



# Scanning Electron Microscopy Scheme

## BACKGROUND

This report covers Round 14B 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 65 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 399 results submitted.

The samples were as follows:

14BSEMS1 – High density (109.1 fibres/mm<sup>2</sup>) – amosite fibres

14BSEMS2 – High density (55.5 fibres/mm<sup>2</sup>) - chrysotile fibres

14BSEMS3 – Medium density (40.8 fibres/mm<sup>2</sup>) – chrysotile fibres

14BSEMS4 – Medium density (30.0 fibres/mm<sup>2</sup>) – amosite 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** – One laboratory did not submit results for 14BSEMS2 & 14BSEMS3.

**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 750x to 4500x 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.

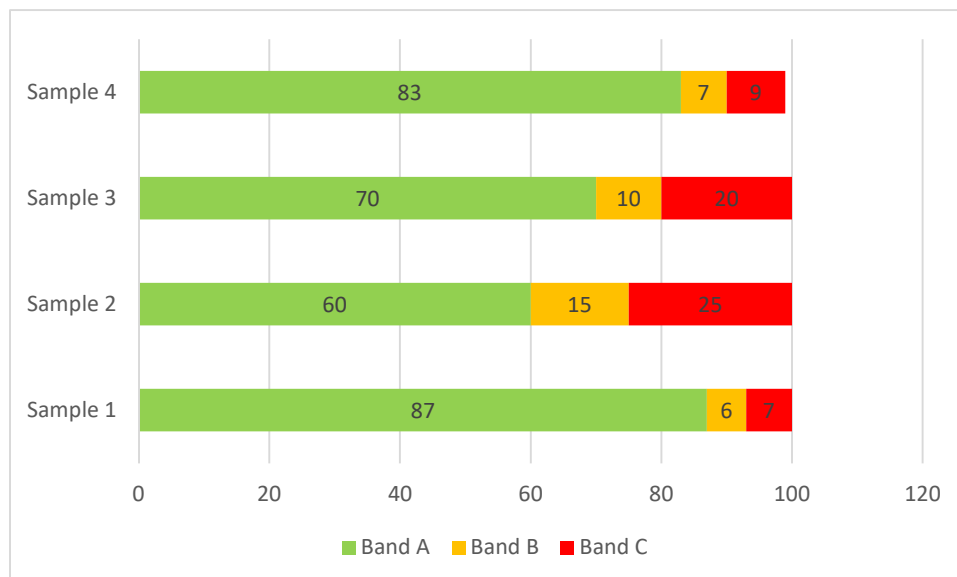
## Round 14B Overview

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 14B.*

	Sample 1	Sample 2	Sample 3	Sample 4
<b>Number of results</b>	100	100	100	99
<b>Median (fibres/mm<sup>2</sup>)</b>	109.1	55.5	40.8	30.0
<b>25th percentile (fibres/mm<sup>2</sup>)</b>	86.7	39.1	25.0	21.7
<b>75th percentile (fibres/mm<sup>2</sup>)</b>	122.5	73.2	53.6	36.4
<b>Interquartile range (fibres/mm<sup>2</sup>)</b>	35.8	34.1	28.6	14.7
<b>Mean (fibres/mm<sup>2</sup>)</b>	108.3	56.9	41.2	28.9
<b>Standard deviation (fibres/mm<sup>2</sup>)</b>	57.8	31.1	24.5	13.2
<b>Relative standard deviation (%)</b>	53.3	56.1	59.4	45.6

*Note: The relative standard deviation (RSD) is calculated by (standard deviation/mean)\*100%. This statistic illustrates the variation relative to the size of the mean value. For very low values of the mean (e.g. Sample 1), the value of the RSD can be considered largely meaningless.*



*Figure 1: Banded scores for participants in SEMS Round 14B (categorised as per RICE scoring system - see Appendix 2)*

