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Barry Castleman's Brake Mechanic File

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Report of The Royal Commission on Matters of Health and Safety Arising from the Use of Asbestos in Ontario

Volume Two

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Royal Commission rept.

mid-1970s while average exposures by 1980 were generally within the 2 f/cc guideline.

Bragg noted that in open-pit mining, workers may be protected from fibre levels in excess of 2 f/cc by enclosing the work stations on the equipment that they operate.[60] He concluded that ". . . with the exception of blasting crews, enclosures costing approximately $5,000 to $10,000 per operating station would provide fibre levels at 0.1 f/cc except while entering and leaving the working area. It is expected that blasters would have to wear personal protective devices in the presence of high fibre levels." In the milling operation, it is unlikely that fibre levels can be reliably reduced below 2 f/cc. Even this level would require careful maintenance. Bragg concluded that "It is our estimation that only personal protective devices could provide fibre levels below 2 f/cc for personnel in present asbestos mills."[61] While wet-milling processes have been developed and are used elsewhere in the world, water may render the fibre unfit for the uses to which Canadian fibre is usually put. Research is ongoing in Australia trying to find ways to make this process compatible with the major uses of chrysotile asbestos.

G. Other Fixed Place Exposure

In addition to mining and manufacturing, Ontario fixed place workers may be exposed to asbestos in brake repair, in shipbuilding and repair, and in railroad equipment maintenance. The exposures that occur in these activities will be reviewed below.

G.1 Asbestos Exposure During Brake Repair

Chrysotile asbestos is widely used as a major component of automotive brakes, in both disc pads and drum linings. Depending on the type of brake, the asbestos content of the pad or lining will constitute from 25 to 65% of the total product weight. Within the last few years, cost- and performance-competitive non-asbestos substitutes have become available for disc brakes. However, while some of the major brake manufacturers have recently begun to market non-asbestos drum brake linings, they are available only in a limited number of applications. This suggests that we cannot, in the immediate future, rely on the substitution of non-asbestos materials for asbestos in brakes as the sole method of controlling the asbestos exposure received by brake mechanics, but instead must assume that many brakes will continue to contain asbestos.

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[60] Bragg, *The Technical Feasibility and Cost of Controlling Workplace Exposure to Asbestos Fibres*, pp. 84–85.

[61] Ibid., p. 85.

Table 6.11

Summary of Asbestos Dust Levels in Ontario Asbestos and Talc Mines (Fibres per Cubic Centimetre)

Year	Average		Range	% Greater than 2 f/cc
1975	Area	1.4	to 2.4	18
	Personal	3.8	to 10.1	60
1976	Area	2.9	to 45.0	37
	Personal	3.2	to 13.4	63
1977	Area	3.3	to 10.3	58
	Personal	4.9	to 16.2	83
1978	Area	1.3	to 7.2	12
	Personal	2.0	to 6.2	46
1979	Area	0.8	to 1.0	0
	Personal	2.4	to 6.3	NA
1980	Area	2.3	to 6.5	63
	Personal	1.5	to 9.2	14

SOURCE: Ontario Ministry of Labour data.

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Automotive mechanics may be exposed to brake dust during inspection, modification, removal, or installation of brake linings. However, the extent of occupational exposure to asbestos in the servicing of disc brakes is considerably less than in the servicing of drum brakes because disc brakes retain little brake wear debris and disc pads seldom require manual modification to ensure a good fit. During the inspection and installation of drum brake linings, the exposure to asbestos may result from the removal of brake wear debris from the drum and back plates. Historically, brake wear debris was most frequently removed by directing compressed air into the brake housing, to blow out the debris deposited in the drum.[62]

A substantial body of scientific literature has reported that the asbestos undergoes significant chemical and physical alteration during braking. While it is generally agreed that the high temperature experienced during braking alters the asbestos, there is still debate surrounding both the extent of this alteration and the identity and characteristics of the wear debris that is produced. For example, Jacko and DuCharme suggested that the high temperature experienced during vehicle braking caused 99.7% of the asbestos in the brake linings to be converted into inert, harmless particles.[63] Similar results were reported by Lynch; Hatch; Hickish and Knight; Anderson et al.; and Williams and Muhlbaier.[64] And, while Alste, Watson, and Bagg concluded that the major effect of braking appears to be the separation of bundles of fibres and reduction of average length without any crystal structure alteration,[65] Jacko has suggested that the wear debris collected by Alste, Watson, and Bagg may have resulted from studying brake linings with poor wear characteristics.[66]

Williams and Muhlbaier conducted 23 analyses of wear products from disc brakes and 24 from drum brakes.[67] They found that the average

[62] Barry Castleman et al., "The Hazards of Asbestos for Brake Mechanics," *Public Health Reports* 90:3 (May-June 1975): 254-256.

