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A Preliminary Assessment of Asbestos Awareness and Control Measures in Brake and Clutch Repair Services in Knoxville and Knox County, Tennessee

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Abstract

The pending OSHA standard revision proposed in 1990 to lower the asbestos Permissible Exposure Limit (PEL) and to mandate effective asbestos control measures (ACM) in brake and clutch assembly work may have a profound effect on industries involved in such operations. Health protection of workers will be improved and costs of improved control methods and training will increase. Considering these facts, this preliminary study was designed to assess the level of worker and management awareness of asbestos hazards associated with brake and clutch repair and to determine what ACM had been implemented by businesses in Knoxville and Knox County, Tennessee. The study, in a metropolitan area of approximately 336,000 people, revealed eight different categories of businesses conducting brake and clutch repair work with an estimated 363 potentially exposed employees. Results of the study suggest that managers and employees of the 80 businesses studied were in need of asbestos hazard awareness training and more adequate asbestos control measures.

There are more than 150,000 full-time brake and clutch mechanics working with asbestos-containing brake shoes and clutch facings in the United States (1). In the Knoxville/Knox County, Tennessee area, there are approximately 363 such workers, including part-time mechanics, working in 107 business locations. Worker exposure in brake and clutch repair operations is regulated by 29 CFR 1910.1001, General Industry Standards, requiring employers to ensure that workers are not exposed in excess of the OSHA Permissible Exposure Limit (PEL), eight-hour time weighted average (0.2 fibers/cc of breathing air) or in excess of the 30-minute excursion limit (0.1 fibers/cc) (2). If one-half of the PEL is demonstrated in the workplace, protective program requirements such as medical surveillance, recordkeeping, training, respiratory protection, and regulated areas must be implemented. Alternatively, Appendix F of the regulation can be adopted as the method of choice by the employer in lieu of the afore-

mentioned requirements and is triggered when one-half of the PEL is exceeded. Appendix F, entitled "Work Practices and Engineering Controls for Automotive Brake Repair Operations," is nonmandatory. Appendix F provides guidance on procedures to be implemented, such as enclosed High Efficiency Particulate Air (HEPA) vacuum systems, compressed air/solvent systems, and spray cans that can be used by workers to reduce exposure.

On July 20, 1990, OSHA issued a newly proposed rule to further protect workers against unnecessary exposure to asbestos associated with brake and clutch work (3). The proposed rule, which is likely to be adopted in the new administration, would amend the nonmandatory Appendix F by mandating control measures. New requirements would include use of one of the following protective measures: the enclosed cylinder/HEPA vacuum system method, the solvent spray can method, the wet brush recycle method, or equivalent methods that would reduce exposure levels to those of

the first procedure cited above. Alternate methods of control would have to be proven protective through sampling.

Further, the proposed standard would lower the PEL for workers from 0.2 fibers/cc to 0.1 fibers/cc, eight-hour time weighted average. Several studies in the United States, Great Britain, Finland, Germany, Japan, and China have demonstrated exposures above the PEL during brake, clutch, and associated repair work (4-9). However, when good work practices were utilized worker exposures fell well below the PEL (5,10). Many of the aforementioned studies evaluated exposure levels but made few asbestos control measure recommendations. As a result of National Institute of Occupational Safety and Health's (NIOSH) findings in studies of known asbestos control measures, OSHA issued a proposed standard in 1990 that will mandate techniques to protect the health of brake and clutch repair workers. This proposed standard's impact can be measured only by determining the types of ACM in use and the level of asbestos hazard awareness existing in brake and clutch repair businesses in the U.S. at the present time.

