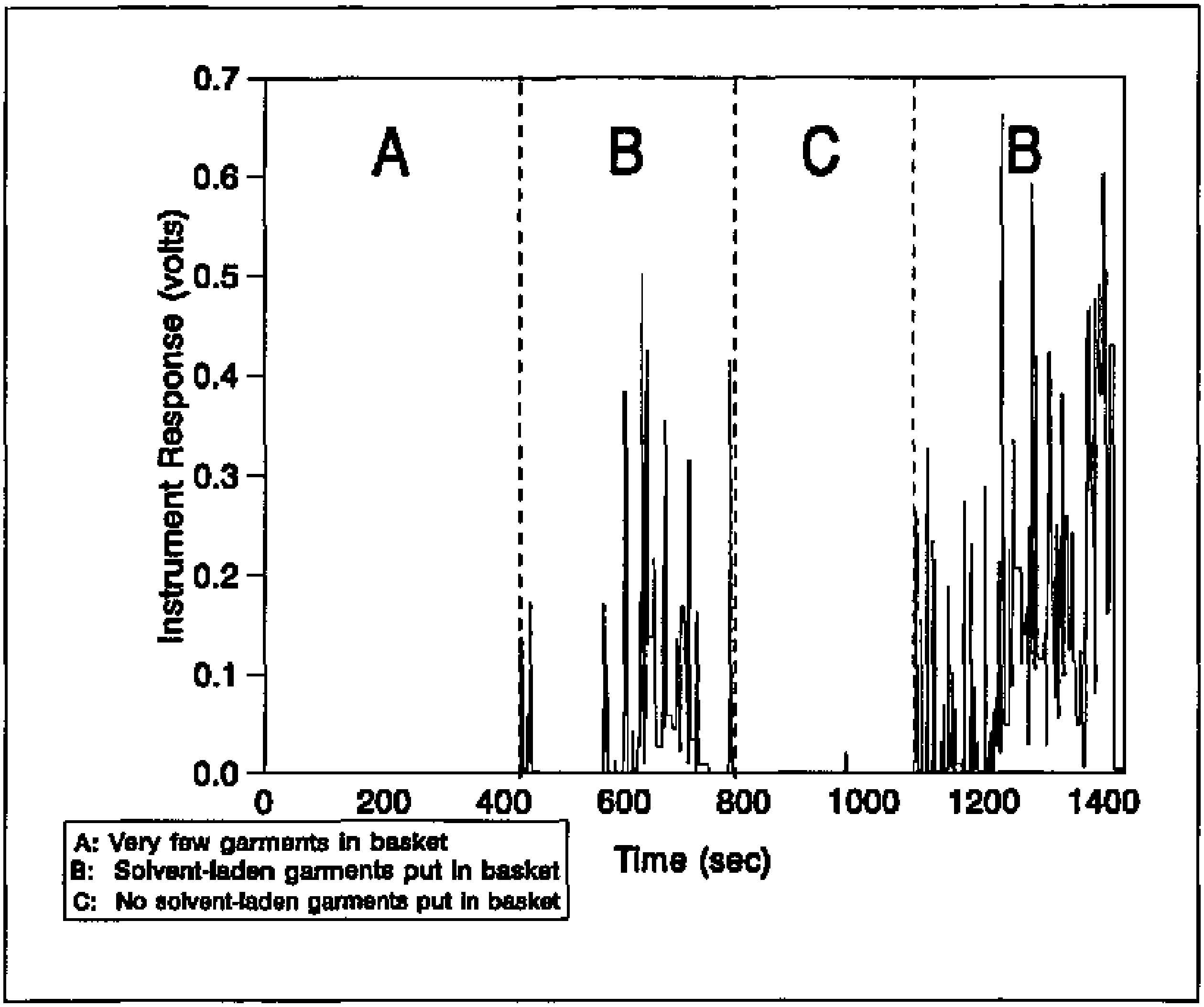

Figure 4 Real Time Solvent Concentrations Over Basket

Larger shops have more space which provides greater flexibility for isolating various processes, such as the spotting process It appears that there is very little room at Widmer's to properly isolate the spotter from the other six employees in the tag-in room, yet still maintain the close proximity to the tag-in and dry cleaning process to ensure an acceptable flow of operations Although the spotter has greater exposure to solvents compared to other workers in the tag-in room, the other workers are needlessly exposed During discussions with the other workers in the tag-in room, it appeared that almost all reported headaches that they believed were caused by breathing the solvents. There were several complaints regarding the odor of some of the solvents also In order to be effective, process isolation must be used in conjunction with good local and general ventilation to lower the spotter's exposures