[63] Michael G. Jacko and Robert T. DuCharme, "Brake Emissions: Emission Measurements from Brake and Clutch Linings from Selected Mobile Sources," EPA Report 68-04-0020, NTIS PB-222-372 (Southfield, Michigan: Bendix Research Labs, March 1973).

[64] Jeremiah R. Lynch, "Brake Lining Decomposition Products," *Journal of the Air Pollution Control Association* 18 (1968): 824-826; D. Hatch, "Possible Alternatives to Asbestos as a Friction Material," *Annals of Occupational Hygiene* 13:1 (January 1970): 25-29; D.E. Hickish and K.L. Knight, "Exposure to Asbestos During Brake Maintenance," *Annals of Occupational Hygiene* 13.1 (January 1970): 17-21; A.E. Anderson et al., "Asbestos Emissions from Brake Dynamometer Tests," SAE Paper 730549 presented at Society of Automotive Engineers Meeting, Detroit, Michigan, 14-16 May 1973; and Ronald L. Williams and Jean L. Muhlbaier, "Asbestos Brake Emissions," *Environmental Research* 29 (1982): 70-82.

[65] J. Alste, D. Watson, and J. Bagg, "Airborne Asbestos in the Vicinity of a Freeway," *Atmospheric Environment* 10:8 (1976): 583-589.

[66] Michael G. Jacko, "Physical and Chemical Changes of Organic Disc Pads in Service," *Wear* 46 (1978): 163.

[67] See note 64, *supra.*

asbestos content of the wear products was 0.029%, which means that over 99.9% of the asbestos in the brake pad or shoe was transformed chemically or physically so that it was no longer an identifiable asbestos fibre. Furthermore, they found that less than 1% of all asbestos fibres observed were longer than 5 microns.

Rohl et al. analyzed the wear debris from brake drums of automobiles and found that in general only 3 to 6% by weight of the debris was recognizable asbestos, implying that 94 to 97% of the debris was some other material.[68] They further determined that such asbestos as was present in the wear debris consisted predominantly of short fibres. About 80% of the asbestos fibre in the debris was shorter than 3,750 Angstroms (0.375 microns) in length[69] so that a very small fraction, perhaps 1%, of these fibres would have been longer than 5 microns. Thus, researchers seem to be in agreement that brake wear produces debris that is 6% or less asbestos, and that less than 1% of these asbestos fibres are longer than 5 microns.

Fibre levels experienced during removal of brake wear debris and reported by various authors are summarized in Table 6.12. Most of the readings were derived from optical measurements which means that non-asbestos fibres as well as asbestos fibres were counted. Although the peak levels reported in a number of studies were high (87 f/cc), these levels were realized only intermittently and for brief durations. In contrast, the samples taken over a longer period that included these peak exposures, yielded time-weighted average fibre counts within the range of values found in other occupational exposures to asbestos in Ontario. Furthermore, since we concluded that asbestos constitutes a small fraction of the brake wear debris, it is likely that many of the reported airborne fibres were not asbestos fibres, and that the actual concentrations of asbestos fibres longer than 5 microns experienced during removal of wear debris were below the current 1 f/cc control limit, on a time-weighted average basis.

Table 6.12 also shows airborne fibre levels experienced during modification of new brake linings. Grinding and bevelling new brake linings to allow them to fit the brake drum do not subject the lining to the same high temperatures that are experienced during braking, so physical and chemical alteration of asbestos is unlikely to occur. Thus, the exposure of mechanics during grinding of brake linings resembles more closely the exposure experience of employees engaged in friction products manufacture than it does the exposure of mechanics involved in removing brake wear debris from drums, in that most fibres observed during grinding will be asbestos fibres.

[68] Arthur N. Rohl et al., "Asbestos Exposure During Brake Lining Maintenance and Repair," *Environmental Research* 12 (1976): 113.

[69] Ibid., Table 2, p. 117.

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[70] William V. Lorimer et
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[71] Letter from Mr. Arthu
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[72] See, for example, M.A.
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103:39 (1973): 1354–135
in the United States," a
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final report to the U.S.
1983. (Mimeographed.)

