

IN-DEPTH SURVEY REPORT:

**EVALUATION OF CONTROL TECHNOLOGY FOR
PERCHLOROETHYLENE IN DRY CLEANING SHOPS**

at

**Dry Cleaning Depot
New York, New York**

**REPORT WRITTEN BY
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ABSTRACT

NIOSH evaluated eight dry cleaning shops to determine the extent of exposure and the technological feasibility of controlling worker exposure to perchloroethylene (Perc). In this study, dry cleaning plants were selected and data taken to characterize worker exposure levels and control technology for "fourth generation" closed-loop, dry-to-dry machines (with an integrated, in-line refrigerated condenser and a carbon absorber to recover Perc vapors during the dry cycle), and "fifth generation" machines, having the same features as fourth generation machines plus an internal monitor/interlock system to prevent door opening at Perc concentrations above a set level. Full shift time-weighted average (TWA) and short duration ceiling and 15 minute short term exposure level (STEL) Perc exposures were measured on several workers in each shop. Information was collected at each dry cleaning plant to correlate Perc measurements with controls and equipment.

Results of measurements at Dry Cleaning Depot indicate a range of 0.07 to 2.66 ppm for full shift measurements. Data gathered at the eight dry cleaning shops monitored indicate that in almost all instances the full shift TWA concentration of Perc were below the 5 to 10 ppm range.

STEL and ceiling measurements at Dry Cleaning Depot ranged from 0.8 to 11.3 ppm for STEL measurements and 20 to 1530 ppm for ceiling values. The comparable range for the set of eight shops was 2 to >2,000 ppm and 0.2 to 60 ppm, with half the measurements of Ceiling and STEL levels below 168 ppm and 4.2 ppm, respectively.

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) conducted a study of control technologies for perchloroethylene (Perc) in small and medium sized dry cleaning establishments to determine the extent of exposure and to gather control and operational information to assist in determining technological feasibility of controlling worker exposure to Perc. Facilities selected for this study were those with "fourth generation" closed-loop, dry-to-dry machines (with an integrated, in-line refrigerated condenser and a carbon absorber to recover Perc vapors during the dry cycle), and "fifth generation" machines, having the same features as a fourth generation machines plus an internal monitor/interlock system to prevent door opening at Perc concentrations above a set level. This report describes the portion of that study conducted at Dry Cleaning Depot in New York City in April, 1998. The combined results of all eight shops evaluated in this study can be found in "Evaluation of eight dry cleaning shops with state-of-the-art control equipment," published April 9, 1999 (NIOSH publication number ECTB 240-04A).

METHODS

Equipment, Controls, and Physical Facilities

Background information was collected at each dry cleaning plant regarding the equipment, controls, materials and procedures at that facility. The purpose of this information was to

correlate Perc measurements with controls and equipment and also to enhance inter-facility comparisons. Typical data collected included

- the make, model, age and repair history of all dry cleaning machines,
- a record of machine use including the number and size of loads processed by each dry cleaning machine during the days of monitoring,
- the number of employees at each shop,
- construction of the building including size, age, and materials,
- control systems in use, including personal protective equipment as well as general and local ventilation systems,
- any unusual occurrences during the sampling periods such as spills or leaks which would produce unusual exposures

Perc Exposure Measurements

The study used two sampling techniques to quantify exposure of workers to Perc in the selected dry cleaning shop. The first was long duration sampling to measure full shift time weighted average (TWA) Perc concentrations. The other was real-time monitoring to measure peak and short term Perc concentrations.

TWA Measurements

All exposed job categories in the selected shops were monitored during the evaluation to determine full shift time-weighted average breathing zone exposures to Perc. Samples were collected on sorbent tubes using battery powered personal sampling pumps worn by the workers. Additional samplers were placed at selected locations throughout the shop to measure the Perc concentration at these locations. Sampling and analysis was according to method 1003 in the NIOSH Manual of Analytical Methods¹. Sampling trains were calibrated on-site to the appropriate flow rates and analysis was by an accredited contract laboratory.

