Scanning Electron Microscopy Scheme

BACKGROUND

This report covers Round 14A 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 482 results submitted.

The samples were as follows:

14ASEMS1 – High density (92.0 fibres/mm^2) – amosite fibres

14ASEMS2 – High density (68.0 fibres/mm^2) - chrysotile fibres

14ASEMS3 – Medium density (33.0 fibres/mm^2) – chrysotile fibres

14ASEMS4 – Medium density (33.5 fibres/mm^2) – 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^2) 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 ranging from 900x to 4000x 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 14A 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 14A.

	Sample 1	Sample 2	Sample 3	Sample 4
Number of results	122	121	119	120
Median (fibres/mm^2)	92.0	68.0	33.0	33.5
25th percentile (fibres/mm^2)	79.6	45.9	24.8	26.4
75th percentile (fibres/mm^2)	109.4	91.0	50.0	41.0
Interquartile range (fibres/mm^2)	29.8	45.1	25.3	14.6
Mean (fibres/mm^2)	93.5	69.7	41.3	37.2
Standard deviation (fibres/mm^2)	30.3	35.0	34.0	21.2
Relative standard deviation (%)	32.4	50.3	82.4	57.0

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.
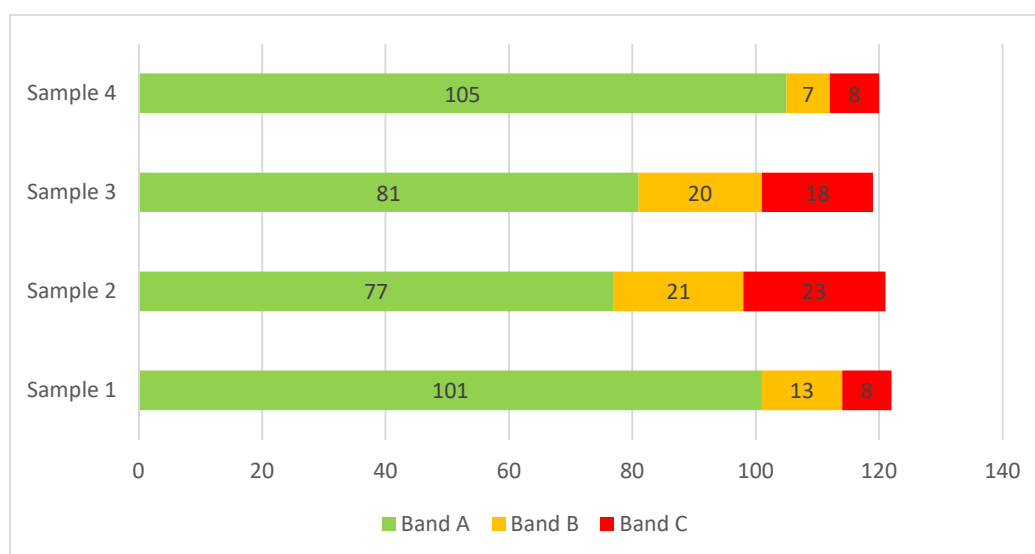
Figure 1: Banded scores for participants in SEMS Round 14A (categorised as per RICE scoring system - see Appendix 2)
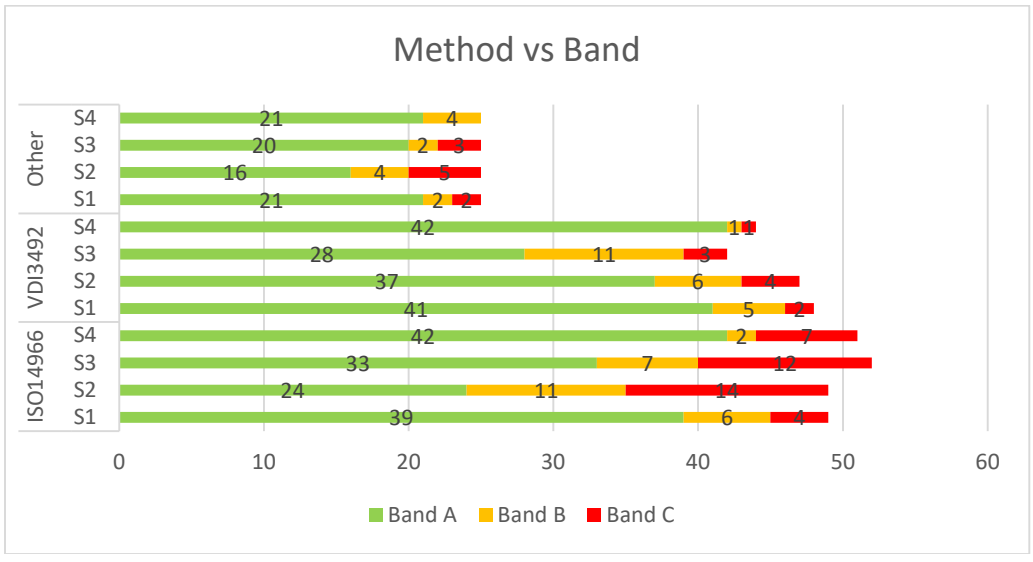
Figure 2: Banded scores for participants in SEMS Round 14A divided according to method used
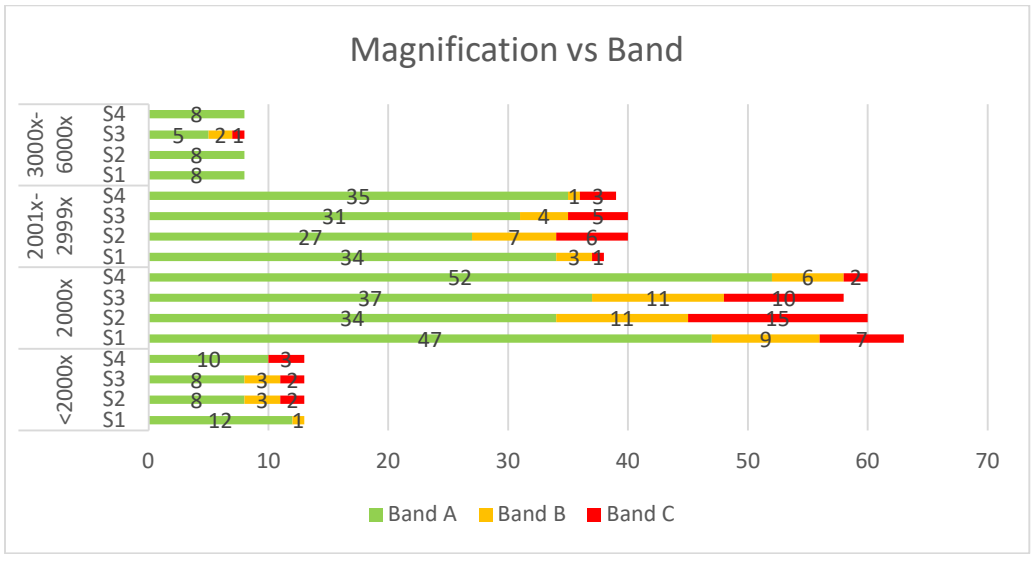
Figure 3: Banded scores for participants in SEMS Round 14A divided according to magnification use

