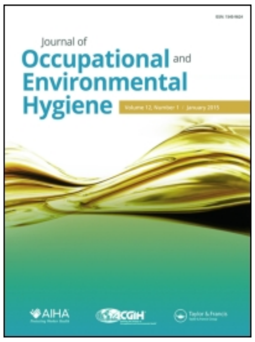

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Exposure Assessment in Auto Collision Repair Shops

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Workers in auto collision shops are exposed to a variety of chemical and physical hazards. Previous studies have focused on measuring levels of isocyanates, but little is known about exposures to dust, noise, and solvents. In preparation for an intervention effectiveness study in small collision repair businesses, sampling was conducted on 3 consecutive days in four representative businesses with three to seven employees. Full-shift and task-specific exposures were measured for dust and solvents (for operations other than painting and spray gun cleaning). Full-shift personal exposures and tool-specific noise levels were also evaluated. Samples of banded earplugs were distributed to employees and feedback was collected after 1 week of wear time. Dust and solvent exposures did not exceed the OSHA PELs. Noise exposure doses were below the OSHA PEL; however, 4 of the 18 measurements were in excess of the ACGIH® threshold limit value. The majority of tools generated noise levels above 85 dBA. Air guns, wrenches, cutoff wheels, and air drills generated noise levels with the 5th percentile above 90 dBA. Mean noise levels generated by hammers, grinders, and ratchets were also above 95 dBA. Three pairs of banded earplugs had the best reviews in terms of comfort of use. This study was conducted during a time when all shops reported relatively low production levels. Noise exposure results suggest that it is likely that technicians' 8-hr time-weighted average exposures may be in excess of 85 dBA during periods of higher production, but exposures to dust and solvents are unlikely to approach OSHA exposure limits. These pilot test results will be useful when developing recommendations and technical assistance materials for health and safety interventions in auto collision repair businesses.

[Supplementary materials are available for this article. Go to the publisher's online edition of the Journal of Occupational and Environmental Hygiene for the following free supplemental resource: a PDF containing a table on employee feedback on seven hearing band models, an example of an HP feedback card, a table showing a tool for selecting the solvents to be analyzed for area samples, a table containing MSDS and sample information for degreasing compounds, additional information for degreasing operations, an excerpt from the discussion with the AssayTech lab manager, and an image from the paint mixing room that returned the highest styrene and acetone concentrations.]

Keywords auto collision shops, dust, noise, personal protective equipment

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INTRODUCTION

In the United States approximately 220,000 people work in 35,800 auto collision businesses (NAICS code 811121). Fifty-six percent of shops have four or fewer employees, and only 21% have 10 or more.[1] Employees may be exposed to physical and chemical hazards in all stages of vehicle repair, assembly, and painting. To date, most hazard information for this industry has focused on isocyanate and solvent exposures during painting processes.[2–6] Dust exposure assessments have been performed for task-specific short-term operations, but little information is available on full-day dust exposures among body technicians. In addition, limited data are available on noise levels and chemical exposures for operations other than painting.

In the auto collision repair process, an estimator first conducts a damage assessment. A body technician is then responsible for vehicle disassembly and parts repair or replacement. Parts are repaired by applying and sanding successive layers of filling products (two-part systems consisting of a styrene-containing polystyrene resin paste mixed with a peroxide hardener) until the original shape is restored. Filler is mixed in batches on a palette and applied using a flexible spatula. Preparation for painting, which is performed by a painter helper or a painter, includes application of a layer of primer over the repaired surface, sanding the primer and old clear coat from the adjacent surface, taping and covering with plastic or paper sheeting the areas that do not need painting, and degreasing the surface immediately prior to paint application. Degreasing is accomplished either by spraying the product and then wiping the surface or by using a presoaked cloth or paper towel.