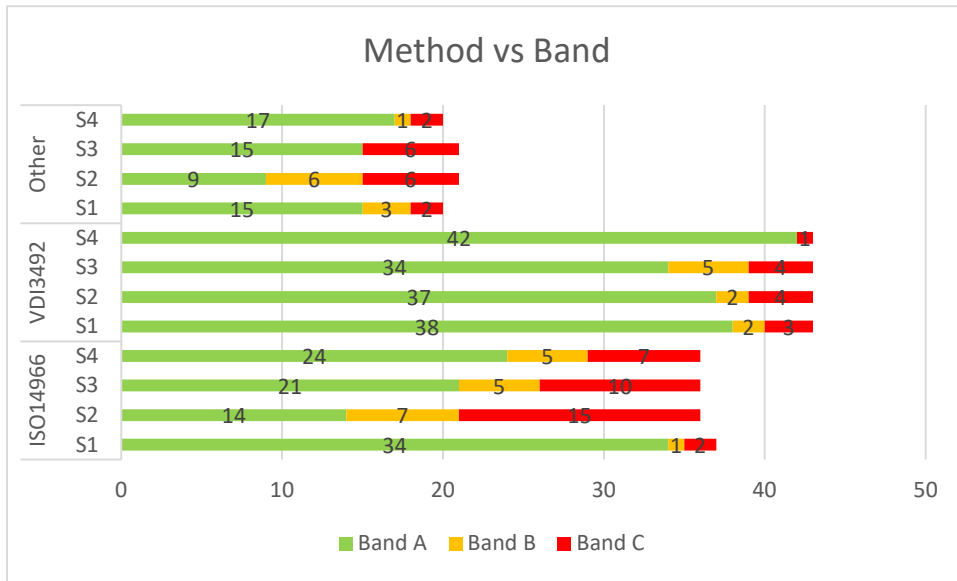


Figure 2: Banded scores for participants in SEMS Round 14B divided according to method used

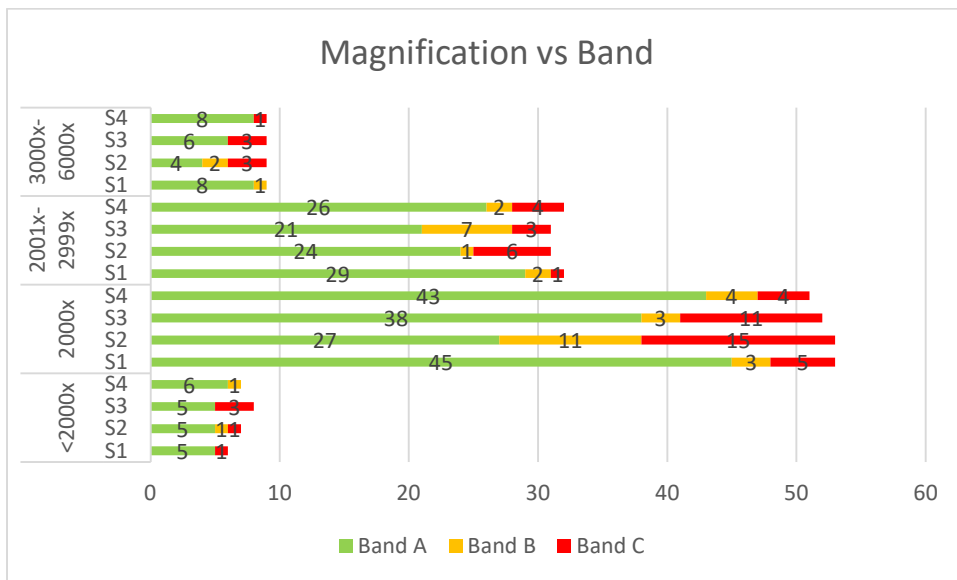


Figure 3: Banded scores for participants in SEMS Round 14B divided according to magnification use

# APPENDIX 1

## Sample 1 (14BSEM1) - High density (109.1 fibres/mm<sup>2</sup>) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
139	84.87	A
139	95.12	A
709	140.5	A
818	59.7	B
818	152.6	A
1181	92	A
1277	105.2	A
1458	98	A
1458	114	A
1507	115.9	A
1546	75.92	A
1558	88	A
1562	113.7	A
1562	115.2	A
1562	117.7	A
1569	129	A
1575	55.8	B
1575	57.6	B
1575	78.9	A
1592	111	A
1640	118	A
1646	107.864	A
1649	90	A
1680	75	A
1680	79.3	A
1680	91.7	A
1715	64.29	B
1717	107.8	A
1717	113.6	A
1717	116.3	A
1718	16	C
1718	44.5	C
1734	85	A
1734	132	A
1738	105.2	A
1745	72.1	A
1759	126.7	A
1759	136.6	A
1759	162.9	A
1768	128.13	A

