Scanning Electron Microscopy Scheme

BACKGROUND

This report covers Round 10 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 51 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 372 results submitted.

The samples were as follows:

10SEM1 – Medium density (56.0 fibres/mm^2) - amosite fibres

10SEM2 – Medium density (20.0 fibres/mm^2) - amosite fibres

10SEM3 – High density (72.3 fibres/mm^2) - amosite fibres

10SEM4 – Medium density (29.0 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.

LABORATORY ASSESSMENT

RESULTS

Calculations – Note that results from one laboratory were not included in the calculation of the median for all four samples.

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 4000x, 3000x, 2000x and 1000x 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 10 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 10

	Sample 1	Sample 2	Sample 3	Sample 4
Number of results	92	94	93	93
Median (fibres/mm^2)	56.1	19.8	71.7	29.0
25th percentile (fibres/mm^2)	45.8	16.1	57.0	24.0
75th percentile (fibres/mm^2)	71.7	24.7	89.3	37.0
Interquartile range (fibres/mm^2)	25.8	8.6	32.3	13.0
Mean (fibres/mm^2)	59.7	22.1	74.2	31.7
Standard deviation (fibres/mm^2)	23.2	9.2	22.0	13.9
Relative standard deviation (%)	38.8	41.8	29.7	43.7

*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.*

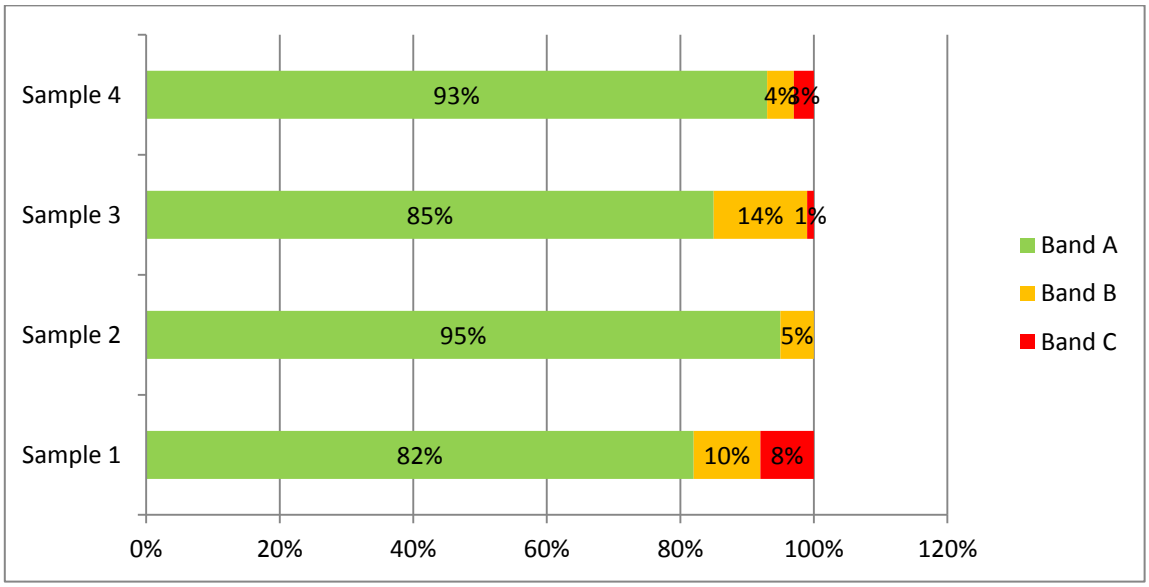


Figure 1: Banded scores for participants in SEMS Round 10 (categorised as per RICE scoring system - see Appendix 2)

Figure 2: Banded scores for participants in SEMS Round 10 divided according to method used

