Ontario

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

Volume One

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would consider using another sort of microscope if it were shown to be equally accurate.[69]

At the time this ambient air guideline was developed, the occupational exposure standard was 2 f/cc longer than 5 microns measured by the optical microscope. The work week is approximately 40 hours, while exposure to ambient air could be continuous, or 168 hours per week. Thus, to maintain the same cumulative exposure, the environmental standard would have to be less than one-fourth the workplace standard, 0.476 f/cc measured optically. Because environmental exposure is involuntary and uninformed, and may affect the infirm as well as the healthy, a lower exposure was deemed appropriate, so the exposure was divided by 10. Rounding this downward yielded the 0.04 f/cc ambient standard. However, compliance with the environmental guideline requires use of the TEM, so a measurement of 0.04 f/cc by TEM might be equivalent to approximately 0.004 f/cc measured by the optical microscope. It does not appear that this greater resolution of the TEM was considered in setting the Ontario environmental guideline, with the result that the guideline may provide an order of magnitude more protection than was contemplated. Exposures that comply with the environmental guidelines may thus be approximately 1/250 of the chrysotile exposure allowed by the recently adopted workplace control limit. However, as noted above, no single measurement methodology has been promulgated for applying this guideline. The Ministry itself uses TEM, and this of course is appropriate, while the use of optical microscope methods is completely inappropriate.

C.2 Airborne Asbestos Concentrations

Asbestos fibre concentrations in the air have been studied in locations outside Ontario. Chapter 9, Table 9.4 summarizes air monitoring data in buildings and outdoors. Sebastien's study of air quality in outdoor locations in Paris, using electron microscope techniques, found average mass concentrations of 0.96 ng/m^3, with 99% of all observations at or less than 7 ng/m^3. Sebastien did not report the fibre count. Nicholson studied ambient asbestos fibre concentrations in the outdoor air in New York City, using the TEM and a preparation technique called the "rub-out method." Eighty-three percent of Nicholson's observations were at or below 20 ng/m^3, and 96% were less than 50 ng/m^3. In Chapter 9 we estimate the optical fibre count that might be implied by these mass measurements and thereby equate Sebastien's 7 ng/m^3 to 0.0002 f/cc measured optically, while Nicholson's 20 ng/m^3 is equivalent to 0.0006 f/cc measured optically. We

[69]Telephone communication between Mr. Bruce Martin, Air Resources Branch, Ontario Ministry of the Environment and Royal Commission on Asbestos Staff, 8 July 1983.

conclude that in the outdoor air it would be quite unusual to observe more than the optical microscope equivalent of 0.001 f/cc longer than 5 microns.

Selikoff, Nicholson, and Langer found concentrations of 10 to 50 ng/m^3 of chrysotile in the air of New York City in an early study published in 1972.[70] Lanting and den Boeft used the indirect preparation method and TEM analysis to determine asbestos fibre concentrations in industrial and rural towns in Holland.[71] They found, in large industrial towns, levels of 0.5 to 2.0 ng/m^3 and in rural towns, levels of 0.1 to 0.5 ng/m^3. The fibre concentrations were higher in a tunnel carrying heavy traffic, a result the authors attributed to dust from brake linings. Bruckman and Rubino reported that ambient chrysotile asbestos levels were generally less than 10 ng/m^3 in both urban and rural locations in Connecticut.[72] However, measurements conducted near highway toll plazas indicated that levels higher than 10 ng/m^3 occurred, and it was concluded that brake lining wear was responsible.

In 1975 and 1976, the Ontario Ministry of the Environment surveyed the asbestos fibre concentrations in the air at a number of locations in the province.[73] The survey report began by stating: "This program was not designed as an air quality survey, but rather it was an attempt to acquire knowledge of the character of the sampled asbestiform fibres from various sources/sites and to get an indication of present asbestos concentrations in Ontario." Air samples were drawn through a Nuclepore filter, the filter was washed ultrasonically in water, and a portion of that water was transferred to a TEM grid for fibre counting. Any fibre with a 3 to 1 length to diameter ratio was considered to be "asbestiform." Among these asbestiform fibres, chrysotile and the amphiboles were identified by morphology, selected area electron diffraction, or energy dispersive x-ray analysis.

