



Scanning Electron Microscopy Scheme

BACKGROUND

This report covers Round 12B of the SEMS asbestos fibre counting PT scheme. The scheme is operated by HSE, 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 HSE using the modified sputnik multi-port sampling instrument.

INTRODUCTION

A total of 38 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 287 results submitted.

The samples were as follows:

12BSEM1 – Medium density (14.0 fibres/mm²) - chrysotile fibres

12BSEM2 – Medium density (23.2 fibres/mm²) - amosite fibres

12BSEM3 – High density (77.4 fibres/mm²) – amosite fibres

12BSEM4 – No asbestos (0 fibres/mm²) – MMMF fibres

INFORMATION SUBMITTED BY LABORATORIES

Laboratories were asked to supply the following information:

- Number of fibres >5µm in length counted (amphibole, chrysotile & 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/mm²) 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 ranging from 900x – 4000x 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.

Round 12B Overview

Summary statistics from this round of results are displayed in Table 1. Below this, Figure 1 displays the percentage of participants in each scoring band (as per the RICE scoring system). Figures 2 and 3 show the band scored by participants divided according to magnification and method used respectively.

Table 1: Summary statistics for results received in SEMS Round 12B.

	Sample 1	Sample 2	Sample 3	Sample 4
Number of results	71	72	74	70
Median (fibres/mm ²)	14.0	23.2	77.4	0.0
25th percentile (fibres/mm ²)	8.0	17.0	64.1	0.0
75th percentile (fibres/mm ²)	23.7	28.0	88.9	0.0
Interquartile range (fibres/mm ²)	15.7	11.0	24.8	0.0
Mean (fibres/mm ²)	16.5	23.4	77.5	1.1
Standard deviation (fibres/mm ²)	10.9	7.4	21.1	7.2
Relative standard deviation (%)	65.8	31.6	27.3	667.4

Note: The relative standard deviation (RSD) is calculated by $(\text{standard deviation}/\text{mean}) \times 100\%$. This statistic illustrates the variation relative to the size of the mean value. For very low values of the mean (e.g. Sample 4), the value of the RSD can be considered largely meaningless.

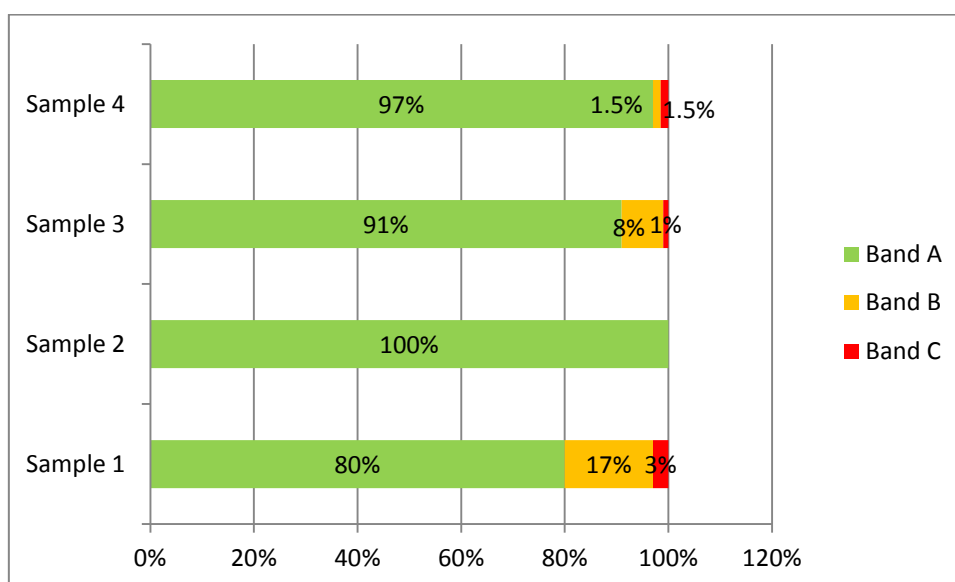


Figure 1: Banded scores for participants in SEMS Round 12B (categorised as per RICE scoring system - see Appendix 2)