Finally, painting involves the application of a sealing product, the color, and a clear coat using a spray gun. After painting is complete, the body technician reassembles the car and a painter helper or detailer cleans the vehicle. In smaller shops, a single employee may perform all tasks except the initial damage assessment.

A wide range of powered and nonpowered tools may be used for each task. Body technicians use repair tools (e.g., screwdrivers, wrenches, hammers, and so on), compressed-air driven equipment (e.g., grinders, sanders, ratchets, cutoff wheels), and electric tools (e.g., welding machines, plasma cutters). Painters and painter helpers primarily use paint guns and sanders. Electric buffers and, occasionally, power washers are used in detailing operations.

As part of the development of safety interventions for a multi-year effectiveness study in auto collision repair industry, a pilot study was conducted at several representative locations. Employee exposures to dust, noise, and solvents were assessed during a range of body repair and painting preparation operations. A preliminary assessment of hearing protection acceptability was also conducted.

METHODS

Businesses participating in the current study were selected from a convenience sample of collision repair shops in a metropolitan area. Businesses that performed either complete auto body and paint restoration projects or worked mainly on large vehicles (such as fire trucks, buses, RVs) were not eligible for this project. All activities were approved by the Park Nicollet Institute and University of Minnesota Institutional Review Boards for Human Subjects Protection. Informed consent was obtained from owners of each business as well as individual participants.

Participating Businesses

The five participating shops were considered representative of auto collision repair businesses in the United States,[1] with a range of three to seven employees and at least one paint booth. All shops were independently owned and not part of a national chain. Personal sampling for noise, solvent, and dust exposures was conducted in four businesses. One additional business participated in the assessment of personal protective equipment.

Sampling Methods

In each business, sampling took place on 3 consecutive days (Tuesday–Thursday). The target number of samples in each business was 14 personal dust samples (3 full shift and 11 task based), 12 solvent samples (3 area and 9 personal), and at least 3 full-shift personal noise samples in addition to tool-specific noise levels.

Body technicians were eligible for 8-hr sampling for dust and noise exposures and for task-specific dust and solvent sampling. Painters and painter helpers were eligible to participate in task-specific dust and solvent sampling depending on their operations. At least one paint-mixing room area sample was taken each day over the duration of the shift. Mixing room air movement was visualized using smoke tubes during the last day of sampling in each shop.

Dust Sampling

Dust sampling was performed using 5μm PVC filters in two-piece preweighed cassettes attached to personal sampling pumps (Aircheck 52; SKC Inc., Eighty Four, Pa.), operated at 2 L/min. Prior to shipping to the laboratory, samples were stored in a closed zip-locked bag, face up, at room temperature. For each shop, one blank was also submitted for analysis. Before and after each sampling session, pumps were calibrated with a representative cassette in line. If airflow variation was more than 5% at the end of the day, the sample was discarded. Samples were analyzed using NIOSH method 0500.[7]

A direct-reading, light-scattering laser photometer (DustTrak, model 8520; TSI Inc., Shoreview, Minn.) was used to measure airborne concentrations of particulate matter between 0.5 and 10 μm (PM10). The instrument was held within 1 ft of the employee's face. The instrument was zeroed daily before and after the sampling session. Data were saved on a computer at the end of each day.

Observation sheets were used to record the activities taking place during full-shift dust monitoring. Dust-generating activities that lasted less than 2 min were recorded as "events." For activities lasting longer, the actual duration was recorded. Each grinding and sanding event was assigned a duration of 2 min, while each compressed air cleaning event was assigned a duration of 1 min. The total duration of dust-generating activities was calculated by adding the time assigned to or recorded for different operations.

Solvent Sampling

Solvent concentrations were measured using organic vapor diffusion badges (#566; Assay Technology, Boardman, Ohio). Area samples were taken in the mixing room for the duration of the workday (usually 8 hr). The monitor was placed at breathing zone height near the location most frequented by the painter. For specific operations (mixing and applying filler and surface degreasing), the badges were open for sampling for 15 min or the duration of the task, whichever was longer. Badges were capped at the end of the sampling session and placed in Teflon-lined pouches provided by the manufacturer. Samples were stored at room temperature prior to shipping. Samples were sent for analysis at the end of each shop's sampling session. One blank per shop was also submitted.

