# Scanning Electron Microscopy Scheme

## BACKGROUND

This Interim Report covers the 6(2) round of the SEMS asbestos fibre counting PT scheme. The scheme is operated by HSL, in collaboration with APC, Germany and TNO, Netherlands.

## SAMPLES

Four samples were circulated representing a range of different fibre densities and fibre types. All samples were produced at HSL using the modified sputnik multi-port sampling instrument.

## INTRODUCTION

A total of 6 laboratories participated in this round (including the validating laboratories). Laboratories were able to submit up to three results per sample and many laboratories took advantage of this with a total of 48 results submitted. The laboratory performance for Round 6(2) was assessed by combining the data from this round with the data from Round 6. The same samples were used in both rounds.

The samples were as follows:

6SEM1 – Medium – high density (<50 fibres $mm^{-2}$) - chrysotile asbestos fibres

6SEM2 – Medium (<30 fibres $mm^{-2}$) - amosite asbestos fibres

6SEM3 – High density (<70 fibres $mm^{-2}$) – crocidolite asbestos fibres

6SEM4 – Very low density (<10 fibres $mm^{-2}$) – no asbestos fibres

## INFORMATION SUBMITTED BY LABORATORIES

Laboratories were asked to supply:

- The number of fibres >5µm long counted (amphibole, chrysotile and other inorganic)
- The number of fields of view searched
- The area of the field of view
- The magnification and the method used

Laboratories were asked to calculate the fibre density (in fibres $mm^{-2}$) for each fibre type identified.  There was also an option to include the number of fibres ≤5µm in length.

**LABORATORY ASSESSMENT**

**RESULTS**

**Calculations –** No errors were identified in this round.

**Screen area** – The fibre densities submitted by laboratories have not been recalculated and the density calculation and therefore screen area has not been verified.

**Magnification** – As was the case in earlier rounds, some laboratories used an operating magnification outside the range defined in ISO 14966 (or VDI 3492).

Magnifications of 2650x, 2100x and 2000x were recorded.

Results for total asbestos fibre densities for each laboratory are summarised in Appendix 1.


**Data Analysis**
Data analysis is based upon the total asbestos fibre densities (amphibole & chrysotile) derived from fibre numbers counted and the area of the filter searched. The distribution of fibres on a filter derived from airborne sampling is normally described as being Poisson-distributed.  For Poisson-distributed counts, the variance (standard deviation squared) is equal to the mean. However, in practice the variation may be larger due to differences in sample production, laboratories and individual microscopists.  A comparison of the observed standard deviations with the expected standard deviations (expected under Poisson distribution) show that the observed variation is larger than that expected, and it is difficult to quantify how much of this may be due to differences in sample production, and how much is due to differences between labs/microscopists.

The laboratory performance for Round 6(2) was assessed by combining the data from this round with the data from Round 6. The same samples were used in both rounds.

For this Interim Report, the data have been compared against the criteria used in the UK phase contrast fibre counting proficiency testing scheme RICE. Details of the analysis used can be found in Appendix 2.

# APPENDIX 1

## Sample 1 (6SEM1) - Total asbestos fibre density (fmm$^{-2}$)

| Lab Number | Total Asbestos | RICE |
|---|---|---|
| 300 | 60.0 | B |
| 1458 | 35.6 | A |
| 1458 | 41.3 | A |
| 1562 | 58.4 | A |
| 1562 | 61.4 | B |
| 1562 | 62.9 | B |
| 1884 | 19.0 | A |
| 1884 | 21.0 | A |
| 1884 | 70.0 | B |
| 1894 | 6.0 | C |
| 1960 | 117.0 | C |
| 1960 | 138.9 | C |
| * | 32.5 | |
| * | 41.5 | |
| * | 32.8 | |
| * | 120.5 | |
| * | 40.5 | |
| * | 44.0 | |
| * | 24.5 | |
| * | 42.0 | |
| * | 64.0 | |
| * | 65.0 | |
| * | 21.1 | |
| * | 25.8 | |
| * | 30.7 | |
| * | 34.5 | |
| * | 38.5 | |
| * | 49.2 | |
| * | 23.0 | |
| * | 23.5 | |
| * | 23.8 | |
| * | 29.7 | |
| * | 35.8 | |
| * | 41.0 | |
| * | 54.6 | |
| * | 21.8 | |
| * | 26.5 | |
| * | 4.0 | |
| * | 32.0 | |
| * | 35.6 | |
| * | 36.8 | |
| * | 38.8 | |
| * | 15.2 | |
| * | 31.3 | |
| * | 34.4 | |
| * | 37.5 | |