Health Risk of Asbestos

Asbestos is well-characterized clinically and has been the subject of extensive epidemiological research (11-16). Although there are several published retrospective studies demonstrating asbestosis, fibrosis, rales, pulmonary deficiency, and a few cases of mesothelioma in brake shoe and clutch repair workers, debate in the literature as to the toxicity of dust associated with this type of work is conflicting. Studies conducted to determine the presence and size of asbestos

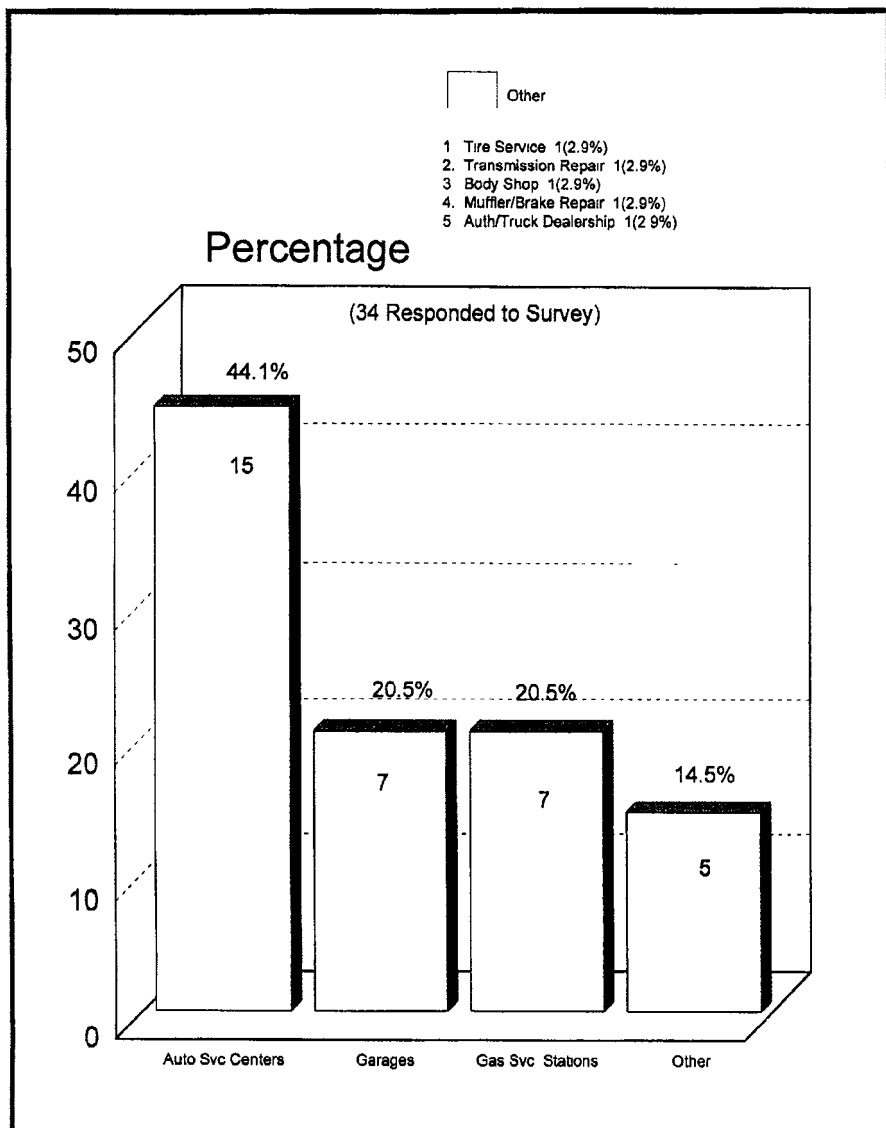


Figure 1. Types of businesses by percent and total responding to survey.

fibers have shown asbestos content in brake shoe dust ranging from 0.1% to 30% by weight with a median length of 0.5 microns (17). The current debate centers around findings that high braking temperatures result in dehydroxylation of chrysotile asbestos followed by loss of morphology and transformation into forsterite and silica (17-20). Although thought not to cause asbestosis and related cancers, the biological activity (cytotoxicity) associated with these materials has not been extensively studied. However, asbestos diseases have occurred in this occupational workforce.

This study, occurring between January 1 and March 31, 1991, examines the awareness level of management and employees

to the hazards of working with asbestos-containing brakes and clutches and is relevant to both large and small business operations. Also, asbestos control methods utilized in the Knoxville/Knox County area at the time of the study are discussed.

