Scanning Electron Microscopy Scheme

BACKGROUND

This report covers Round 7 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 46 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 362 results submitted.

The samples were as follows:

7ASEM1 - Medium density (52.2 fibres mm^{-2}) - amosite fibres

7ASEM2 - Low density (13.5 fibres mm^{-2}) - chrysotile fibres

7ASEM3 - Low density (0 fibres mm^{-2}) - no asbestos fibres

7ASEM4 - Low density (12.9 fibres mm^{-2}) - amosite & crocidolite fibres

INFORMATION SUBMITTED BY LABORATORIES

Laboratories were asked to supply the following information:

- 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 – The fibre density for at least one result was identified as being incorrectly calculated 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 6000x, 4000x, 3000x, 2000x and 1000x 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.

For this 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 (7ASEM1) - Total asbestos fibre density (52.2 fmm^{-2})

Lab Number	Total Asbestos	RICE
818	31.97	B
1445	87.00	B
1458	41.30	A
1458	52.90	A
1507	67.63	A
1579	54.00	A
1579	54.50	A
1579	56.00	A
1620	35.50	A
1620	41.00	A
1620	44.00	A
1639	54.00	A
1639	90.00	B
1722	49.50	A
1722	49.50	A
1722	54.30	A
1738	39.60	A
1738	45.20	A
1738	46.20	A
1767	4.70	C
1767	4.70	C
1767	24.80	B
1768	22.37	C
1768	24.12	B
1768	29.39	B
1776	51.00	A
1776	54.00	A
1812	51.00	A
1812	51.00	A
1812	59.00	A
1817	119.00	C
1826	47.00	A
1830	44.64	A

APPENDIX 1

1830	49.60	A
1830	64.98	A
1868	73.30	A
1871	62.50	A
1871	66.50	A
1871	81.50	A
1885	16.00	C
1885	18.00	C
1885	19.00	C
1910	40.00	A
1913	39.00	A
1913	51.00	A
1928	45.60	A
1928	46.90	A
1928	52.30	A
1936	63.93	A
1936	74.92	A
1937	39.50	A
1937	40.50	A
1939	59.95	A
1939	63.95	A
1940	71.70	A
1941	74.00	A
1941	88.00	B
1948	61.50	A
1958	69.01	A
1960	55.50	A
1960	64.40	A
1968	52.00	A
1976	45.00	A
1976	47.00	A
1977	20.50	C
1993	52.00	A
1993	57.00	A
1993	58.00	A

APPENDIX 1

1999	82.79	A
1999	98.97	B
2022	91.00	B
2024	60.00	A
2024	88.00	B
2024	90.00	B
2029	32.57	A
2029	37.84	A
2029	41.79	A
2044	40.71	A
2050	77.00	A
2050	83.00	A
2050	87.50	B
2059	37.00	A
2061	42.01	A
2061	61.45	A
2069	79.00	A
2073	23.40	C
2073	29.25	B
2076	69.00	A
2076	76.00	A
2079	81.00	A

Mean	54.2
Median	**52.2**
STDev	21.7
Min	0.0
Max	119.0

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
32	84.4	23.9	110.8	<23.9	>110.8

APPENDIX 1

Sample 2 (7ASEM2) - Total asbestos fibre density (13.5 fmm^{-2})

Lab Number	Total Asbestos	RICE
818	48.95	C
1445	8.00	A
1458	6.70	A
1458	13.50	A
1507	23.19	A
1579	11.00	A
1579	12.00	A
1579	13.00	A
1620	3.00	B
1620	3.50	B
1620	6.50	A
1639	8.00	A
1639	26.00	A
1639	33.00	B
1722	10.90	A
1722	16.50	A
1722	19.30	A
1738	10.00	A
1738	11.40	A
1738	13.80	A
1767	0.00	C
1767	0.00	C
1767	9.30	A
1768	9.21	A
1768	18.42	A
1768	18.86	A
1776	19.00	A
1776	21.00	A
1812	10.00	A
1812	10.00	A
1812	10.00	A
1817	27.00	A

APPENDIX 1

1826	22.00	A
1830	14.38	A
1830	15.87	A
1830	18.85	A
1868	16.70	A
1871	10.50	A
1871	16.50	A
1871	17.50	A
1885	13.00	A
1885	14.00	A
1885	14.00	A
1910	14.00	A
1913	6.00	A
1913	10.00	A
1928	10.10	A
1928	10.70	A
1928	12.70	A
1936	5.99	A
1936	6.22	A
1936	6.99	A
1937	11.90	A
1937	13.40	A
1939	10.49	A
1939	12.49	A
1940	29.20	A
1941	21.00	A
1941	36.50	B
1948	15.50	A
1958	32.45	B
1960	11.80	A
1960	18.80	A
1968	17.50	A
1976	54.00	C
1976	63.00	C
1977	2.72	B

APPENDIX 1

1993	21.00	A
1993	37.00	B
1993	37.00	B
1999	0.00	C
1999	0.95	C
2022	56.00	C
2024	5.00	A
2024	12.00	A
2024	21.00	A
2029	2.73	B
2029	8.17	A
2029	13.57	A
2044	2.94	B
2050	7.50	A
2050	11.50	A
2050	12.00	A
2059	21.00	A
2061	14.39	A
2061	16.34	A
2069	23.00	A
2073	17.02	A
2073	21.27	A
2076	20.00	A
2076	21.00	A
2079	31.00	A

