In-Depth Survey Report

Assisting Furniture Strippers in Reducing the Risk from Methylene Chloride Stripping Formulations at

Sunset Strip, Inc.
Huntington Beach, California

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SIC CODE	7641
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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) has conducted research on ventilation controls for reducing furniture stripping methylene chloride exposures to the OSHA PEL of 25 ppm Low cost ventilation systems were designed by NIOSH researchers along with Benny Bixenman of Benco Sales, Inc (Cookville, Tennessee) The controls were constructed and installed by Benco Sales The controls consisted of enclosing and attaching local exhaust systems to the stripping tank and the rinsing booth and adding an air shower at the stripping booth This survey tested four control combinations using new ventilation, 1) worker A with an air shower, 2) worker A without an air shower, 3) worker B with an air shower, and 4) worker B without an air shower During each test, sorbent tube sampling and real-time sampling were employed Sorbent tube data collected in the worker's breathing zone ranged from 11 to 53 ppm Passive monitor data results were similar A statistical difference in breathing zone exposure was found between workers (p=0 0001), with worker A having the lowest exposures No statistical difference in breathing zone exposures was found for the two air shower conditions, therefore, more data are needed to determine ability of the air shower to lower exposures Breathing zone exposures (95% confidence limits) for worker A, with or without the air shower, were lower than the OSHA PEL of 25 ppm Differences between the workers are believed to be related to work practices

INTRODUCTION

In January, 1997, the Occupational Safety and Health Administration reduced the methylene chloride standard from 500 ppm to 25 ppm over an eight-hour time-weighted average (TWA) As a follow-up from that reduction, researchers from the National Institute for Occupational Safety and Health (NIOSH) determined that a demonstration site was needed to show furniture strippers how to reduce employee methylene chloride exposures to the new OSHA standard while furniture stripping

In September 1999, researchers from the National Institute for Occupational Safety and Health (NIOSH) conducted a study of worker exposures at Sunset Strip, Inc as part of work related to a NIOSH cooperative agreement with the Institute for Research and Technical Assistance (IRTA) (Santa Monica, California) NIOSH was one part of a team which was evaluating worker exposures at the facility after installation of a new ventilation system Additionally, Benco Sales, Inc (Cookville, Tennessee) participated by building and installing the ventilation system

PLANT AND PROCESS DESCRIPTION

Sunset Strip, Inc employed four full-time men, including the owner One person stripped furniture full-time and the others repaired and finished the furniture The stripping area occupied about 1225 ft^2 of a 2800 ft^2 leased unit of an industrial building There was also another leased unit of the same industrial building where sanding and repair work were performed

Paint, varnishes, and stains were stripped using a flow system The flow system consisted of an open tray in which items were stripped by pumping stripping solution through a brush in a flow pattern over the item while brushing stripped coatings from the furniture The stripping solution flowed to a drain in the tray and then into a pail where it was again pumped through the brush to flow over the item being stripped The employee then transported the furniture to a table in the rinse area where a high pressure water system was used to spray the solution from the furniture Oxalic acid solution was then lightly sprayed on most pieces of furniture to reduce lightening of the wood The furniture was then moved to an adjacent area to dry

HEALTH HAZARDS AND OCCUPATIONAL EXPOSURE CRITERIA

Potential chemical hazards in the furniture stripping industry are found primarily during the handling, stripping, and rinsing of the furniture Other exposure sources may include transferring of the stripping solution, the evaporation of solution from the tank, and the evaporation of the solution from the furniture The major routes of entry of methylene chloride and other solvents into the body include inhalation of vapors and absorption of the liquid through the skin The severity of the hazard depends on ventilation, general workstation design, work practices, duration of exposure, the formulation of the stripping solution, type of operation, and temperature

Health effects studies of methylene chloride exposure have been focused on effects on the central nervous system, effects on cardiovascular morbidity and mortality, induction of cancer in exposed workers (NIOSH, 1977), reproductive disorders (Kelley, 1988), and effects on liver function Repeated skin contact with methylene chloride may cause dry, scaly, and cracked skin At high airborne concentrations (greater than 500 ppm), vapors are irritating to the eyes and upper respiratory tract Direct contact with the liquid can cause skin burns Methylene chloride is a mild narcotic Effects from intoxication include headache, giddiness, stupor, irritability, numbness, and tingling in the arms and legs The reports of odor threshold range from 25 to 350 ppm (NIOSH, 1977)