Methods

The study, descriptive by design, was limited to a target population of 107 brake and clutch repair businesses known to be located in the Knoxville/Knox County, Tennessee area. The local Chamber of Commerce was utilized to identify repair locations and their managers. Eighty of the 107 businesses were randomly selected and their managers queried by a mailed ques-

tionnaire. The questionnaire, containing 33 questions, was designed to assess the knowledge level of management and that of employees as perceived by management and to determine the types of ACM currently in use. The questionnaire was divided into three sections. The first requested descriptive information about the business operations. It was designed to identify types of businesses, number of workers, types of repair, duration, and quantity of brake and clutch work. The second, concerning health hazard awareness, was designed to reveal knowledge level and belief of risk associated with asbestos as indicated by management. It was anticipated that the resultant responses, in conjunction with information from the third section concerning asbestos control methods, would reveal to researchers if a relationship between health beliefs, knowledge, and ACM might exist (21). The third section was comprised of multiple response questions to identify ACM or its absence. Descriptive data was compiled by comparing frequencies and percentages of responses to questions and by a selective comparison of questions.

Discussion and Results

The findings of this exploratory study can be broadly generalized to the target population of all brake and clutch repair businesses in Knoxville and Knox County. Survey results were skewed because three categories of brake and clutch repair businesses (automobile service centers, garages, and gasoline service stations) made up 85% of responders. Five other business types, each with a single responder, made up the remainder of the results (Figure 1). Findings may not be applicable to businesses included in this portion of the target population. Based on responses, the survey identified as many as 363 workers engaged in brake and clutch repair. The response rate of 42.5%, 34 of 80 businesses responding, based on two mailings, most likely resulted due to such factors as small size of firm, level of education of the potential respondent, and privilege of nondisclosure. Although personal follow-up visits to interview those who did not respond was considered, such action would have introduced another variable.

The average number of brake jobs accomplished ranged from 2.4 to 14.5 per week. A brake job consisted of one axle

with two sets of brakes. The average time required to conduct a brake job ranged from 0.7 to 7.25 hours a day. Dependent on the number of available workers sharing the effort, employee's exposure time could range from 1.25 to 7.25 hours a day. This was the case only if a worker repaired one vehicle or at the most two vehicles per day. Literature review revealed one study that found it unusual for a mechanic to perform brake service work on more than one vehicle a day (5). Assuming an individual inhales 100 liters of air per minute while working for 1.25 hours, the person would breathe 7,500 liters of air. This would equate to 43,500 liters for 7.25 hours. If the individual used the worst ACM method, compressed air blowing (0.11 fibers/cc exposure), he/she would have an exposure of 935,000 fibers for a 1.25 hour brake job (1). Given an exposure of 0.11 fibers/cc, the 1.25 hour work period, unprotected, would result in an exposure level less than the OSHA PEL of 0.2 fibers/cc. The 7.25 hour work period would reach only the OSHA PEL action level of 0.1 fibers/cc. Based on historical data from five different studies compiled by NIOSH, the normal length of time typical for a brake job, and the assumption that similar working conditions and ACM were used, it would be unlikely that brake workers in the Knoxville/Knox County area are exposed routinely to asbestos in excess of the PEL.

If the proposed rules to lower the PEL to 0.1 fibers/cc of air are implemented, then the PEL could be exceeded routinely (2). However, if findings of other studies were used as a means of projecting exposures to brake repair (for example, a 15.9 fibers/cc exposure level associated with compressed air blowing) the responding repair locations would exceed the current OSHA PEL (3).

Compared to brake work, management indicated that clutch repair work was conducted on a less frequent basis in all reporting categories averaging 2.5 clutches per week to 14.5 clutches for the larger automobile service centers. Length of time required to complete clutch repairs varied from 2 to 4.5 hours a vehicle. One British study demonstrated an average asbestos exposure of 0.79 fibers/cc of air to personnel during a normal eight-hour work shift (14). Assuming similar working conditions and procedures while accomplishing, as re-

