



# Scanning Electron Microscopy Scheme

## BACKGROUND

This report covers Round 12A 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 263 results submitted.

The samples were as follows:

12ASEM1 – medium density (25.2 fibres/mm<sup>2</sup>) - chrysotile fibres

12ASEM2 – low density (11.0 fibres/mm<sup>2</sup>) - amosite fibres

12ASEM3 – high density (80.6 fibres/mm<sup>2</sup>) – amosite fibres

12ASEM4 – no asbestos (0 fibres/mm<sup>2</sup>) – 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/mm<sup>2</sup>) 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 across a range of 650x to 4000x were used.

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 12A 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 12A.

	Sample 1	Sample 2	Sample 3	Sample 4
Number of results	67	67	66	63
Median (fibres/mm <sup>2</sup> )	25.2	11	80.6	0
25th percentile (fibres/mm <sup>2</sup> )	16.7	9.0	56.0	0
75th percentile (fibres/mm <sup>2</sup> )	34.5	14.3	91.3	0
Interquartile range (fibres/mm <sup>2</sup> )	17.8	5.3	35.3	0
Mean (fibres/mm <sup>2</sup> )	26.2	12.4	75.9	2.3
Standard deviation (fibres/mm <sup>2</sup> )	13.6	6.3	26.4	11.2
Relative standard deviation (%)	51.8	50.6	34.8	488.3

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.

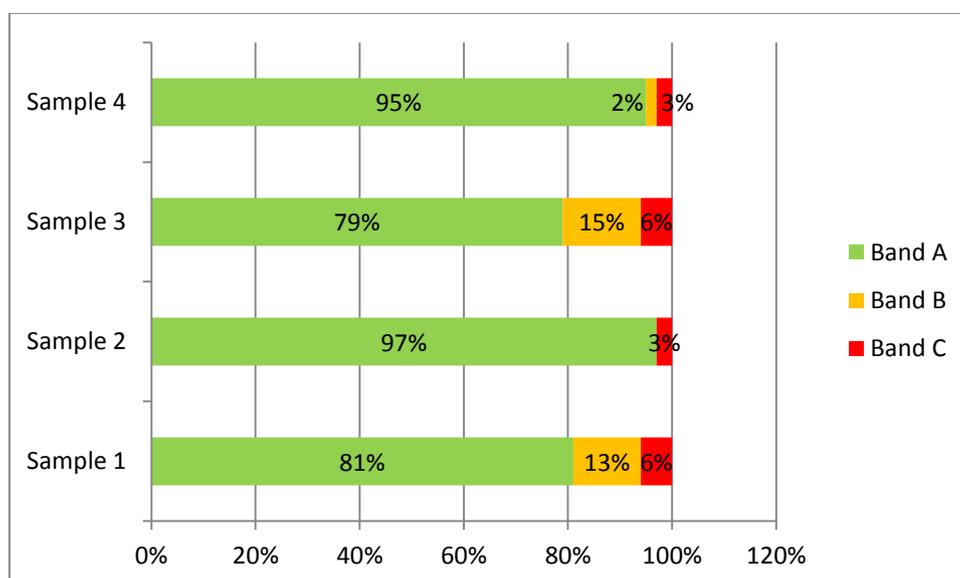


Figure 1: Banded scores for participants in SEMS Round 12A (categorised as per RICE scoring system - see Appendix 2)

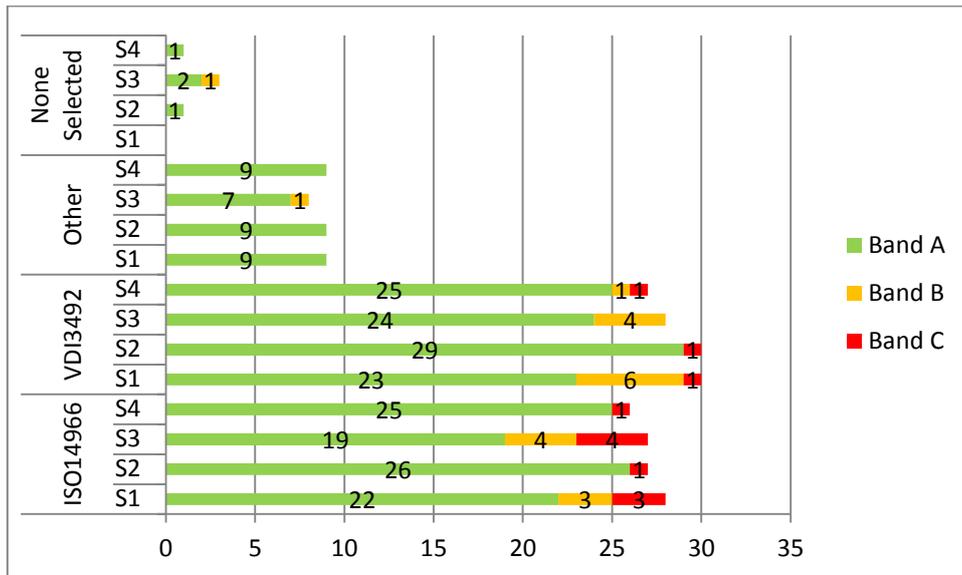


Figure 2: Banded scores for participants in SEMS Round 12A divided according to method used