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| | |
|---|---|
| * | 0.0 |
| * | 34.0 |
| * | 18.4 |
| * | 35.0 |
| * | 11.0 |
| * | 12.5 |
| * | 13.5 |
| * | 65.0 |
| * | 24.5 |
| * | 36.5 |
| * | 37.0 |
| * | 37.0 |
| * | 23.0 |
| * | 28.6 |
| * | 29.4 |
| * | 0.7 |
| * | 4.1 |
| * | 4.8 |
| * | 13.0 |
| * | 32.0 |
| * | 33.0 |
| * | 52.0 |
| * | 12.1 |
| * | 25.8 |
| * | 7.5 |
| * | 14.0 |
| * | 12.0 |
| * | 22.9 |
| * | 39.9 |
| * | 36.0 |
| * | 27.9 |
| * | 51.6 |
| * | 81.5 |
| * | 90.8 |
| * | 34.0 |
| * | 30.0 |
| * | 42.0 |

* Round 6 Data

| | |
|---|---|
| Mean | 36.3 |
| **Median (Ref)** | **33.0** |
| STDev | 25.0 |
| Min | 0.0 |
| Max | 138.9 |

| RICE A (Lower) | RICE A (Upper) | RICE B (Lower) | RICE B (Upper) | RICE C (Lower) | RICE C (Upper) |
|---|---|---|---|---|---|
| 17.4 | 59.4 | 11.6 | 81.8 | <11.6 | >81.8 |

## Sample 2 (6SEM2) - Total asbestos fibre density (fmm$^{-2}$)

| Lab Number | Total Asbestos | RICE |
|---|---|---|
| 300 | 23.0 | A |
| 1458 | 24.5 | A |
| 1458 | 27.4 | A |
| 1562 | 18.6 | A |
| 1562 | 20.2 | A |
| 1562 | 22.8 | A |
| 1884 | 13.0 | A |
| 1884 | 17.0 | A |
| 1884 | 22.0 | A |
| 1894 | 27.0 | A |
| 1960 | 39.8 | A |
| 1960 | 51.8 | B |
| * | 26.0 | |
| * | 30.0 | |
| * | 29.2 | |
| * | 33.3 | |
| * | 43.5 | |
| * | 38.0 | |
| * | 27.2 | |
| * | 29.0 | |
| * | 36.0 | |
| * | 17.0 | |
| * | 17.2 | |
| * | 18.3 | |
| * | 22.5 | |
| * | 27.0 | |
| * | 25.5 | |
| * | 41.0 | |
| * | 19.5 | |
| * | 22.5 | |
| * | 26.9 | |
| * | 32.0 | |
| * | 39.1 | |
| * | 29.0 | |
| * | 32.2 | |
| * | 22.8 | |
| * | 21.6 | |
| * | 26.0 | |
| * | 25.0 | |
| * | 19.0 | |
| * | 19.3 | |
| * | 20.5 | |
| * | 23.8 | |
| * | 28.6 | |
| * | 29.9 | |
| * | 32.6 | |

# APPENDIX 1

| | |
|---|---|
| * | 19.2 |
| * | 12.0 |
| * | 14.9 |
| * | 29.0 |
| * | 11.0 |
| * | 13.0 |
| * | 14.0 |
| * | 32.0 |
| * | 15.6 |
| * | 28.0 |
| * | 30.0 |
| * | 27.0 |
| * | 20.6 |
| * | 31.0 |
| * | 31.8 |
| * | 9.6 |
| * | 13.7 |
| * | 18.5 |
| * | 20.0 |
| * | 19.0 |
| * | 26.0 |
| * | 27.0 |
| * | 29.9 |
| * | 32.2 |
| * | 29.4 |
| * | 41.8 |
| * | 23.0 |
| * | 28.2 |
| * | 30.3 |
| * | 25.0 |
| * | 20.1 |
| * | 34.1 |
| * | 52.6 |
| * | 52.6 |
| * | 23.0 |
| * | 25.0 |
| * | 37.0 |

* Round 6 Data

| | |
|---|---|
| Mean | 26.3 |
| **Median (Ref)** | 26.0 |
| STDev | 9.0 |
| Min | 9.6 |
| Max | 52.6 |

| RICE A (Lower) | RICE A (Upper) | RICE B (Lower) | RICE B (Upper) | RICE C (Lower) | RICE C (Upper) |
|---|---|---|---|---|---|
| 12.5 | 49.8 | 7.6 | 70.5 | <7.6 | >70.5 |