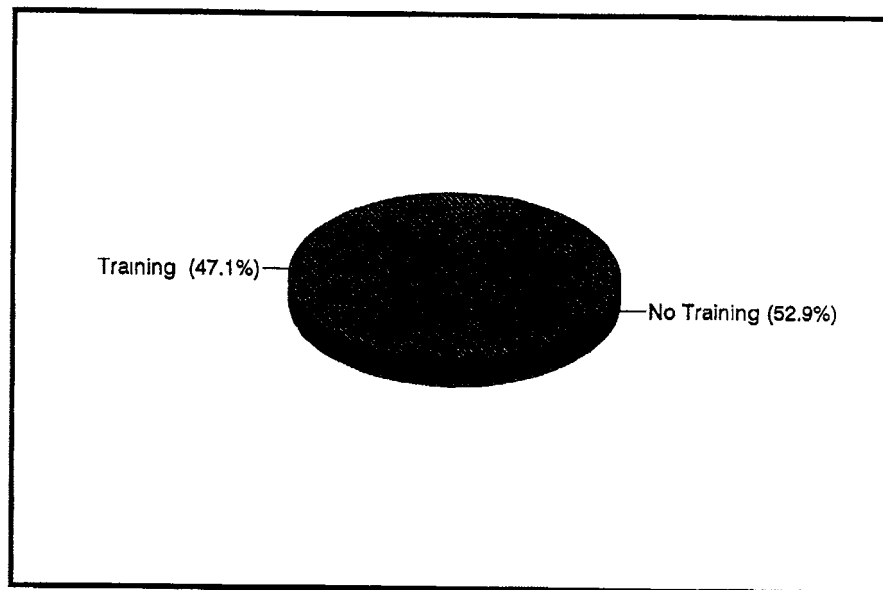


Figure 2. Percent of employee hazard awareness training on asbestos as indicated by management of businesses surveyed.

ported, one to two clutch jobs a day at 2 to 4.5 hours each, local area workers could exceed current and future recommended OSHA PELs. Considering that brake and clutch repair work in the businesses surveyed, especially when compared to findings of similar studies, may be potentially hazardous due to asbestos dust emissions, the need for use of asbestos-free parts and worker hazard awareness training becomes more evident. The results of the survey

revealed that even though three-fourths of the businesses surveyed stocked asbestos-free parts, 65% continued to use those containing asbestos.

Hazard awareness training reportedly had been given to employees at only 47% of the businesses reviewed (Figure 2). Eighty-eight percent of managers also indicated that workers were aware of asbestos hazards associated with brake and clutch repair (Figure 3). With a high degree of accuracy,

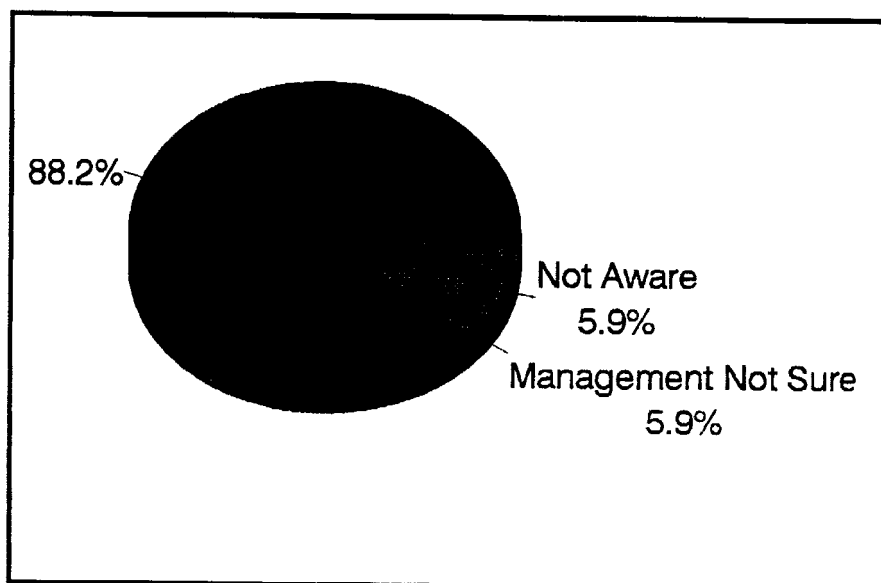


Figure 3. Percent of employee's awareness of asbestos hazards associated with brake and clutch dust as indicated by management of businesses surveyed.