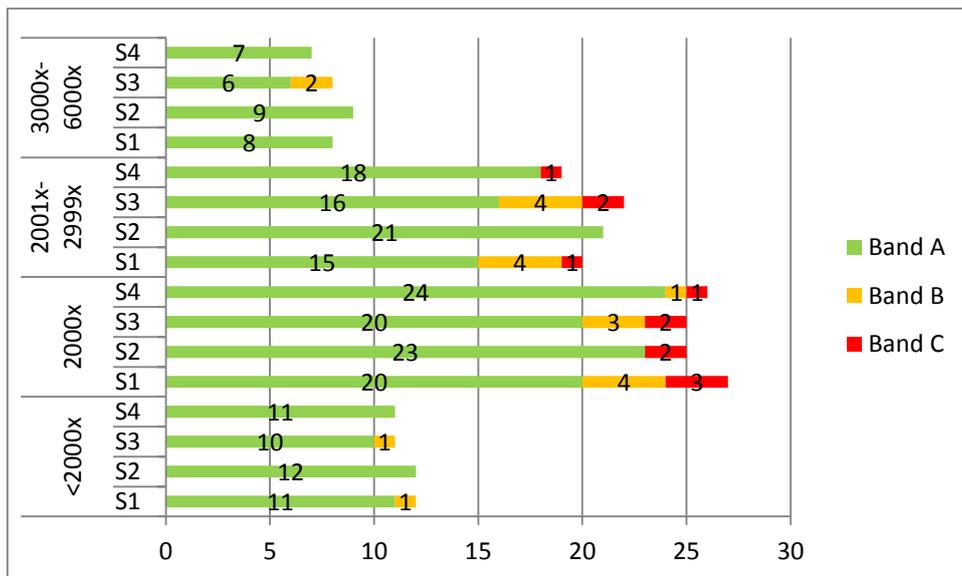


Figure 3: Banded scores for participants in SEMS Round 12A divided according to magnification use

# APPENDIX 1

## Sample 1 (12ASEM1) - Medium density (25.2 fibres/mm<sup>2</sup>) - chrysotile fibres

Lab Number	Total Asbestos	Band (RICE)
7	22.1	A
7	31	A
7	29	A
139	33.17	A
139	18.54	A
139	3.42	C
709	20	A
1546	27.9	A
1562	48.5	A
1562	43.3	A
1562	49.5	B
1575	12.8	A
1575	16.45	A
1575	9.14	B
1579	25	A
1579	23.5	A
1579	23	A
1646	23.375	A
1680	38.5	A
1680	39.1	A
1680	36.5	A
1717	12.8	A
1717	6.9	C
1722	12.4	A
1722	14.5	A
1722	11.4	B
1738	24.8	A
1745	12.4	A
1784	17	A
1814	25.2	A
1826	19.57	A
1836	7.98	B
1838	19	A
1838	12	A
1838	11	B
1868	36.4	A
1877	41.95	A
1889	30.4	A
1903	32	A
1903	34	A
1927	27.43	A

# APPENDIX 1

1938	21	A
1976	41	A
1976	28	A
1976	55	B
2024	17	A
2037	21.875	A
2037	21.875	A
2037	26.042	A
2051	19.68	A
2051	30.51	A
2051	14.91	A
2069	29.5	A
2107	27	A
2107	32	A
2107	11	B
2132	0	C
2182	63	B
2215	28.54	A
2259	34.98	A
2259	32.06	A
2265	42.5	A
2265	60	B
2269	0	C
2284	38	A
2284	35	A
2289	41.98	A

Mean	26.2
<b>Median</b>	
<b>(Ref)</b>	25.2
STDev	13.6
Min	0.0
Max	63.0

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
11.9	48.7	7.2	69.2	<7.2	>69.2