A death resulting from using methylene chloride to strip furniture was reported (Summer 1999) An 18-year old man was stripping furniture at a small facility in Chattanooga, Tennessee where it was assumed that he was overcome by vapors and collapsed into the stripping tank This facility had no local ventilation system to remove the methylene chloride vapors Also the solution in the dip tank was at a low level causing the employee to put his face into the tank to scrub the furniture A local exhaust ventilation system for the dip tank in conjunction with maintaining a higher level of stripping solution in the tank were recommended to the facility owner to prevent another tragedy (Hall and Estill, 1999)

The current Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) for methylene chloride (62 Federal Register 1494, 1997) is an 8-hour time-weighted average (TWA) concentration of 25 parts per million (ppm), with a short-term exposure limit

(STEL) concentration of 125 ppm for a 15 minute period This standard was adopted on January 10, 1997 The previous standard was a PEL of 500 ppm with an STEL of 1000 ppm

An action level of 12 5 ppm was also put into place by the new methylene chloride standard Once it has been determined that an employee has exposures over the action level, the employer must begin compliance activities including exposure monitoring (every six months) and medical surveillance (employees see a health care provider at the expense of the employer, if exposed more than 30 days per year) If exposures are also above the PEL, exposure monitoring is required every three months (OSHA, 1997)

NIOSH regards methylene chloride as a "potential occupational carcinogen" and recommends that methylene chloride be reduced to the lowest feasible limit (NIOSH, 1992) This recommendation was based on the observation of cancers and tumors in both rats and mice exposed to methylene chloride in air (NIOSH, 1986)

BACKGROUND

A new ventilation system was installed at this facility prior to any sampling The new ventilation system, supplied and installed by Benco Sales, and designed in cooperation with NIOSH researchers, consisted of two exhaust systems--one for the stripping area and one for the rinsing area, and a supply ventilation system--an air shower for the stripping area The stripping tank consisted of a 96 by 42 inch tank that was 37 inches high The depth of the tank sloped from 9 to 13 inches There was a baffle made of sheet metal around the tank that enclosed the area on the back, both sides, and on half of the top This baffle reached 53 inches above the top edge of the tank In addition, a flexible plastic sheet was used to further enclose the tank on the front half of the top (with exception of the location of the air shower) and on the front side (with the exception of the opening for access) The resultant front opening was 67 by 53 inches (Figure 1) The hood consisted of two slots that were 80 inches long by one inch wide The slots were one inch above the lip of the tank The hood was connected through a 36 by 16 inch transition to a 16 inch diameter duct on the left side The 16 inch duct which included a long radius 90 ° elbow, went through the ceiling, and was connected on the roof through a second long radius 90 ° elbow to a centrifugal blower (Dayton centrifugal blower

Figure 1 Stripping Area

Model 2C799A, RPM 1725, HP 2) The blower was then connected to a 12 inch diameter duct which went directly up for approximately 4 feet The stripping hood exhausted approximately 3100 cfm with an average slot velocity of 2700 fpm (range of 2000 to 3300 fpm)

An air shower over the front part of the stripping tank enclosure provided clean make up air over the worker (Figure 2) The air was supplied through a 48 by 48 inch dual-tempered pegboard at a height of 95 inches There was a 48 by 48 by 30 inch plenum attached through a transition to an 8 inch diameter duct which made a 90 ° turn and went though the ceiling and roof where it was attached to a centrifugal blower (Dayton centrifugal blower Model 2C797A, RPM 1725, HP 3/4) Intake ductwork for the fan extended to the edge of the roof with a 90 ° turn downward so that it drew air from the side of the building The flow rate for the air shower was 1040 cfm

