IN-DEPTH SURVEY REPORT:

EVALUATION OF CONTROL TECHNOLOGY FOR PERCHLOROETHYLENE IN DRY CLEANING SHOPS

at

Ten Ten Cleaners
San Francisco, California

REPORT WRITTEN BY
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Report Date
March, 2000

Report No
EPHB-201-20A

240 - 12

U S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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

STUDY SITE: Ten Ten Full Service Dryclean
1010 Clement St
San Francisco, California 94118

SIC CODE: 7216

NAICS: 812320

STUDY DATES: February 18-24, 1998

PLANT OWNER/OPERATOR: Eric Tong

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DISCLAIMER

Mention of company names or products does not constitute endorsement by the Centers for

Disease Control and Prevention

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 Ten Ten Cleaners indicate a range of <0 008 to 0 59 ppm for full shift charcoal tube 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 Ten Ten Cleaners ranged from 0 5 to 7 3 ppm for STEL measurements and 9 to 620 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 Ten Ten Cleaners in San Francisco, California, on February 18 to 24, 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, and 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 Methods[1] 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

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

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[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

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

Shop T was the second of three San Francisco facilities monitored It is co-located with businesses both left and right and a residence on the level above This shop occupies an estimated 30 feet wide by 40 feet deep space, with the front left corner being devoted to a coin operated self-service wet

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laundry facility On-site monitoring at this shop was done on February 18 and 19, 1998, followed by independent sampling on the 20th through the 24th

Shop T had one Union, Model L353, 35 pound dry cleaning machine which had been installed approximately one year prior It employed three people who ran an average of five loads per day Air flow through the vapor barrier room at this shop was measured at 1,300 cubic feet per minute when the door was open

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

Ten Ten Cleaners

DATE	JOB TITLE	C T CONC (PPM)	BADGE CONC (PPM)
2/18/98	OPERATOR	0 49	0 57
2/18/98	PRESSER	0 19	(0 19)
2/18/98	COUNTER PERSON	<0 008	<0 115
2/18/98	AREA / OUTSIDE BARRIER ROOM	0 16	(0 18)
2/18/98	AREA / INSIDE BARRIER ROOM	0 59	0 72
2/19/98	OPERATOR	0 32	0 35
2/19/98	COUNTER PERSON	0 02	(0 24)
2/19/98	PRESSER	0 20	0 54
2/19/98	AREA / OUTSIDE BARRIER ROOM	0 15	0 27
2/19/98	AREA / INSIDE BARRIER ROOM	0 41	0 56
2/23/98	OPERATOR	n / s	(0 19)
2/20/98	OPERATOR	n / s	<0 1
2/24/98	OPERATOR	n / s	(0 21)

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"n / s" indicates this data not sampled

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

"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 Ten Ten Cleaners 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 "T") 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	F	N	L	T	G	D	A	J
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 that of 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	Operator	Presser	Miscellaneous	Area samples
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	Los Angeles		San Francisco		New York	
Job category	Operator	Other	Operator	Other	Operator	Other
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

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SUMMARY OF REAL-TIME MEASUREMENTS

Results of Perc measurements at Ten Ten Cleaners using the real-time monitoring instrument are presented above. These measurements show a range of 0 5 to 7 3 ppm for STEL measurements and 9 to 620 ppm for ceiling values. At the 8 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.
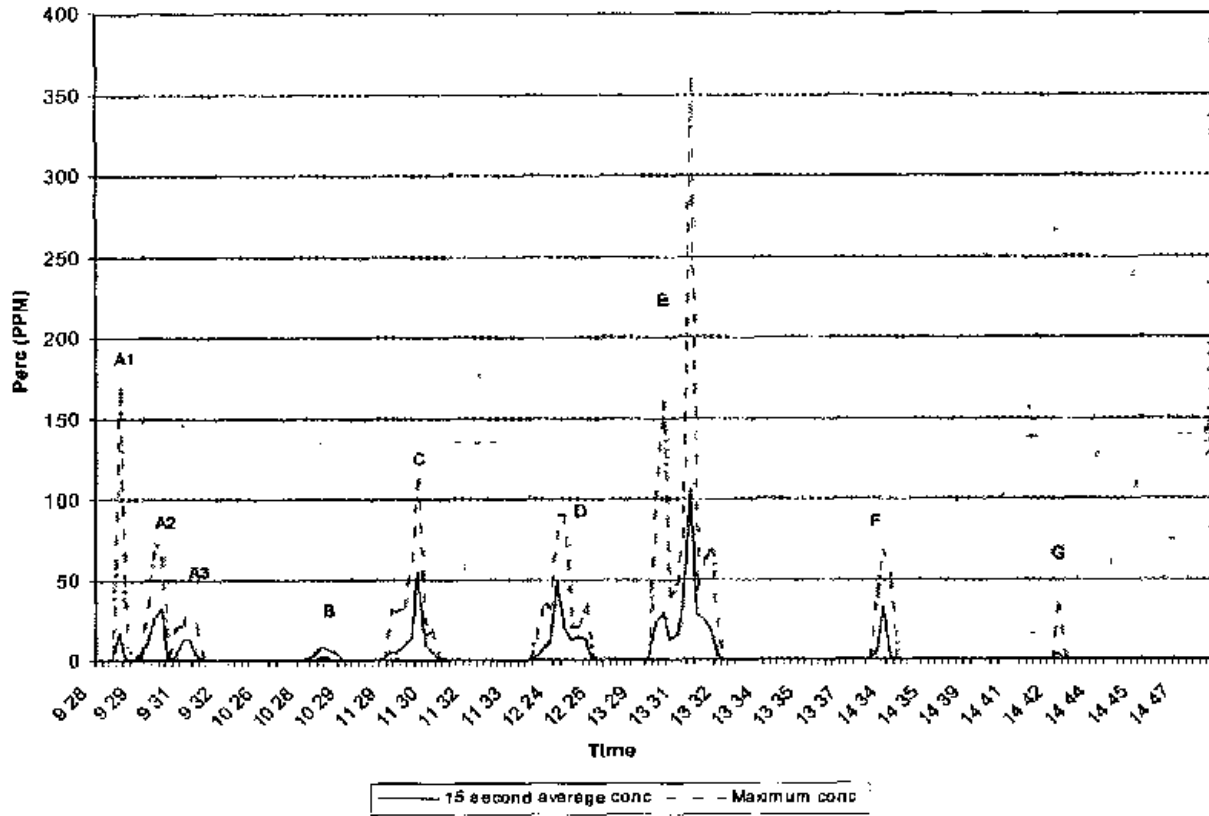
Table 5