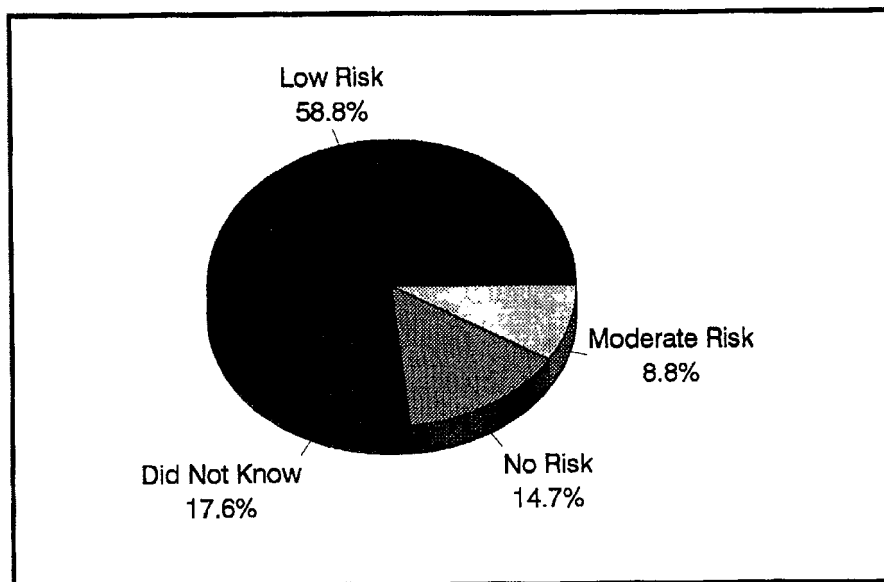


Figure 4. Belief of degree of disease risk associated with asbestos as reflected by 34 of 80 responding business managers.

these same individuals identified brakes, disc pads, and clutches as sources of asbestos exposure. This knowledge, in conjunction with a better than average response on what particular jobs could cause asbestos exposure, seemingly indicated a moderate degree of knowledge about the hazards of working with asbestos. However, several

contradictions found when reviewing the overall responses cast serious doubt on the awareness level of management and their employees. When asked to rank the health risk associated with asbestos exposure, 58% of responders considered it to be a low hazard. Only 17.6% considered asbestos to be a moderate health hazard, and none

thought it a high risk. The responses conceivably are a good example of denial of threat and possible worker incentive to minimize the threat of illness to ensure continuance of employment. This is a classic example of preventive health behavior as reflected in the Health Belief Model (90). It is also realized that such responses could be due to ignorance of hazards or the lack of communication of hazards by management. The ignorance level also could be due to the absence of involvement of insurance carriers, local health departments, and state OSHA health inspectors in providing guidance. This is supported by the results showing that 71% of these businesses were not informed on basic health protection. Management (79%) was aware that asbestos could cause cancer, and almost one-half knew of asbestosis. Surprisingly, 12% were either unsure or did not think that asbestos caused disease. These responses served to contradict the survey finding that a majority view asbestos as a low risk. Management was aware that asbestos causes terminal diseases and knows where it is found in the workplace, yet they still consider it a low risk. This contradictory situation indicated a need for awareness training.

One-half of management surveyed responded that they were familiar with OSHA laws on asbestos, and 23% reportedly were aware of pending stricter changes to the OSHA requirements. The responses to the survey revealed that 94% were not aware of the PEL, a level of exposure emphasized by the law, although 50% said they were familiar with current OSHA requirements. Adding further contradiction to management's cognizance of Tennessee OSHA laws was the finding that only one manager was aware that the law regulated use of respirators for protection against asbestos, and almost one-third were sure no such legal requirement existed (Figure 5). Assuming truthful reporting by management, the need for awareness training is made obvious by the responses to the questionnaire.