Mean	15.8
Median	**13.5**
STDev	11.3
Min	0.0
Max	63.0

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
4.4	31.7	1.8	48.6	<1.8	>48.6

APPENDIX 1

Sample 3 (7ASEM3) - Total asbestos fibre density (0 fmm^{-2})

Lab Number	Total Asbestos	RICE
818	0.00	A
1445	0.00	A
1458	0.00	A
1458	0.00	A
1507	0.00	A
1579	0.00	A
1579	0.00	A
1579	0.00	A
1620	0.00	A
1620	0.00	A
1620	0.00	A
1639	0.00	A
1639	0.00	A
1722	0.00	A
1722	0.00	A
1722	0.00	A
1738	0.00	A
1738	0.00	A
1738	0.00	A
1767	0.00	A
1767	3.60	A
1767	8.30	B
1768	0.00	A
1768	0.00	A
1768	0.00	A
1776	0.00	A
1776	0.00	A
1812	0.00	A
1812	0.00	A
1812	0.00	A
1817	0.00	A
1826	0.00	A
1830	0.00	A

1830	0.00	A
1830	0.00	A
1871	0.00	A
1871	0.00	A
1871	0.00	A
1885	0.00	A
1885	0.00	A
1885	3.00	A
1910	0.00	A
1913	0.00	A
1913	0.00	A
1928	0.00	A
1928	0.00	A
1928	0.00	A
1936	0.00	A
1936	0.00	A
1937	0.00	A
1937	1.00	A
1939	0.00	A
1939	0.00	A
1940	96.30	C
1941	0.00	A
1941	0.00	A
1948	0.00	A
1958	0.00	A
1960	0.00	A
1960	0.00	A
1968	0.00	A
1976	0.00	A
1976	0.00	A
1977	0.00	A
1993	0.00	A
1993	0.00	A
1993	0.00	A
1999	1.90	A

APPENDIX 1

1999	2.85	A
2022	0.00	A
2024	0.00	A
2024	0.00	A
2029	0.00	A
2029	0.00	A
2029	0.00	A
2044	0.00	A
2050	0.00	A
2050	0.00	A
2050	2.00	A
2059	0.00	A
2061	0.00	A
2061	1.00	A
2073	0.00	A
2073	0.00	A
2076	0.00	A
2076	0.00	A
2079	0.00	A

Mean	1.4
Median (Ref)	**0.0**
STDev	10.4
Min	0.0
Max	96.3

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 1

Sample 4 (7ASEM4) - Total asbestos fibre density (12.8 fmm^{-2})

Lab Number	Total Asbestos	RICE
818	15.98	A
1445	14.00	A
1458	4.80	A
1458	6.30	A
1507	21.26	A
1579	20.00	A
1579	21.00	A
1579	23.00	A
1620	7.00	A
1620	7.00	A
1620	9.00	A
1639	13.00	A
1639	805.00	C
1722	7.20	A
1722	14.10	A
1722	15.30	A
1738	6.20	A
1738	12.40	A
1738	13.80	A
1767	3.60	B
1767	5.40	A
1767	24.60	A
1768	7.02	A
1768	9.65	A
1768	10.09	A
1776	17.00	A
1776	18.00	A
1812	11.00	A
1812	11.00	A
1812	11.00	A
1817	11.00	A
1826	15.00	A
1830	13.89	A

APPENDIX 1

1830	16.87	A
1830	18.85	A
1868	26.70	A
1871	16.50	A
1871	17.50	A
1871	19.00	A
1885	10.00	A
1885	10.00	A
1885	13.00	A
1910	9.00	A
1913	4.00	B
1913	7.00	A
1913	11.00	A
1928	9.40	A
1928	11.40	A
1928	11.40	A
1936	3.99	B
1936	7.99	A
1936	7.99	A
1937	8.60	A
1937	9.50	A
1939	8.49	A
1939	15.99	A
1940	17.50	A
1941	8.00	A
1941	14.50	A
1948	8.00	A
1958	12.80	A
1960	13.20	A
1960	14.60	A
1968	9.00	A
1976	10.00	A
1976	13.00	A
1977	7.50	A
1993	12.00	A

APPENDIX 1

1993	15.00	A
1993	17.00	A
1999	11.83	A
1999	31.54	B
2022	25.00	A
2024	14.50	A
2024	18.00	A
2024	21.50	A
2029	13.57	A
2029	17.54	A
2029	20.54	A
2044	10.85	A
2050	14.00	A
2050	18.00	A
2050	18.50	A
2059	15.00	A
2061	8.52	A
2061	11.03	A
2069	17.00	A
2073	10.63	A
2073	11.17	A
2076	16.00	A
2076	22.00	A
2079	8.00	A

Mean	21.9
Median (Ref)	**12.8**
STDev	83.2
Min	3.6
Max	805.0

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
4.1	30.8	1.6	47.5	<1.6	>47.5

APPENDIX 2

DATA ANALYSIS

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

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

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