All samples were analyzed using Occupational Safety and Health Administration (OSHA) Method 7.[8] Solvents to be analyzed in the paint-mixing room samples were selected using the information listed in material safety data sheets (MSDS) of the paint thinner and spray gun washing fluid. For personal samples taken during degreasing operations, solvents were selected from the ingredients listed for the degreaser. When the MSDS did not list individual compounds, samples were analyzed for total hydrocarbons (THC). This analysis quantifies the C4-C15 compounds and reports the result as n-hexane.

TABLE I. All-Day Dust Samples Results for Body Technicians

Shop ID	Sample Time (mins)	Estimated Duration of Dust-Generating Operations (mins)	Concentration[A] (mg/m^3)	Calculated 8-Hour TWA[B] (mg/m^3)
1	509	79	2.90	3.01
	419	19	0.68	0.77
	455	21	0.47	0.49
2	460	0	0.86	0.82
	486	5	0.76	0.76
	428	34	1.30	1.16
3	439	27	0.43	0.39
	322	17	0.51	0.34
	300	4	0.47	0.29
4	455	9	0.34	0.32
	340	5	0.48	0.34
	318	8	1.20	0.79

[A]Laboratory-reported level of quantitation: 0.01 mg.
[B]Assumes no exposure for time not sampled.

In addition to personal dosimeters, Gastec styrene detector tubes (#124 and #124L; Gastec Corp., Kanagawa, Japan) were used to collect grab samples during mixing and applying body filler operations. The measuring range of tube #124 was 20–500 ppm (coefficient of variation [CV] 15% for 20 to 100 ppm) and 2 to 25 ppm (CV 10% for 2 to 5 ppm and 5% for 5 to 25 ppm) for tube #124L.

Noise Sampling

Full-shift personal noise monitoring was conducted using Quest Technologies' (Oconomowoc, Wisc.) NoisePro DLX dosimeters, calibrated before and immediately after each sampling session. The microphone was placed on the shoulder of the dominant hand. Data were downloaded to a computer at the end of each sampling session and analyzed using QuestSuite Professional software (version 1.70; Quest Technologies Inc.) Noise dose was measured simultaneously using two OSHA settings: (1) permissible exposure limit (PEL) exchange rate: 5 dB, criterion level: 90 dB, threshold level: 90 dB and hearing conservation (HC); (2) exchange rate: 5 dB, criterion level: 90 dB, threshold level: 80 dB); and the ACGIH setting (exchange rate: 3dB, criterion level: 85 dB, threshold level: 80 dB).

Tool-generated noise levels were measured using a Chameleon (Metrosonics Inc., Oconomowoc, Wisc.) sound level meter. Multiple readings were taken for tools used with different attachments. For example, a grinder may be operated using a grinding disk, a sanding disk, a wire brush, or a rubber disk. Multiple readings were also taken when tools were used on different substrates (sheet metal vs. molded plastic).

Hearing Protection Evaluation

Seven models of banded earplugs with a noise reduction rating >20 dBA were identified from a safety products catalog. Ten employees in two shops were asked to evaluate several models of hearing protectors and provide written feedback. Each hearing protector was distributed to at least two employees. Feedback cards were collected 1 week later with information about the duration of use, comfort, ease of use and storage, interference with other equipment, goodness of seal, sturdiness of headband, and whether the employee would be likely to wear the earplugs again.