The most convincing evidence that workers and management were deficient in asbestos hazard awareness was the fact that only 47% of the businesses had provided such training, and, of those, only 6% had included legal requirements as a topic covered. This deficit in training is substanti-

	Yes	No	Do Not Know	No Response
Does Tennessee have laws concerning asbestos use?	17 (50%)	0	17 (50%)	0
Is management aware of newly proposed laws requiring specific asbestos control measures (ACM)?	23 (68%)	3 (8.8%)	8 (24%)	0
Is management aware that newly proposed legislation would reduce by one-half the legal allowable exposure limit to asbestos?	15 (44%)	7 (20.5%)	12 (35%)	1 (2.9%)
Is management aware that the legal allowable exposure limit to asbestos was 2 fibers/cc?	2 (6%)		32 (94%)	
Is management aware of the legal requirements for a respirator program when respirators were used?	1 (2.9%)	10 (29%)	22 (65%)	1 (2.9%)

Figure 5. Awareness of asbestos legal requirements current and pending as indicated by management surveyed.

ated by the reported unfamiliarity of legal requirements. In summary, although management expressed general awareness of hazards associated with asbestos work and awareness of legal requirements, a closer inspection of the survey results indicated limited knowledge when compared to OSHA training requirements (3).

When queried on what asbestos dust control measures were implemented during brake and clutch repair, 50% of businesses surveyed were found to be using wet brush recycle, liquid solvent squirt bottle, and wet brush methods (Figure 6). The first two mentioned are recommended under the current OSHA standards and will be mandated if proposed rules are adopted. The most preferred method recommended by OSHA, the enclosed cylinder High Efficiency Particulate Air (HEPA) vacuum method, was used by only one business. The scarcity of this method was probably due to its high cost and concern that it would be difficult to operate (11). The wet-wipe cloth/rag method, used by 26% of those surveyed, presents the problem of temporarily wetting fibers down that can later be re-aerosolized. This method gives a false sense of security, as does the water hose method of control used by 11.8% of the businesses responding. The water hose method merely wets down surfaces contaminated with asbestos, which after drying allows dust to be reentrained into the workroom air. Alarming, 14.7% of those surveyed were using compressed air hoses to blow out brakes and clutches, a method that has been shown to generate high fiber counts at great distances from brake and clutch work. Concentration levels as high as 29 fibers/cc at distances of 5 feet from brake drums and 4.8 fibers/cc at distances of 20 feet have been measured (17). Peak exposures in the breathing zone of mechanics have been demonstrated by NIOSH to reach 15 fibers/cc, eight-hour time weighted average (3). Use of compressed air-blowing is strictly forbidden by OSHA. Another method cited as used by 8.8% of the businesses surveyed was ordinary vacuuming, which differs from HEPA vacuuming. Vacuum cleaners without HEPA filters create a greater hazard by reducing further the fiber sizes of asbestos and by exhausting the dust back into the workroom. Use of vacuuming should be allowed only when HEPA filters are em-

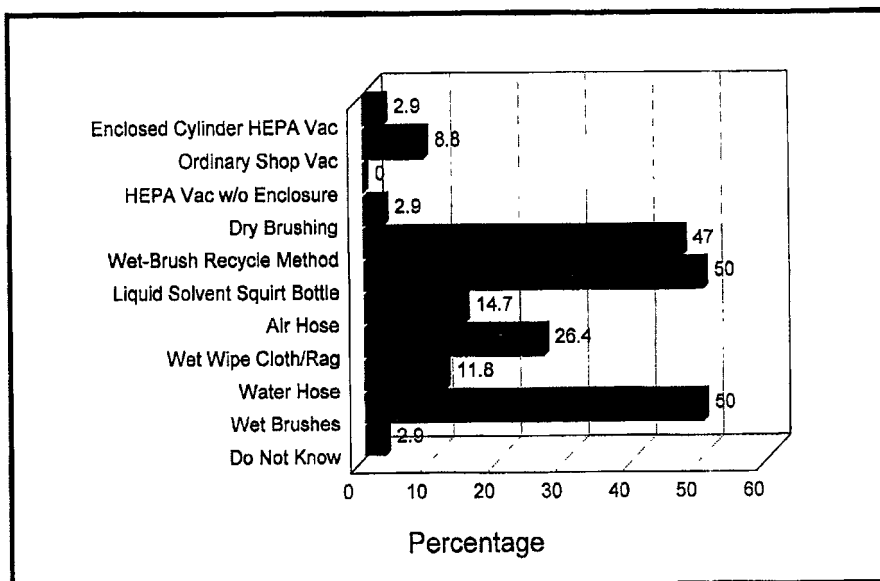


Figure 6. Percent of use of cleaning and dust control methods as indicated by management survey. Firms may use more than one method.