# APPENDIX 1

1768	133.33	A
1768	153.95	A
1774	113	A
1776	91	A
1812	102	A
1812	112	A
1812	116.5	A
1814	77.7	A
1826	159.74	A
1832	86.5	A
1832	109.5	A
1836	86.73	A
1888	122	A
1910	116	A
1938	118	A
1958	80.3	A
1963	47	C
1963	60	B
1966	102	A
1984	126.94	A
1984	130.6	A
1984	149.68	A
1990	93	A
1990	115	A
1990	137	A
2026	132.2	A
2026	142.9	A
2032	43.5	C
2076	120	A
2076	131	A
2116	100	A
2159	84.1583	A
2168	89.8	A
2168	93.1	A
2168	102.8	A
2174	145.59	A
2191	115.37	A
2191	124.7	A
2194	108.9	A
2194	119.1	A
2194	128.1	A
2202	90.68	A
2203	138.89	A
2207	108	A
2207	127	A
2211	78.5	A

# APPENDIX 1

2211	79.5	A
2211	87	A
2215	109.26	A
2230	116.18	A
2230	118.17	A
2251	120.4	A
2259	123.91	A
2260	30.5	C
2284	94	A
2307	114	A
2317	88.568	A
2324	50	C
2332	604	C
2344	56.9784	B

Mean            108.3  
 Median  
 (Ref)            109.1  
 STDev           57.8  
 Min              16  
 Max              604

<b>RICE A (Lower)</b>	<b>RICE A (Upper)</b>	<b>RICE B (Lower)</b>	<b>RICE B (Upper)</b>	<b>RICE C (Lower)</b>	<b>RICE C (Upper)</b>
<b>70.9</b>	<b>169.0</b>	<b>54.6</b>	<b>218.2</b>	<b>&lt;54.6</b>	<b>&gt;218.2</b>

# APPENDIX 1

## Sample 2 (14BSEM2) – High density (55.5 fibres/mm<sup>2</sup>) - chrysotile fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
139	45.36	A
139	45.85	A
709	66	A
818	54.7	A
818	93	B
1181	23	C
1277	105.8	B
1458	56	A
1458	60	A
1507	70.79	A
1546	80.075	A
1558	31	B
1562	118	C
1562	118.2	C
1562	128	C
1569	7	C
1575	24.1	C
1575	34.7	A
1575	38.4	A
1592	104	B
1640	41.5	A
1646	61.091	A
1649	57.03	A
1680	92.6	B
1680	94.7	B
1680	97	B
1715	91.68	B
1717	49.7	A
1717	51.2	A
1717	51.4	A
1718	15.5	C
1718	20.5	C
1734	69	A
1734	74	A
1738	47.6	A
1745	73.1	A
1759	0	C
1759	0	C
1759	0	C
1768	32.89	B



# APPENDIX 1

1768	39.39	A
1768	40.35	A
1774	101	B
1776	62	A
1812	48	A
1812	51	A
1812	52	A
1814	94.1	B
1826	94.63	B
1832	58	A
1832	66	A
1836	41.87	A
1888	3	C
1910	75	A
1938	59	A
1958	45.3	A
1963	12	C
1963	18	C
1966	66.4	A
1984	53.56	A
1984	54.3	A
1984	62.37	A
1990	55	A
1990	62	A
1990	72	A
2026	47.3	A
2026	58.2	A
2026	70	A
2032	5	C
2076	87	A
2076	88	A
2116	64	A
2159	37.624	A
2168	101.9	B
2168	106.5	B
2168	117.6	C
2174	56.84	A
2191	43.2	A
2191	72.17	A
2194	14.69	C
2194	19.18	C
2194	30.6	B
2202	45.09	A
2203	51.59	A
2207	17	C
2207	24.5	C

# APPENDIX 1

2211	39.5	A
2211	40.5	A
2211	58	A
2215	117.24	C
2230	71	A
2230	81.43	A
2251	118	C
2259	51.51	A
2260	0	C
2284	19	C
2307	70	A
2317	70.854	A
2324	73.5	A
2344	6.8585	C

Mean            56.9  
 Median  
 (Ref)            55.5  
 STDev           31.1  
 Min              0  
 Max              128

<b>RICE A (Lower)</b>	<b>RICE A (Upper)</b>	<b>RICE B (Lower)</b>	<b>RICE B (Upper)</b>	<b>RICE C (Lower)</b>	<b>RICE C (Upper)</b>
<b>34.6</b>	<b>88.5</b>	<b>26.1</b>	<b>115.6</b>	<b>&lt;26.1</b>	<b>&gt;115.6</b>