RESULTS

Dust

Twenty-three dust samples were collected in four shops. Twelve were full-shift samples collected on body technicians; 11 task-specific samples were collected on either body technicians or painters, depending on the operations performed. All dust concentrations were below the Minnesota[(9)] and federal[(10)] OSHA PEL of 15 mg/m^3 for particulates not otherwise regulated (Table I). The duration of dust-generating operations was estimated from the observation sheets associated with individual samples. Calculated 8-hr time-weighted average (TWA) concentrations are strongly correlated with the duration of the dust-generating tasks (correlation coefficient = 0.86). Regression analysis shows that for each 1-min increase in the duration of dust-generating operations there is a corresponding 0.03 mg/m^3 increase in the calculated 8-hr TWA concentration ($p = 0.0002$).

Sanding operations performed by painters or painter helpers during vehicle surface preparation tended to take longer than those performed by body technicians, and they generated larger amounts of dust. In each shop, at least one short-term personal sample had a corresponding series of DustTrak measurements. For samples taken simultaneously, PM10 dust levels measured with the direct-reading instrument were between 13 and 58% of those measured with personal filter samples (Table II).

The effect of a down-draft ventilated booth on dust levels measured by the direct-reading instrument during a sanding

TABLE II. Task-Specific Dust Samples Results

Shop ID	Sample Time (mins)	Concentration[A] (mg/m^3)	Employee Job Title	Tasks Performed	DustTrak Sample Time (mins)	DustTrak Concentration (mg/m^3)
1	26	2.6	Body tech	Sanding filler and old paint		
	61	3.8	Painter	Sanding primer and clear coat		
	27	< 1.9	Body tech	Sanding primer		
	114	1.1	Painter	Sanding primer and clear coat	92.6	0.63
2	43	4.0	Painter	Sanding filler and primer		
	55	1.3	Body tech	Sanding filler		
	35	6.4	Painter	Sanding primer and clear coat	33.1	0.84
3	31	1.6	Painter	Sanding primer and clear coat	22.4	0.91
	60	1.2	Painter	Sanding clear coat		
4	54	5.4	Painter	Sanding filler and primer	39.4	2.11
	49	3.4	Painter	Sanding primer	45.1	1.32

[A]Laboratory-reported level of quantitation: 0.01 mg.

operation is shown in Figure 1. Data recorded before 11:08 a.m. show dust levels generated during sanding outside the booth. Compressed air cleaning operations created PM10 concentrations as high as 7 mg/m^3. When sanding was performed inside the booth, the maximum concentrations were about 4.5 times lower.

Solvents

Twenty-seven passive samples (12 area- and 15 task-specific) and 17 colorimetric tube measurements were collected in four shops. Of the nine samples collected during surface degreasing operations, six had nondetectable levels of 1, 2, 4 trimethyl benzene, THC, or xylene. Three samples returned THC (reported as n-hexane) concentrations of 150, 160, and 320 ppm. We are not able to explain these results and suspect that degreaser spray droplets landed directly on the badge. However, we note that all three samples were taken in the same shop, under various settings (operations were performed both on the shop floor and in a prep station with additional downdraft ventilation), and the degreaser was sprayed two or three times in a row. This frequency of degreaser application is different from the observations made in all other shops, where the degreaser was applied only one time, regardless of the method used (sprayed or applied with a pre-wetted towel). All other solvent concentrations were lower than the current Minnesota OSHA PEL[9] or short-term exposure limit (STEL) for individual chemicals (Table III).

One 8-hr area sample taken in a mixing room recorded a concentration of 31 ppm of toluene, 55% higher than the ACGIH-recommended TLV of 20 ppm.[11] The same sample returned the highest acetone concentration of 35 ppm. While all the paint storage and mixing rooms had additional ventilation, airflow visualization using a smoke tube indicated little or no air mixing in these rooms when the door was closed and ventilation was on. The only noticeable airflow and mixing occurred when the door was opened.