ployed (3). Such filters clean exhaust air at a 99.97% efficiency. The use of these inadequate methods and the lack of use of approved methods by all businesses surveyed, further underscored the need for awareness training and guidance on appropriate asbestos control measures and legal requirements.

Floor cleaning methods were found inadequate to control asbestos dust in work areas, especially in that 23% of the businesses allowed employees to dump wheel drum dust directly on the shop floor. Sixty-five percent of those surveyed used water hoses to wash down work areas. The second most prevalent method used, wet mopping (47%), presents a similar occurrence to that of the water hose method. Dry sweeping, an extremely hazardous procedure used by 29% of the firms surveyed, readily aerosolizes asbestos fibers into the air for workers to breathe. The use of an air hose, as reported by one business surveyed, is a violation of state law.

The method most often used by businesses surveyed to protect non-asbestos workers from those mechanics working with asbestos was handwashing. Although handwashing prevents asbestos workers from possibly ingesting asbestos fibers, it does little to protect adjacent workers in the area. More importantly and used less frequently by those studied was the use of showers, clothes changes for personnel,

segregated repair areas, entry prevention signs, and appropriate asbestos dust control measures to reduce dust in work locations.

Conclusion

Based on responses received to questions on workers' asbestos health hazard awareness, knowledge is concluded to be weak. Substantiating this conclusion was evidence that more than one-half of the respondent businesses had provided no training on asbestos awareness and control measures. Those that indicated they had provided training did not address the legal requirements of OSHA. Although methods of control had been implemented in all locations, a large percentage of the control methods employed during brake and clutch repairs and housekeeping measures were inadequate, potentially enhancing exposure of personnel. In some cases, the methods were in violation of OSHA standards. Conditions reported in this survey at a minimum could be exposing workers at the OSHA action level (0.1 fibers/cc) which triggers legal requirements for worker health hazard training (3). Available on-site, asbestos-free clutches and brakes were not preferentially utilized in all locations. In most areas, management of the businesses surveyed were not receiving training or guidance from insurance carriers, local health departments, or Tennessee OSHA on appropriate asbestos protective mea-

asures.

Barriers to workers' asbestos awareness training may exist due to costs in providing such training and the fear of interference with work schedules. Although not traditionally involved in occupational health investigations, austere state budgets may create a vacuum in worker health surveillance of small businesses that local health departments may have to fill. Such an approach is one of the service and protection objectives cited in *Healthy People 2000* by the U.S. Department of Health and Human Services (22).

In conclusion, implementation of the following recommendations by the businesses surveyed should protect the health of their employees and assist in complying with current and future legal requirements:

1. Preferentially use asbestos-free brakes, disc pads, and clutch parts;
2. Businesses should seek input from insurance carriers, local health departments, state, or federal OSHA on available guidance and training on asbestos exposure prevention;
3. Ensure that one or more of the four primary OSHA-recommended asbestos dust control procedures are used;
4. Avoid use of asbestos control methods that aerosolize asbestos dust in brake and clutch repair and cleaning operations. Do not use compressed air or broom cleaning methods, and do not allow brake drum dust to be dumped on the floor;
5. Utilize HEPA wet vacuum methods when cleaning floors;
6. If OSHA-recommended control measures are not utilized, be prepared to provide monitoring data to show lack of need for compliance; and
7. Institute administrative procedures and methods, and provide adequate facilities to prevent inadvertent exposure of non-asbestos workers to asbestos dust.