A separate second set of personal TWA measurements was made on selected personnel (primarily operators) using passive "badge" samplers. This set of measurements represents two days of sampling done concurrently with the method 1003 sampling, plus three days of sampling done following the NIOSH visit. The simultaneous sampling allowed for a comparison of methods, and the subsequent sampling allowed for additional information regarding the distribution of exposures. The operators were instructed in how to collect their own samples using these devices, and asked to submit the samples along with a log of cleaning activity in a pre-addressed postage paid mailer.

¹ National Institute for Occupational Safety and Health, *NIOSH Manual of Analytical Methods*, 4th Ed, Method 1003, Issued 1/15/98, Superintendent of Documents, U S Govt Printing Office, Washington, D C, Pub No DHHS (NIOSH) 94-113

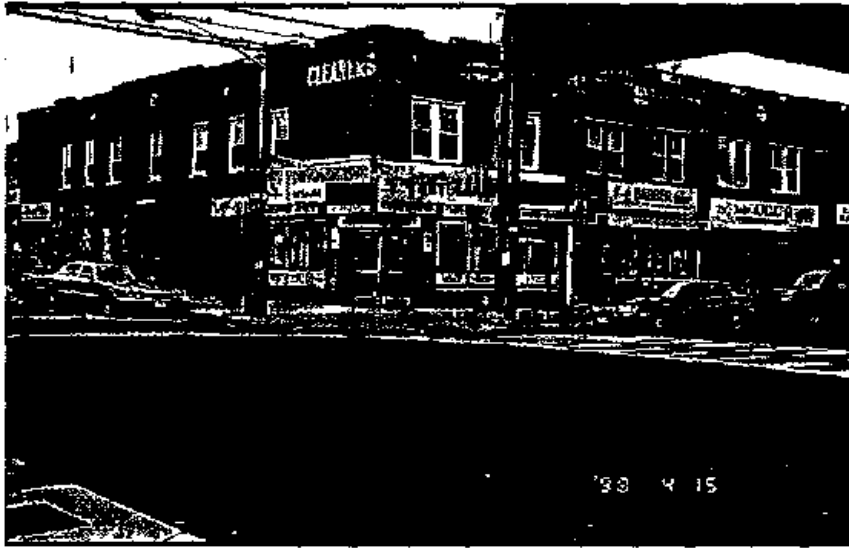
Real-time Monitoring for Peak Exposures

Machine operators were monitored during several exposure events using a Photovac model 2020 photoionization detector (PID) monitor (Perkin Elmer Photovac, Norwalk, Connecticut) to determine breathing zone Perc concentration on a real time basis. Exposure events were primarily unloading/loading operations, but also included any repair, maintenance or other operation which resulted in increased Perc exposure. The PID monitor was calibrated on-site with a commercially procured Perc calibration gas (Scott Specialty Gas, Troy, Michigan), and operated according to manufacturers instructions. These instruments included data-logging capabilities, and were downloaded to laptop computers for data storage. Each exposure event was monitored for the duration of that event, and for a sufficient time prior and subsequent to establish a background concentration such that 5, 10 and 15 minute average exposures could be calculated.

RESULTS

DRY CLEANING DEPOT

New York



The last three dry cleaning facilities evaluated, starting with Dry Cleaning Depot, were in metropolitan New York city. Dry Cleaning Depot was a co-located facility, bordered left and right by other businesses and situated below a residence. It was a brick veneer building approximately 25 feet wide and 50 feet long. The basement below the shop was also used for storage of cleaned garments as well as supplies.

Dry Cleaning Depot employed five people and had one Realstar model RS373 45 pound dry cleaning machine which processed an average of five loads per day. At the time of this testing it was approximately 18 months old. This machine had no fugitive emissions control, but the owner said that the air in the drum was circulated through a carbon adsorber and back into the drum when the door was open.

The owner of Dry Cleaning Depot appeared to be concerned about minimizing Perc emissions and also about providing good cleaning for garments, and to accomplish both goals he undersized the loads, running 35 pounds in his 45 pound machine, and he ran "good morning" cycles, designed to remove Perc vapor from the drum, not only at the beginning of the day but at any time the machine had not been used for a period of time.

Dry Cleaning Depot was a corner building and therefore did not have as much natural ventilation as some of the other shops which could create cross drafts with open doors and windows. However, it did have a general area exhaust fan and three canopy hoods over specific operations. Measurements of general ventilation indicated as much as 9,000 cfm through the shop, with the canopy hoods exhausting from 250 and 1000 cfm from above pressing stations and 500 cfm from a spotting area near the machine.

