IN-DEPTH SURVEY REPORT:

EVALUATION OF CONTROL TECHNOLOGY FOR PERCHLOROETHYLENE IN DRY CLEANING SHOPS

at

Golden State Cleaners
San Francisco, California

REPORT WRITTEN BY
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STUDY SITE	Golden State Cleaners 3287 Army Street San Francisco, CA 94110
SIC CODE	7216
NAICS	812320
STUDY DATES	February 19-25, 1998
PLANT OWNER/OPERATOR	Mike Nguyen
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SUMMARY

NIOSH industrial hygienists 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 charcoal tube measurements at Golden State Cleaners indicate a range of 0 18 to 0 59 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 Golden State Cleaners ranged from 0 2 to 10 1 ppm for STEL and 2 to 371 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

Researchers from 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 Golden State Cleaners in San Francisco, California on February 19 to 25, 1998 The combined results of all 8 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

1 TWA measurements

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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 places 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.

2   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

The fifth shop studied, Golden State Cleaners, was the only one of the three in San Francisco which was a stand-alone as opposed to a co-located facility, and it was larger than the other two San Francisco shops although no measurement of size was made. The building was of brick and wood construction, with a concrete floor in the production area which was a few steps lower than the counter and storage areas. Air velocity through the vapor barrier room was claimed by the owner to be approximately 1,700 cfm, although the ducts were not readily accessible and no measurements were made during this study.

Golden State Cleaners operated with one Permac Model P546, 45 pound, dry cleaning machine about one year old. It employed four people and processed three loads per day during the time of this study, although the owner claimed that this was below average due to the weather which was rainy around the time of this study. (This relationship between rain and work load was claimed by other shop operators during this study also.)

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The temperature was cool, being generally in the 60 to 70°F range, yet a large garage door and a small door opposite were both open at all times, creating a rapid air exchange through the production area   The on-site monitoring was done on February 19 and 20, 1998, with independent sampling on the 23rd through the 25th

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

Golden State Cleaners

DATE	JOB TITLE	C T CONC (PPM)	BADGE CONC (PPM)
02/19/98	OPERATOR	0 59	0 91
02/19/98	PRESSER	0 36	0 32
02/19/98	PRESSER	0 47	0 42
02/19/98	AREA / INSIDE BARRIER ROOM	0 19	<0 28
02/19/98	AREA / OUTSIDE BARRIER ROOM	0 17	<0 20
02/20/98	OPERATOR	0 18	<0 17
02/20/98	PRESSER	0 18	0 21
02/20/98	PRESSER	0 40	0 41
02/20/98	AREA / INSIDE BARRIER ROOM	0 20	<0 17
02/20/98	AREA / OUTSIDE BARRIER ROOM	0 06	<0 18
02/23/98	OPERATOR	n / s	1 65
02/24/98	OPERATOR	n / s	0 94
02/25/98	OPERATOR	n / s	0 42

" n / s" indicates no sample
"AREA" indicates an area 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 Golden State Cleaners are compared with those obtained at other shops below, and conclusions are presented regarding relative exposure by job and by shop location

A. 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 G) 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

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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

It can be seen from these data that Golden State Cleaners (G) and shop T, also in San Francisco, had the lowest Perc exposures Data in Table 2 also indicate Shop N had both a mean and median almost ten times shops G and T, and 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	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 3 shops sampled in San Francisco and the other 5 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 3 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 2 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

The above tables indicate that all shops evaluated, including Golden State Cleaners, have been able to reduce time weighted average employee exposures to levels below the current OSHA permissible exposure limit" of 100 ppm for an 8 hour period, and also below the recommended 8 hour threshold limit value of 25 ppm'"

B. Summary of real time measurements

Results of Perc measurements at Golden State Cleaners using the real-time monitoring instrument are presented in Figures I and II These measurements show a range of 0 2 to 10 1 ppm for STEL and 2 to 371 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