Local ventilation is considered the "classic method" of control, attempting to capture contaminants before they escape into the environment There needs to be sufficient face velocity for the exhaust system to help to capture and prevent solvent vapors from escaping into the shop 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 Widmer's management attempted to use local ventilation by installing the small kitchen exhaust hood However, this ventilation was not appropriate nor effective for three reasons (1) The velocity of air from the hood was inadequate to capture the contaminants originating from the table surface, (2) Improper placement. if the velocity of air was high enough to capture the contaminants, since the hood is located over the spotter's head, the contaminants would be pulled through the personal breathing zone (PBZ) of the worker, and (3) The contaminated air was being exhausted into the adjacent room where a worker was performing dry cleaning, the contaminated air should be vented outside the building

General ventilation should add fresh air and remove general facility air to dilute contaminant concentrations below a specified level The air handling unit which serviced the tag-in room appeared to be in good condition, however the fresh air intake was closed Although the maintenance personnel explained that the intake is controlled automatically by the system, the fresh air intake should never be fully closed

The use of personal protective equipment at this facility needs improvement Personal protective equipment is particularly important for the spotters who use a wide variety of hazardous chemicals There was a very brief written policy regarding respirators, but no fit testing program was in place There was no written program or policy concerning the use of other personal protective equipment Workers and management seemed largely unconcerned with its usage. Both gloves and respirators were available, but not being used The gloves were made of natural rubber, and the respirator was a single-use variety. The gloves were likely inappropriate due to the variety of chemicals being used The respirator was not marked "disposable after use," so even if it was used, it would likely be reused at a later date

General maintenance and housekeeping appeared to be good The shop, although crowded, was neat and orderly and regular maintenance was performed. Routine maintenance was performed on all the equipment

CONCLUSIONS AND RECOMMENDATIONS

Widmer's Dry Cleaning was able to maintain all exposure levels below NIOSH recommendations and OSHA limits for the following chemicals trichloroethylene, 2-butoxyethanol, hexylene glycol, MIBK, and n-butyl acetate However, NIOSH recommends controlling perc to the lowest feasible limit. As expected, the highest TWA PBZ exposures (long- and short-term) were for the spotter. The highest area exposures were found on the spotting table These levels are likely due to an inadequate local exhaust ventilation system. When considering the additive effect of the multiple solvents being used, it appears that exposures are well below what is considered acceptable

Even though concentrations were below those recommended, there were still complaints from the employees working in the clothing tag-in room. These complaints indicated additional measures should be taken to reduce unpleasant odors and subsequent irritation of employees It is recommended that exhaust ventilation to the outside should be incorporated for the spotting process. A slot hood at table level or a downdraft table exhausting to the outside should be considered With the exhaust located closer to the source of contaminants, the contaminants will not be pulled up through the breathing zone of the spotter before being removed

There are plans by Widmer's management to enlarge the facility This enlargement will occur on the first and second floors, to increase the amount of room in the area near the back wall of the clothing tag-in room The spotting process should be moved to this new area and be isolated from the other workers in the tag-in room During the construction process would be an optimum time to design and incorporate proper exhaust to the outdoors for the spotting process in the new area Makeup air must be provided to account for the air exhausted An inadequate volume of makeup air may result in negative pressure areas, perhaps resulting in drafts which may interfere with the exhaust hood If makeup air is introduced, it should enter some distance from the exhaust to prevent short circuiting of the air As recommended by the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), the ventilation system in all dry cleaning facilities should provide at least 30 cfm of outside air per person.[9]

The management should consider additional training for the spotter regarding reducing solvent usage and how to perform more selective pre-spotting This would also help to reduce the off-gassing of the solvents on the garments in the baskets waiting to be dry cleaned

Dermal and splash exposures are also a concern during the spotting process Use of PPE such as gloves, goggles, and a chemical resistant apron is suggested for routine use by the spotter Gloves and aprons 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 Whenever swelling or softening of the gloves or seepage of perc into the glove is observed, the gloves should be replaced Damaged gloves can actually increase the potential hazard since solvents can be trapped inside the glove, providing constant solvent contact with the spotter's skin