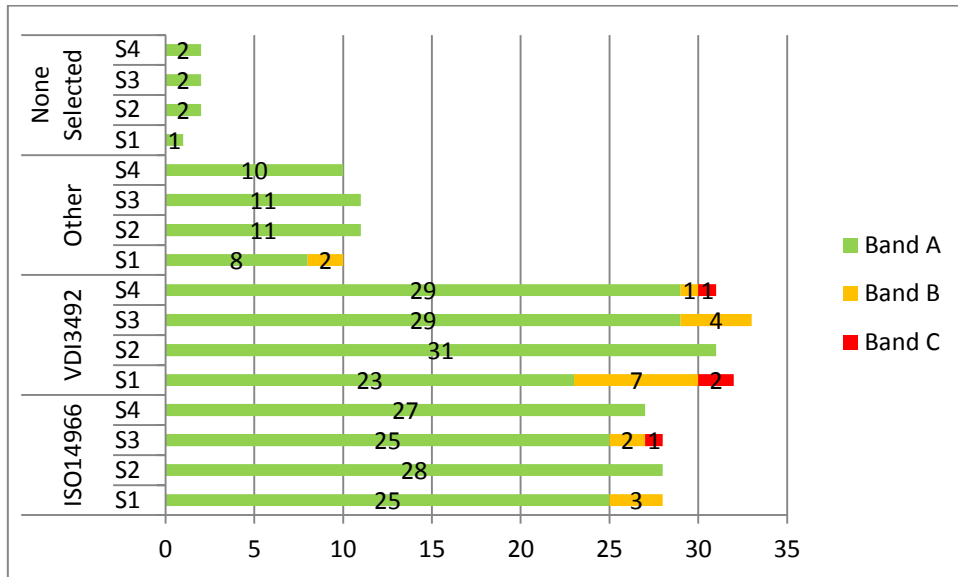


Figure 2: Banded scores for participants in SEMS Round 12B divided according to method used

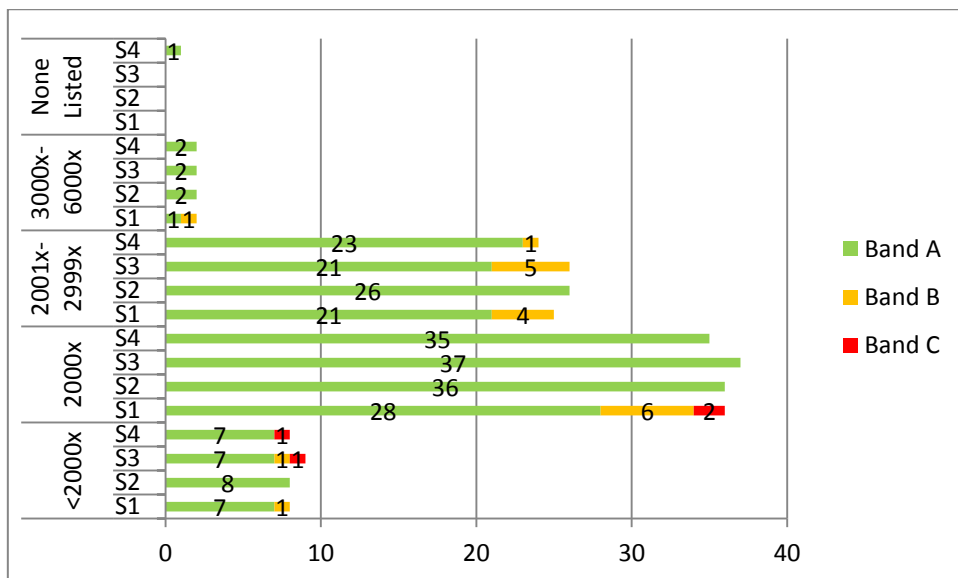


Figure 3: Banded scores for participants in SEMS Round 12B divided according to magnification use

APPENDIX 1

Sample 1 (12BSEM1) - Medium density (14 fibres/mm²) - chrysotile fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
1187	9.48	A
1187	8.88	A
1277	10	A
1456	21.6	A
1458	15.4	A
1458	12	A
1458	13.2	A
1477	35.839	B
1477	40.682	B
1477	50.852	C
1507	20.17	A
1558	5	A
1582	29	A
1592	28	A
1638	10	A
1638	5	A
1640	18.8	A
1708	12.07	A
1708	10.21	A
1715	12.87	A
1761	20	A
1761	19	A
1761	19	A
1764	8	A
1764	3	B
1764	3.5	B
1767	21.68	A
1767	24.62	A
1767	27.69	A
1774	26	A
1812	8	A
1812	11	A
1812	11.5	A
1831	5	A
1831	8.7	A
1831	6	A
1832	5	A
1832	6.5	A
1860	13.21	A
1866	28.4	A

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1866	26.6	A
1866	33.9	B
1892	14.5	A
1892	7	A
1910	14	A
1923	12.6	A
1923	15.5	A
1928	22.5	A
1928	18.4	A
1928	22.8	A
1936	4.99	A
1936	2	B
1939	5	A
1939	4	B
1958	28.34	A
1966	17.0096	A
2023	28.46	A
2023	25.95	A
2023	17.93	A
2032	3.8	B
2085	15.5	A
2085	14	A
2135	3	B
2135	3	B
2135	1	C
2168	32.4	A
2168	30.6	A
2168	39.4	B
2174	33.46	B
2203	20.66	A
2254	11.83	A

