



# Scanning Electron Microscopy Scheme

## BACKGROUND

This report covers Round 13C 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 281 results submitted.

The samples were as follows:

13CSEM1 – Low density (0 fibres/mm<sup>2</sup>) – no asbestos (MMMMF fibres present)

13CSEM2 – High density (64.6 fibres/mm<sup>2</sup>) - amosite fibres

13CSEM3 – Medium density (17.6 fibres/mm<sup>2</sup>) – amosite fibres

13CSEM4 – High density (85.0 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.

**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 4500x 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.

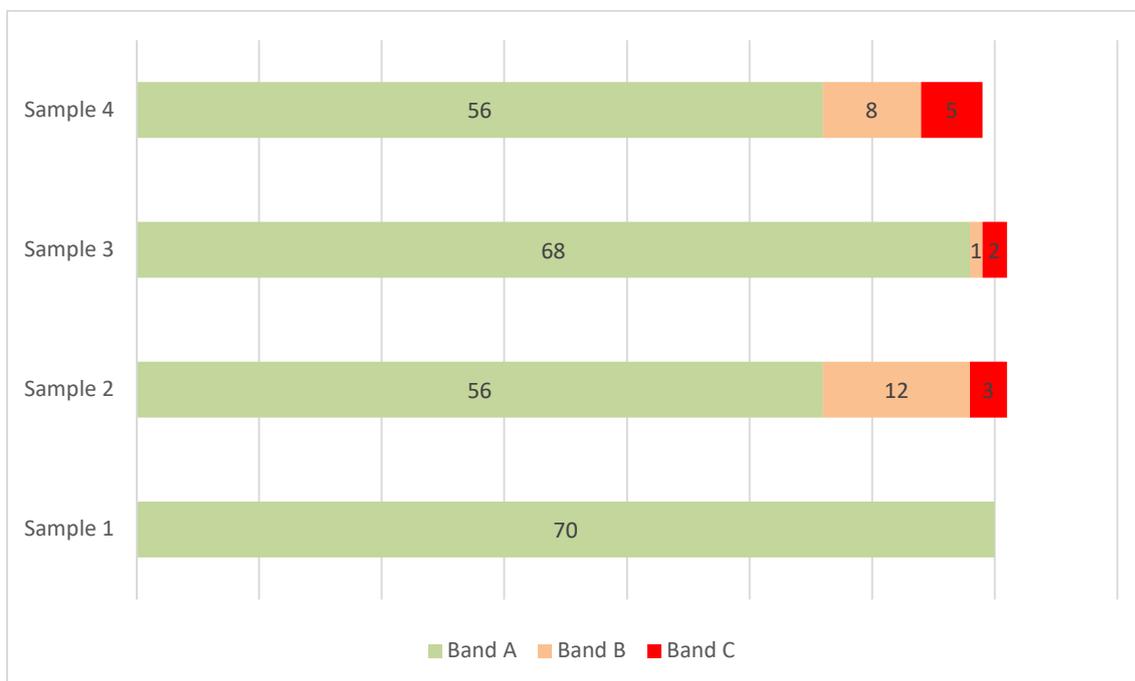
## Round 13C Overview

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 13C.*

	Sample 1	Sample 2	Sample 3	Sample 4
<b>Number of results</b>	70	71	71	69
<b>Median (fibres/mm<sup>2</sup>)</b>	0.0	64.6	17.6	85.0
<b>25th percentile (fibres/mm<sup>2</sup>)</b>	0.0	48.2	13.2	71.1
<b>75th percentile (fibres/mm<sup>2</sup>)</b>	0.0	73.0	21.2	100.0
<b>Interquartile range (fibres/mm<sup>2</sup>)</b>	0.0	24.8	8.0	28.9
<b>Mean (fibres/mm<sup>2</sup>)</b>	0.0	62.6	19.4	90.5
<b>Standard deviation (fibres/mm<sup>2</sup>)</b>	0.1	19.8	12.3	32.9
<b>Relative standard deviation (%)</b>	836.7	31.6	63.2	36.4