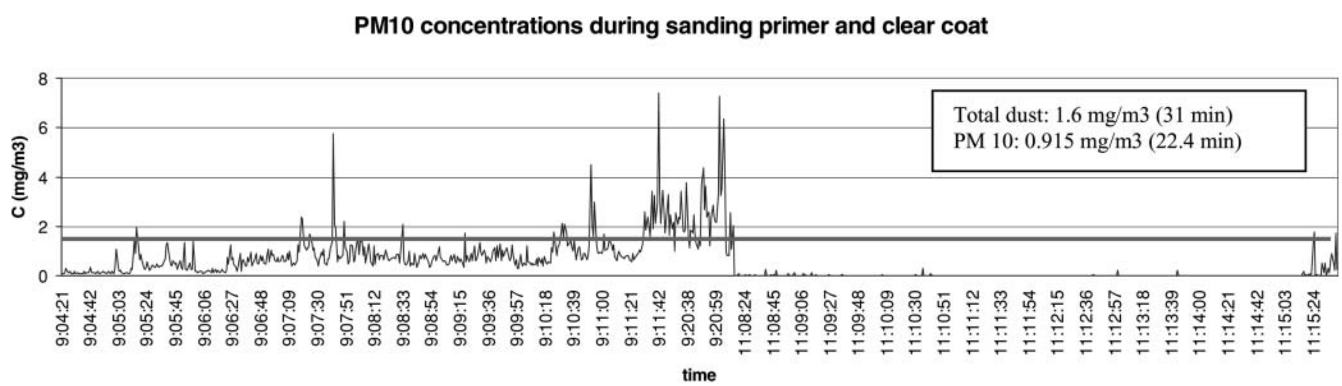

FIGURE 1. PM10 and total dust concentrations recorded for two consecutive sanding events

TABLE III. Solvent Sampling Results

Sample Type	Chemical Name	LOD (μg/sample)	N	Mean (ppm)	SD (ppm)	Min (ppm)	Max (ppm)	MN OSHA PEL^{A} (ppm)	ACGIH TLV (ppm)
Area (398–530 min)	Acetone	2	6	17.63	9.31	7.8	35	750	500
	Methanol	3	6	5.50	2.93	1.8	8.8	200	200
	Xylenes	1	6	1.82	0.99	0.9	3.6	100	100
	Toluene	2	6^{B}	15.32	11.23	3.1	31	100	20
Grab (2 min)	Styrene	N/A	17	13.20	9.50	2	30		
Personal diffusion monitor (15–91 min)	Styrene	0.5	6	10.20	6.30	1	16	100 (STEL)	40 (STEL)
Personal diffusion monitor (15–43 min)	THC	40	3^{C}	210	95.39	150	320		
	1, 2, 4 trimethyl benzene	1	3^{D}						
	Xylene	1	2^{D}						

^{A}Federal OSHA PEL: acetone 1000 ppm, methanol 200 ppm, xylenes 100 ppm, toluene 200 ppm, styrene 200 ppm (STEL)
^{B}Total number of samples was 12; 6 values were under the laboratory LOD and were not included in the analysis.
^{C}Total number of samples was 9; 6 values were under the laboratory LOD and were not included in the analysis; results are reported as n-hexane.
^{D}All values were under the laboratory limit of detection.

Noise

Seventeen personal noise dosimetry samples were collected on body technicians; data were lognormally distributed. No dose exceeded the OSHA PEL;[12] however, one sample in each shop was above the ACGIH TLV.[11] The geometric mean of the noise doses calculated using the ACGIH criteria was about 10 times higher that for the data calculated using the OSHA criteria (Table IV).

The variation of noise levels observed for each tool category is likely to depend on the brand, maintenance condition, type of attachment (such as grinding disk vs. a wire brush), substrate (bare metal vs. painted metal vs. plastic), compressed air pressure in the line, and the pressure exerted by the employee when operating the tool. While most of the loudest tools (i.e., chisels, cutoff wheels) are used for brief operations (usually lasting no more than a few minutes), several tools used often for longer periods of time generate noise levels above 100 dBA (i.e., buffers, sanders). Statistical analysis of the datasets for air gun, wrench and cutoff wheel indicate with 99% certainty that less than 5% of the noise levels generated by these tools was under 90 dBA (Table V).