Sample 1 (14ASEM1) - High density (92 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	113.9	A
7	121.3	A
7	133	A
199	130.5	A
199	132.4	A
300	80	A
807	107.82	A
807	124.62	A
1187	45.01	C
1187	59.22	B
1445	97	A
1456	99.8	A
1477	90.081	A
1477	94.924	A
1477	96.862	A
1576	57.14	B
1576	83.95	A
1579	102.5	A
1579	103	A
1579	104.5	A
1582	137	A
1620	86	A
1620	96	A
1620	103	A
1638	123.1	A
1639	83	A
1658	75.5	A
1658	84	A
1669	95	A
1669	167	B
1669	190.2	C
1675	80	A
1684	92	A
1684	104.1	A
1684	108	A
1687	132.3	A
1708	54.3	B
1708	58.5	B
1720	137.5	A
1761	77	A
1761	98	A
1761	113	A
1764	87.5	A
1764	92.5	A

1764	120	A
1765	91.79	A
1765	111.76	A
1767	50.6	B
1767	64.1	A
1767	78.3	A
1784	89.4	A
1817	159	B
1831	72.8	A
1831	114.9	A
1838	96.5	A
1838	99	A
1838	118	A
1841	106	A
1841	120	A
1860	150.08	B
1877	84.08	A
1889	117	A
1903	80	A
1903	100	A
1922	79.46	A
1922	90.16	A
1923	102.5	A
1927	109.8	A
1927	114.71	A
1928	68.7	A
1928	69.2	A
1928	74.6	A
1937	80.4	A
1937	84	A
1937	99.7	A
1976	89	A
1976	110	A
1976	112	A
1977	86.03	A
1981	29.52	C
1981	37.14	C
1981	39.05	C
1993	74.2	A
1993	76	A
1993	81.6	A
2020	91.33	A
2020	95.33	A
2020	97.33	A
2024	73.5	A
2029	63	A
2029	77	A
2051	118.09	A

