



# Scanning Electron Microscopy Scheme

## BACKGROUND

This report covers Round 13B 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 41 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 293 results submitted.

The samples were as follows:

13BSEM1 – Low density (0 fibres/mm<sup>2</sup>) – no asbestos (MMMMF fibres present)

13BSEM2 – High density (59.1 fibres/mm<sup>2</sup>) - amosite fibres

13BSEM3 – Medium density (23.5 fibres/mm<sup>2</sup>) – amosite fibres

13BSEM4 – High density (97.0 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** – Participants are responsible for carrying out and submitting the results of their own calculations of fibre density. These density calculations are not verified by HSE when the round results are calculated. However, from inspection of the data for this round, no obvious calculation errors were observed (though a small number of likely data entry errors were seen).

**Screen area** – Although the submitted screen area is not used by HSE to verify density calculations (and therefore this will not necessarily affect participant results), we have noted that several participants have erroneously been recording the “screen area” as the total area counted (i.e. 1mm<sup>2</sup>). We would like to remind participants that this value should be the area of a single field of view (then multiplied by the number of fields counted to give the total area counted).

**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 4000x were used by participants.

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.

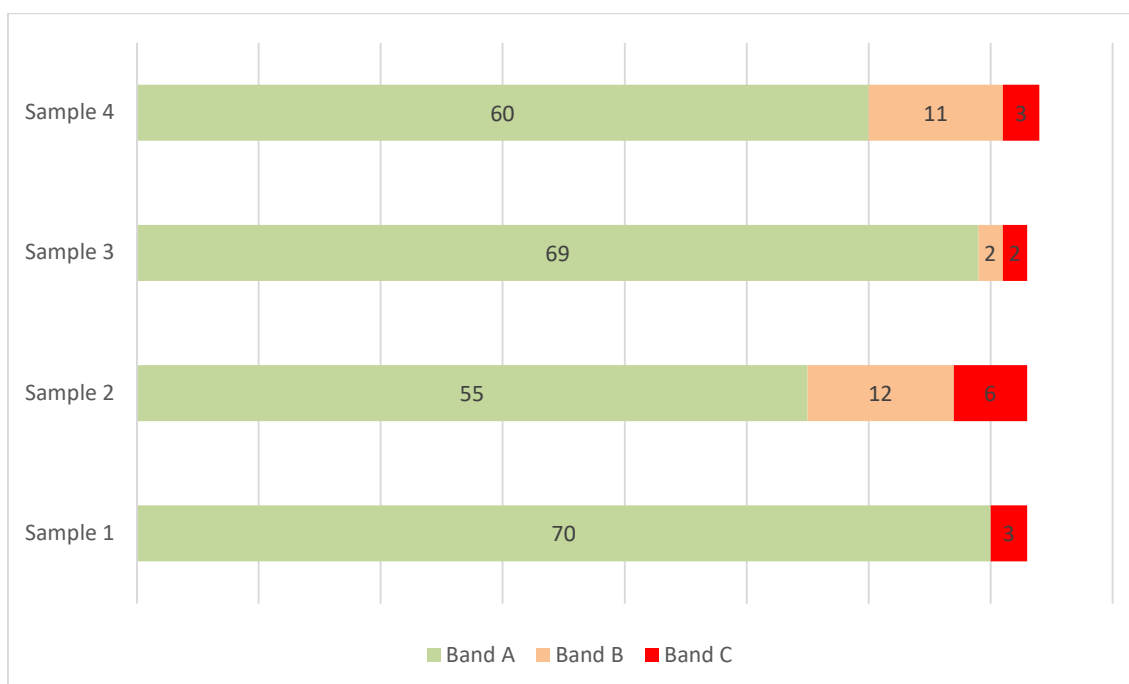
## Round 13B Overview

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 13B.*

	Sample 1	Sample 2	Sample 3	Sample 4
<b>Number of results</b>	73	73	73	74
<b>Median (fibres/mm<sup>2</sup>)</b>	0.0	59.1	23.5	97.0
<b>25th percentile (fibres/mm<sup>2</sup>)</b>	0.0	41.3	18.1	78.0
<b>75th percentile (fibres/mm<sup>2</sup>)</b>	0.0	69.4	27.4	114.2
<b>Interquartile range (fibres/mm<sup>2</sup>)</b>	0.0	28.1	9.3	36.2
<b>Mean (fibres/mm<sup>2</sup>)</b>	3.8	55.5	23.1	93.4
<b>Standard deviation (fibres/mm<sup>2</sup>)</b>	18.7	20.3	8.0	30.3
<b>Relative standard deviation (%)</b>	490.7	36.6	34.8	32.5