# APPENDIX 1

## Sample 3 (14BSEM3) - Medium density (40.8 fibres/mm<sup>2</sup>) - chrysotile fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
139	29.26	A
139	30.24	A
709	50	A
818	68.7	A
818	96.9	C
1181	9	C
1277	35.8	A
1458	35	A
1458	52	A
1507	68.9	A
1546	13.828	C
1558	25	A
1562	80.3	B
1562	94.6	C
1562	103.5	C
1569	5.5	C
1575	19.2	B
1575	20.8	B
1575	23.8	A
1592	57	A
1640	41.5	A
1646	36.273	A
1649	40.5	A
1680	55	A
1680	56.7	A
1680	60.7	A
1715	41.58	A
1717	30.5	A
1717	32.5	A
1717	44.3	A
1718	15	C
1718	16.5	B
1734	24	A
1734	41	A
1738	37	A
1745	47.4	A
1759	0	C
1759	0	C
1759	0	C
1768	20.18	B
1768	23.68	A

# APPENDIX 1

1768	31.47	A
1774	56	A
1776	50	A
1812	33	A
1812	38.5	A
1812	42	A
1814	58.3	A
1826	67.36	A
1832	53.5	A
1832	55	A
1836	63.8	A
1888	4	C
1910	66	A
1938	33	A
1958	44.1	A
1963	7	C
1963	13	C
1966	44.4	A
1984	32.28	A
1984	35.22	A
1984	35.95	A
1990	48	A
1990	49	A
1990	56	A
2026	38.4	A
2026	43.4	A
2026	51.3	A
2032	4.5	C
2076	41	A
2076	52	A
2116	54	A
2159	0	C
2168	103.7	C
2168	109.3	C
2168	113.9	C
2174	39.39	A
2191	20.62	B
2191	44.185	A
2194	46.51	A
2194	49.78	A
2194	57.72	A
2202	41.18	A
2203	9.92	C
2207	20	B
2207	26.5	A
2211	19	B

# APPENDIX 1

2211	26	A
2211	32	A
2215	80.55	B
2230	44.7	A
2230	51.64	A
2251	70	B
2259	35.96	A
2260	25.6	A
2284	25	A
2307	44.5	A
2317	61.997	A
2324	28.5	A
2344	2.1103	C

Mean            41.2  
 Median  
 (Ref)            40.8  
 STDev           24.5  
 Min               0  
 Max              113.9

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
23.2	69.7	16.4	93.8	<16.4	>93.8

# APPENDIX 1

## Sample 4 (14BSEM4) - Medium density (30.0 fibres/mm<sup>2</sup>) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
139	28.29	A
139	32.19	A
709	44	A
818	29.8	A
818	32.8	A
1181	27	A
1277	21.3	A
1458	27	A
1458	34	A
1507	53.01	A
1546	19.771	A
1558	36	A
1562	32.5	A
1562	33.9	A
1562	37.19	A
1569	35	A
1575	18.6	A
1575	21	A
1575	26.5	A
1592	33	A
1640	33.5	A
1646	45.818	A
1649	20.7	A
1680	24	A
1680	27.3	A
1680	35	A
1715	25.74	A
1717	0	C
1717	0	C
1717	0	C
1718	13	B
1718	15.5	A
1734	38	A
1734	41	A
1738	35.2	A
1745	44.3	A
1759	0	C
1759	0.9	C
1759	1.3	C
1768	37.72	A
1768	44.52	A

# APPENDIX 1

1768	46.63	A
1774	34	A
1776	26	A
1812	18	A
1812	20.5	A
1812	22	A
1814	37.1	A
1826	57.74	B
1832	27	A
1832	30.5	A
1836	15.95	A
1888	7	C
1910	23	A
1938	24	A
1958	28.2	A
1963	10	B
1963	19	A
1966	35.6	A
1984	43.29	A
1984	43.29	A
1984	47.69	A
1990	36	A
1990	37	A
1990	43	A
2026	51.3	A
2026	51.7	A
2032	12.5	B
2076	15	B
2076	27	A
2116	30	A
2159	40.099	A
2168	21.3	A
2168	22.7	A
2168	35.2	A
2174	33.9	A
2191	27.49	A
2191	34.36	A
2194	10.61	B
2194	24.48	A
2194	31.82	A
2202	26.47	A
2203	33.73	A
2207	42.5	A
2211	27.5	A
2211	28.5	A
2211	32	A

# APPENDIX 1

2215	64.6	B
2230	36.74	A
2230	37.73	A
2251	30	A
2259	34.01	A
2260	39.3	A
2284	25	A
2307	29.5	A
2317	32.475	A
2324	26.5	A
2332	0	C
2344	7.3861	C

Mean            28.9  
 Median  
 (Ref)            30.0  
 STDev           13.2  
 Min              0  
 Max              64.6

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
15.3	55.3	9.8	77.0	<9.8	>77.0



## 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<sup>2</sup>)

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<sup>2</sup>)\*

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<sup>-2</sup> 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/mm<sup>2</sup>.