# APPENDIX 1

## Sample 2 (12ASEM2) - Low density (11 fibres/mm<sup>2</sup>) - amosite fibres

Lab Number	Total Asbestos	Band (RICE)
7	10.8	A
7	9.8	A
7	11.3	A
139	7.32	A
139	8.29	A
709	18.5	A
1546	47.1	C
1562	13.9	A
1562	13.7	A
1562	15.8	A
1575	8.23	A
1575	10.05	A
1575	6.4	A
1579	16.5	A
1579	17.5	A
1579	17	A
1646	9.74	A
1680	10.9	A
1680	13.7	A
1680	19.4	A
1717	11.8	A
1717	6.9	A
1722	8.6	A
1722	9.7	A
1722	12.1	A
1738	13.9	A
1745	7.6	A
1784	11.5	A
1814	9	A
1826	12.19	A
1836	12.96	A
1838	10	A
1838	10	A
1838	11	A
1868	9.1	A
1877	13.98	A
1889	10.9	A
1903	15	A
1903	8	A
1903	11.5	A
1927	14.69	A
1927	10.29	A

# APPENDIX 1

1938	26	A
1976	11	A
1976	7	A
1976	25	A
2024	9.5	A
2037	14.583	A
2037	15.625	A
2037	11.458	A
2051	12.79	A
2051	10.82	A
2051	16.9	A
2069	9	A
2107	9	A
2107	8	A
2107	8	A
2132	0	C
2182	13	A
2215	4.43	A
2259	10.69	A
2259	8.75	A
2265	20	A
2269	4.3	A
2284	17	A
2284	22	A
2289	10.995	A

Mean	12.4
<b>Median</b>	
<b>(Ref)</b>	11.0
STDev	6.3
Min	0.0
Max	47.1

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
3.1	27.8	1	43.8	<1	>43.8

# APPENDIX 1

## Sample 3 (12ASEM3) - High density (80.6 fibres/mm<sup>2</sup>) - amosite fibres

Lab Number	Total Asbestos	Band (RICE)
7	78.3	A
7	108.5	A
7	114.6	A
139	67.81	A
139	67.81	A
709	71.5	A
1546	107.9	A
1562	97.7	A
1562	91.8	A
1562	89.9	A
1575	55.76	A
1575	51.19	B
1575	47.53	B
1579	84	A
1579	82	A
1579	81	A
1646	92.528	A
1680	64.3	A
1680	54.1	A
1680	55.9	A
1717	49.2	B
1717	24.6	C
1722	56.2	A
1722	55.2	A
1722	52.8	A
1738	95.1	A
1745	51.1	B
1784	82.5	A
1814	41.6	B
1826	49.72	B
1836	91.72	A
1838	83	A
1838	75	A
1838	81	A
1868	134.5	B
1877	87.89	A
1889	56.6	A
1903	65	A
1903	55	A
1927	86.21	A
1927	61.23	A
1938	82	A

# APPENDIX 1

1976	87	A
1976	67.5	A
1976	104	A
2024	87.5	A
2037	59.375	A
2037	81.25	A
2051	105.3	A
2051	82.66	A
2051	99.41	A
2069	89	A
2107	88	A
2107	92	A
2107	31	C
2132	0	C
2182	65	A
2215	117.11	A
2215	43.79	B
2259	71.43	A
2259	80.17	A
2265	130.5	B
2269	21.6	C
2284	111	A
2284	134	B
2289	79.962	A

Mean	75.9
<b>Median (Ref)</b>	80.6
STDev	26.4
Min	0.0
Max	134.5

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
52.4	124.9	40.3	161.2	<40.3	>161.2

Sample 4 (12ASEM4) - Low density (0 fibres/mm<sup>2</sup>) - MMMF fibres

Lab Number	Total Asbestos	Band (RICE)
7	0	A
7	0	A
7	0	A
139	2.44	A
139	0	A
709	0	A
1546	67.9	C
1562	0	A
1562	0.5	A
1562	0.7	A
1575	0	A
1575	0	A
1575	0	A
1579	0	A
1579	0	A
1579	0	A
1646	0	A
1680	1.2	A
1680	0	A
1680	0	A
1717	0	A
1717	0	A
1722	0	A
1722	0	A
1722	0	A
1738	0	A
1745	0.9	A
1784	0	A
1814	0	A
1826	0	A
1836	0	A
1838	0	A
1838	0	A
1838	0	A
1868	0	A
1877	0	A
1889	0	A
1903	0	A
1927	0	A
1938	0	A
1976	0	A
1976	0	A

# APPENDIX 1

1976	0	A
2024	0	A
2037	2.083	A
2037	2.083	A
2051	0	A
2051	0	A
2051	0	A
2069	0	A
2107	0	A
2107	0	A
2107	0	A
2132	0	A
2182	0	A
2215	58.06	C
2259	0	A
2259	0	A
2265	6	B
2269	0	A
2284	0	A
2284	2	A
2289	0	A

Mean	2.3
<b>Median (Ref)</b>	0.0
STDev	11.2
Min	0.0
Max	67.9

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.  $\text{mm}^{-2}$ )

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.  $\text{mm}^{-2}$ )\*

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. $\text{mm}^{-2}$  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  $\text{mm}^2$ .

