Scanning Electron Microscopy Scheme

BACKGROUND

This report covers Round 11C 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 39 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 268 results submitted.

The samples were as follows:

11CSEM1 – High density (72.0 fibres/mm^2) - amosite fibres

11CSEM2 – Medium density (44.2 fibres/mm^2) - amosite fibres

11CSEM3 – No asbestos added (0.0 fibres/mm^2) - MMMF fibres present

11CSEM4 – Medium density (20.6 fibres/mm^2) - chrysotile 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^2) for each fibre type identified.

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 of ranging from 900x to 2750x 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 11C 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 11C

	Sample 1	Sample 2	Sample 3	Sample 4
Number of results	67	67	67	67
Median (fibres/mm^2)	72.0	44.2	0.0	20.6
25th percentile (fibres/mm^2)	62.2	35.8	0.0	13.8
75th percentile (fibres/mm^2)	90.0	54.5	0.0	31.3
Interquartile range (fibres/mm^2)	27.8	18.8	0.0	17.5
Mean (fibres/mm^2)	76.7	44.9	0.4	22.7
Standard deviation (fibres/mm^2)	31.6	15.6	1.8	13.9
Relative standard deviation (%)	41.2	34.8	437	61.3

*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, the value of the RSD can be considered largely meaningless.*

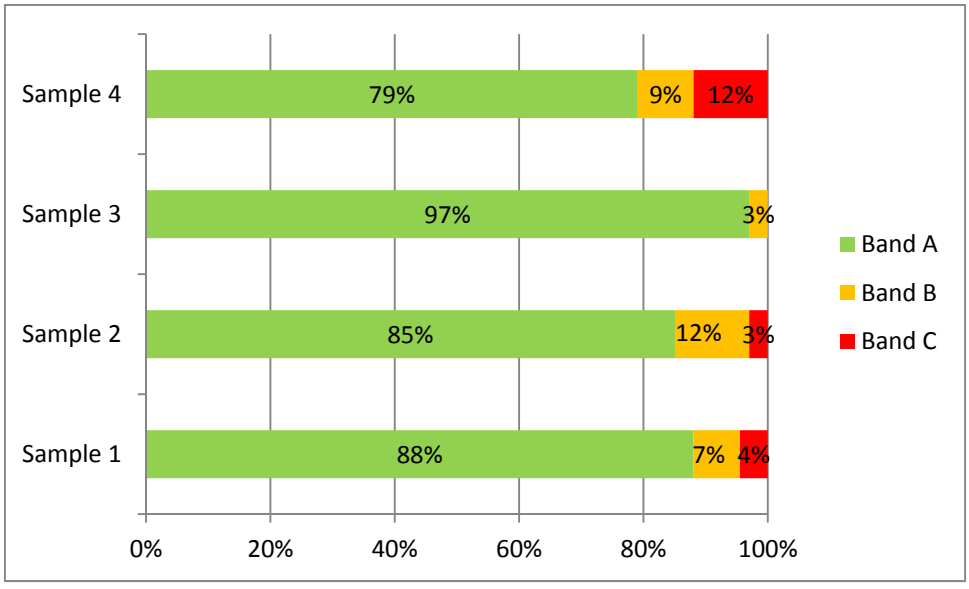

Figure 1: Banded scores for participants in SEMS Round 11C (categorised as per RICE scoring system - see Appendix 2)

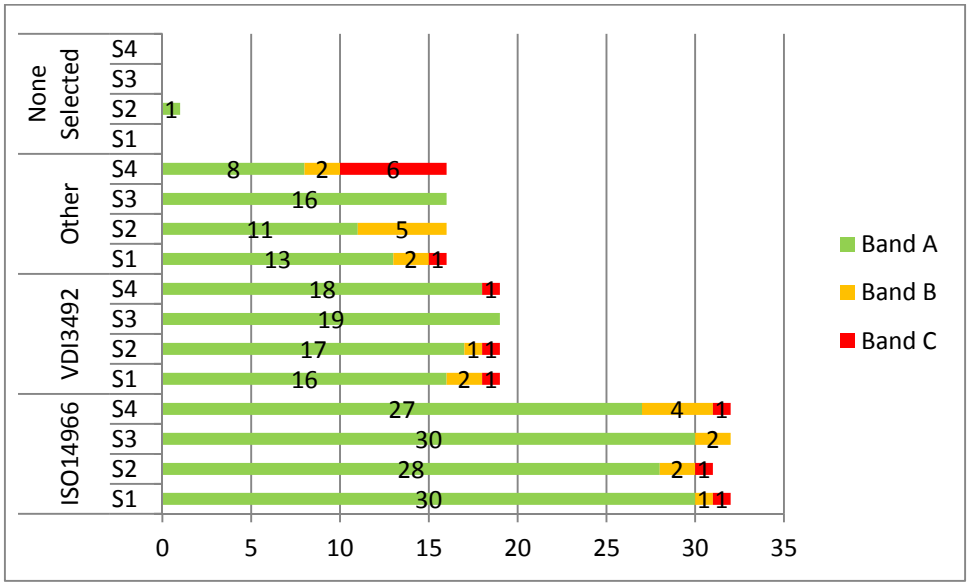

Figure 2: Banded scores for participants in SEMS Round 11C divided according to method used

