TEM AIRBORNE
ASBESTOS MEASUREMENTS

UNIVERSITY OF MANITOBA
GRITTY GROTTO – FRANK KENNEDY CENTRE
WINNIPEG, MANITOBA

Prepared for:

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Attention: Mr. Paul Houle

Pinchin Project Number: 40020.123

February 28, 2008
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APPENDIX I  Detailed Laboratory Results
1. INTRODUCTION

Pinchin Environmental Ltd. (Pinchin) was retained by the University of Manitoba (Client) to take measurements of airborne asbestos levels within the Gritty Grotto of the Frank Kennedy Centre, located on the Fort Gary Campus of the University of Manitoba, Winnipeg, Manitoba.

The following sections of this report describe the collection and analysis of three air samples taken at locations determined by Mr. Paul Houle of the Client’s Environmental Health and Safety Office.

2. SAMPLING AND ANALYTICAL PROCEDURE

The sample locations were selected by Mr. Houle of the Client’s Environmental Health and Safety Office, within the Gritty Grotto of the Frank Kennedy Centre.

The following is a list of the sample locations:

<table>
<thead>
<tr>
<th>Location</th>
<th>Sample No.</th>
<th>Date Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treadmill Area, West, Adjacent to Track</td>
<td>GG-001</td>
<td>February 14, 2008</td>
</tr>
<tr>
<td>Weight Room Area, Centre</td>
<td>GG-002</td>
<td>February 14, 2008</td>
</tr>
<tr>
<td>Archery Area, Northeast, Adjacent to Track</td>
<td>GG-003</td>
<td>February 14, 2008</td>
</tr>
</tbody>
</table>

Sampling was conducted by Mr. Jason Combe and Mr. Roberito Fajardo of Pinchin on February 14, 2008 between 09:30 and 17:30 hrs. Building occupants were present during the sampling period and building air handling systems remained operational.

Each sample was collected by drawing a predetermined volume of air through a mixed cellulose ester (MCE) filter having a pore size of 0.45 μm and an effective collection area of 380 mm². The filter, backed by a 5.0 μm pore-size MCE diffuser filter and cellulose support pad, was held in a 25 mm three-piece conductive cassette with a 50 mm extension cowl. Diaphragm vacuum pumps fitted with needle valves for flow control were used in sample collection. The pumps were calibrated using a primary standard before use. The samples were taken open-faced at heights representative of occupant breathing zones (approximately 4.5 feet to 7 feet).
The samples were analyzed by Transmission Electron Microscopy (TEM) at EMSL Analytical Inc. Laboratories, Williamsville, N.Y. according to the EPA Level II Procedure (formerly Yamate Level II procedure, US EPA Contract 69-02-3266, Draft Report dated July 1984). According to the method, a section of each filter is carbon coated, the filter is dissolved away and the carbon film, embedded with the collected particles, is directly transferred to a 200-mesh grid. The grid is then scanned under a Transmission Electron Microscope at approximately 20,000 times magnification. Fibrous particles (structures) meeting specified size criteria are classified as individual fibres, fibre bundles, clusters or matrices. Asbestos structures are sized and identified as Chrysotile or Amphibole (Amosite/Grunerite, Crocidolite, Actinolite/Tremolite, and/or Anthophyllite) by a combination of morphology (shape and appearance), selected area electron diffraction (SAED, crystallographic structure) and energy dispersive x-ray analysis (EDXA, elemental composition). A total of 100 structures must be counted or 10 grid openings scanned, whichever is first. The analytical sensitivity is determined by the volume of the sample and the number of grid openings observed. The Limit of Detection for this method has been determined to be one confirmed asbestos structure in the total number of grid openings analyzed.

The results are presented by asbestos type and structure (fibre) length, i.e. structures less than 5 micrometers long (<5 µm) and structures with a length greater than or equal to 5 micrometers (≥5 µm). The total number of structures of all asbestos types present is given for each length category and the total concentration of all asbestos types of all lengths is also given. The calculated concentration of asbestos present is dependent upon the number of structures counted, the area of the filter analyzed, the effective collection area of the filter and the volume of air drawn through the filter. If no asbestos structures are identified in the sample, the result is reported as being less than the Limit of Detection.