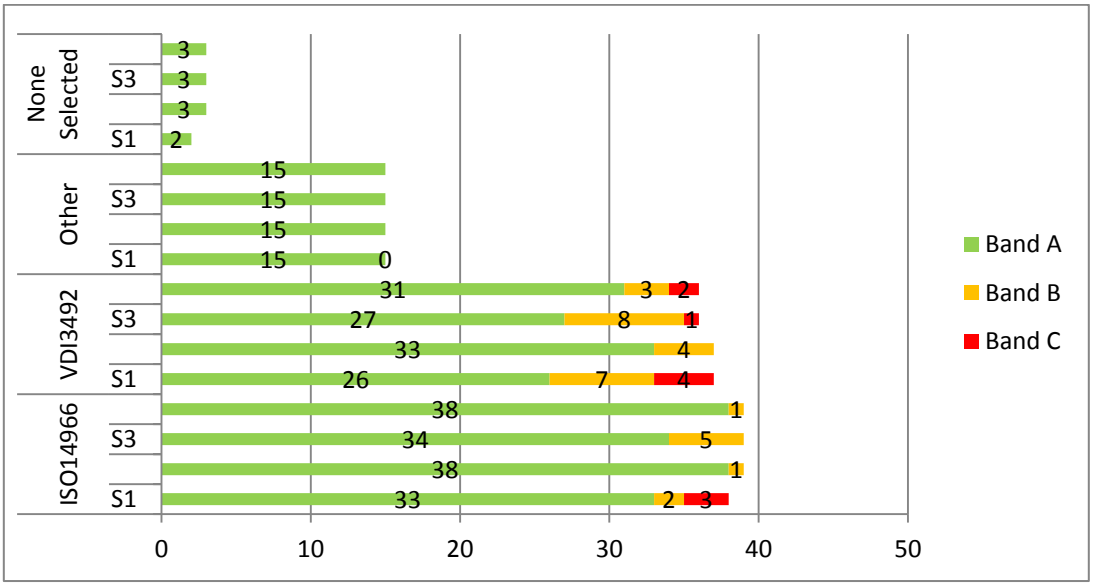
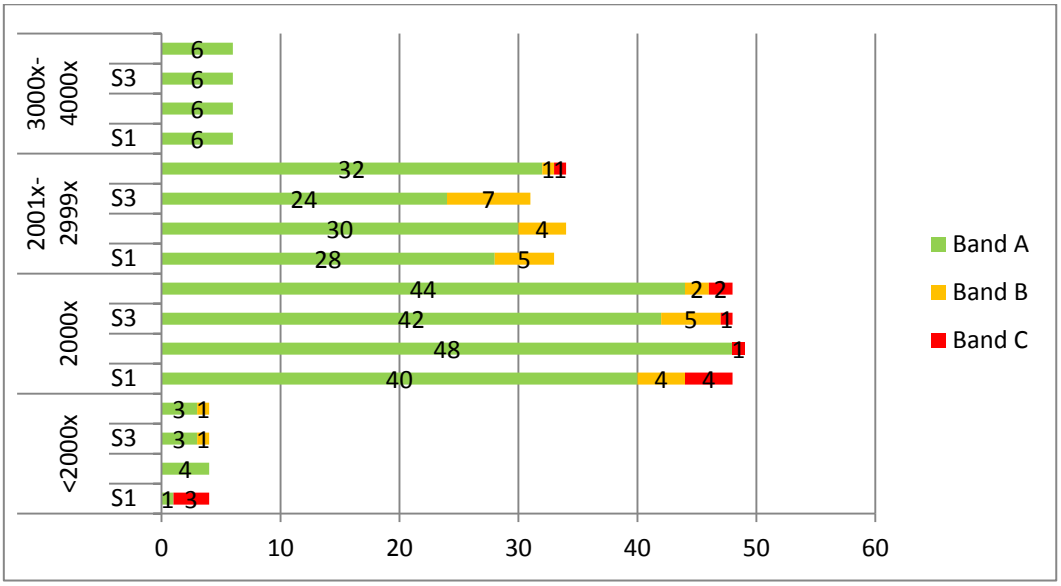


Figure 3: Banded scores for participants in SEMS Round 10 divided according to magnification use



APPENDIX 1

Sample 1 (10SEM1) - Medium density (56.0 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	70.9	A
7	85	A
139	52.2	A
139	55.75	A
300	66	A
709	73.5	A
807	46.09	A
807	48.43	A
1181	88.71	A
1187	66.92	A
1267	45	A
1267	52	A
1277	67.6	A
1445	72	A
1477	37.037	A
1477	33.043	B
1477	34.495	B
1507	95.11	B
1546	54.74	A
1562	68	A
1562	71.6	A
1562	69.3	A
1569	56	A
1579	63	A
1579	65	A
1579	64	A
1582	84.5	A
1592	32	B
1592	23	C
1639	79	A
1640	47.6	A
1658	57	A
1658	48.5	A
1680	60.8	A
1680	65.1	A
1680	41.9	A
1684	51	A
1687	94	B
1708	77.5	A
1708	73.3	A
1708	76.6	A
1715	71.29	A

1717	42.3	A
1717	38.4	A
1717	64.4	A
1718	63	A
1718	51	A
1718	79	A
1734	64	A
1734	49	A
1738	88	A
1745	54.4	A
1759	38.66	A
1759	40.13	A
1759	42.86	A
1761	63	A
1761	56	A
1761	61	A
1764	49.5	A
1764	47	A
1764	43.5	A
1767	39.23	A
1767	41.45	A
1767	43.7	A
1768	42.32	A
1774	52.1	A
1774	43.7	A
1784	51.92	A
1812	50.5	A
1812	53.5	A
1812	52.5	A
1814	64.9	A
1817	100	B
1831	77.8	A
1831	53	A
1831	34.1	B
1832	53	A
1838	0	C
1838	0	C
1838	0	C
1852	64.6	A
1852	36	A
1856	56.2	A
1860	82.12	A
1866	71.8	A
1866	72.7	A
1868	116.4	C
1868	119	C

1868	132.7	C
1871	93.5	B
1871	114	B
1877	62.3	A

Mean	59.7
Median (Ref)	56.1
STDev	23.2
Min	0.0
Max	132.7

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
35	89.2	26.5	116.3	<26.5	>116.3