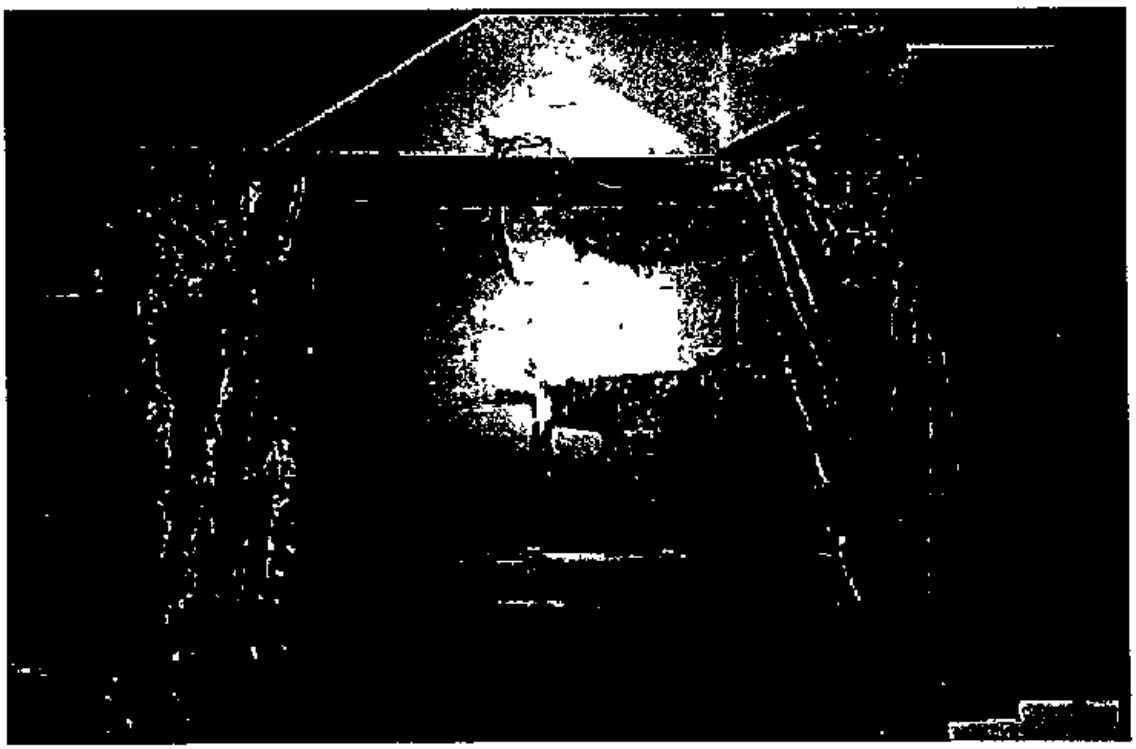

Figure 2 Air shower above stripping area

The rinse area consisted of an 120 by 96 inch enclosed area (Figure 3) Inside the area there was a table with the top made of pegboard The pegboard allowed water to drain from the furniture that had been rinsed The floor was sloped to a floor drain in the enclosure The sides were made of plywood and there was a plywood top 96 inches high Plastic sheet was attached to this to further reduce the front opening to 76 by 48 inches A plenum was attached to the back wall and exhausted air from the enclosure through a 112 by 16 inch opening The plenum was connected through a transition to 12 inch diameter duct at the top The 12 inch duct went through the

ceiling and roof and was connected to a centrifugal blower (Dayton centrifugal blower Model 2C799A, RPM 1725, HP 2) The blower was then connected to a 12 inch diameter duct which went directly up for approximately four feet The rinsing hood exhausted approximately 3200 cfm with an average face velocity at the front opening of 127 fpm (range of 80 to 170 fpm)

The Benco #B7 stripping solution used during this survey, consisted of approximately 70 to 85% methylene chloride, 8 to 15% methanol, and less than 10% other ingredients according to the Material Safety Data Sheet (MSDS) effective May 8, 1997