*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 13B (categorised as per RICE scoring system - see Appendix 2)*

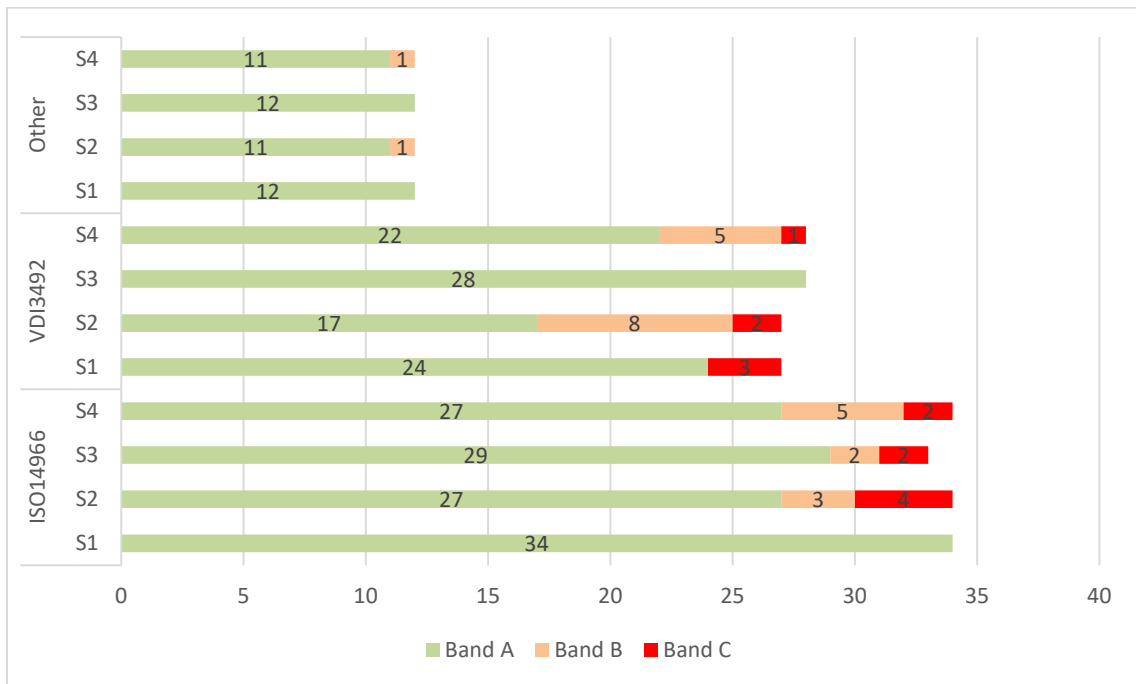


Figure 2: Banded scores for participants in SEMS Round 13B divided according to method used