3. DISCUSSION OF AIR SAMPLING FOR ASBESTOS BY TRANSMISSION ELECTRON MICROSCOPE (TEM)

In order to interpret the results of the air monitoring, it is necessary to discuss the general meaning and use of air sampling. The following discussion will reference various Manitoba, Ontario and United States guidelines or standards. No standards or guidelines based on TEM monitoring have been published by Health and Welfare Canada or other Canadian provinces. In addition, some published research information is used for comparison.
For control of airborne asbestos fibre concentrations in workplaces where asbestos is in use, both Manitoba and Ontario currently applies a time-weighted average exposure limit of 0.1 fibre/mL (fibres longer than 5 µm) for all asbestos types. The specified measurement technique is phase contrast optical microscopy (PCM). In this technique, all particles are reported which are visible in phase contrast illumination at a magnification of 450, are longer than 5 µm, are less than 3 µm in width, and which have a length to width (aspect) ratio equal to or greater than 3 to 1. There is no provision for identification of specific mineral particles.

All fibres, whether asbestos, cellulose, fibreglass, etc. are included in the results. Under the conditions of this examination, the instrumental resolution is inadequate to allow detection of fibres having widths less than about 0.25 µm; particles longer than 5 µm will be included only if their widths are greater than this width. The detection limit varies with the sampling volume. However, the practical lower limit of quantitation is 0.01-0.03 fibres per millilitre (mL), due to the common presence of other fibrous dusts at these levels. Given these limitations, this measurement technique is generally applied only where most airborne fibres are likely to be asbestos, such as in the asbestos industry or inside or immediately adjacent to asbestos abatement operations.

In both Manitoba and Ontario all existing legislation and environmental guidelines concerning permissible airborne asbestos fibre concentrations are expressed in terms of those fibres having lengths exceeding 5 µm. There is a general, although not universal, agreement that shorter fibres pose a lower hazard to health than long fibres. As stated by the Ontario Royal Commission on Asbestos¹ (Page 8 Chapter 1, Section B; Health Effects of Asbestos):

“3. The asbestos fibres which are most likely to cause adverse health effects when inhaled are long and thin. “Length” and “diameter” are, of course, relative phenomena: fibres are measured in microns, one micron being one-millionth of a metre. The hazardous asbestos fibres are those which would be longer than 5, perhaps longer than 8 microns, and thinner than 1.5 or perhaps 0.25 microns.”

In the general environment, when airborne asbestos fibres are present, they are usually too small in diameter to be detected by phase contrast microscopy. In addition, in areas where asbestos is not the principal source of airborne dust, the concentration of airborne asbestos fibres is not necessarily correlated with the total fibre concentration.

Particles or aggregates of particles can appear to be fibres when viewed under the conditions of the PCM examination. Conversely, features, which appear in PCM to be non-fibrous particles, may actually be closely associated groups of fibres. In these circumstances it is not possible to predict the airborne asbestos level from the result of a measurement made by PCM. For measurement of asbestos fibre concentrations in the outside atmosphere, to which the general public may be exposed continuously, the Ontario Ministry of the Environment (MOE) suggested a “guideline” of 0.04 fibre/mL (fibres longer than 5 µm) measured by TEM in the 1980s. Therefore, only asbestos fibres are reported.

In addition, the instrumental resolution is adequate to allow detection of even the very fine asbestos fibres. The origin or justification of this level has not been published for peer review. Although this guideline has never been withdrawn, more recent testing indicates that it is significantly higher than actually measured in ambient (outdoor) air. The Province of Manitoba has never undertaken such a review nor have they established a control limit based on TEM test sampling.

Guidelines have not yet been established specifically for asbestos air quality in general occupancy buildings. The most thorough literature review of TEM air monitoring of buildings containing Asbestos Containing Material (ACM) was published in 1991 by the Health Effects Institute2. Based on the results of monitoring of 198 buildings containing ACM, their report stated that the concentration of airborne asbestos fibres (longer than 5 µm) ranged from 0.00004 to 0.00243 f/mL with a mean concentration of 0.00027 f/mL and a 95% percentile of 0.0014 f/mL. Based on this, it is clear that the existence of airborne fibres longer than 5 µm, even in a building with ACM, is relatively uncommon. It should be noted however that low levels of short (<5 µm) Chrysotile fibres are commonly found in both ambient air and in buildings with and without ACM. Although no study has provided an average for short fibres (as was provided by the HEI for fibres >5µm) it is quite common to detect up to 3 fibres of Chrysotile asbestos in the TEM counting area of a typical air sample (with a volume collected in the order of 2000-2400 litres). Amosite or Crocidolite asbestos are not normally detected in ambient (outdoor) or building air.