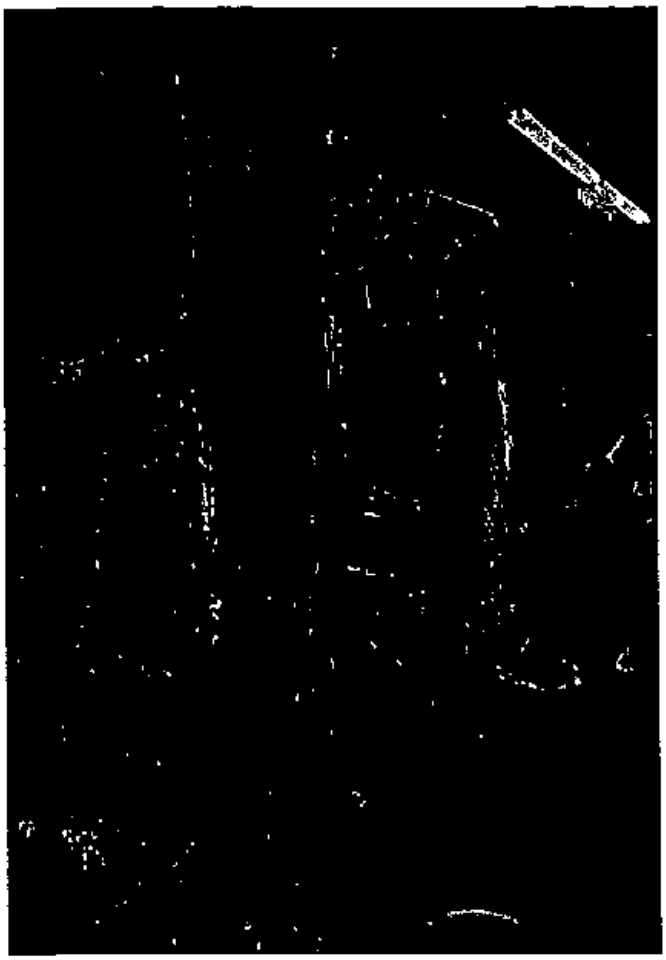

Figure 3 Rinsing Area, notice sampling location at top of opening

METHODS

A survey was conducted in September 1999 Air sampling measurements in the workers' breathing zone were taken for two employees The two workers who stripped the furniture, workers A and B, differed in their experience and knowledge of methylene chloride properties and hazards and their physical characteristics Worker A, an employee of Benco Sales, Inc , had a degree in chemical engineering and typically worked as a furniture stripping solution formulator Worker A had read and studied the research on methylene chloride and knew about its ability to quickly evaporate into the air and its exposure hazards Worker A was approximately 5'5" in stature Worker B, an employee of Sunset Strip, knew that there was an interest in the hazards of methylene chloride but had not particularly studied these areas Worker B was approximately 6'5" in stature

There were four scenarios that were sampled 1) worker A with the air shower, 2) worker A without the air shower, 3) worker B with the air shower, and 4) worker B without the air shower Three rounds of sampling were conducted The order of the four scenarios was designed as a Latin Square with four rounds of sampling, but time allowed for only three rounds During each of the sampling rounds, sorbent tube samples were collected in the worker's breathing zone for approximately 45 minutes for each scenario The workers conducted both stripping and rinsing operations In addition, to the breathing zone samples, sorbent samples were taken in the stripping area (located directly below the front edge of the air shower at a height of 67 inches,

figure 4), this was about 24 inches outside the enclosure opening), the rinsing area (at a height of 68 inches at the front opening of the enclosure, figure 3), in the general shop area (located at a height of 67 inches about 112 inches from the front of the stripping tank enclosure, Figure 5), and at the drying area (outside the shop, located at a height of 46 inches, Figure 6) Air was sampled at a flow rate of 50 ml/minute through sorbent tubes (Supelco ORBO-91, Bellefonte, PA) using personal sampling pumps (Gillian Model LFS 113D, West Caldwell, NJ) The ORBO tube