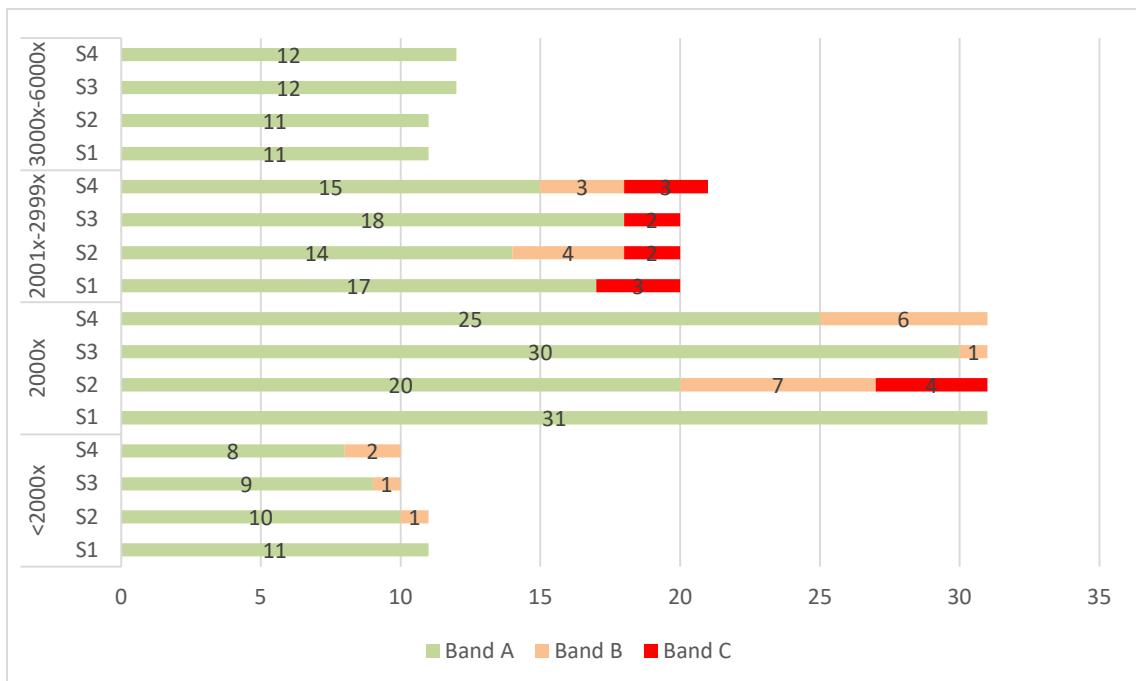


Figure 3: Banded scores for participants in SEMS Round 13B divided according to magnification used

# APPENDIX 1

**Sample 1 (13BSEM1) - Low density (0 fibres/mm<sup>2</sup>) – no asbestos (MMMf fibres present)**

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	0	A
7	0	A
7	0	A
139	0	A
139	0	A
709	0	A
807	0	A
807	0	A
1562	0	A
1562	0	A
1562	0	A
1569	0	A
1575	0	A
1575	0	A
1582	0	A
1638	0	A
1640	0	A
1684	0	A
1684	0	A
1684	0	A
1715	0	A
1734	0	A
1734	0	A
1767	0	A
1767	0	A
1767	0	A
1776	0	A
1784	0	A
1836	0	A
1838	0	A
1838	0	A
1838	0	A
1889	0	A
1889	0	A
1889	0	A
1903	0	A
1903	0	A
1910	0	A
1937	0	A
1939	0	A
1939	0	A

# APPENDIX 1

1976	0	A
1976	0	A
1976	0	A
2024	0	A
2032	0	A
2045	0	A
2045	0	A
2051	0	A
2051	0	A
2051	0	A
2062	0	A
2062	0	A
2062	0	A
2116	0	A
2188	0	A
2188	0	A
2194	0	A
2194	0	A
2202	0	A
2203	0	A
2207	0	A
2207	0	A
2226	80.23	C
2226	88.68	C
2226	108.95	C
2251	0	A
2265	0	A
2291	0	A
2302	0	A
2302	0	A
2302	0	A
2317	0	A

Mean 3.8  
**Median (Ref)** 0  
 STDev 18.7  
 Min 0  
 Max 109

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

# APPENDIX 1

## Sample 2 (13BSEM2) - High density (59.1 fibres/mm<sup>2</sup>) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	73	A
7	76.7	A
7	79.3	A
139	60.49	A
139	62.93	A
709	106.5	B
807	66.05	A
807	71.41	A
1562	64.7	A
1562	71.8	A
1562	74.9	A
1569	72	A
1575	48	A
1575	49	A
1582	36	B
1638	64	A
1640	53.5	A
1684	71	A
1684	73.6	A
1684	74	A
1715	93.07	B
1734	35	B
1734	58	A
1767	39.05	A
1767	44.76	A
1767	59.05	A
1776	45	A
1784	30.57	B
1836	88.72	A
1838	28	C
1838	28	C
1838	29	B
1889	78.9	A
1889	79.45	A
1889	79.75	A
1903	61	A
1903	62	A
1910	100	B
1937	52.5	A
1939	63.95	A
1939	63.95	A