TWA Data

The following table shows time weighted average data collected for the duration of a work shift by charcoal tube and passive samples.

Table 1

TWA PERC CONCENTRATION

<u>DATE</u>	<u>JOB TITLE</u>	<u>C T CONC</u> (PPM)	<u>BADGE CONC</u> (PPM)
4/14/98	Operator/presser	0 73	0 80
4/14/98	Assembler	0 38	0 40
4/14/98	Area - on top of machine	1 47	1 15
4/14/98	Manager/operator	0 73	0 71
4/14/98	Area - BZ on counter	0 17	0 18
4/14/98	Presser	0 69	0 78
4/14/98	Basement, center of hanging clothes	0 35	0 33
4/15/98	Manager/operator	1 49	1 47
4/15/98	Operator/presser	0 63	0 70
4/15/98	Assembler	0 55	0 55
4/15/98	Area - on top of machine	2 66	2 95
4/15/98	Area - upstairs residential hallway	0 07	<0 09
4/15/98	Presser	0 73	0 83
4/23/24	Manager/operator	n / s	0 68
4/24/98	Manager/operator	n / s	1 40
4/27/28	Manager/operator	n / s	0 99
4/23/98	Operator/presser	n / s	3 30
4/24/98	Operator/presser	n / s	3 20
4/27/98	Operator/presser	n / s	4 95

"n / s" indicates this data not sampled

"AREA" indicates an area rather than personal sample, collected in location indicated

"BZ" signifies breathing zone level, approx 5' above floor

"OPERATOR" is the person most frequently operating cleaning machine

CONCLUSIONS

In this study, eight dry cleaning shops using 4th and 5th generation equipment were evaluated to determine the effectiveness of the systems on those machines to control occupational exposure of workers to Perc. Workers' exposure in shops in Los Angeles, San Francisco, and New York were measured using full shift TWA monitoring devices and also using real-time monitors to measure short duration exposure excursions during load change and other events anticipated to cause increased exposure. Information was also collected on the dry cleaning equipment used, local and general exhaust ventilation and work load.

Perc measurements made at Dry Cleaning Depot are compared with those obtained at other shops below, and other conclusions are presented regarding relative exposure by job and by shop location.

SUMMARY OF TWA MEASUREMENTS

Results of TWA measurements for Perc are presented above for the shop described in this report. Table 2 below summarizes the mean, median and number of charcoal tube samples collected at each shop, including the shop described in this report (identified as D). This table indicates a range of measurements from <0.008 ppm (the limit of detection for this analytical method) to 16.8 ppm for the 96 samples collected. The overall mean, median and geometric mean for these 96 samples was 1.33, 0.73 and 0.63 ppm, respectively. The duration for most personal samples was less than 8 hours. Observation of these workers during the un-sampled time, however, indicated that they were either not exposed (e.g., had left the shop) or were not exposed to concentrations of Perc above that measured (e.g., were not performing Perc related work).

Table 2

Summary Statistics for the 8 Dry Cleaning Shops Monitored

(Perc concentration in ppm)

Shop	<u>E</u>	<u>N</u>	<u>L</u>	<u>I</u>	<u>G</u>	<u>D</u>	<u>A</u>	<u>J</u>
Mean	1.54	3.70	0.52	0.25	0.28	0.82	0.76	1.82
Median	1.05	1.82	0.22	0.20	0.20	0.69	0.49	1.08
Geo Mean	1.27	1.59	0.27	0.15	0.23	0.58	0.51	1.37
N	16	14	11	10	10	13	11	11

Data in Table 2 indicate Shop N had both a mean and median almost twice the closest other shops. A probable cause for this was the presence of an older (3rd generation) machine which was used periodically during the time of this study. Because this machine was not 4th or 5th generation, short term measurements were not made during peak excursions, but it is anticipated that this machine could have produced the increased TWA measurements seen in Shop N.

As anticipated, the job category with the highest exposure was the machine operator. Table 3 shows how these workers compared with the other groupings selected for these samples.