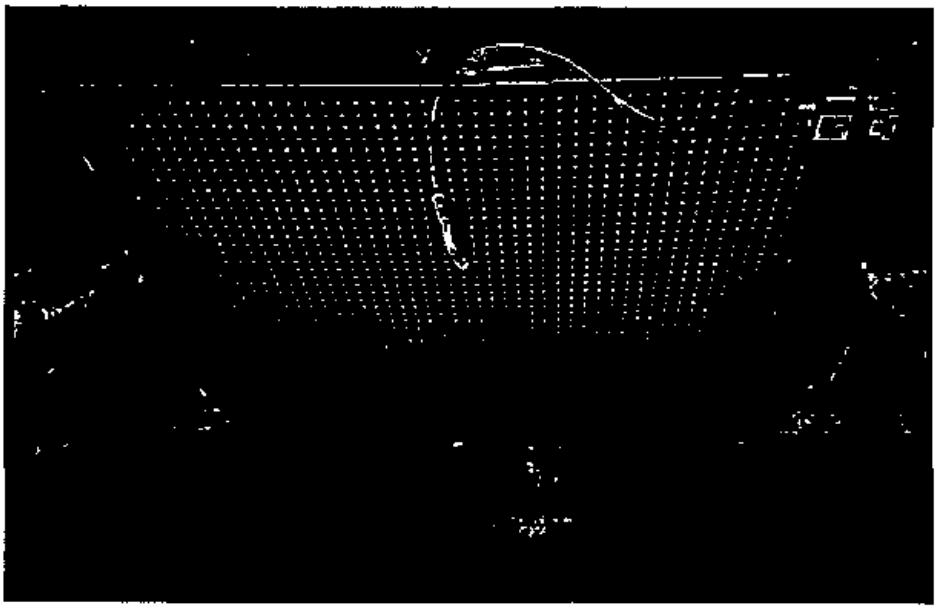

Figure 4 Air shower, notice sampling tube location

Figure 5 General Shop

samples were analyzed by gas chromatography using OSHA Method 80 (Burright, 1990) with modifications for the desorption process, column, and oven conditions

Figure 6 Drying area

Breathing zone passive monitor samples (SKC 575 Series, Eighty Four, PA) were collected in the workers' breathing zone for each scenario These were analyzed by gas chromatography using a combination of NMAM 4th edition Method 1005 (NIOSH, 1994) with modifications and the manufacturer's instructions Bulk samples of the unused stripping solution and used stripping solution before replenishment were collected to determine the methylene chloride percentages (wt%/wt) The bulk samples were analyzed by gas chromatography

The total exhaust volumetric flow rate for the strip tank was measured at nine feet before the fan in the duct It was measured using the pitot traverse method with a Velocicalc (T S I , Model 8386A, St Paul, MN) The slot velocities for the stripping tank were determined with a Velocicalc by averaging eight evenly spaced measurements The total exhaust volumetric flow rate for the rinsing area was determined by using a Velocicalc at evenly spaced locations across the front opening The exhaust volumetric flow rate of the air shower was determined with a Velocicalc using the pitot traverse method in the duct four feet from the hood

Real time sampling was performed in the breathing zone of both workers A MiniRae Model 2000 photoionization analyzer with a 11 7 eV lamp was used to detect solvent vapors in the air The data were stored on a data logger, internal to the MiniRae These data were downloaded, after each sampling run, to a portable computer for further analysis For each sampling period, 35 to 48 minutes of data were collected, with the exception of one sampling run which was only 16 minutes Data were collected at a rate of once per minute The workers were video taped while stripping and rinsing the furniture These video tapes were synchronized for time with the real-time data The tapes were then viewed at the laboratory and each minute was given one of four tasks stripping, rinsing, transporting, or other Other consisted of leaving the camera field of view or talking with customers These real-time data included worker, day, task, air shower, and

run These data were evaluated using the following mixed model (Laird and Ware, 1982)

$$y_{ijklm} = \mu + \alpha_i + r_{j(i)} + d_k + w_l + \varepsilon_{ijklm}$$

Where
α_i= fixed effect of shower, i= 1, 2
$r_{j(i)}$= random effect of jth run for the ith shower level, j = 1, 2, n_i
d_k= random effect of day k, k= 1, 2
w_l= random effect of worker, l = 1, 2
ϵ_{ijklm}= random error for ijlkth treatment combination m = 1, 2, n_{ijkl}

To take into account that outcomes from the same run were highly correlated, a random effect for run was used Likewise, inclusion of random effects for day and worker means that outcomes are assumed to be correlated within these factors

RESULTS

Analyses of these sorbent tube data determined that they were lognormally distributed (Shapiro-Wilk statistic), the natural log of the concentration was used for all analyses Geometric means of survey results from the sorbent tube samples are shown in Table 1 with more detailed results shown in Appendix A