Hearing Protection

Nineteen hearing protection feedback cards were collected from nine body technicians. From responses to questions about comfort, goodness of the seal, and whether they would wear a particular model again, three of the seven tested models were identified as having the most positive feedback: Sphere and Reflex (E-A-R; 3M, St. Paul, Minn.) and Cool Cap (Moldex, Culver City, Calif.). We were not able to identify which specific design features of these models contributed to employees' assessment of comfort. However, we observed differences in the angle of the earplug holders, the tension applied by the headband, and the option to adjust some of hearing band's elements.

DISCUSSION

The primary goal of this project was to update the existing body of data regarding personal exposures to dust, solvents, and noise in auto collision repair shops. Personal exposures were generally well below current federal or Minnesota OSHA PELs[9] and ACGIH TLVs.[11]

TABLE IV. Personal Noise Sampling Results Summary

Dosimeter Settings	N	Min (% dose)	Max (% dose)	MVUE^{A} (% dose)	GM (% dose)	GSD	95th Percentile (% dose)	UTL(95th%, 95%)^{B} (% dose)
OSHA PEL^{C}	17	1.9	21.3	8	6.66	1.85	18.31	30.71
ACGIH	17	16.1	256.7	79.89	62.9	2.05	205.26	375.76

^{A}MVUE = minimum variance unbiased estimate of the arithmetic mean of a lognormal distribution.
^{B}UTL (95th%, 95%) = the upper confidence limit for the distribution of the 95th percentile.
^{C}Minnesota OSHA PEL is identical to the federal OSHA PEL.

TABLE V. Shop Tool Noise Levels

Tool	Noise Level Range (dB)	N	n	Mean (dB)	SD (dB)	5th% (dB)	95th% (dB)
Buffer (electric)	77.9–100.5	9	3	88.5	6.5	79.7	97.1
Sander	78.2–103.7	32	4	90.1	5.5	81.3	97.0
Hammer (manual)	86–103.9	6	3	95.6	6.3	87.4	103.0
Grinder	81.7–109.3	14	4	96.0	7.0	84.2	105.3
Ratchet	82–110.3	13	2	96.1	8.7	82.8	109.0
Air gun	88.8–105.2	13	4	98.4	5.0	91.4	105.1
Wrench	93.8–103.6	8	3	98.7	3.4	93.8	102.8
Cut-off wheel	100.1–109.3	5	2	104.4	3.5	100.5	108.5
Air knife	98.3	1[A]	1				
Air riveter	93.8–94.7	2[A]	1				
Air buffer	95.9	1[A]	1				
Chisel	106.1–107.9	2[A]	1				
Decal eraser	95.5	1[A]	1				
Air drill	94.5–102	3	2	98.7	3.8	95.0	101.7
Air hammer	89.1–106.8	3	2	95.8	9.6	89.3	105.3
Hammer (manual/slide)	87.2–88.4	2[A]	2				
Heat gun	79.5–94.1	2[A]	1				
Paint shaker	79.2–84.5	2[A]	2				
Plasma cutter	94.3	1[A]	1				
Reamer	100.6	1[A]	1				
Air saw	98.2–104	2[A]	2				
Broken wrench	120.3	1[A]	1				
Wrench (missing muffler)	107.3	1[A]	1				

[A]Insufficient data for statistical analysis.