Table 3
Summary Statistics for Job Categories
(Perc concentration in ppm)

Job category	<u>Operator</u>	<u>Presser</u>	<u>Miscellaneous</u>	<u>Area samples</u>
Mean	2.92	0.81	0.82	0.89
Median	1.51	0.73	0.23	0.41
Geo Mean	1.54	0.68	0.25	0.41
N	22	30	15	29

The range of operator exposures was from 0.18 to 16.8 ppm

It is interesting to note that the measurements in San Francisco were as a group lower than in either of the other two cities. Table 4 groups samples by city for this comparison. The obvious difference between the three shops sampled in San Francisco and the other five shops was the use of vapor barrier rooms in San Francisco which enclosed the dry cleaning equipment and was vented to ambient. However, this difference could also have been due to a selection bias. While shops in all three cities were selected because they had relatively new equipment with state-of-the-art controls to reduce workers' exposure to Perc, the individual who assisted in the selection of the San Francisco sites was particularly knowledgeable in the exposure levels at many dry cleaning shops in that city. He might have been more successful in selecting shops with low levels of Perc than in the other two cities.

Table 4

Summary Statistics by Shop Location

(Perc concentration in ppm)

City	<u>Los Angeles</u>		<u>San Francisco</u>		<u>New York</u>	
	<u>Operator</u>	<u>Other</u>	<u>Operator</u>	<u>Other</u>	<u>Operator</u>	<u>Other</u>
Mean	7.71	1.52	0.77	0.24	2.16	0.75
Median	5.38	1.22	0.59	0.18	1.95	0.55
Geo Mean	5.16	1.09	0.59	0.16	1.79	0.54
N	5	25	7	24	9	26

SUMMARY OF REAL-TIME MEASUREMENTS

Results of Perc measurements at Dry Cleaning Depot using the real-time monitoring instrument are presented below. These measurements show a range from 0.8 to 11.3 ppm for STEL and 20 to 1530 ppm for ceiling values. At the eight shops in this study, a total of 106 exposure events, primarily load changes, were monitored, and Ceiling and STEL measurements were determined for each. The C measurements ranged from 2 to >2,000 ppm (the upper limit of quantification for the real time monitor). The STEL measurements ranged from 0.2 to 60 ppm. These data are summarized in Table 5 below.

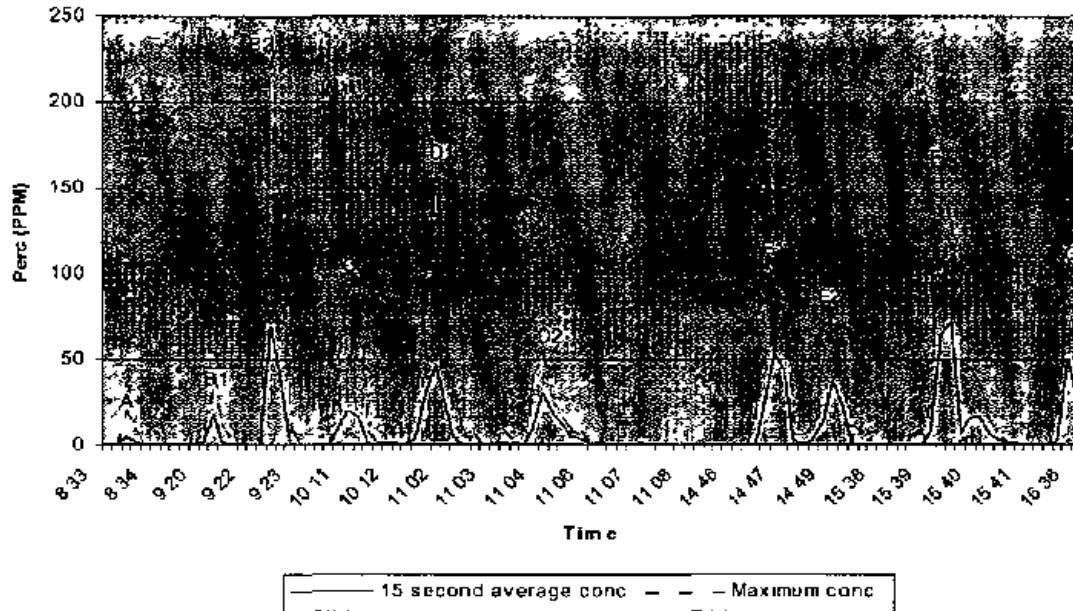
Table 5

Summary of Ceiling and STEL Measurements

(Perç concentration in ppm)