The locations (breathing zone, stripping, rinsing, drying, and general areas) of the sorbent tube samples were compared by analysis of variance and significant differences were found (F=24 2, df = 4, p=0 0001) A Bonferroni post hoc analysis was used to determine which sample locations were different from the others The breathing zone samples were found to be significantly higher than all other sampling locations (p=0 05) while the drying area samples were found to be significantly lower than all other sampling locations (p=0 05) Time-weighted average results were calculated for each area location for each day (Table 2)

When comparing only breathing zone sorbent tube samples, a significant difference was found between the two workers with worker B having a higher concentration (ANOVA, F=65 51, p=0 0001) No significant difference was found when comparing the use of the air shower

Area samples were taken in four locations – stripping, rinsing, drying, and general shop For the rinsing area samples, breathing zone samples for worker B were found to be statistically higher than those of worker A (ANOVA, df = 1, F = 5 44, p= 0 0445) For the drying area samples, no differences were found when comparing worker or air shower use For the general shop area samples, results were statistically higher when the air shower was in use (ANOVA, df = 1, F= 6 77, p=0 0287) For other area sample comparisons, no differences were found

Table 1 Sorbent Tube Sampling Results

Operating Scenario	Location* - Task	Total Time (min)	Methylene Chloride Geometric Mean (ppm)	Upper 95% Confidence Limit (ppm)
Worker A with air shower	BZ - stripping and rinsing	155	12	15
	Area - stripping, rinsing, and general	501	9 2	13
	Area - drying	170	2 5	7 5
Worker A without air shower	BZ - stripping and rinsing	158	15	23
	Area - stripping, rinsing, and general	569	5 8	7 2
	Area - drying	183	2 7	13
Worker B with air shower	BZ - stripping and rinsing	153	35	40
	Area - stripping, rinsing, and general	506	14	18
	Area - drying	164	3 0	26
Worker B without air shower	BZ - stripping and rinsing	143	41	78
	Area - stripping, rinsing, and general	469	8 9	12
	Area - drying	153	2 1	15

* BZ - Worker's Breathing Zone

The passive monitor summary results are shown in Table 3 with more detailed results given in Appendix B Passive monitor results were compared to the ORBO tube results and no statistically significant difference was seen (T-test, t = 0 92, p=0 38) Passive monitor samples were not used in the full model

Bulk samples were taken of the stripping and rinsing solution used during the survey to determine percent methylene chloride content Unused B7 stripper had 79% methylene chloride and used

stripper had 60% methylene chloride contents by weight

Real-time data were not collected during all sampling sessions because of equipment malfunctioning Of the 12 sampling sessions, real-time data were collected for only eight Therefore, not all combinations of the air shower and worker variables were included In fact, there was no real-time data collected for worker B while the air shower was off There was only one real-time session collected with worker A while the air shower was on Table 4 shows the real-time data that were collected Additionally, one point from one run was removed because it was three times higher than the next higher point Knowing that the photo ionization detector does not respond so quickly, it was determined that this high result was an equipment malfunction

Table 2 Methylene Chloride Time-Weighted Averages for Area Locations by Day (ppm)

Sample Location	Day 1		Day 2	
	conc (ppm)	time (min)	conc (ppm)	time (min)
Stripping	8 1	473	13	208
Rinsing	5 9	479	11	209
General	12	472	12	207
Drying	2 0	466	5 3	204

Table 3 Passive Monitoring Sampling Results Collected at the Workers Breathing Zone

Operating Scenario	Time (min)	Methylene Chloride Geometric Mean (ppm)	Upper 95% Confidence Limit
Worker A with air shower	161	11	18
Worker A without air shower	164	14	24
Worker B with air shower	157	30	40
Worker B without air shower	144	44	58

* BZ - Employee's Breathing Zone

Table 4 Number of Real-Time Data Collection Periods During Each Scenario

Air Shower	Worker A	Worker B
On	1*	3
Off	3	0

* One other run was collected but the data was discarded because values recorded were almost all zeros indicating an equipment malfunction