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 where a wide variety of toxic chemicals were being used to remove stains Additionally, there should be an eye wash station located near the spotting area to provide prompt eye irrigation if it is needed If chemical contamination of the eye does occur, prompt irrigation for at least 15 min can play a deciding role in limiting the extent of damage

Implementation of these recommendations should help Widmer's Dry Cleaners lower exposures to volatile spotting solvents during the spotting process to as low as technically feasible In summary, effective engineering measures, good work practices, and appropriate PPE should be implemented and maintained in order to keep exposures to hazardous spotting solvents as low as possible

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APPENDICES

APPENDIX A: BACKGROUND

The National Institute for Occupational Safety and Health (NIOSH), is located in the Centers for Disease Control and Prevention (CDC) under the Department of Health and Human Services (DHHS) In the late 1970s and early 1980s, a NIOSH-sponsored engineering control technology study was conducted in the dry cleaning industry [1] Since that study, 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). 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 This industry currently has in excess of 30,000 commercial shops and approximately 244,000 employees in the United States [2]

Data from the OSHA Integrated Management Information System (IMIS) from 1984-1988, indicates that approximately 20 percent of samples taken at dry cleaning shops exceeded 100 ppm [3] In 1988, the OSHA Director of Federal-State Operations conducted a nationwide query of the OSHA State Consultation Programs asking for high risk small businesses in need of occupational safety and health research The dry cleaning industry was the second-most mentioned small business behind autobody repair shops [4] Preliminary information gathered by the NIOSH Division of Surveillance, Hazard Evaluations, and Field Studies has shown a high incidence of back pain among laundry and dry cleaning workers [5]

REFERENCES - APPENDIX A

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APPENDIX B: POTENTIAL HAZARDS

Spotting involves the selective application of a wide variety of chemicals and steam to remove specific stains Some of the chemicals and chemical families that are used on a fairly regular basis for spotting in addition to PERC are as follows. other chlorinated solvents, amyl acetate, petroleum naphtha, oxalic acid, acetic acid, esters, ethers, ketones, 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. Use of dilute hydrofluoric acid, which is found in rust removal spotting agents, poses the greatest risk from acute dermal exposure, however, many of the chemicals used can cause occupational dermatoses from chronic exposure to the skin

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 the following depression of the central nervous system, damage to the liver and kidneys, impaired memory, confusion, dizziness, headache, drowsiness, and eye or nose and throat irritation, repeated dermal exposure may result in dry, scaly, and fissured dermatitis [1] Over the past 15 yr, studies conducted by the National Cancer Institute (1977) and the National Toxicology Program (1986) have established a link between perc exposure and cancer in animals Other studies have shown an elevated risk of urinary tract,[2,3,4] esophageal,[2,5] and pancreatic cancer[6,7] among individuals who work in dry cleaning establishments. Most of these studies involved exposure to a variety of solvents and have not been linked specifically to perc exposure Cancer mortality research is continuing at NIOSH and other research organizations As measured by personal sampling, the International Fabricare Institute found perc exposure levels during spotting was many times lower than OSHA standards, for some other spotting chemicals being used, exposures were below detection limits [8] Another study indicated that in general, inhalation exposures are minimized due to the limited quantities of chemicals and the intermittent nature and short duration of the task [9] During personal sampling by the Arthur D. Little Company at the International Fabricare Institute's Analysis Laboratory,[10] perc exposure levels during spotting were many times lower than OSHA standards and some chemicals being used were below detection limits [6]

REFERENCES - APPENDIX B

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APPENDIX C: METHODOLOGY

INDUSTRIAL HYGIENE SAMPLING

The objective of this site visit was to evaluate occupational exposures to the chemicals used during the spotting process The chemicals used were Pyratex (n-butyl acetate, 2-butoxyethanol, methyl isobutyl ketone, and hexylene glycol); 2-in-1 Streetex (hexylene glycol and trichloroethylene), Picrin (mostly trichloroethylene), and perchloroethylene

Personal and area air sampling were conducted for two days in the clothing tag-in area, there were five area locations, and two personal breathing zones (PBZ) evaluated A diagram of the clothing tag-in room and sample locations are shown in Figure 3 All air sampling results are shown in Appendix D.