Summary of Ceiling and STEL Measurements

(Perc concentration in ppm)

	Ceiling	STEL
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

Ten Ten Cleaners

Day 1

EVENT	TIME	DESCRIPTION	CEILING	15 MINUTE STEL
A	9 28 - 9 33	Unload / load machine	168 ppm	2 4ppm
B	10 27 - 10 29	Unload / load machine	9	0 5
C	11 29 - 11 31	Unload / load machine	113	2 1
D	12 23 - 12 26	Unload / load machine	89	2 6
E	13 30 - 13 32	Unload / load machine	359	5 4
F	14 33 - 14 34	Unload machine	66	1 1
G	14 42 - 14 43	Clean lint trap	34	0 5

EVENT	TIME DESCRIPTION	CEILING	15 MINUTE STEL
A 9 28 - 9 33	Unload / load machine	168 ppm	2 4ppm
B 10 27 - 10 29	Unload / load machine	9	0 5
C 11 29 - 11 31	Unload / load machine	113	2 1
D 12 23 - 12 26	Unload / load machine	89	2 6
E 13 30 - 13 32	Unload / load machine	359	5 4
F 14 33 - 14 34	Unload machine	66	1 1
G 14 42 - 14 43	Clean lint trap	34	0 5

Figure II

Real time sampling results

Ten Ten Cleaners

Day 2
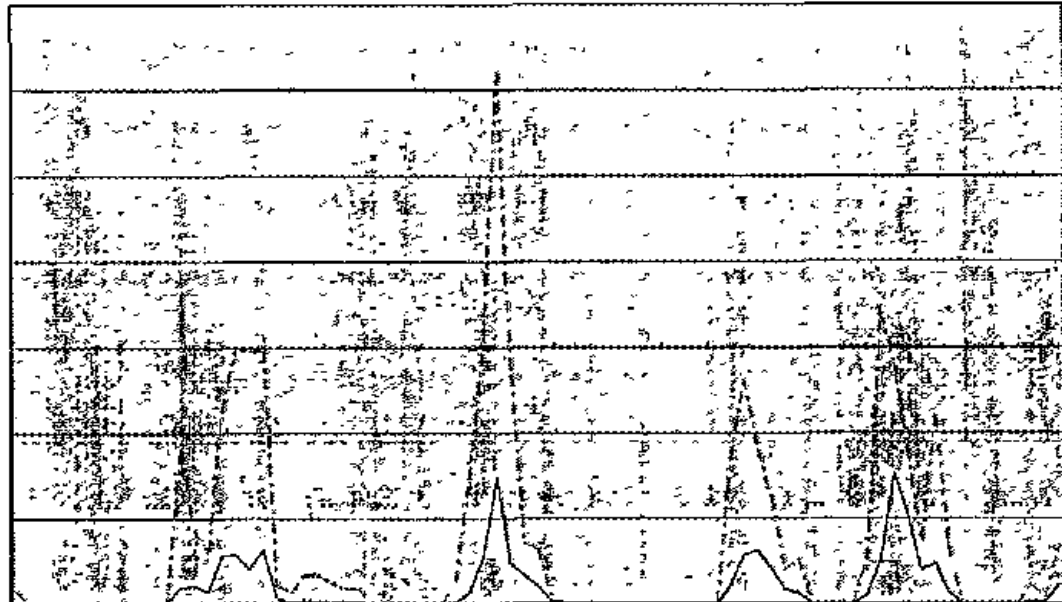
EVENT	TIME	DESCRIPTION	CEILING	15 MINUTE STEL
A	10 37 - 10 40	Unload / load machine	300 ppm	5 2 ppm
B	11 37 - 11 39	Unload / load machine	620	5 7
C	12 24 - 12 26	Unload / load machine	263	3 8
D	13 27 - 13 29	Unload / load machine	339	7 3
E	15 26 - 15 26	Unload machine	67	0 7