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

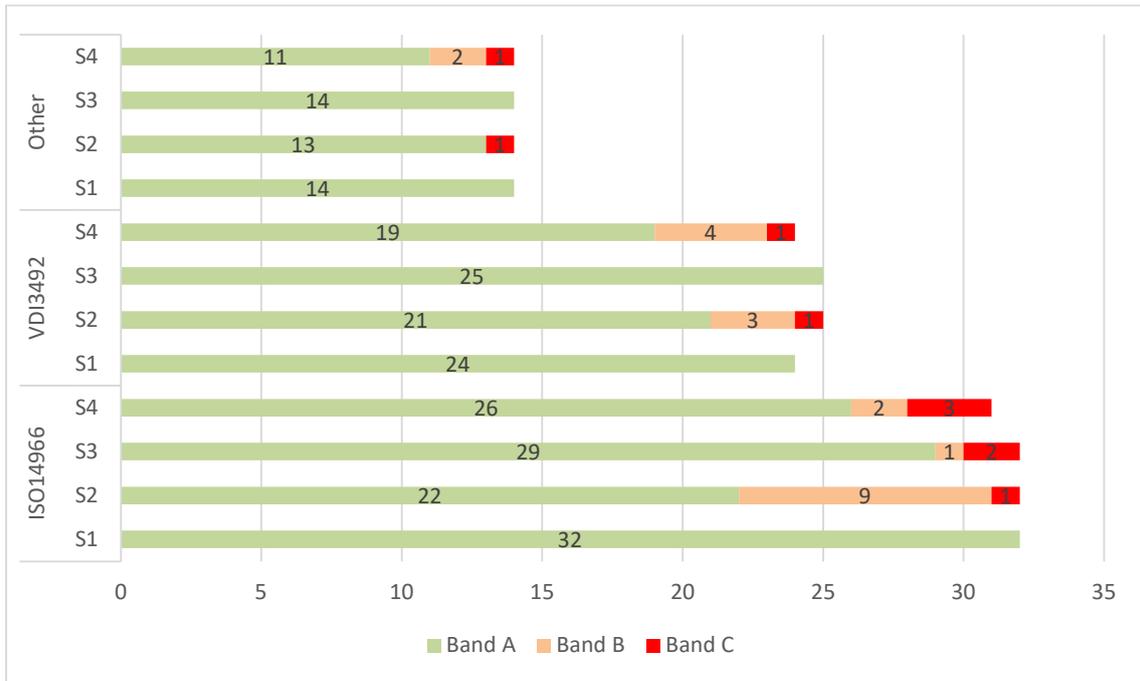


Figure 2: Banded scores for participants in SEMS Round 13C divided according to method used