Enander et al.[(13)] measured 8-hr dust exposures for body technicians and found concentrations ranging from 0.6 and 11.3 mg/m^3. The highest exposures occurred in a large collision shop where five body technicians were sanding for 6 to 8 hr per day. Jayjock and Levin[(14)] found a maximum concentration of 39.8 mg/m^3 during a 55-min sampling period, and a 5.1 mg/m^3 exposure during a 197-min period. Several studies measured dust concentrations generated during sanding operations and found exposures ranging from 0.22 to 170 mg/m^3 for sampling periods ranging from 6 to 40 min.[(3–5,15,16)]

Unlike prior investigations, body technicians in the current study were seldom engaged in dust-generating operations, and task-specific dust concentrations measured were between 1.3 and 2.6 mg/m^3. Body technicians' 8-hr dust exposures ranged from 0.3 to 3 mg/m^3 and were strongly correlated with the amount of time spent performing dust-generating operations. While the results were compared with the current federal and Minnesota OSHA PEL for dust exposure, the authors recognize that this standard is outdated and not adequate. However, a direct comparison with the ACGIH-recommended levels of exposure cannot be made, as our samples collected "total dust" and the ACGIH recommendations are for either "respirable" or "inhalable" fractions of airborne particulates.

A recent survey of work practices in the collision industry shows that shops repair the damaged parts only 26% of the time.[(17)] Insurance companies may be more likely to require that parts be replaced and not repaired because after-market parts are more readily available and labor costs are higher. This approach influences directly the amount of sanding performed by body technicians in most auto body collision shops. However, for the shops that specialize in repainting the cars entirely, a technician's exposure to dust is likely higher than observed in this study.

Painters or painter helpers were more likely than body technicians to perform multiple and lengthier sanding operations, generating task-specific dust concentrations from 1.1 to 6.4 mg/m^3. Direct-reading instrument measurements showed that a downdraft booth can be an effective means of controlling dust exposures. Performing sanding in a downdraft booth or using other local exhaust ventilation options (central dust collection system, tool-attached dust collection bags, and so on) would not only lower technicians' exposure to dust but would also reduce the frequency and duration of surface cleaning tasks, thus decreasing exposure to noise generated by compressed air guns.

No previous published reports were found describing personal exposures to solvents during surface degreasing and body filler mixing and application. We are not able to explain the concentrations recorded during surface degreasing tasks in one shop. Given the fact that degreasing is performed both with and without additional ventilation and by different methods (spraying and presoaked towels) it would be useful to quantify painters' personal exposure during all degreasing operations performed in a day. To eliminate the uncertainty in the type of analysis needed, it would be best to calibrate the analytical equipment using the specific degreasing product. Body filler mixing operations generated only transient peaks, with a maximum styrene concentration of 30 ppm. Based on our observations of the frequency and duration of these tasks, overexposures are unlikely.

No previous reports were found regarding solvent concentrations in paint mixing rooms. In our study, the highest toluene concentration recorded was 31 ppm, 1.5 times greater than the current ACGIH TLV of 20 ppm. This was likely due to the containers of paint thinner left partially uncovered while mixing tools and spray gun parts were immersed in liquid. We also observed a partially full, uncovered drip pan that was placed under the pump attached to the drum of thinner. No other shop participating in our study had a drip pan or any open containers, aside from a few paint mixing cups (with the open surface of the lid about the size of a dime) and occasionally an open funnel. Because painters are likely to be exposed to toluene during other operations (paint gun cleaning, spraying), it may be possible that exposures above the ACGIH TLV could occur. It would be useful to evaluate the personal exposure to solvents for the duration of a full workday.

Paint mixing rooms are considered inside storage rooms for the flammable or combustible liquids present in a collision shop. As such, their design and construction must be in compliance with OSHA Standard 1910.106 Flammable and Combustible Liquids,[18] which requires that the ventilation of the room provides at least six complete air changes per hour. In all shops participating in this study, mixing rooms had additional ventilation with the exhaust grille located about 1 ft above the floor, usually by the hazardous waste drum. The air intake was usually situated close to the ceiling, which ranged in height from 8 to 15 ft. While the ventilation was always in use during the workday, air movement was not noticeable beyond 2–3 inches in front of the exhaust grille. Airflow and mixing were visible when the door to the room was open, but leaving the door open is not in line with the fire safety requirements. Obtaining ventilation measurements would have been helpful to document the capacity of the currently installed ventilation systems.