For the long-term PBZ samples, the chemicals chosen for which to sample were those found in the largest percentages in the solvents, or occurred in more than one solvent These long-term PBZ sample results are shown in Table 1. For the short-term PBZ samples, those chemicals with a STEL were sampled for; results are shown in Table 2 For the area samples, only the two chemicals in the largest abundance in the solvents were sampled for, results are shown in Table 3

Area air samples were taken on the spotting table (sample #3), denoted as "table" in Appendix D, above the spotting table (sample #4), denoted as "above," to the far right (sample #2), denoted as "back," at a tagging station closest to the spotter (sample #5), denoted as "tag stn," and near the door to the far left of the spotting table (sample #7), denoted as "door." Samples #2, #5, and #7 were approximately 10 ft away Personal breathing zone samples were taken for the spotter (sample #1) and on a tagger (sample #6), and are denoted as "spotter" and "tagger" in Appendix D. There were 15-min PBZ samples taken for the spotter for those chemicals with a Short-Term Exposure Limit (STEL), these are denoted in Appendix D as "spot15 "

With the exception of sampling for hexylene glycol, all sampling was done using 100 mg/50 mg coconut shell charcoal tubes and carbon disulfide desorption Analysis was done using a gas chromatograph with flame ionization detector Hexylene glycol sampling was done using 100 mg/50 mg coconut shell charcoal tubes, using the OSHA Stopgap Method,[1] and a desorption solution of 95:5 methylene chloride to methanol

There were four chemicals sampled for in which Short-Term Exposure Limits (STELs) existed perc, trichloroethylene, methyl isobutyl ketone (MIBK), and n-butyl acetate For these chemicals, the samples were taken in 15-min time periods with a flow rate of 0 2 liters/min For perc and trichloroethylene, longer sampling periods were also taken, as described below

When sampling for perc and trichloroethylene, the NIOSH Methods 1003[2] and 1022[3] were used, respectively Samples were collected over a time period of 120 min, with a flow rate of 0 2 liters/min The limit of detection (LOD) for both processes was 0 01 mg/sample

When sampling for methyl isobutyl ketone (MIBK), NIOSH Method 1300 for ketones was used [4] For n-butyl acetate, NIOSH Method 1450 for esters was used Only the short-term samples were collected for MIBK and n-butyl acetate The LOD for both processes was 0 01 mg/sample

NIOSH Method 1403 for alcohols was used to sample for 2-butoxyethanol.[6] Samples were collected over a 120-min time period with a flow rate of 0 05 liters/min The LOD for this process was 0 01 mg/sample

To sample for hexylene glycol, the OSHA Stopgap Method[1] was used This method calls for sampling using a charcoal tube, with a desorption solution of 95 5 methylene chloride to methanol Samples were collected over a 120-min time period with a flow rate of 0.2 liters/min Analysis was done using a gas chromatograph with flame ionization detector The limit of detection for this process was 0 01 mg/sample

VIDEO EXPOSURE MONITORING

Real-time monitoring was used to study in greater detail how specific tasks affect worker exposure to organic spotting solvents, the instrument output of data is instantaneous Real-time monitoring of exposure levels were performed using a MicroTIP® IS3000® (PHOTOVAC Inc, Thornhill, Ontario) with a 10 6 eV ultraviolet lamp This instrument uses a photoionization detector to provide an analog output response proportional to the concentration of ionizable pollutants present in the air The MicroTIP® was spanned using 100 ppm isobutylene span gas The MicroTIP® was set for a measuring range between 0 to 200 ppm, and was placed over the basket where garments are stored after the spotting procedure

Information gathered using the MicroTIP® was electronically recorded on a Rustrak® data logger (Rustrak® Ranger, Gulton, Inc., East Greenwich, RI) and downloaded to a portable computer using Pronto® software. During the gathering of real-time data, a video camera was also used to record worker activities

VENTILATION

General ventilation measurements were taken with a Kurz® Model 1440-5 (Kurz Instruments, Inc.) digital air velocity meter Various air flows throughout the clothing tag-in room were qualitatively evaluated using smoke tubes The capacity and dimensions of general dilution ventilation systems were recorded

REFERENCES - APPENDIX C

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APPENDIX D

APPENDIX D

WIDMER'S DRYCLEANING CINCINNATI OH (SPOTTING PROCESS)