For all conditions of air shower and worker, these real-time data were compared by task The task of stripping was found to be statistically higher than each of the other three tasks ($F=117.9$, $p<0.0001$) (Table 5) A comparison of the two air shower conditions was made for all the tasks and the stripping only task (Table 6) - A statistically significant difference was not found for either comparison Additionally, there was no effect found when comparing workers

Table 5 Real-Time Data Comparing Furniture Stripping Tasks

Task	Estimate of Solvent Vapors Concentration (least squares means, ppm)
Stripping	32 6
Rinsing	22 4
Transport	18 4
Other	22 6

Table 6 Real-Time Estimate of Solvent Vapors Average Concentration (least square means, ppm)

Task	Air Shower On	Air Shower Off
Stripping Only	33 7	34 8
All	23 4	24 7

DISCUSSION

The sorbent tube samples showed that worker A with or without the use of the air shower resulted in exposures below the OSHA PEL of 25 ppm for methylene chloride Because the 95% confidence limits for worker A (with or without the use of the air shower) were above 12 5 ppm, it is not believed that this facility would generally meet the OSHA action limit Therefore, even for worker A, the additional OSHA safeguards of exposure monitoring and medical evaluations would need to be put into place

The breathing zone samples for worker B resulted in mean exposures above the OSHA PEL of 25 ppm Statistical results showed a difference between the breathing zone exposure levels for the two workers The exposure differences could be attributed to work practices or physical characteristics From viewing the workers during the survey and limited viewing of video tapes afterwards, work practices differences consisted of worker A keeping his head out of the two ventilation booths and turning off the solution recycling system when not needed Quantity of furniture stripped was not collected That information could have helped to determine if worker B stripped at a faster rate and therefore was exposed to more stripping solution Physical characteristics could have influenced exposures because worker B was much taller than worker A, worker B leaned over the tank, and therefore, into the ventilation booth more often than worker A

The air shower seemed to consistently lower breathing zone exposures by about 15%, but this difference was not statistically significant Use of the air shower consistently increased the concentrations of methylene chloride in the stripping and rinsing areas by a small margin This increase is probably the result of the air shower providing air to the stripping exhaust system rather than the general (stripping and rinsing) area providing air to the stripping exhaust system The real-time data enabled the worker's breathing zone concentrations to be separated by task Looking at only the stripping task, no difference in real-time concentrations were seen when comparing air shower use There may be many reasons for this inability to show a difference including a lack of power (small sample size) and that there was no data available for one of conditions Therefore, more data are needed to determine the viability of the use of an air shower

A review of the geometric means, upper confidence limits, and time-weighted averages for the area samples shows that workers in these areas would be below the OSHA standard of 25 ppm It is believed that workers not stripping furniture but working in the building would meet the OSHA action limit of 12 5 ppm and would not require the exposure monitoring and medical evaluations

Even with local ventilation at the stripping area, the worker was most exposed to methylene chloride during the stripping task Estill et al (2000) compared tasks using real-time data of a furniture stripper and found the rinsing task to be the highest although both the stripping and rinsing tasks were well ventilated, however, a statistical comparison was not made In addition,

the furniture stripping process utilized a dip tank instead of a solution recycling system

Passive monitors were shown to be comparable with the sorbent tube samples Estill et al (2000) also found no difference after a side-by-side comparison of passive monitors with Orbo samples and charcoal samples Passive monitors are cost effective for furniture stripping owners because they can purchase and use passive monitors without hiring experts Passive monitors in both of these studies were used for only about one hour It is believed that samples would become saturated if used for eight hours, thereby producing artificially low results The furniture stripper must review the manufacturer's instructions carefully to assure that they will not be saturating the passive monitors Initially, owners should collect eight one-hour samples consecutively to sample one complete work day Once approximate methylene chloride levels are established, owners can better estimate sampling length before saturation