In October 1987, the U.S. Environmental Protection Agency published Asbestos-Containing Materials in Schools; Final Rule and Notice. This rule is a result of the Asbestos Hazard Emergency Response Act (AHERA). Included in this rule is the requirement for post asbestos-removal (clearance) air monitoring using aggressive air sampling, and analysis of the air samples by TEM for the presence of asbestos. Asbestos is identified using morphology, SAED and EDXA, and asbestos, which is longer than 0.5 µm and has an aspect ratio of 5:1 or greater is included in the results. If the average airborne asbestos concentration based on 5 samples inside the work area is higher than the equivalent of 0.02 fibre/mL, the inside airborne asbestos level must be shown to be less than the outside value.

If the indoor air is shown to have a higher fibre concentration than the outside, the area is considered unacceptable for re-occupancy. Since asbestos fibres of all lengths are included, the airborne asbestos concentration of 0.02 fibre/mL is considerably more stringent than that suggested in both Manitoba and Ontario workplaces. It must be stressed that the AHERA method has been designed only for the clearance of asbestos removal sites where the presence of airborne asbestos is an indication of the lack of acceptable cleaning.

Based on all of the above studies and guidelines, it is reasonable to conclude that the asbestos content of air in a building should be considered to be elevated only when:

- the average concentration of fibres >5µm exceeds 0.0014 f/mL (the 95th percentile of the HEI reported result); or

- more than 3 fibres (all lengths) are detected in the 10 fields analysed of a TEM sample (2000-2400 L); or

- asbestos fibres other than Chrysotile are detected in the sample.

These criteria will be used to evaluate the air samples collected. It should be noted that even if concentrations exceed these criteria they do not automatically imply an actual health risk to occupants – merely an elevated level of airborne asbestos at the time of sampling.
4. RESULTS AND DISCUSSION

The three indoor samples were collected in typical areas of the building during normal building use and occupation. The results presented in Appendix I show that no asbestos fibres of any length were found in any of the samples collected.

Based on the results of this monitoring, the airborne concentration of asbestos in all the locations from which samples were collected is not considered elevated over normal ambient (outdoor) levels of asbestos fibre. While the result reported is representative only of the time of sample collection, it has been our experience that this result is typical and repeatable, even in buildings with friable asbestos.

I trust the above information is satisfactory. Should you have any additional questions, please call.

Pinchin Environmental Ltd.

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Reviewed by:

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Per: Edwin Wooster
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APPENDIX I

DETAILED LABORATORY RESULTS
Asbestos Fiber Analysis by Transmission Electron Microscopy (TEM), Selected Area Electron Diffraction (SAED), and Energy Dispersive X-Ray Microanalysis (EDX) - Performed by EPA Level II Method.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Volume (liters)</th>
<th>Asbestos Type(s)</th>
<th># Structures</th>
<th>Analytical Sensitivity (S/cc)</th>
<th>Concentration</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>GG-001</td>
<td>4032</td>
<td>None Detected</td>
<td>2</td>
<td>0.0015</td>
<td>&lt;16.00</td>
<td>&lt;0.0015</td>
</tr>
<tr>
<td></td>
<td>140800638-0001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GG-002</td>
<td>4032</td>
<td>None Detected</td>
<td>1</td>
<td>0.0015</td>
<td>&lt;16.00</td>
<td>&lt;0.0015</td>
</tr>
<tr>
<td></td>
<td>140800638-0002</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>GG-003</td>
<td>4032</td>
<td>None Detected</td>
<td>5</td>
<td>0.0015</td>
<td>&lt;16.00</td>
<td>&lt;0.0015</td>
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<tr>
<td></td>
<td>140800638-0003</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analyst(s)

Rhonda McGee (3)

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