2051	123.01	A
2051	129.9	A
2059	59.11	B
2059	75.58	A
2069	107	A
2085	83.893	A
2107	86	A
2107	89	A
2107	92	A
2132	69	A
2132	82	A
2135	53	B
2135	95	A
2135	103	A
2167	80	A
2182	72.5	A
2188	83.04	A
2188	85.96	A
2226	80.65	A
2226	95.44	A
2226	95.86	A
2265	150	B
2288	7.48	C
2289	86.55	A
2329	83.8	A
2329	101.8	A
2330	146.73	B
2335	20	C
2341	0	C
2346	174.5	B

Mean	93.5
Median (Ref)	92.0
STDev	30.3
Min	0
Max	190.2

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
59.8	142.6	46.0	184.0	<46.0	>184.0

APPENDIX 1

Sample 2 (14ASEM2) – High density (68 fibres/mm^2) - chrysotile fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	12.3	C
7	15.2	C
199	30.5	C
199	32.8	C
300	74	A
807	110.62	B
807	128.82	B
1187	21.32	C
1187	37.31	B
1445	86	A
1456	47.9	A
1477	96.862	A
1477	97.346	A
1477	98.799	A
1576	74.29	A
1576	81.94	A
1579	84	A
1579	85	A
1579	86	A
1582	98	A
1620	69.5	A
1620	76.5	A
1620	90	A
1638	77.5	A
1639	88	A
1658	69	A
1658	72	A
1669	84	A
1669	123	B
1669	184	C
1675	110	B
1684	88.1	A
1684	91	A
1684	93	A
1687	79.1	A
1708	46.4	A
1708	50.12	A
1720	54.5	A
1761	27	C
1761	29	C
1761	47	A

1764	94.5	A
1764	116.5	B
1764	136	B
1765	93.79	A
1765	141.33	C
1767	29.2	C
1767	58.21	A
1767	78.36	A
1784	15.3	C
1817	192	C
1831	71.6	A
1831	89.1	A
1838	42	B
1838	47	A
1838	50	A
1841	41	B
1841	61	A
1860	127.42	B
1877	56.05	A
1889	108.88	B
1903	63.5	A
1903	75.5	A
1922	44.35	A
1922	63.35	A
1923	68	A
1927	58.33	A
1927	83.82	A
1928	35.9	B
1928	38.6	B
1928	45.9	A
1937	58.8	A
1937	60.6	A
1937	61.1	A
1976	61	A
1976	104	A
1976	107	B
1977	61.9	A
1981	30.47	C
1981	30.48	C
1981	37.14	B
1993	82.8	A
1993	94.4	A
1993	103	A
2020	66	A
2020	93.75	A
2020	96.88	A
2024	27	C
2029	24	C

2029	27	C
2051	60.03	A
2051	127.93	B
2051	135.8	B
2059	0	C
2059	0.97	C
2069	71	A
2085	71.429	A
2107	41	B
2107	42	B
2107	45	A
2132	59	A
2132	61	A
2135	27	C
2135	53	A
2135	56	A
2167	59.5	A
2182	97.5	A
2188	30.4	C
2188	52.05	A
2226	57.43	A
2226	63.77	A
2226	75.59	A
2265	85	A
2288	1.25	C
2289	48.92	A
2329	80.8	A
2329	109.7	B
2330	124.18	B
2335	14	C
2341	88	A
2346	92.2	A

Mean	69.7
Median (Ref)	68.0
STDev	35.0
Min	0
Max	192

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
44.2	105.4	34.0	136.0	<34.0	>136.0

APPENDIX 1

Sample 3 (14ASEM3) - Medium density (33.0 fibres/mm^2) - chrysotile fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	10.8	C
7	12.3	B
199	21.9	A
199	31.4	A
199	31.9	A
300	44	A
807	45.74	A
807	57.39	A
1187	21.32	A
1187	31.98	A
1445	71	B
1456	15.9	B
1477	73.131	B
1477	76.521	B
1477	88.144	C
1576	30.48	A
1576	46.21	A
1579	29.5	A
1579	30	A
1579	30	A
1582	46	A
1620	25.5	A
1620	35	A
1620	57	A
1638	34	A
1639	33	A
1658	33	A
1658	35	A
1669	55	A
1669	79	B
1669	89	C
1675	26	A
1684	75	B
1684	79.9	B
1684	82.3	C
1687	45.4	A
1708	20.4	A
1708	22.3	A
1720	29	A
1761	9	C
1761	10	C
1761	22	A
1764	49	A
1764	50	A
1764	66.5	B