The 1975 survey of 7 areas, taking several samples in each area, contained no area with median sample concentrations of fibres longer than 5 microns greater than 0.01 f/cc. In fact, the median count in each area of fibres longer than 5 microns was usually zero or non-detectable. The count of fibres longer than 5 microns in any single sample, if not zero or non-detectable, ranged as high as 0.054 f/cc. The number of fibres of all lengths

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[70] Irving J. Selikoff, William J. Nicholson, and Arthur M. Langer, "Asbestos Air Pollution," *Archives of Environmental Health* 25:1 (July 1972): 1–13.

[71] R.W. Lanting and J. den Boeft, *Atmospheric Pollution by Asbestos Fibres*, Report no. G908 (Delft, Holland: Instituut voor Milieuhygiene en Gezondheidstechniek, T.N.O., 1979).

[72] Leonard Bruckman and Robert A. Rubino, "Asbestos: Rationale Behind a Proposed Air Quality Standard," *Journal of the Air Pollution Control Association* 25:12 (December 1975): 1207.

[73] Ontario, Ministry of the Environment, Air Resources Branch, "Asbestos as a Hazardous Contaminant, Progress Report II; Asbestos Ambient Air Monitoring Survey," Report no. ARB-TDA-20-76, Toronto, February 1976.

was considerably greater than the number of fibres longer than 5 microns, but still always less than 1 f/cc. The median mass measurement for each area in 1975 was generally less than 1 ng/m^3, but the highest median was 25.7 ng/m^3. The maximum reading at any location was 184 ng/m^3. It is interesting that the highest mass occurred in Timmins, a city in the heart of Northern Ontario's mining area, where it is at least conceivable that non-asbestos mining activities might cause fibres to become airborne. Kretschmar and Kretschmar have reported various asbestos deposits in the Timmins area.[74] The host rock in non-asbestos mines in the area is tuffaceous, of volcanic origin, which could raise dust that might look like asbestos fibres. Only 14% of the asbestiform fibres in the Timmins data were identified as chrysotile, raising the possibility that some of the remaining fibres, while counted as asbestiform, may have been something other than asbestos.[75]

The Ministry of the Environment's supplementary report, containing the 1976 survey results, concluded by stating:

> The fibre concentrations reported in this survey were consistently an order of magnitude smaller than comparable samples in the previous survey. This may be due to a systematic difference in the analysts' procedures, however, both programs provided internally consistent data. Since the analytical methodology was not standardized at this time, the results should be considered semi-quantitative and used for comparison purposes only. That is, those results should not be taken as a basis for air quality assessment.[76]

This illustrates the difficulties that have been encountered in measuring ambient asbestos levels. The concentration of fibres longer than 5 microns is indeed quite low, with median concentrations of zero or the detection limit in most locations. Once again, the concentration of fibres longer than 5 microns is a small fraction of the concentration of fibres of all lengths, indicating the typical predominance of small fibres in the samples.[77] Recognizing that the optical microscope cannot see thin fibres detected by the electron microscope, we could divide the count of fibres longer than 5 microns by 10, to conclude that there is very little exposure

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[74] Ulrich Kretschmar and Dianne Kretschmar, *Talc, Magnesite, and Asbestos Deposits in the Kirkland Lake - Timmins Area, Districts of Timiskaming and Cochrane,* Ontario Geological Survey Open File Report 5391 (Toronto: Ontario Ministry of Natural Resources, 1982).

[75] Ontario, Ministry of the Environment, "Asbestos as a Hazardous Contaminant, Progress Report II," Table 2, p. 26.

[76] Ibid., "Asbestos Air Monitoring Survey: Supplement to Report ARB-TDA-20-76," Report no. ARB-TDA-20S-78, Toronto, 1978, p. 4.

[77] Ibid.

greater than the optical microscope equivalent of 0.001 f/cc. However, the 1976 report discouraged the use of these figures as indicators of asbestos fibre concentrations, because of the great variation between the two sets of measurements and the undeveloped state of the measurement technology at the time. As in the 1975 survey, the mass measurements are correspondingly low, with only one median mass measurement greater than 1 ng/m^3 and the highest mass measurement equal to 36 ng/m^3.