[73] Muriel L. Newhouse a
Following Exposure to
Medicine 22 (1965): 261
Register 1967–68," *Brit*
McDonald et al., "Epid
Cancer 26:4 (1970): 914

Table 6.12 shows that bevelling and grinding may cause considerable fibre release. For instance, Lorimer et al. reported dust levels gathered during personal samplings of short duration, analyzed by optical microscope, which ranged from 1.7 to 7.0 f/cc for grinding truck brake linings and 23.7 to 72.0 f/cc for bevelling new linings.[70] The Ontario Ministry of Labour found fibre levels ranging from less than 0.1 f/cc to 15.6 f/cc during machining of brake linings at five brake relining shops in Ontario.[71]

Considering the fibre levels reported in these activities, we believe that the mechanics who regularly grind and bevel brake linings without undertaking proper precautions may be exposed to airborne asbestos fibre concentrations that exceed either the current Ontario chrysotile short-term exposure limit or the TWA control limit, or both.

Medical studies investigating the relationship between brake repair and the incidence of pulmonary disease have consistently demonstrated a greater prevalence of abnormalities among brake repair workers than would be expected in the general population.[72] As well, Newhouse and Thompson, Greenberg and Davies, and A.D. McDonald et al. have all documented cases of mesothelioma in brake repair and automotive mechanics.[73] While it has been suggested that the pattern of disease manifested in brake repair workers parallels that of workers employed in industries with occupational exposure to asbestos, no epidemiological investigation of mortality has been conducted which would either support or refute this proposition.

There are three distinct types of brake repair facilities in Ontario. The first type encompasses the vast majority of the estimated 11,000 establishments in Ontario doing automotive work. Most of these shops are general service stations, independent garages, and franchised new car dealers that will rarely perform more than 8 to 10 brake jobs per week. None of the

[70] William V. Lorimer et al., "Asbestos Exposure of Brake Repair Workers in the United States," *The Mount Sinai Journal of Medicine* 43:3 (May-June 1976): 207-218.

[71] Letter from Mr. Arthur L. Gladstone, Senior Policy Advisor, Occupational Health and Safety Division, Ontario Ministry of Labour to the Royal Commission on Asbestos, 12 August 1981.

[72] See, for example, M.A. Boillat and M. Lob, "Risk of Asbestosis in Workers Employed in Replacing Automobile Brake Linings," *Schweizerische Medizinische Wochenschrift* 103:39 (1973): 1354-1359; Lorimer et al., "Asbestos Exposure of Brake Repair Workers in the United States," and William J. Nicholson, "Investigation of Health Hazards in Brake Lining Repair and Maintenance Workers Occupationally Exposed to Asbestos," final report to the U.S. National Institute for Occupational Safety and Health, April 1983. (Mimeographed.)

[73] Muriel L. Newhouse and Hilda Thompson, "Mesothelioma of Pleura and Peritoneum Following Exposure to Asbestos in the London Area," *British Journal of Industrial Medicine* 22 (1965): 261-269; Morris Greenberg and T.A. Lloyd Davies, "Mesothelioma Register 1967-68," *British Journal of Industrial Medicine* 31 (1974): 91-104; Alison D. McDonald et al., "Epidemiology of Primary Malignant Mesothelial Tumors in Canada," *Cancer* 26:4 (1970): 914-919.

Table 6.12

Asbestos Exposure During Brake Maintenance

Reference	Operation	Sampling Method/Location (Number)	Sample Period (Minutes)	Fibre Concentration (f/cc)	Peak/ TWA*	Comments
Hickish and Knight[a]	Blowing out dust	Area by side of car (2)	90	1.25	TWA	Four brake blowouts
		Area on dust cloud during blowing (2)	90	2.55	TWA	during time
	Brake cleaning on trucks	Personal (2 men)	450	0.68	TWA	– eight hour shift
			100	7.09	TWA	– brake work
			300	0.08	TWA	– not working on brakes
	Background	Area (AM/PM)				
	– adjacent bay		180	0.28/0.07	TWA	Brakes blown
	– 2 bays away		180	0 17/0.07	TWA	in AM but
	– garage centre		180	0.49/0 11	TWA	not in PM
Knight and Hickish[b]	Blowing dust	Personal	60	5.35		
			60	0.84		
		Personal (2)	2 secs.	87.0	Peak	During blowing
		Area samples adjacent bay	60	0.52		
			60	0.16		
Hatch[c]	Blowing dust	Area samples in dust cloud (7)	few secs.	43 ± 2.1	Peak	Hand-held pump
Lorimer et al.[d]	Blowing dust	Personal 3-5 ft. from operation (4)	2-10	6.6-29.4	Peak	
		Personal 5-10 ft. from operation (3)	2-10	2.0- 4.2	Peak	
		Personal 10-20 ft. from operation (2)	2-10	0.4- 4 8	Peak	
	Blowing dust	Background 10-75 ft. from operation (6)	few secs. - 10 mins.	0.1- 0.8	Peak	
	Grinding used truck brakes	Personal (10)	2-10	1.7- 7.0		
		Background 10-60 ft. (5)		0 2- 1.7		
	Bevelling new linings	Personal (5)		23 7-72.0		
		Background 8-30 ft. (4)		0 3- 0.6		