# APPENDIX 1

## Sample 3 (6SEM3) - Total asbestos fibre density (fmm$^{-2}$)

| Lab Number | Total Asbestos | RICE |
|---|---|---|
| 300 | 75.0 | A |
| 1458 | 70.2 | A |
| 1458 | 82.7 | A |
| 1562 | 74.9 | A |
| 1562 | 79.0 | A |
| 1562 | 92.3 | A |
| 1884 | 41.0 | B |
| 1884 | 45.0 | B |
| 1884 | 57.0 | A |
| 1894 | 27.0 | C |
| 1960 | 160.3 | C |
| 1960 | 167.2 | C |
| * | 70.0 | |
| * | 81.0 | |
| * | 53.9 | |
| * | 103.1 | |
| * | 90.0 | |
| * | 60.0 | |
| * | 64.1 | |
| * | 66.0 | |
| * | 94.0 | |
| * | 85.0 | |
| * | 108.0 | |
| * | 35.7 | |
| * | 50.3 | |
| * | 52.7 | |
| * | 58.0 | |
| * | 64.5 | |
| * | 76.2 | |
| * | 23.5 | |
| * | 28.0 | |
| * | 58.5 | |
| * | 102.0 | |
| * | 104.0 | |
| * | 102.0 | |
| * | 73.6 | |
| * | 53.5 | |
| * | 63.8 | |
| * | 42.5 | |
| * | 59.0 | |
| * | 76.1 | |
| * | 78.5 | |
| * | 84.8 | |
| * | 63.8 | |
| * | 76.8 | |
| * | 92.4 | |

| | |
|---|---|
| * | 128.6 |
| * | 60.8 |
| * | 66.0 |
| * | 46.1 |
| * | 58.0 |
| * | 40.0 |
| * | 41.0 |
| * | 45.0 |
| * | 93.0 |
| * | 42.9 |
| * | 58.5 |
| * | 60.0 |
| * | 74.0 |
| * | 63.5 |
| * | 65.1 |
| * | 71.5 |
| * | 75.5 |
| * | 78.2 |
| * | 94.0 |
| * | 61.0 |
| * | 82.0 |
| * | 83.0 |
| * | 88.0 |
| * | 55.7 |
| * | 59.3 |
| * | 42.8 |
| * | 47.8 |
| * | 55.0 |
| * | 85.6 |
| * | 86.7 |
| * | 71.5 |
| * | 71.3 |
| * | 114.6 |
| * | 157.9 |
| * | 164.1 |
| * | 118.0 |
| * | 60.0 |
| * | 75.0 |
| * Round 6 Data | |
| Mean | 73.9 |
| **Median (Ref)** | 70.8 |
| STDev | 28.9 |
| Min | 23.5 |
| Max | 167.2 |

| RICE A (Lower) | RICE A (Upper) | RICE B (Lower) | RICE B (Upper) | RICE C (Lower) | RICE C (Upper) |
|---|---|---|---|---|---|
| 46.0 | 109.7 | 35.4 | 141.6 | <35.4 | >141.6 |

## Sample 4 (6EM4) - Total asbestos fibre density (fmm$^{-2}$)

| Lab Number | Total Asbestos | RICE |
|---|---|---|
| 300 | 0 | A |
| 1458 | 0 | A |
| 1458 | 0 | A |
| 1562 | 0 | A |
| 1562 | 0 | A |
| 1562 | 0 | A |
| 1884 | 0 | A |
| 1884 | 0 | A |
| 1884 | 0 | A |
| 1894 | 0 | A |
| 1960 | 0 | A |
| 1960 | 0 | A |
| * | 0 | |
| * | 0 | |
| * | 0 | |
| * | 0 | |
| * | 0 | |
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# APPENDIX 1

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| * | 0 |
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| | |
|---|---|
| * Round 6 Data | |
| Mean | 0.0 |
| **Median (Ref)** | 0.0 |
| STDev | 0.3 |
| Min | 0.0 |
| Max | 2.0 |

| RICE A (Lower) | RICE A (Upper) | RICE B (Lower) | RICE B (Upper) | RICE C (Lower) | RICE C (Upper) |
|---|---|---|---|---|---|
| | 3.8 | | 10.9 | | >10.9 |

# APPENDIX 2

## DATA ANALYSIS – METHOD 1

## Regular Inter-laboratory Counting Exchange (RICE) Criteria

Where **R** is the reference value – in this case the Median value.

**High density samples** ($R > 63.7$ fibres. mm$^{-2}$)

Target band A:  $> 0.65R$ to $<1.55R$

Target band B: $> 0.50R$ to $0.65R$ [band -B] and $> 1.55R$ to $2.00R$ [band +B]

Target band C:  $< 0.50R$ [band -C] and $> 2.00R$ [band +C]

**Low density samples** ($R \leq 63.7$ fibres. mm$^{-2}$)*

Target band A:  $(\sqrt{R}\text{-}1.57)^2$ to $(\sqrt{R}+1.96)^2$ [band A]

Target band B:  $<(\sqrt{R}\text{-}2.34)^2$ to $(\sqrt{R}\text{-}1.57)^2$  [band -B]
$\qquad\qquad\quad$ $>(\sqrt{R}+1.96)^2$ to $(\sqrt{R}+3.30)^2$ [band +B]

Target band C:  $<(\sqrt{R}\text{-}2.34)^2$  [band -C]
$\qquad\qquad\quad$ $>(\sqrt{R}+3.30)^2$  [band +C]

* For samples less than 5.5 fibres.mm$^{-2}$ the lower limit is set to zero when the component within the brackets ($\sqrt{R}$-n) is less than zero.

The plot below shows the positions of the performance limits in relation to the reference counts up to reference density 500 fibres per mm$^2$.