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IN-DEPTH SURVEY REPORT
EVALUATION OF CONTROL TECHNOLOGY FOR PERCHLOROETHYLENE IN DRY CLEANING SHOPS

AT

Jim Dandy Cleaners
New York, New York

REPORT WRITTEN BY
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U S DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway, R5
Cincinnati, Ohio 45226

PANT SURVEYED	Jim Dandy Cleaners 1662 Dutch Broadway Elmont, NY 11003
SIC CODE	7216
NAICS	812320
SURVEY DATES	April 16-22, 1998
STUDY CONDUCTED BY	G Edward Burroughs, Ph D , CIH, NIOSH Lynda Ewers, Ph D , NIOSH Lauralynn Taylor, MSPH, NIOSH David Marlow, NIOSH
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SUMMARY

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 Jim Dandy Cleaners indicate a range of 0 51 to 5 29 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 Jim Dandy Cleaners ranged from 2 5 to 8 2 ppm for STEL measurements and 39 to 1097 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 Jim Dandy Cleaners 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

1. 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 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, CT) 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, MI), 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

[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 , Publication No DHHS (NIOSH) 94-113

RESULTS

Jim Dandy Cleaners

NEW YORK

The final shop evaluated with fourth generation equipment was Jim Dandy Cleaners, and like the first shop it had two dry cleaning machines Jim Dandy Cleaners was a stand-alone shop in the New York metropolitan area situated in a single story, flat roofed, concrete block building approximately 50 feet wide by 60 feet long On-site sampling at this shop was done on April 16-17, 1998, with independent samples collected between the 20th and 22nd

Dry cleaning equipment was two 70 pound capacity Realstar model RS640 machines, both installed approximately 18 months prior to the dates of this study During that time, both machines had the door gaskets replaced and one had a thermostat replaced Both machines ran an average of 12 loads per day, and a maximum of 65 pounds per load was observed The shop operated on one shift with a total of 25 employees

Table 1 shows time weighted average data collected for the duration of a work shift by charcoal tube and passive samples

Table 1 TWA Perc Concentration at Jim Dandy Cleaners

Date	Job Title	C T Conc (PPM)	Badge Conc (PPM)
4/16/98	Operator	1 95	2 37
4/16/98	Presser #2	0 92	1 08
4/16/98	Assistant Operator	5 29	5 58
4/16/98	Presser #3	1 08	1 26
4/16/98	Presser #1	0 53	0 71
4/17/98	Operator	2 27	2 37
4/17/98	Presser #2	0 98	1 12
4/17/98	Presser #1	0 51	0 60
4/17/98	Presser #3	0 66	0 72
4/17/98	Assistant Operator	3 29	3 96
4/17/98	Area-on top of machine	2 51	3 15
4/21/98	Presser	n / s	4 95
4/22/98	Assistant Operator	n / s	5 54
4/21/98	Presser	n / s	1 01
4/22/98	Assistant Operator	n / s	2 26
4/21/98	Presser	n / s	6 13
4/22/98	Assistant Operator	n / s	6 75

"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 Jim Dandy Cleaners are compared with those obtained at other shops below, and other 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 J) 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 Eight 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 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

