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TURNER BROTHERS ASBESTOS CO. LTD.



P O BOX NO 40
ROCHDALE
ENGLAND

DATE: 21/4/72

21st April, 1972.

Mr. P. P. Sweeney,
Asbestos Information Association/
North America,
77 East 40th Street,
New York,
New York 10016,
U.S.A.

Dear Matt,

It was nice to talk with you on the telephone last week.

I have not been able to find out whether Mr. Laxon is due to pay another visit to the States, but we think not, and I have heard nothing regarding a further approach to me.

In regard to your request for information on sampling errors, I enclose a copy of a report compiled for me by my Senior Assistant, who is probably the most experienced dust counter in the U.K. I hope you find it helpful.

I am off to Sweden on Sunday.

With kind regards,

Yours sincerely,

A handwritten signature in ink, appearing to be "S. Holmes".
S. Holmes

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2. Sample Collection and Reduction Errors

The volume (V) of the air sample is usually determined by a "flowmeter" type flowmeter. These instruments are rated as having an accuracy of $\pm 5\%$ of the full scale, but it is considered that the practical limitation in measuring the level of the fluid adds significantly to this error, e.g., 2 l/min can only be calibrated to within ± 0.05 l/min ($\pm 2.5\%$). No error is assumed for the measurement of sample periods.

There is also a small error associated with the measurement of the microscope "field of view" used for the calculation of results. The diameter of the dust & count (d & f) circle, after counting the air-do, can be measured (using the stage micrometer) to the nearest 0.2 mm, i.e., ± 0.1 mm ($\pm 0.5\%$). Similarly the error in measuring the diameter of the microscope field of view (d & f) with a suitable stage micrometer is $\pm 1 \mu\text{m}$ ($\pm 0.4\%$).

There should be no error in recording the number of fields counted (n) and therefore the above errors are as shown in the formula used for the evaluation of the asbestos fibre concentrations:

$$\begin{aligned} \text{Dust Concentration (f/ml)} &= \frac{V^2}{d^2} \times \frac{1}{V} \times \frac{n}{n} \\ \text{Errors associated with above formula} &= \frac{\pm 0.5\%}{\pm 0.4\%} \times \frac{1}{3.5\%} \times \frac{\pm 0.5\%}{1} \\ &= \pm 5.2\% \times \pm 0.5\% \end{aligned}$$

where C is the theoretical error associated with the fibre count (n)

Assuming even samples, C = 13.5% when n = 200 fibres

$$\therefore \text{Total Error} = \pm 14.5\%$$

and C = 12.6% for n = 100 fibres

$$\therefore \text{Total Error} = \pm 13.5\%$$

This level of error is considered acceptable, as it is relatively small compared with the probable variations of dust levels inherent at most production processes. For example results for 10 minute tests may fluctuate from $\pm 20\%$ to $\pm 40\%$ of the mean dust level. The actual total errors are found to be a little higher than the theoretical errors calculated above (see section 1).

3. Errors Due to Contamination of Samples

A further source of error, that can be significant in the measurement of asbestos dust levels ± 2 f/ml, is contamination of the membrane filter samples. Most "control" filters prepared by the standard procedure (Technical Note 1) are frequently counted at 700 and the "background" fibre contamination varies from 1 to 20 fibres per 100 fields of view. Adding the random contribution and a sample volume of 1000 ml, there would be a further error of 20% associated with the calculated level of 2 f/ml (60 with 1 f/ml, pre-rata), using the TAI set-up and counting 100 fields.

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To: Dr. L. Holmes

21st April 1972

The errors associated with the use of asbestos filter counts
for the estimation of asbestos fibre levels

1. Errors associated with the definition of asbestos fibres

Fibre counts may be affected by:-

- a) Sample preparation.
- b) Microscopic conditions.
- c) Different interpretations of asbestos fibres and their configurations.
- d) Estimation of 5 μ m length.
- e) Bias in the selection of fields to be counted.
- f) Visual acuity of observer.
- g) Statistical errors associated with counting.

Only (g) can be calculated. Work at ICI has indicated that random samples, prepared by the method described in the revised (September 1971) Technical Note 1, produce Count deposited according to the Roesser law. Statistical analysis has shown that, if 200 fibres are counted, the statistical error (95% confidence limits) is $\pm 13.5\%$. Well prepared samples (a) however, significantly increase this error.

In 1969 an initial comparison of asbestos filter counts, carried out amongst the 3 major companies in the UK, indicated differences of up to 60%, 50% being quite common. These differences were very significant, as they are related to the geometry of the highest count, i.e. the 60% difference was for counts of 1.7 and 9.6 f/ml. Experiments indicated that (b) the microscopes were not the cause of the differences, all 3 microscopes being set up properly for phase contrast illumination. Acceptable agreement was arrived at only after close personal liaison between the "chief-counters" from each company. Once counting conventions to cover (c) and (d) had been mutually agreed upon, the majority of test counts were within 2% of one another. The order of error is that recognized in the laboratories at ICI.

Bias in the selection of fields of view (e) is probably included in the above error. Random sampling is seldom achieved when left to personal choice, but the multi-stage sampling technique recommended in Technical Note 1 helps to reduce this bias.

We have also found that fibre counting is dependent upon the visual acuity of the microscopist (f). This is particularly critical when counting fibres of diameter close to the wavelength of illumination and therefore the resolution of the microscope (i.e. asbestos fibres).

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This error can obviously be reduced by taking precautions when preparing the reference samples and increasing the sample volume. If the contamination can be eliminated and relatively high volume collected (≈ 100 l), asbestos dust levels down to 0.01 f/dl may be measured using the membrane filter method.

J. H. Jones

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Health Physics Department,
T.B.A. Co. Ltd.

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