A 10-day noise dosimetry study by Jayjock and Levin[14] found that body technicians may receive exposures up to 160% of the OSHA PEL. McCammon and Sorensen[19] measured an 8-hr noise dose of 185% of the OSHA PEL for a body technician, with a peak sound level of 135 dBA. In comparison with these previous studies, the highest noise dose we measured using OSHA PEL criteria was 21.3%. However, the highest dose recorded using the ACGIH sampling criteria was 257%, indicating that even though the employees thought of the shops as "quiet" during the days of the sampling, some were exposed to noise levels that in the long term may have an adverse effect on their hearing. It is likely that when shops are busier, personal noise exposure may exceed regulatory standards.

In 1984, Jayjock and Levin[14] measured the noise output of various tools in a collision shop and found that the noise levels measured during orbital sander use ranged from 95 to 98 dBA, while pneumatic chisels, compressed air hoses, pneumatic and electric grinders, and fileboard sanders were all louder than 100 dBA (102 to 115 dBA). We also found several tools with sound level outputs exceeding 100 dBA. It was surprising to find OSHA-compliant air guns (for which the air pressure is no more than 30 psi when the tip of the gun is placed directly against the skin) generating noise levels as high as 103 dBA. It is our experience that when a label such as "OSHA-compliant" is seen on a product, a technician is likely to interpret it as an all-encompassing seal of approval. Little is known about how to obtain tool noise-level information, and 6 out of 10 tool manufacturers that we identified from the products used in the participating shops do not provide any noise data for their tools. Absent this information, technicians may underestimate the importance of using hearing protection devices even when they perform short tasks using loud tools.

No previous studies regarding worker field evaluation of hearing protection devices were identified. Among seven hearing bands tested, the three models that received the best reviews incorporated specific design features that enhanced user comfort by allowing for better positioning of the earplugs and possibly by exerting less pressure on the earplugs. This knowledge may be useful to both equipment distributors and shop owners, who often cover the cost of at least one type of hearing protection device for their employees.

There are some limitations to the data gathered in this study. Samples were collected for only 3 days in each shop during a relatively slow production time. Ideally, sampling would follow the seasonal variations observed in the industry. This study does not address personal exposures during spraying and paint mixing operations and did not evaluate the type or effectiveness of personal protective equipment being worn during personal sampling. The duration estimated for each dust-generating "event" was based on one author's (AB) observations of the work practices in the participating shops. We were unable to collect more precise data regarding the actual duration of dust-generating operations for each full-shift dust sample. This study collected "total dust" exposure samples. However, to be able to compare the results with the ACGIH TLV, it would have been better to collect samples of the respirable or inhalable fractions of airborne dust.

CONCLUSIONS

Results from this project proved useful in refining intervention activities with small auto collision repair businesses. Data suggest that solvent exposures for operations other than spray painting and paint gun cleaning are below current OELs. Unlike previous studies, noise dosimetry did not identify personal exposures above the current regulatory limits. However, given the high noise levels recorded for many shop tools, it is possible that increased shop activity (production) would lead to overexposures. Collision repair technicians would benefit from receiving more information about ways to identify noisy tools, about hearing protectors, and hearing loss. Personal dust sampling results indicate that respiratory protection would not be required during dust-generating tasks. Direct-reading measurements showed that downdraft booths can be an effective method for controlling personal exposures to dust during sanding operations. User feedback on hearing protection devices indicates that models that have adjustable parts may be more comfortable and thus more likely to be used consistently. The results of this study are not representative of shops that perform high-volume vehicle repair and painting or that work on large vehicles (fire trucks, buses, ambulances, and so on).

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