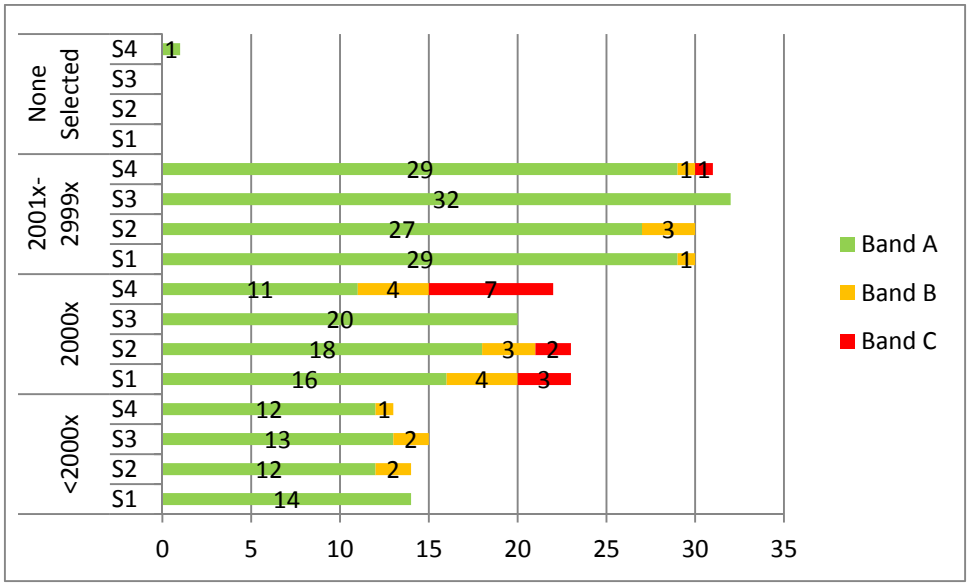

Figure 3: Banded scores for participants in SEMS Round 11C divided according to magnification used

APPENDIX 1

Sample 1 (11CSEM1) - High density (72.0 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
1620	63.5	A
1620	58	A
1620	70	A
1187	62.06	A
1187	59.81	A
1868	93.15	A
1868	83.15	A
1868	84.25	A
1923	88	A
1923	76.6	A
1937	41.4	B
1937	45.7	B
1938	58	A
1928	71.1	A
1928	64.4	A
1928	74.4	A
1958	1.62	C
1966	69.1	A
1976	70	A
1976	75	A
1976	70	A
1993	90	A
1993	95	A
1993	89	A
2020	74.67	A
2020	94.79	A
2020	73.96	A
2032	66	A
2037	70.83	A
2037	70.83	A
2037	111.11	A
1977	259	C
2069	99	A
2107	92	A
2107	94	A
2107	87	A
2116	76	A
2182	103.5	A
2191	68.52	A
2202	61.76	A
2203	38.82	B
2061	78.41	A

2061	62.238	A
2061	62.238	A
1992	55.22	A
1992	55.72	A
2098	96.5	A
2194	55.9	A
2051	110.41	A
1936	67.93	A
1936	64.93	A
1646	65.789	A
2053	88.06	A
2053	90	A
2125	129.5	B
2125	99.2	A
1948	95	A
2192	84.3	A
2192	88.4	A
2059	40.7	B
2059	52.33	A
2188	61.5	A
2188	66.66	A
2261	98.2	A
2260	1.9	C
2265	72	A
2168	98.1	A