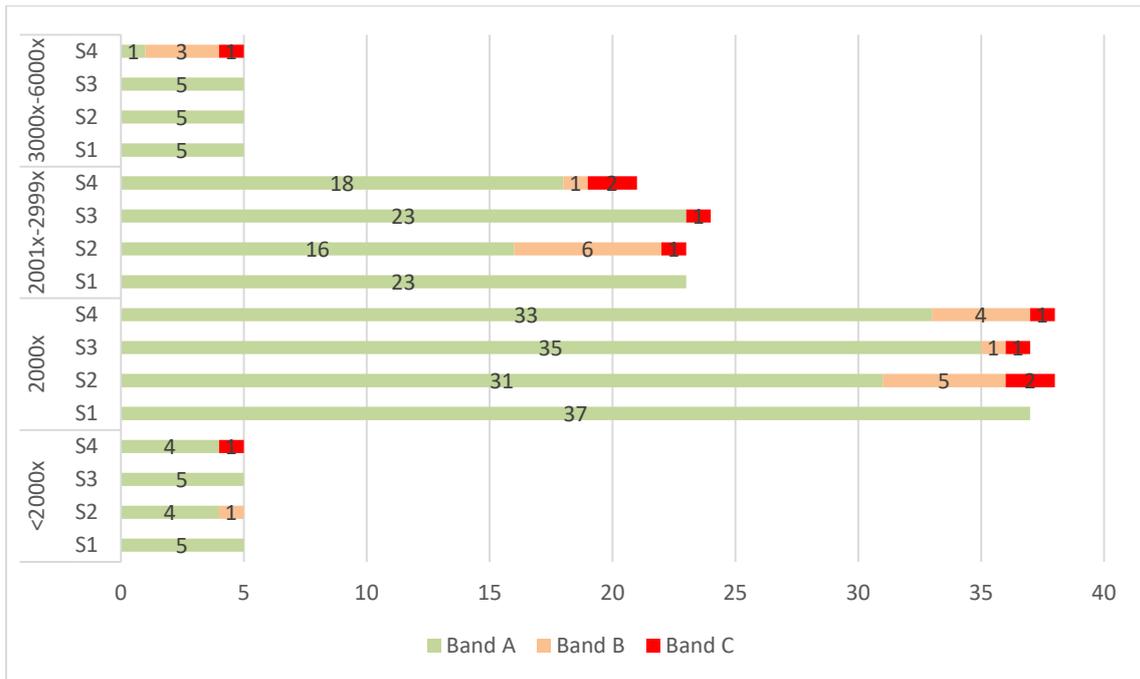


Figure 3: Banded scores for participants in SEMS Round 13C divided according to magnification used

# APPENDIX 1

**Sample 1 (13CSEM11) - Low density (0 fibres/mm<sup>2</sup>) – no asbestos (MMMMF fibres present)**

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
142	0	A
142	0	A
1181	0	A
1187	0	A
1187	0	A
1456	0	A
1458	0	A
1458	0	A
1458	0	A
1477	0	A
1477	0	A
1477	0	A
1507	0	A
1576	0	A
1576	0	A
1646	0	A
1708	0	A
1708	0	A
1717	0	A
1717	0	A
1717	0	A
1759	0	A
1759	0	A
1759	0	A
1761	0	A
1812	0	A
1812	0	A
1812	0	A
1814	0	A
1817	0	A
1826	0	A
1832	0	A
1832	0	A
1832	0	A
1856	0	A
1922	0	A
1922	0	A
1923	0	A
1927	0	A
1928	0	A
1928	0	A

# APPENDIX 1

1928	0	A
1948	0	A
1958	0	A
1984	0	A
1984	0	A
1984	0	A
1993	0	A
1993	0	A
1993	1	A
2020	0	A
2020	0	A
2020	0	A
2029	0	A
2029	0	A
2059	0	A
2059	0	A
2076	0	A
2076	0	A
2107	0	A
2107	0	A
2168	0	A
2168	0	A
2168	0	A
2182	0	A
2195	0	A
2216	0	A
2284	0	A
2305	0	A
2305	0	A

Mean 0.0  
**Median (Ref)** 0  
 STDev 0.1  
 Min 0  
 Max 1

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 (13CSEMS2) - High density (64.6 fibres/mm<sup>2</sup>) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
142	67.6	A
142	72.8	A
1181	53.62	A
1187	37.9	B
1187	38.49	B
1456	40	B
1458	48	A
1458	55.4	A
1458	57.3	A
1477	48.431	A
1477	55.211	A
1477	73.131	A
1507	65.41	A
1576	90.48	A
1576	90.67	A
1646	68.298	A
1708	49.66	A
1708	55.23	A
1717	76.1	A
1717	100.4	B
1717	119.6	B
1759	72.9	A
1759	80.8	A
1759	104.3	B
1761	62	A
1812	42.5	A
1812	49	A
1812	52	A
1814	78.3	A
1817	72	A
1826	44.59	A
1832	38.5	B
1832	45	A
1832	51	A
1856	54.73	A
1922	72.1	A
1922	98.9	A
1923	30.8	C
1927	88.166	A
1927	90.13	A
1928	55.6	A

# APPENDIX 1

1928	65	A
1928	73.1	A
1948	27	C
1958	72.68	A
1984	70.44	A
1984	87.31	A
1984	90.25	A
1993	45	A
1993	68	A
1993	72	A
2020	52	A
2020	64.58	A
2020	66.67	A
2029	83	A
2029	87	A
2059	38.5	B
2059	67.8	A
2076	27	C
2076	33.5	B
2107	38	B
2107	39	B
2168	43.52	A
2168	60.19	A
2168	67.13	A
2182	58.5	A
2195	68.37	A
2216	56	A
2284	77	A
2305	37.1835	B
2305	65.1394	A