<u>Summary of Ceiling and STEL Measurements</u>

for 8 dry cleaning shops evaluated

(Perc concentration in ppm)

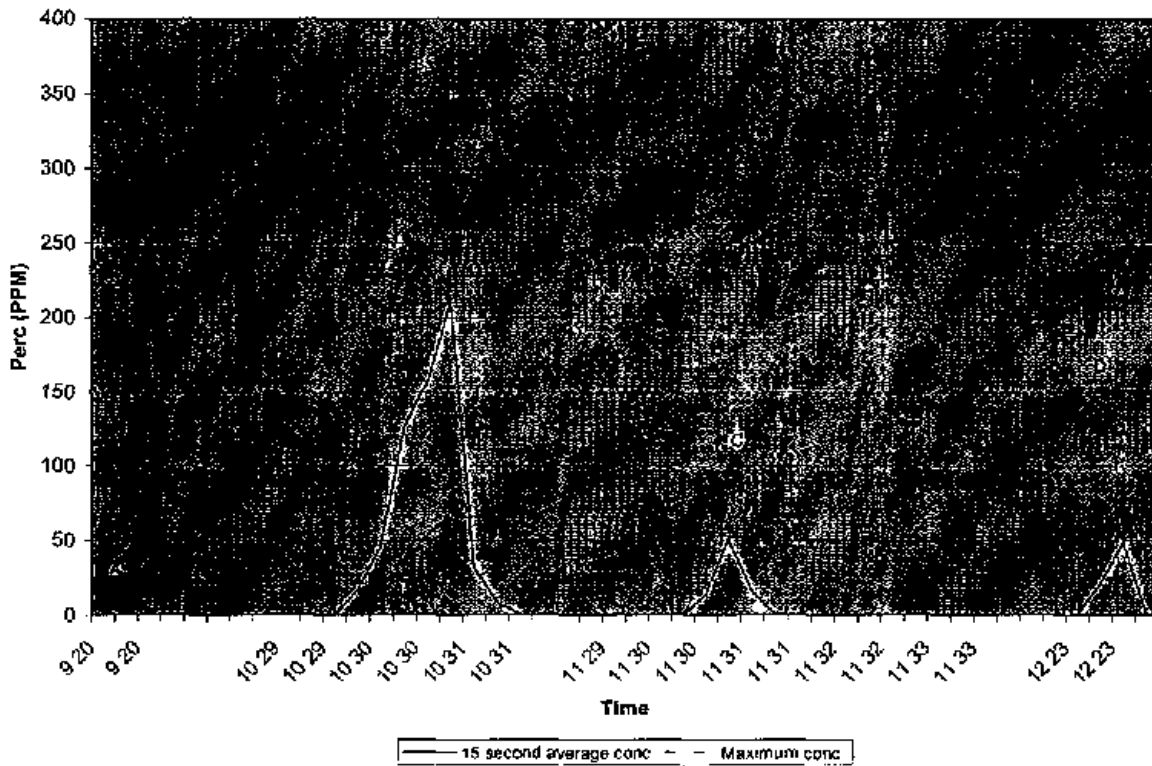|	<u>Ceiling</u>	<u>STEL</u>
N	106	106
Mean	323 ppm	8 5 ppm
Median	168 ppm	4 2 ppm
Geo Mean	107 ppm	4 8 ppm
Low	2 ppm	0 2 ppm
High	2000 ppm	60 0 ppm

Figures I and II, as well as Table 5, indicate that Golden State Cleaners and the other 7 shops evaluated were able to maintain short duration (STEL) exposures below the OSHA and ACGIH levels of 300 and 100 ppm, respectively[2][3] There are no established criteria with which to compare the Ceiling measurements