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

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

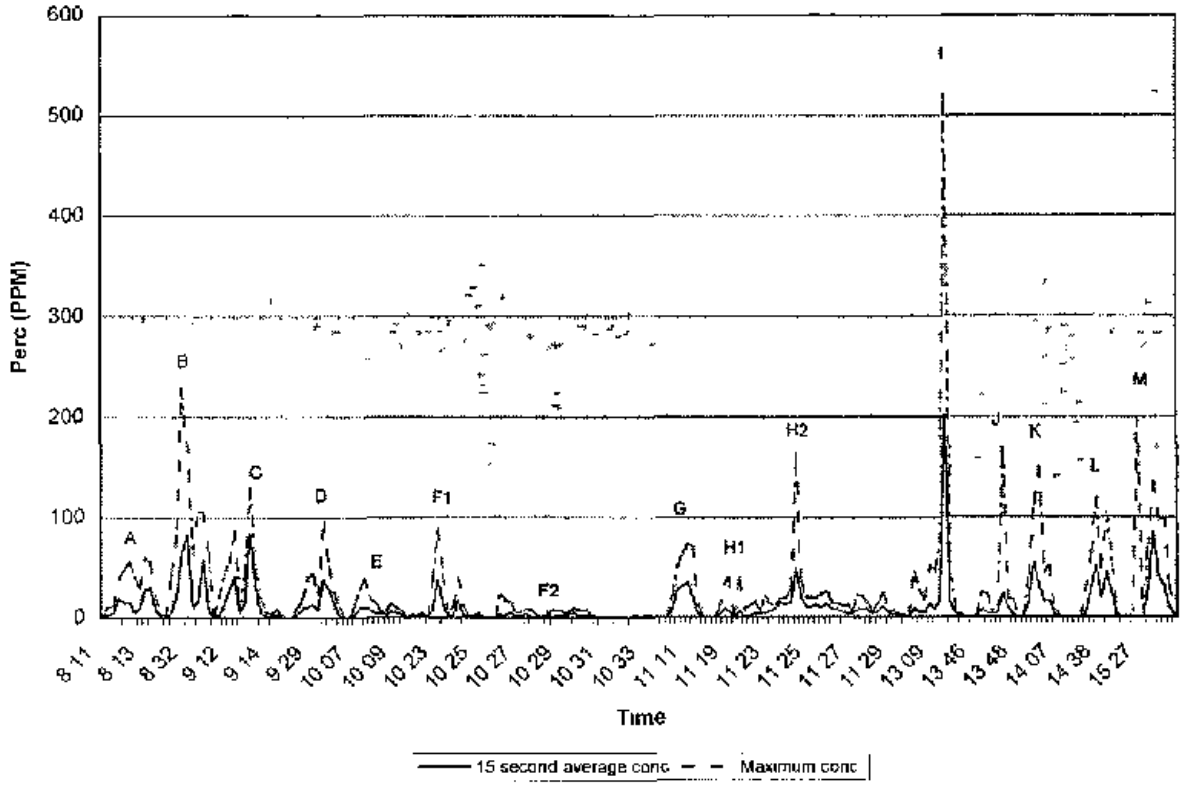
B. Summary of real time measurements

Results of Perc measurements at Jim Dandy Cleaners using the real-time monitoring instrument are presented below These measurements show a range from 2 5 to 8 2 ppm for STEL measurements and 39 to 1097 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
(Perc concentration in ppm)

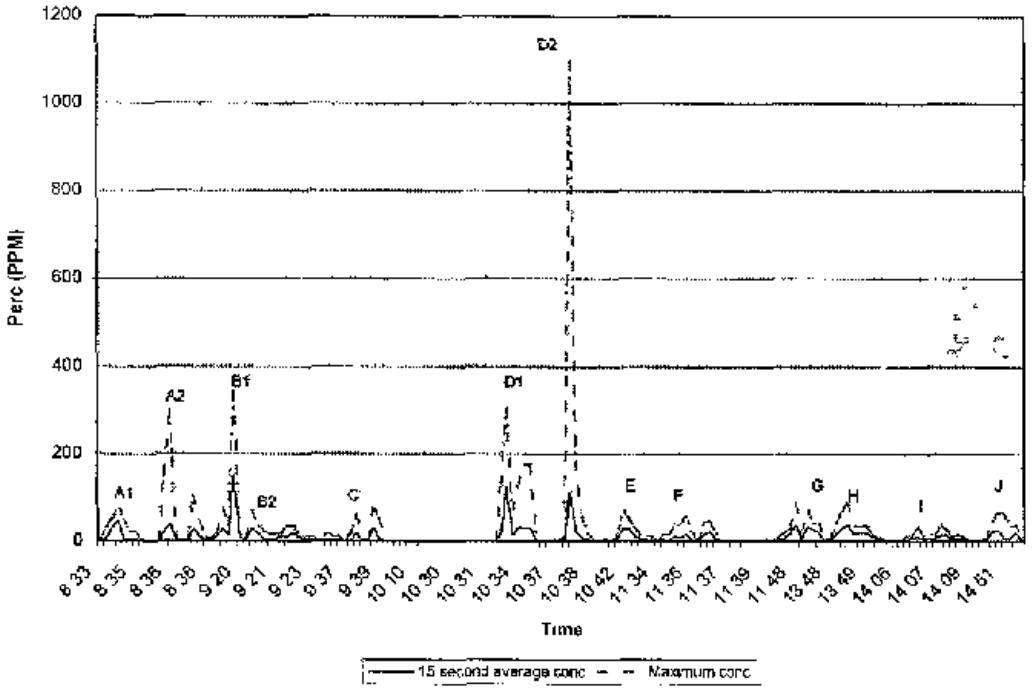
	Ceiling	STEL
N	106	106
Mean	323 ppm	8 5 ppm
Median	168 ppm	4 2 ppm
Geo Mean	107 ppm	4 8 ppm
Low	2 ppm	0 2 ppm
High	2000 ppm	60 0 ppm

Figure I
Real – time sampling results
Jim Dandy Cleaners
Day 1



EVENT	TIME	DESCRIPTION	CEILING	15 MINUTE STEL
A	8 11 - 8 14	Unload / load machine #1	55 ppm	3 9 ppm
B	8 31 - 8 33	Unload / load machine #2	229	6 2
C	9 12 - 9 15	Unload / load machine #1	130	5 4
D	9 28 - 9 30	Clean traps, machine #2	95	3 7
E	10 07 - 10 11	Unload / load machine #1	39	2 5
F	10 23 - 10 34	Unload / load machine #2 & hang garments	88	2 6
G	11 10 - 11 12	Unload / load machine #1	73	3 9
H	11 18 - 11 30	Unload / load machine #2 & hang garments	162	5 8
I	13 07 - 13 10	Clean traps, machine #2	521	6 2
I	13 45 - 13 48	Unload / load machine #1	168	2 6
K	14 05 - 14 07	Unload / load machine #2	149	4 0
L	14 37 - 14 39	Unload / load machine #1	118	4 6
M	15 27 - 15 28	Unload / load (machine not specified)	199	5 0

Figure II
Real – time sampling results
Jim Dandy Cleaners
Day 2



EVENT	TIME	DESCRIPTION	CEILING	15 MINUTE STEL
A	8 33 - 8 38	Unload / load machine 2 & clean traps	303 ppm	5 0 ppm
B	9 19 - 9 23	Unload / load machine 1	343	7 1
C	9 36 - 9 39	Unload / load machine 2	77	2 9
D	10 33 - 10 39	Unload / load machine 2, & inspect back of machine	1097	8 2
E	10 42 - 10 43	Unload / load machine 1	71	3 4
F	11 35 - 11 37	Unload / load machine 2	58	3 3
G	11 47 - 11 49	Unload / load machine 1	85	4 3
H	13 48 - 13 50	Unrecorded events	87	4 7
I	14 05 - 14 09	Unrecorded events	38	3 1
J	14 50 - 14 52	Unrecorded events	67	3 5