The most recent Ontario data have been collected in a study performed by Dr. Eric J. Chatfield of the Ontario Research Foundation for this Commission.[78] The results of that study are summarized in Table 11.4. This study used the direct preparation of the sample for TEM analysis rather than the indirect method used in the 1975 and 1976 Ontario studies.

The asbestos fibre concentrations found by Chatfield in the rural area near Bracebridge, Ontario, were extremely low. In analyzing 10 samples, Chatfield found only 2 small fibres. In 8 samples, no fibres were counted. Thus, the fibre concentration was reported as less than the detection limit, or 0.0005 f/cc even in the most contaminated sample. In the city of Peterborough, only 4 fibres were found in 3 samples, yielding a maximum concentration of less than 0.001 f/cc.

The other samples were taken adjacent to an expressway ramp in downtown Toronto and in two suburban locations in Mississauga and Oakville. The greatest asbestos fibre concentrations in the study were found in the expressway ramp location, but even here the maximum concentration was only 0.0042 f/cc over 5 microns in length, and the median concentration was less than 0.0033 f/cc. Thus, the maximum concentration was only 10% of the current Ontario Ministry of the Environment Ambient Air Quality Guidelines for Asbestos. The suburban fibre concentrations were still lower.

Chatfield summarized these data as follows:

> The airborne chrysotile concentrations in all locations amounted to a few thousandths of a fibre/mL. No amphibole fibres were detected. The number of chrysotile fibres counted for each measurement was very low, and most of the values were close to the detection limits. Where large mass concentrations were detected, it was usually found that most of the mass was accounted for by one thick fibre.[79]

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[78] Eric J. Chatfield, *Measurement of Asbestos Fibre Concentrations in Ambient Atmospheres,* Royal Commission on Asbestos Study Series, no. 10 (Toronto: Royal Commission on Asbestos, 1983).

[79] Ibid., p. 75.

Table 11.4

Ontario Airborne Asbestos Concentrations*
1982

Location (No. of Samples)	Asbestos Fibre Concentration: All Lengths, Median f/cc	All Lengths, Maximum f/cc	Over 5 Microns, Median f/cc	Over 5 Microns, Maximum f/cc	Asbestos Fibre Mass, All Lengths: Median ng/m³	Asbestos Fibre Mass, All Lengths: Maximum ng/m³
Toronto (12) (Expressway Ramp)	0.0034	0.0084	<0.0033	0.0042	0.025	20
Mississauga (8) (Suburb)	<0.0009	0.004	0.0007	<0.002	0.0	0.017
Oakville (13) (Suburb)	0.001	0.0063	<0.0009	0.002	0.0012	8.81
Rural (10) (near Bracebridge)	<0.0004	<0.0005	<0.0004	<0.0005	0.0	0.0079
Peterborough (3) (Small City)	0.0018	0.0019	<0.001	<0.001	0.014	0.24

Notes: *All asbestos is chrysotile.
Fibres counted by TEM following direct preparation method.

SOURCE: The numbers in this table are derived from Dr. Chatfield's raw data. Dr. Chatfield reports confidence intervals rather than individual fibre counts. See Eric J. Chatfield, *Measurement of Asbestos Fibre Concentrations in Ambient Atmospheres,* Royal Commission on Asbestos Study Series, no. 10 (Toronto: Royal Commission on Asbestos, 1983), Tables 8, 9, 10, 11, 12, pp. 77-81.

All of the fibre counts reported in Table 11.4 were taken by electron microscope. Because the electron microscope can detect thin fibres that could not be observed under an optical microscope, the fibre concentration in Table 11.4 could be divided by 10 to approximate roughly the concentration of fibres that could be visible under an optical microscope. After dividing by 10, all concentrations of fibres longer than 5 microns would be well below the 0.001 f/cc level.

Considering all of the above data together, we conclude that asbestos fibre concentrations in the ambient air are extremely low. Counts of fibres longer than 5 microns taken by electron microscope are often less than 0.001 f/cc. If we consider the fibres that would be seen by an optical microscope, it is extremely rare in Ontario to have concentrations greater than 0.001 f/cc. The recent Ontario data suggest that fibre levels are lowest where population density is lowest, although the earlier Ontario data did not reveal this relationship. In Chapter 9 we conclude that the health risks presented to building occupants from exposure to 0.001 optically visible fibres per cubic centimetre is not significant. It follows that the fibre levels discussed in this section present a clearly insignificant health risk. We see no reason to worry about the health effects of the prevalent level of asbestos fibres in the outdoor air in Ontario.