Mean	76.7
Median (Ref)	72
STDev	31.6
Min	1.6
Max	259.0

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
46.8	111.6	36	144	<36	>144

25th %ile	62.2
75th%ile	90.0
Interquartile	27.8
RSD/%	41.2

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Sample 2 (11CSEM2) - Medium density (44.2 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
1620	31	A
1620	52	A
1620	47.5	A
1187	29.02	A
1187	49.75	A
1868	54.5	A
1868	66.05	A
1868	68.15	A
1923	41.6	A
1923	32.9	A
1937	41	A
1937	51.9	A
1938	44	A
1928	35.5	A
1928	41.6	A
1928	45.6	A
1958	0.95	C
1966	50.4	A
1976	19.5	B
1976	56	A
1976	36	A
1993	52	A
1993	55	A
1993	61	A
2020	79.17	B
2020	76.19	B
2020	54.17	A
2032	22	B
2037	47.92	A
2037	34.38	A
2037	55.56	A
1977	70.7	A
2069	48	A
2107	53	A
2107	37	A
2107	57	A
2116	45	A
2182	53.5	A
2191	64.084	A
2202	40.94	A
2203	25.88	A

2061	38.715	A
2061	38.225	A
2061	42.146	A
1992	31.12	A
1992	26.1	A
2098	54.5	A
2194	31.4	A
2051	59.96	A
1936	41.95	A
1936	43.95	A
1646	45.113	A
2053	42.1	A
2053	57.58	A
2125	69.5	A
2125	77.9	B
1948	51	A
2192	40.2	A
2192	44.2	A
2059	11.63	C
2059	24.22	B
2188	43.1	A
2188	36.21	A
2261	24.9	B
2260	19	B
2265	27.5	A
2168	57.4	A

Mean	44.9
Median (Ref)	44.2
STDev	15.6
Min	1.0
Max	79.2

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
25.8	74.1	18.6	99	<18.6	>99

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Sample 3 (11CSEM3) – No asbestos added (0.0 fibres/mm^2) – MMMF fibres present

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
1620	0	A
1620	0	A
1620	0	A
1187	0	A
1187	0	A
1868	0	A
1868	0	A
1868	0	A
1923	0	A
1923	0	A
1937	2.9	A
1937	1	A
1938	0	A
1928	0	A
1928	0	A
1928	0	A
1958	0	A
1966	0	A
1976	0	A
1976	0	A
1976	0	A
1993	0	A
1993	0	A
1993	0	A
2020	0	A
2020	0	A
2020	0	A
2032	0	A
2037	0	A
2037	0	A
2037	0	A
1977	0	A
2069	0	A
2107	0	A
2107	0	A
2107	0	A
2116	0	A
2182	0	A
2191	0	A
2202	0	A
2203	0	A
2061	0	A

2061	0	A
2061	0	A
1992	10.54	B
1992	10.54	B
2098	0	A
2194	0	A
2051	0	A
1936	0	A
1936	0	A
1646	0.94	A
2053	0	A
2053	0	A
2125	0	A
2125	0	A
1948	0	A
2192	0	A
2192	0	A
2059	0	A
2059	0	A
2188	1.72	A
2188	0.57	A
2261	0	A
2260	0	A
2265	0	A
2168	0	A

Mean	0.4
Median (Ref)	0
STDev	1.8
Min	0.0
Max	10.5

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

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Sample 4 (11CSEM4) - Medium density (20.6 fibres/mm^2) - chrysotile fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
1620	26	A
1620	34	A
1620	28	A
1187	10.66	A
1187	7.7	B
1868	14.55	A
1868	20.45	A
1868	13.65	A
1923	27.1	A
1923	17.4	A
1937	2.9	C
1937	1.4	C
1938	23	A
1928	15.4	A
1928	16.1	A
1928	16.1	A
1958	0.5	C
1966	17.3	A
1976	32	A
1976	32	A
1976	26	A
1993	36	A
1993	31	A
1993	34	A
2020	80.58	C
2020	51.04	B
2020	32.29	A
2032	5	B
2037	38.89	A
2037	23.96	A
2037	20.83	A
1977	20.4	A
2069	29	A
2107	18	A
2107	14	A
2107	19	A
2116	17	A
2182	31.5	A
2191	36.47	A
2202	24.15	A
2203	12.94	A
2061	30.384	A

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2061	20.583	A
2061	19.603	A
1992	11.04	A
1992	11.04	A
2098	14.5	A
2194	13.1	A
2051	43.78	B
1936	2.997	C
1936	3.99	C
1646	18.797	A
2053	32.9	A
2053	27.58	A
2125	38.7	A
2125	31.8	A
1948	17.5	A
2192	33.1	A
2192	31.1	A
2059	3.88	C
2059	2.91	C
2188	24.14	A
2188	21.26	A
2261	30.8	A
2260	8.6	B
2265	12	A
2168	55.6	B

Mean	22.7
Median (Ref)	20.6
STDev	13.9
Min	0.5
Max	80.6

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
8.8	42.2	4.8	61.4	<4.8	>61.4

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/mm^2.