Table 6.12 (continued)

Asbestos Exposure During Brake Maintenance

Blowing dust	Background 10-75 ft. from operation (6)	few secs. -10 mins.	0.1- 0.8	Peak
Grinding used truck brakes	Personal (10)	2-10	1.7- 7.0	
	Background 10-60 ft (5)		0.2- 1.7	
Bevelling new linings	Personal (5)		23.7-72.0	
	Background 8-30 ft. (4)		0 3- 0 6	

Table 6.12 (continued)

Asbestos Exposure During Brake Maintenance

Reference	Operation	Sampling Method/Location (Number)	Sample Period (Minutes)	Fibre Concentration (f/cc)	Peak/ TWA*	Comments
Rohl et al.[e]	Cleaning drums with dry brush	1-3 ft. from operation (2)	3-8	1.3- 3.6	Peak	
	Background samples 3 minutes after cleaning drums with dry brush	12 ft (3)		0- 0.2		

Note. *TWA means time-weighted average.

SOURCE: [a]D.E Hickish and K L Knight, "Exposure to Asbestos During Brake Maintenance," *Annals of Occupational Hygiene* 13:1 (January 1970): 17-21

[b]K L. Knight and D.E. Hickish, "Investigations into Alternative Forms of Control for Dust Generated During the Cleaning of Brake Assemblies and Drums," *Annals of Occupational Hygiene* 13:1 (January 1970): 37-39.

[c]D. Hatch, "Possible Alternatives to Asbestos as a Friction Material," *Annals of Occupational Hygiene* 13:1 (January 1970): 25-29.

[d]William V Lorimer et al., "Asbestos Exposure of Brake Repair Workers in the United States," *The Mount Sinai Journal of Medicine* 43:3 (May-June 1976). 207-218.

[e]Arthur N. Rohl et al., "Asbestos Exposure During Brake Lining Maintenance and Repair," *Environmental Research* 12 (1976):110-128.

employees here are organized. The second type of shop is the automotive shops, frequently franchised, specializing exclusively in brake repair work, or brake repair and one or two other specialities. The majority of employees in this type of shop are also not organized. Shops of this type complete on average in excess of 50 brake jobs per week. The exposure of mechanics in these shops is greater than in the shops of the first type simply because of the higher frequency of operations. The third type of shop is the service department for the large automotive fleets. This includes the shops of major trucking companies and urban transit operators. In a large shop of this type, there may be a separate brake department where the workers deal only with brakes. It is in such shops that it is likely that a substantial volume of bevelling and grinding of new brake linings will be performed.

Brake jobs involving the installation of new brake linings in the first two types of shops will seldom require manual modification of the linings. This is because for virtually all passenger vehicles and small trucks undergoing brake repair in these shops, pre-machined linings (i.e., linings which are manufactured to conform to the exact dimensions of the brake drum) are available and only infrequently will manual modification be required to fit the relined shoe to the drum. For those operations using pre-machined linings, it would be unlikely that more than 5% of all relined brake shoes would require manual modifications to fit the drum. Thus, the major opportunity for exposure to brake dust is removed. However, there is still potential for exposure to brake wear debris in these shops.

While pre-machined brake linings are available for the larger vehicles repaired in the third type of shop, some fleet owners stock only one oversized brake lining size and alter the linings to meet the specific size requirements of the brake drums being repaired. In these shops, we would expect that a number of employees would engage continuously in grinding and bevelling of drum brake linings.

Mechanics repairing drum brakes may be protected from dust exposure in two ways. A high efficiency particulate air (HEPA) filtered vacuum may be used to remove wear debris from brakes, instead of blowing the debris out with an air hose. Alternatively, wet cleaning methods may be used either by wiping the drum and assembly with a damp cloth or by directing pressurized water or brake shoe spray into the drum. Bragg discussed the use of an inexpensive spray with a bowl to collect the contaminated liquid. Brake washer systems, including the liquid spray hose and trolley, are available for about $200.[74]

[74] Bragg, *The Technical Feasibility and Cost of Controlling Workplace Exposure to Asbestos Fibres*, p. 90.

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