# APPENDIX 1

1976	40	A
1976	47	A
1976	48	A
2024	63	A
2032	37	B
2045	60	A
2045	79	A
2051	39.36	A
2051	41.33	A
2051	45.24	A
2062	60.5	A
2062	66.5	A
2062	68.5	A
2116	50	A
2188	0	C
2188	0	C
2194	26.54	C
2194	36.23	B
2202	59.52	A
2203	69.44	A
2207	26.5	C
2207	41.5	A
2226	31.25	B
2226	34.63	B
2226	43.07	A
2251	50.2	A
2265	33.5	B
2291	63.9004856	A
2302	50.8	A
2302	51.3	A
2302	57.7	A
2317	61.013	A

Mean            55.5  
**Median (Ref)**    59.1  
 STDev           20.3  
 Min              0  
 Max              106.5

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
37.3	93.0	28.5	120.6	<28.5	>120.6



# APPENDIX 1

## Sample 3 (13BSEM3) - Medium density (23.5 fibres/mm<sup>2</sup>) – amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	20.6	A
7	22.1	A
7	24.1	A
139	17.56	A
139	32.68	A
709	33	A
807	16.1	A
807	17.5	A
1562	23.5	A
1562	24	A
1562	31.4	A
1569	26.5	A
1575	13.7	A
1575	26.4	A
1582	25	A
1638	25	A
1640	26.5	A
1684	18	A
1684	22.5	A
1684	28.6	A
1715	56.44	B
1734	14	A
1734	23	A
1767	17.14	A
1767	17.14	A
1767	18.1	A
1776	25	A
1784	17.19	A
1836	32.9	A
1838	19	A
1838	21	A
1838	28	A
1889	21.89	A
1889	27.37	A
1889	34.33	A
1903	25	A
1903	27	A
1903	33	A
1910	33	A
1937	15	A
1939	25.95	A

# APPENDIX 1

1939	27.98	A
1976	26	A
1976	27	A
1976	30	A
2024	28.5	A
2032	10	B
2045	22	A
2045	27	A
2051	20.67	A
2051	21.65	A
2051	26.57	A
2062	29	A
2062	30	A
2062	35	A
2116	20	A
2188	0	C
2188	0	C
2194	11.38	A
2194	13.9	A
2202	24.29	A
2203	19.84	A
2207	15	A
2226	16.89	A
2226	19	A
2226	20.27	A
2251	18.3	A
2265	28.5	A
2291	24.688824	A
2302	15.6	A
2302	19.7	A
2302	23.2	A
2317	31.491	A

Mean 23.1  
**Median (Ref)** 23.5  
 STDev 8.0  
 Min 0  
 Max 56.4

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
10.7	46.3	6.3	66.4	<6.3	>66.4

Sample 4 (13BSEM4) - High density (97.0 fibres/mm<sup>2</sup>) – amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	110.1	A
7	117.1	A
7	121.3	A
139	98.05	A
139	159.72	B
709	128	A
807	78.41	A
807	98.02	A
1562	117	A
1562	124.8	A
1562	134.6	A
1569	125	A
1575	40.2	C
1575	50.9	B
1582	92	A
1638	109	A
1640	115	A
1684	95	A
1684	96	A
1684	98.8	A
1715	124.75	A
1734	54	B
1734	93	A
1767	61.56	B
1767	68.57	A
1767	98.9	A
1776	63	B
1784	51.91	B
1836	78.76	A
1838	70	A
1838	78	A
1838	87	A
1889	97.99	A
1889	102.13	A
1889	104.99	A
1903	75	A
1903	81	A
1903	88	A
1910	101	A
1937	63.3	A
1939	119.91	A

# APPENDIX 1

1939	119.91	A
1976	56	B
1976	104	A
1976	105	A
2024	102	A
2032	52	B
2045	101	A
2045	102	A
2051	64.95	A
2051	92.5	A
2051	129.9	A
2062	123	A
2062	148	A
2062	148	A
2116	84	A
2188	0	C
2188	0	C
2194	74.99	A
2194	78.37	A
2202	81.9	A
2203	153.77	B
2207	56.5	B
2207	60.5	B
2226	87.84	A
2226	90.79	A
2226	92.06	A
2251	78.1	A
2265	100	A
2291	92.9461609	A
2302	107.6	A
2302	113.2	A
2302	114.5	A
2317	123.011	A

Mean 93.4  
**Median (Ref)** 97.0  
 STDev 30.3  
 Min 0  
 Max 159.7

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
63.1	150.4	48.5	194.0	<48.5	>194.0

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

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  $\text{mm}^2$ .