Area	Perc (ppm)	Perc Avg** Exp (ppm)	Trichloro ethylene (ppm)	Trichloro ethylene Avg** Exp (ppm)	2-Butoxy ethanol (ppm)	Hexylene Glycol (ppm)	MIBK (ppm)	nButylAcetate (ppm)		Date	Time (min)
tag stn	8.93	5.15	2.18	1.32						8-29-94	130
tag stn	2.79		2.19							8-29-94	117
tag stn	5.24		0.43							8-29-94	119
tag stn	3.30		0.45							8-29-94	123
above	3.33	4.83	0.72	1.77						8-29-94	120
above	4.57		0.71							8-29-94	119
above	8.25		2.71							8-29-94	132
above	2.74		2.89							8-29-94	114
back	3.81	5.30	0.56	1.49						8-29-94	122
back	2.98		2.35							8-29-94	117
back	9.00		2.56							8-29-94	129
back	5.12		0.46							8-29-94	119
door	3.11	5.58	1.69	1.10						8-29-94	119
door	9.71		1.87							8-29-94	127
door	5.63		0.39							8-29-94	116
door	3.69		0.42							8-29-94	126
spot15	2.85	5.87	(2.11)	2.21			(1.88)	(1.59)		8-29-94	13
spot15	(6.40)		0.54*				0.72*	(1.22)		8-29-94	17
spot15	3.59		0.51*				(1.36)		1.96	8-29-94	18
spot15	3.04		(1.14)				(1.53)		2.26	8-29-94	16
spot15	3.29		(0.54)				0.73*	(0.61)		8-29-94	17
spot15	3.00		2.99				(0.81)	(1.38)		8-29-94	15
spot15	7.26		2.81				(1.75)	(2.22)		8-29-94	14
spot15	4.34		0.61				(1.63)		2.28	8-29-94	15
spot15	10.16		0.61*				(1.63)	(2.07)		8-29-94	15
spot15	7.26		0.83*				1.11*	(0.94)		8-29-94	11
spot15	3.77		(0.61)				(1.63)	(2.07)		8-29-94	15
spot15	1.79		4.09				(0.81)	(1.38)		8-29-94	15
spot15	15.97		7.33				(1.63)		2.35	8-29-94	15
spot15	2.71		3.79				(1.63)		2.62	8-29-94	15
spot15	8.22		(1.22)				(1.63)	(2.07)		8-29-94	15
spot15	7.26		(1.22)				(2.44)		3.52	8-29-94	15
spot15	5.81		0.61*				(1.63)		2.35	8-29-94	15
spot15	(1.45)		(1.83)				0.81*	0.69*		8-29-94	15
spot15	16.93		9.16				(2.44)		3.53	8-29-94	15
spot15	3.82		0.61*				(0.81)	(1.38)		8-29-94	15
spot15	9.16		6.30				(2.29)		3.17	8-29-94	16
spot15	9.82		(1.08)				(1.44)		2.25	8-29-94	17
spot15	4.03		0.51*				0.68*	(0.58)		8-29-94	18
spot15	3.39		3.72				(1.63)	(2.07)		8-29-94	15
spot15	2.13		3.54				(0.81)	(1.38)		8-29-94	15
spot15	8.22		(1.22)				(1.63)	(2.07)		8-29-94	15
spot15	4.10		(1.08)				(0.72)	(1.22)		8-29-94	17
spotter	2.44	5.40	3.93	2.37						8-29-94	125
spotter	8.73		4.48							8-29-94	133

* reported as ND
** Average exposure is time weighted
( ) reported between LOD and LOQ
LOD = 0.01 mg/sample
LOQ = 0.033 mg/sample

APPENDIX D

WIDMER S DRYCLEANING CINCINNATI OH (SPOTTING PROCESS)