1765	60.86	B
1765	61.86	B
1767	124.43	C
1767	213.68	C
1767	263.16	C
1784	9.6	C
1817	43	A
1831	18.5	A
1831	27.9	A
1838	14	B
1838	14	B
1838	21	A
1841	45	A
1841	62	B
1860	42	A
1877	33.03	A
1889	49.26	A
1903	35.5	A
1903	50	A
1922	20.96	A
1922	23.88	A
1923	33.6	A
1927	64.21	B
1927	83.82	C
1928	20.4	A
1928	22.5	A
1928	24.5	A
1937	31.4	A
1937	45.8	A
1937	48	A
1976	47	A
1976	51	A
1976	55	A
1977	25.17	A
1981	0.95	C
1981	3.81	C
1981	5.71	C
1993	26.2	A
1993	34.5	A
1993	41.9	A
2020	36.46	A
2020	40.67	A
2020	52.08	A
2024	17	B
2029	29	A
2029	32	A
2051	14.76	B
2051	61.01	B

2051	79.71	B
2059	0	C
2059	0	C
2069	50	A
2085	44.414	A
2107	30	A
2107	31	A
2107	32	A
2132	19	A
2132	29	A
2135	25	A
2167	45.5	A
2182	37	A
2188	25.15	A
2188	25.15	A
2226	26.18	A
2226	29.98	A
2265	67	B
2288	3.32	C
2289	27.28	A
2329	26.9	A
2329	35.9	A
2330	54.73	A
2335	43	A
2341	31	A
2346	6.5	C

Mean	41.3
Median (Ref)	33
STDev	34.0
Min	0
Max	263.16

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
17.4	59.4	11.6	81.8	<11.6	>81.8

APPENDIX 1

Sample 4 (14ASEM4) - Medium density (33.5 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	24.1	A
7	26.5	A
199	21.4	A
199	22.9	A
300	29	A
807	47.69	A
807	54.7	A
1187	20.73	A
1187	44.42	A
1445	40	A
1456	28.4	A
1477	36.323	A
1477	39.713	A
1477	41.166	A
1576	35.24	A
1576	39.34	A
1579	26	A
1579	27	A
1579	28.5	A
1582	32	A
1620	25.5	A
1620	38	A
1620	53	A
1638	33.5	A
1639	31	A
1658	33.5	A
1658	34	A
1669	41	A
1669	43	A
1669	75	B
1675	37	A
1684	27.1	A
1684	37.3	A
1684	39.7	A
1687	24.8	A
1708	33.4	A
1708	35.7	A
1720	47	A
1761	28	A
1761	36	A
1761	56	A
1764	39	A
1764	48.5	A
1764	49	A
1765	19.95	A

1765	40.91	A
1767	106.84	C
1767	113.36	C
1767	169.9	C
1784	25.5	A
1817	33	A
1831	22.2	A
1831	53.3	A
1838	25	A
1838	26	A
1838	29	A
1841	38	A
1841	41	A
1860	50.97	A
1877	30.03	A
1889	32.84	A
1903	26.5	A
1903	37	A
1922	24.37	A
1922	25.34	A
1923	35.4	A
1927	33.82	A
1928	15.4	B
1928	17.4	B
1928	20.1	A
1937	26.9	A
1937	30.1	A
1937	31.9	A
1976	57	A
1976	87	C
1976	106	C
1977	22.45	A
1981	4.76	C
1981	13.33	B
1981	17.14	B
1993	30	A
1993	38.6	A
1993	46.4	A
2020	30.67	A
2020	31.25	A
2020	37.5	A
2024	32	A
2029	36	A
2029	37	A
2051	11.81	C
2051	40.35	A
2051	41.33	A
2059	19.86	A

2059	22.29	A
2069	42	A
2085	47.375	A
2107	28	A
2107	29	A
2107	32	A
2132	25	A
2132	27	A
2135	29	A
2135	31	A
2135	35	A
2167	17	B
2182	33.5	A
2188	24.56	A
2188	25.73	A
2226	34.63	A
2226	38.43	A
2226	41.8	A
2265	35.5	A
2288	22.44	A
2289	31.99	A
2329	46.9	A
2329	47.9	A
2330	57.09	A
2335	80	B
2341	0	C
2346	49.4	A

Mean	37.2
Median (Ref)	33.5
STDev	21.2
Min	0
Max	169.9

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
17.8	60.0	11.9	82.6	<11.9	>82.6

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 ≤ 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.