	<u>Ceiling</u>	<u>STEL</u>
N	106	106
Mean	323 ppm	8.5 ppm
Median	168 ppm	4.2 ppm
Geo Mean	107 ppm	4.8 ppm
Low	2 ppm	0.2 ppm
High	2000 ppm	60.0 ppm

Figure I
 Real - time sampling results
 Dry Cleaning Depot
 Day 1



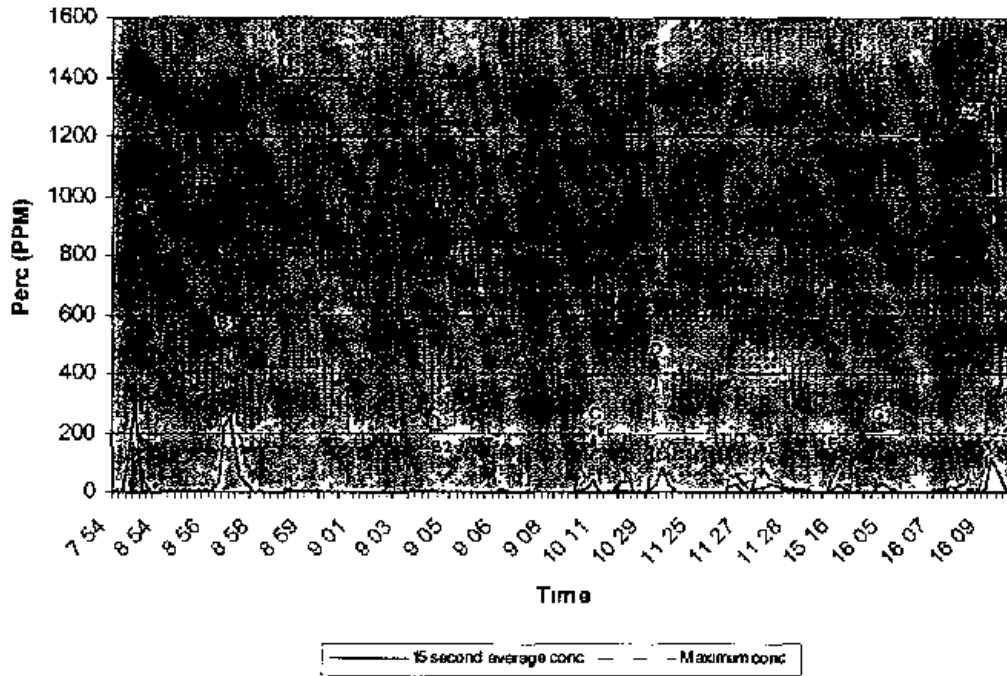
<u>EVENT</u>	<u>TIME</u>	<u>DESCRIPTION</u>	<u>CEILING</u>	<u>15 MINUTE STEL</u>
A	8 33 - 8 34	Load machine	20 ppm	0 8 ppm
B	9 20 - 9 23	Unload / load machine	238	2 8
C	10 10 - 10 12	Unload / load machine	91	1 4
D	11 01 - 11 07	Unload / load machine & clean filters and traps	161	3 7
E	14 47 - 14 49	Unload / load machine	106	4 0
F	15 39 - 15 41	Unload / load machine & clean button trap	156	3 9
G	16 36 - 16 36	Unload / load machine	107	2 0

Figure II

Real - time sampling results

Dry Cleaning Depot

Day 2



<u>EVENT</u>	<u>TIME</u>	<u>DESCRIPTION</u>	<u>CEILING</u>	<u>5 MINUTE STEL</u>
A	7 54 - 7 55	Loading machine	881 ppm	8 2 ppm
B	8 56 - 9 07	Unloading / loading machine & hanging garments	498	11 3
C	10 10 - 10 12	Unloading / loading machine	181	2 6
D	10 29 - 10 30	Unloading / loading machine	366	3 7
E	11 26 - 11 29	Unloading / cleaning lint traps	67	3 8
F	15 15 - 15 16	Loading	93	2 1
G	16 05 - 16 10	Unload / load onto cart	1530	6 2