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References

1. NIOSH (1989), *Control of Asbestos Exposure During Brake Drum Service*, DHHS (NIOSH) Publication No. 89-121.
2. USDOL, OSHA (1989), Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite, Current Rule 29CFR 1910.1001. USDOL, OSHA (1990), Proposed Rules, 29 CFR 1910.1001 and 29 CFR 1926.58, *Federal Register* 55, 29712-25.
3. *Federal Register* (1990), Proposed Rules, Vol. 55, No. 140.
4. Kauppinen, T. and Korhonen (1987), Exposure to Asbestos During Brake Maintenance of Automotive Vehicles by Different Methods, *Am. Industrial Hygiene Association, J.* 48 (5), 499-504.
5. Moore, L.L. (1988), Asbestos Exposure Associated with Automotive Brake Repair in Pennsylvania, *Am. Industrial Hygiene Association, J.*, 49, A12-A13.
6. Cheng, V.K.I. and F.J. O'Kelly (1986), Asbestos Exposure in the Motor Vehicle Repair and Servicing Industry in Hong Kong, 10, 63-72.
7. Rodelsperger, K, H. Jahn, B. Brukel, J. Manke, R. Paur, and H.J. Weitowitz (1986), Asbestos Dust Exposure During Brake Repair, *Am. J. Industrial Hygiene Med.*, 10, 63-72.
8. Inoko, Masanori and Arisio Kyoko (1982), Determination of Chrysotile Fibers in Residual Dust on Road Vehicle Brake Drums, Institute of Environmental Science and Technology, Yokohama National University, Yokohama, Japan, *Environmental Pollution*, (Series B)4, 249-255.
9. Hickish, D.E. and K.L. Knight (1970) Exposure to Asbestos During Brake Maintenance, *Ann. Occupation Hygiene*, Vol. 13, pp. 17-24.
10. P.E.I. Associates, Inc. (1985), Asbestos Dust Control in Brake Maintenance, A Study.
11. Bernarde, M.A. (1990), *Asbestos the Hazardous Fiber*, CRC Press, Boca Raton, Florida.
12. Rohl, Arthur N., Arthur M. Longer, M.S. Wolff, and I. Weisman (1976), Asbestos Exposure During Brake Lining Maintenance and Repair, *Environmental Research*, 12, 110-128.
13. Lorimer, W.V., MD, A.N. Rohl, Ph.D., A. Miller, MD, W.J. Nicholson, Ph.D. and I.J. Selikoff, MD (1976), Asbestos Exposure of Brake Repair Workers in the United States, *The Mount Saint Journal of Medicine*, Vol. 43, No. 3.
14. Mossman, B.T., J.B. Gnon, M. Corn, A. Seaton, and J.B.L. Gee (1990), Asbestos: Scientific Developments and Implications for Public Policy, *Science*, Vol. 149, 247-300.
15. Garcia, J.G.N., R.F. Dodson, and K.S. Callahan (1982), Effect of Environmental Particulate on Cultured Human and Bovine Endothelium, Cellular Injury via an Oxidant-Dependent Pathway, *Laboratory Investigations*, 61, 53-61.
16. Liddel, D. and K. Miller (1991), Mineral Fibers and Health, CRC Press, Boca Raton, Florida.
17. Anderson, A.W., R.L. Gealer, R.C. McCune, and J.W. Sprys (1973), Asbestos Emissions from Brake Dynamometry Tests, *Society of Automotive Engineers*, Pub. No. 730549.
18. Williams, R.L. and J.L. Muhlbaier (1982), Asbestos Brake Emissions, *Environmental Research*, 29, 70-82.
19. *Fleet Owner* (1963), Friction Materials on Automobile Brakes.
20. Carrol, W.G. (1962), The Manufacture of Brake Linings, *British Plastics*, 414-417.
21. Maiman, L.A., M.H. Becker, J.P. Kirscht, D.P. Haefner, and R.H. Drachman (1977), Scales for Measuring Health Belief Model Dimensions: A Test of Predictive Value, Internal Consistency, and Relationships Among Beliefs, *Health Education Monograph*, Vol. 5, (3), 215-230.
22. USDHHS (1990), *Healthy People 2000*, Pub. No. (PHS) 91-50213.

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