Our conclusion that ambient asbestos fibre concentrations present no health risk is supported by at least one study of persons exposed to ambient asbestos, but not exposed occupationally. Siemiatycki studied the health of female residents of two Quebec asbestos mining towns who were not employed in the mines, but were regularly exposed to more than 1,000 ng/m^3 of asbestos in the air of the town, perhaps two orders of magnitude greater than the ambient concentration in Ontario. This may be considered as the equivalent of 0.03 f/cc measured optically. (See Chapter 9, Section C.) No significant excess of respiratory cancer was detected among these women.[80]

The 1980 *Report of the Working Group on Air Quality in the Toronto Subway System* found asbestos concentrations in the air of the subway system, measured by TEM, ranging from levels below 0.002 f/cc to 0.3 f/cc.[81] This study indicated that the Ministry of the Environment air quality guideline of 0.04 f/cc was exceeded in 13 out of 52 cases. This comparison

[80] Jack Siemiatycki, "Health Effects on the General Population (Mortality in the General Population in Asbestos Mining Areas)," in *Proceedings of the World Symposium on Asbestos*, Montreal, Quebec: 25-27 May 1982 (Montreal, P.Q.: Canadian Asbestos Information Centre [1983]), p. 342.

[81] Ontario, Ministry of the Environment, Ministry of Labour, and Toronto Transit Commission, *The Report of the Working Group on Air Quality in the Toronto Subway System*, Report ARB-TDA-12-80 (Toronto: Ontario Ministry of the Environment, March 1980), p. 31.

seems to misuse the air quality guideline which was derived assuming exposure for 24 hours per day, 7 days per week. Subway patrons would rarely be exposed more than one hour per day. Operators would rarely be exposed more than 40 hours per week. In a follow-up study, undertaken after asbestos brake linings on the subway cars were replaced with non-asbestos substitutes, the Ontario Research Foundation found that none of the samples taken exceeded the Ministry of the Environment standard.[82] Chatfield reported some of the follow-up data in one of his studies for this Commission.[83]

The widespread occurrence of very low concentrations of asbestos fibres in the ambient air is confirmed by studies looking for asbestos fibres caught in human lung tissue. Uncoated asbestos fibres and asbestos bodies, which are fibres coated with iron and protein, have been discovered in the lungs of urban and rural dwellers who have not been occupationally or para-occupationally exposed to asbestos. For instance, Churg and Warnock discovered uncoated asbestos fibres and asbestos bodies in the lungs of 21 randomly selected subjects of routine autopsies who had fewer than 100 asbestos bodies per gram of lung.[84] They confirmed the lack of occupational exposure in 20 out of these 21 urban residents. This led them to associate this concentration of asbestos fibres and bodies with environmental exposure to asbestos. Using a variety of techniques, Churg and Warnock further identified that 80% of the fibres were chrysotile and the remainder amphiboles. The majority of both types of fibres were less than 5 microns long. This confirms that most residents of urban areas do inhale and retain some asbestos fibres as a matter of course.

C.3 Sources of Airborne Asbestos Fibres

A number of sources may be responsible for emitting asbestos into the ambient air. Asbestos may be introduced into the air by natural mechanisms, such as wind erosion of asbestos-bearing rock and soil. In Ontario, there are natural outcroppings of asbestos, but they are in regions which are not densely populated and are not intensely farmed. Natural contamination in Ontario would constitute at most a very minor source of fibre release in rural environments and a negligible source of release in major

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[82]Ontario, Ministry of the Environment, Ministry of Labour, and Toronto Transit Commission, *The 1980 Follow-Up Report on Air Quality in the Toronto Subway System*, Report ARB-TDA-63-80 (Toronto: Ontario Ministry of the Environment, December 1980), Table 4.1, pp. 11–12.

[83]Chatfield, *Measurement of Asbestos Fibre Concentrations in Ambient Atmospheres*, Table 17, p. 94.

[84]Andrew M. Churg and Martha L. Warnock, "Numbers of Asbestos Bodies in Urban Patients with Lung Cancer and Gastrointestinal Cancer and in Matched Controls," *Chest* 76 (2 August 1979): 143–149.