Mean	16.5
Median (Ref)	14.0
STDev	10.9
Min	1.0
Max	50.9

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
4.7	32.5	2	49.6	<2	>49.6

Sample 2 (12BSEM2) - Medium density (23.2 fibres/mm²) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
1187	21.32	A
1187	15.4	A
1277	11.7	A
1456	12.6	A
1458	14.9	A
1458	22.6	A
1458	19.8	A
1477	22.762	A
1477	23.731	A
1477	29.059	A
1507	39.14	A
1558	15	A
1582	27.5	A
1592	27	A
1638	24	A
1638	28	A
1640	20.7	A
1708	27.85	A
1708	25.53	A
1715	43.56	A
1761	17	A
1761	16	A
1761	13	A
1764	37.5	A
1764	27	A
1764	16.5	A
1767	22.31	A
1767	26.79	A
1767	25.38	A
1774	30	A
1812	28	A
1812	27	A
1812	29	A
1831	22.3	A
1831	14.4	A
1831	15.8	A
1832	17	A
1832	15.5	A
1860	25.48	A

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1866	26	A
1866	29.3	A
1866	32.5	A
1892	27	A
1892	32	A
1910	15	A
1923	18.4	A
1923	28.1	A
1923	15.5	A
1928	21.8	A
1928	19.1	A
1928	25.5	A
1936	30.97	A
1936	32.96	A
1939	13.99	A
1939	14.49	A
1958	24.68	A
1966	37.86	A
2023	18.02	A
2023	22.37	A
2023	24.21	A
2032	17.3	A
2085	12	A
2085	10.5	A
2135	20	A
2135	22	A
2135	28	A
2168	20.4	A
2168	18.2	A
2168	30.1	A
2174	30.27	A
2203	41.31	A
2254	23.67	A

Mean	23.4
Median (Ref)	23.2
STDev	7.4
Min	10.5
Max	43.6

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
10.5	45.9	6.1	65.9	<6.1	>65.9

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Sample 3 (12BSEM3) - High density (77.4 fibres/mm²) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
1187	58.63	A
1187	53.3	A
1277	54.5	A
1277	0	C
1456	73.1	A
1458	57.7	A
1458	82.34	A
1458	92.3	A
1477	88.144	A
1477	92.019	A
1477	95.893	A
1507	88.77	A
1558	54	A
1582	64.5	A
1592	85	A
1638	81.5	A
1638	83	A
1640	80.8	A
1708	81.22	A
1708	77.04	A
1715	112.87	A
1761	67	A
1761	64	A
1761	56	A
1764	96.5	A
1764	69.5	A
1764	126.5	B
1767	61.77	A
1767	70.64	A
1767	54.95	A
1774	93	A
1812	77	A
1812	59.5	A
1812	84	A
1831	75.7	A
1831	59.4	A
1831	44.6	B
1832	49	B
1832	40	B
1860	87.78	A
1866	111.1	A

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1866	116.7	A
1866	88.8	A
1892	85.5	A
1892	75	A
1910	92	A
1923	88.9	A
1923	71.6	A
1923	65.8	A
1928	72.1	A
1928	78.4	A
1928	72.4	A
1936	79.91	A
1936	80.91	A
1939	100.92	A
1939	71.94	A
1958	85.92	A
1966	94.3758	A
2023	58.81	A
2023	77.85	A
2023	61.86	A
2032	47.2	B
2085	66.3	A
2085	72.6	A
2135	101	A
2135	71	A
2135	75	A
2168	91.2	A
2168	63.3	A
2168	93.5	A
2174	81.52	A
2203	107.22	A
2203	98.37	A
2254	142.4	B

Mean	77.5
Median	
(Ref)	77.4
STDev	21.1
Min	0.0
Max	142.4

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
50.3	120	38.7	154.8	<38.7	>154.8

Sample 4 (12BSEM4) - No Asbestos (0 fibres/mm²) - MMMF fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
1187	0	A
1187	0	A
1277	0	A
1456	0	A
1458	0	A
1458	0	A
1458	0	A
1477	0.969	A
1477	0	A
1477	0	A
1507	0	A
1558	0	A
1582	0	A
1592	0	A
1638	0	A
1638	0	A
1640	0	A
1708	0	A
1708	0	A
1715	0	A
1761	0	A
1761	0	A
1761	0	A
1764	0	A
1764	3	A
1764	10.5	B
1767	0	A
1767	0	A
1767	1.54	A
1774	0	A
1812	0	A
1812	0	A
1812	0	A
1831	0	A
1831	0	A
1832	0	A
1832	0	A
1860	0	A
1866	0	A
1866	0	A

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1866	0	A
1892	0	A
1892	0	A
1910	0	A
1923	0	A
1923	0	A
1928	0	A
1928	0	A
1928	0	A
1936	0	A
1936	0	A
1939	0	A
1939	0	A
1958	0	A
1966	59.2592	C
2023	0	A
2023	0	A
2023	0	A
2032	0	A
2085	0	A
2085	0	A
2135	0	A
2135	0	A
2135	0	A
2168	0	A
2168	0	A
2168	0	A
2174	0	A
2203	0	A
2254	0	A

Mean 1.1
Median
(Ref) 0.0
 STDev 7.2
 Min 0.0
 Max 59.3

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
0	3.8		10.9		>10.9

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 .