Previous to the installation of this ventilation system, this facility did not have any localized ventilation for the stripping or rinsing operation Methylene chloride has been measured at other stripping shops that had very limited ventilation systems, exposures at those shops were found to range from 100 to 600 ppm (Jensen et al, 1990, Fairfield et al, 1990) Hence, the ventilation system at this facility lowered exposures However, this ventilation system met the goal of reducing exposures to the OSHA standard only when used by worker A It is believed that this system would be effective for others if they were trained in good work practices including keeping their faces out of the booth, limiting use of the solution recycling system, etc. This ventilation system is recommended for this facility compared to the former situation However, the facility needs to continue to measure and improve the system to get all workers' exposures below the current OSHA standard

Benny Bixenman from Benco Sales, Inc worked together with NIOSH on this study Bixenman provided, built, and installed the ventilation system Bixenman (2000) reported that the system achieved the 12 5 ppm action level for a worker with good work practices This is true for the average exposure reported, but does not take into account the upper confidence levels or address the variability in the data Even the case of worker A with the air shower has an upper confidence level of 15 ppm, and therefore may not always achieve the 12 5 ppm level Wolf and Morris (2000) also reported the results of this study, for each scenario, these authors gave 8-hour time weighted averages, assuming zero exposure for 5-1/2 hours each day Assuming zero exposure for non-stripping time periods may not be appropriate because of possible residual methylene chloride levels in the facility If a worker is not stripping but is still in the facility, while stripping is occurring, exposure would range from 2 to 13 ppm (Table 2) If stripping activities ceased, it is not clear how quickly these levels would drop The reduction rate would depend on whether the exhaust system continued to be operated Most of the stripping shops from which NIOSH researchers collected exposure data conducted stripping operations for 6-8 hours per workday If a stripping shop has a small volume of business, exposures would be more likely to meet the 12 5 ppm OSHA Action Level by spreading stripping over several days of the week for only a few hours per day while operating a ventilation system similar to the one tested here

Bixenman (2000) reported that the cost of system was between $5,000 and $8,000 This reported cost is in line with that calculated by Estill et al (2000) for a similar ventilation system at a facility in Ohio, $8900 (labor and materials) for ventilating both a stripping tank and a rinsing area

CONCLUSIONS

The goal of reducing methylene chloride exposures to the new OSHA standard of 25 ppm was achieved only for the case of the more experienced worker (worker A) while using the air shower Exposure results are statistically different between workers Additionally, use of the air shower resulted in only slightly lower exposures, with no statistical difference Therefore, more data are needed to determine ability of air shower to lower exposures Passive monitors results were similar to the sorbent sampling results and are recommended as an alternative sampling method for sampling short time periods Other workers who are not stripping furniture but who are working in the shop should meet the 12 5 ppm OSHA action level

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Appendix A Sampling Tube Results

	BZ - stripping and rinsing		Area - stripping		Area - rinsing		Area - general		Area - drying	
Operating Scenario	Time min	DCM ppm	Time min	DCM ppm	Time min	DCM ppm	Time min	DCM ppm	Time min	DCM ppm
Worker A with air shower	53	12	59	8 8	59	5 3	58	15	60	2 2
	50	14	55	3 5	54	6 8	55	7 8	55	5 1
	52	11	51	15	59	7 8	51	11	55	1 5
Worker A without air shower	60	13	60	7 4	64	3 2	59	7 6	56	1 0
	46	12	76	4 1	76	3 8	76	6 2	77	2 8
	52	20	51	6 5	51	6 9	56	7 9	50	6 9
Worker B with air shower	54	33	56	18	56	8 4	57	27	56	1 0
	50	35	60	12	60	9 1	60	13	56	2 3
	49	38	55	19	49	21	53	16	52	12
Worker B without air shower	50	27	60	6 0	60	4 2	61	11	59	6 3
	48	53	47	5 8	47	8 2	46	5 8	47	2 3
	45	50	51	11	50	8 8	47	15	47	0 7

* BZ - Worker's Breathing Zone
DCM - Methylene Chloride

Appendix B Passive Monitoring Results (Breathing Zone while Stripping and Rinsing)

Operating Scenario	Time (min)	Methylene Chloride (ppm)
Worker A with air shower	53	10
	54	9 4
	54	15
Worker A without air shower	62	11
	48	12
	54	20
Worker B with air shower	55	25
	50	32
	52	35
Worker B without air shower	51	40
	46	53
	47	40

* BZ - Employee's Breathing Zone