Area	Perc (ppm)	Perc Avg** Exp (ppm)	Trichlo ethylene (ppm)	Trichlo Avg** ethylene Exp (ppm)	2-Butoxy ethanol (ppm)	Hexylene Glycol (ppm)	MIBK (ppm)	nButylAcetate (ppm)		Date	Time min
spotter	4.00		0.55							8-29-94	118
spotter						0.08*				8-29-94	125
spotter						0.08*				8-29-94	133
spotter						0.09*				8-29-94	119
spotter						0.13*				8-29-94	92
spotter					0.12*					8-29-94	82
spotter					0.08*					8-29-94	133
spotter					0.08*					8-29-94	125
spotter					0.08*					8-29-94	118
table	8.80	5.26	2.43	1.53						8-29-94	132
table	3.87		0.54							8-29-94	120
table	2.93		2.56							8-29-94	118
table	5.16		0.46							8-29-94	114
tagger	3.63	2.64	0.47	0.30						8-29-94	120
tagger	0.06*		0.07*							8-29-94	126
tagger	4.46		0.37							8-29-94	114
tag stn	24.88	12.43	7.59	2.82						8-30-94	140
tag stn	3.05		0.94							8-30-94	91
tag stn	11.03		0.73							8-30-94	125
tag stn	6.45		0.95							8-30-94	135
above	6.18	7.27	2.40	1.79						8-30-94	141
above	3.31		1.60							8-30-94	80
above	11.80		1.19							8-30-94	123
above	6.36		1.80							8-30-94	137
back	5.17	6.94	2.11	1.30						8-30-94	139
back	11.91		0.86							8-30-94	128
back	3.67		1.06							8-30-94	81
back	6.00		1.03							8-30-94	133
door	4.05	11.72	0.28	2.13						8-30-94	129
door	24.19		5.85							8-30-94	144
door	4.08		0.90							8-30-94	80
door	10.21		0.59							8-30-94	128
spot15	38.70	6.65	0.61*	1.4			0.81*	(1.38)		8-30-94	15
spot15	5.32		0.61*				(0.81)	(1.38)		8-30-94	15
spot15	4.45		(1.22)				0.81*	(0.69)		8-30-94	15
spot15	3.05		0.61*				(0.81)	(1.38)		8-30-94	15
spot15	8.71		0.61*				(0.81)	2.07		8-30-94	15
spot15	1.16		(0.61)				(1.62)	(2.48)		8-30-94	15
spot15	5.90		(1.14)				(0.76)	(1.94)		8-30-94	16
spot15	9.82		0.54*				(3.52)		4.63	8-30-94	17
spot15	5.81		(1.37)				(2.57)		3.26	8-30-94	20

APPENDIX D

WIDMER'S DRYCLEANING CINCINNATI OH (SPOTTING PROCESS)

Area	Perc ethylene (ppm)	Perc Avg** Exp (ppm)	Trichlo ethylene (ppm)	Trichlo Avg** ethylene Exp (ppm)	2-Butoxy ethanol (ppm)	Hexylene Glycol (ppm)	MIBK (ppm)	nButylAcetate (ppm)	Date	Time min
spot15	2.03		(1.22)				(1.63)	2.48	8-30-94	15
spot15	(1.45)		0.61*				(0.81)	(1.38)	8-30-94	15
spot15	11.13		(1.22)				0.81*	(0.69)	8-30-94	15
spot15	4.16		0.61*				(1.63)	(2.07)	8-30-94	15
spot15	2.81		(0.61)				(2.44)	3.11	8-30-94	15
spot15	8.47		3.76				(0.68)	0.58	8-30-94	18
spot15	9.98		(0.57)				(1.20)	5.69	8-30-94	16
spot15	4.61		0.65*				(2.62)	3.33	8-30-94	14
spot15	7.74		(0.61)				(3.02)	4.00	8-30-94	15
spot15	7.26		0.37*				(0.49)	(0.83)	8-30-94	25
spot15	2.90		5.13				(0.98)	(1.24)	8-30-94	25
spot15	4.70		3.99				(2.15)	3.04	8-30-94	17
spot15	6.80		3.95				(2.83)	3.62	8-30-94	16
spot15	5.81		0.73				(2.10)	2.86	8-30-94	25
spot15	6.57		(0.44)				(1.75)	2.51	8-30-94	21
spot15	4.61		(1.31)				0.87*	(0.74)	8-30-94	14
spotter	4.73	12.31	0.92	3.11					8-30-94	69
spotter	24.07		9.08						8-30-94	117
spotter	10.94		0.80						8-30-94	126
spotter	6.91		1.09						8-30-94	126
spotter						0.15*			8-30-94	67
spotter						0.08*			8-30-94	126
spotter						0.08*			8-30-94	126
spotter						0.09*			8-30-94	119
spotter					0.32*				8-30-94	127
spotter					0.61*				8-30-94	67
spotter					0.34*				8-30-94	119
spotter					0.33*				8-30-94	125
table	3.93	12.01	1.19	3.45					8-30-94	55
table	12.49		0.90						8-30-94	122
table	6.36		1.74						8-30-94	137
table	25.43		8.82						8-30-94	137
tagger	10.21	9.50	0.62	1.46					8-30-94	128
tagger	13.48		2.88						8-30-94	140
tagger	6.24		0.86						8-30-94	128
tagger	4.69		1.22						8-30-94	48