Mean            62.6  
**Median (Ref)**    64.6  
 STDev           19.8  
 Min              27  
 Max              119.6

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
42	100.1	32.3	129.2	<32.3	>129.2

Sample 3 (13CSEM3) - Medium density (17.6 fibres/mm<sup>2</sup>) – amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
142	24.5	A
142	27.5	A
1181	19.86	A
1187	6.51	B
1187	8.88	A
1456	10	A
1458	12.3	A
1458	14.2	A
1458	15.7	A
1477	15.982	A
1477	17.919	A
1477	19.857	A
1507	25.95	A
1576	20.5	A
1576	21.4	A
1646	19.048	A
1708	13.46	A
1708	15.78	A
1717	16.7	A
1717	22.6	A
1717	27.6	A
1759	17.9	A
1759	23.9	A
1759	80.8	C
1761	13	A
1812	12	A
1812	13	A
1812	13	A
1814	27.7	A
1817	19	A
1826	14.76	A
1832	11.5	A
1832	15	A
1832	21	A
1856	18.74	A
1922	12.7	A
1922	32.2	A
1923	10	A
1927	20.082	A
1927	33.797	A
1928	13.4	A
1928	19.4	A

# APPENDIX 1

1928	20.1	A
1948	26	A
1958	10.97	A
1984	17.61	A
1984	19.08	A
1984	22.75	A
1993	12	A
1993	18	A
1993	85	C
2020	13.54	A
2020	16.67	A
2020	19.79	A
2029	23.5	A
2029	25	A
2059	11.5	A
2059	19.9	A
2076	10	A
2076	11	A
2107	11	A
2107	14	A
2168	11.57	A
2168	13.88	A
2168	15.74	A
2182	15	A
2195	21.42	A
2216	22	A
2284	14	A
2305	15.8649	A
2305	19.8312	A

Mean 19.4  
**Median (Ref)** 17.6  
 STDev 12.3  
 Min 6.5  
 Max 85.0

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
6.9	37.9	3.4	56.2	<3.4	>56.2

# APPENDIX 1

## Sample 4 (13CSEM4) - High density (85.0 fibres/mm<sup>2</sup>) – amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
142	104.2	A
142	108.7	A
1181	82.42	A
1187	63.45	A
1187	77.35	A
1456	56	A
1458	48	B
1458	63.7	A
1458	79.9	A
1477	92.987	A
1477	95.893	A
1477	99.283	A
1507	78.68	A
1576	115	A
1576	171.67	C
1646	98.709	A
1708	74.26	A
1708	78.43	A
1717	78.5	A
1717	78.5	A
1717	106.5	A
1759	97.4	A
1759	97.9	A
1759	150.4	B
1761	112	A
1812	53	B
1812	63	A
1812	68	A
1814	106.9	A
1817	128	A
1826	67.04	A
1832	77	A
1832	89	A
1832	89.5	A
1856	63.61	A
1922	82.4	A
1922	193.5	C
1923	86.2	A
1927	94.044	A
1928	75.7	A
1928	86.8	A
1928	98.5	A

# APPENDIX 1

1948	75	A
1958	107.42	A
1984	143.81	B
1984	146.75	B
1984	210.58	C
1993	58	A
1993	85	A
1993	87	A
2020	64	A
2020	71.88	A
2020	78.13	A
2029	117	A
2029	123.5	A
2059	68	A
2059	84.3	A
2076	36	C
2076	40.5	C
2107	100	A
2168	44.91	B
2168	71.06	A
2168	73.15	A
2182	93.5	A
2195	90.61	A
2216	91	A
2284	141	B
2305	50.5696	B
2305	58.9978	A

Mean 90.5  
**Median (Ref)** 85.0  
 STDev 32.9  
 Min 36  
 Max 210.6

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
55.3	131.8	42.5	170	<42.5	>170

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