Figure I
Real – time sampling results
Golden State Cleaners
Day 1
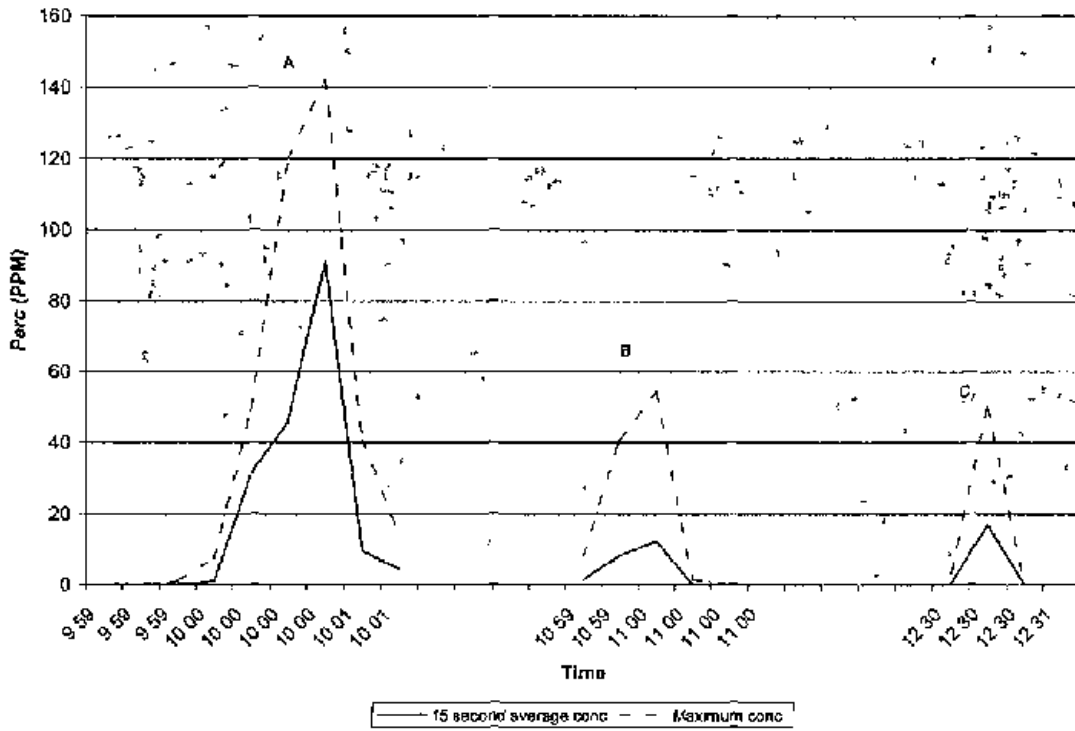
EVENT	TIME	DESCRIPTION	CEILING	15 MINUTE STEL
A	9 59 - 10 01	Unload / load machine	142 ppm	3 6 ppm
B	10 59 - 11 00	Unload / load machine	54	0 9
C	12 30 - 12 31	Unload / load machine	50	0 9

Figure II

Real – time sampling results

Golden State Cleaners

Day 2

EVENT	TIME	DESCRIPTION	CEILING	15 MINUTE STEL
A	9 20 - 9 21	Cleaning machine	2 ppm	0 2 ppm
B	10 29 - 10 31	Unload / load machine	371	10 1
C	11 29 - 11 33	Unload / load machine	75	1 5
D	12 23 - 12 23	Unload / load machine	128	1 4

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REFERENCES

[i] National Institute for Occupational Safety and Health, <u>NIOSH Manual of Analytical Methods</u>, 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

[ii] Occupational Safety and Health Administration, Standards 29CFR Part 1910, Subpart Z, Hazardous Substances, <u>http //www osha-slc gov/OshStd_data/1910_1000_TABLE_Z-2 html</u>, accessed January, 2000

[iii] American Conference of Governmental Industrial Hygienists *Threshold Limit Values for Chemical Substances & Physical Agents and Biological Exposure Indices* ACGIH, Cincinnati, OH (1999)