Sample 2 (10SEM2) - Medium density (20.0 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	23.6	A
7	23.6	A
139	17.92	A
139	16.1	A
300	18	A
709	32.5	A
807	19.25	A
807	16.34	A
1181	27.31	A
1187	22.5	A
1267	17	A
1267	20	A
1277	26.7	A
1445	22	A
1477	12.346	A
1477	18.155	A
1477	18.882	A
1507	11.53	A
1546	22.038	A
1546	17.062	A
1562	29	A
1562	24.4	A
1562	31.5	A
1569	18	A

1579	24	A
1579	22	A
1579	25	A
1582	18	A
1592	15	A
1592	14	A
1639	23	A
1640	27.5	A
1658	18	A
1658	19.5	A
1680	16.1	A
1680	16.1	A
1680	10.1	A
1684	18	A
1687	34.6	A
1708	21.8	A
1708	24.6	A
1708	22.7	A
1715	29.7	A
1717	18.7	A
1717	17.7	A
1717	21.7	A
1718	13	A
1718	9	A
1718	16	A
1734	53	B
1734	56	B
1734	49	B
1738	28	A
1745	17.2	A
1759	19.54	A
1759	34.91	A
1759	48.32	B
1761	28	A
1761	15	A
1761	24	A
1764	11	A
1764	16	A
1764	17.5	A
1767	24.62	A
1767	9.52	A
1767	13.33	A
1768	20.61	A
1774	27.8	A
1774	22.4	A
1784	16.02	A

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1812	20	A
1812	16.5	A
1812	16.5	A
1814	27.7	A
1817	30	A
1831	14.8	A
1831	9	A
1831	11.1	A
1832	15	A
1838	15	A
1838	16	A
1838	12	A
1852	23	A
1852	19	A
1856	20.2	A
1860	15.1	A
1866	20.5	A
1866	19.6	A
1868	38.6	A
1868	35.9	A
1868	33.6	A
1871	24.5	A
1871	44	B
1877	24.7	A

Mean	22.1
Median (Ref)	19.8
STDev	9.2
Min	9.0
Max	56.0

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
8.4	41.4	4.5	60.4	<4.5	>60.4

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Sample 3 (10SEM3) - High density (72.3 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	110.6	A
7	98.3	A
139	96.07	A
139	71.71	A
300	79	A
709	83.5	A
807	82.95	A
807	71.55	A
1181	94.82	A
1187	53.89	A
1267	81	A
1267	75	A
1277	78	A
1445	98	A
1477	54.466	A
1477	61.728	A
1477	41.394	B
1507	76.09	A
1546	58.295	A
1546	52.295	A
1562	73.4	A
1562	88.6	A
1562	89.7	A
1569	62	A
1579	76.5	A
1579	74	A
1579	71.5	A
1582	124.5	B
1592	42	B
1592	45	B
1639	69	A
1640	78	A
1658	66	A
1658	58.5	A
1680	53.7	A
1680	56.9	A
1680	69.4	A
1684	86	A
1687	100	A
1708	84	A
1708	78.4	A
1708	91	A

1715	74.26	A
1717	94.6	A
1717	71.7	A
1717	44.3	B
1718	63	A
1718	63	A
1734	56	A
1734	54	A
1734	53	A
1738	108	A
1745	63	A
1759	60.92	A
1759	52.94	A
1759	51.26	A
1761	92	A
1761	57	A
1761	76	A
1764	61.5	A
1764	53	A
1764	67.5	A
1767	56.92	A
1767	51.43	A
1767	36.23	B
1768	57.89	A
1774	89.3	A
1774	90.6	A
1784	62.18	A
1812	60	A
1812	62	A
1812	56.5	A
1814	74	A
1817	116	B
1831	72.8	A
1831	60.5	A
1831	92.9	A
1832	93	A
1838	47	A
1838	37	B
1838	30	C
1852	81	A
1852	80	A
1856	71	A
1860	52.86	A
1866	113.7	B
1866	125.8	B
1868	103.3	A

1868	109.1	A
1868	112.8	B
1871	129	B
1871	124.5	B
1877	78.3	A

Mean	74.2
Median (Ref)	71.7
STDev	22.0
Min	30.0
Max	129.0

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
47	112.1	36.2	144.6	<36.2	>144.6

Sample 4 (10SEM4) - Medium density (29.0 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	37.4	A
7	35.9	A
139	45.3	A
139	32.68	A
300	28	A
709	37	A
807	37.34	A
807	33.26	A
1181	50.64	A
1187	23.1	A
1267	27	A
1267	34	A
1277	19.2	A
1445	18	A
1477	28.322	A
1477	24.328	A
1477	19.971	A
1507	32.16	A
1546	19.905	A
1546	7.82	C
1562	38.4	A
1562	44.3	A

1562	42.8	A
1569	29	A
1579	33.5	A
1579	34.5	A
1579	34	A
1582	119	C
1592	17	A
1592	9	C
1639	29	A
1640	39.6	A
1658	24	A
1658	32	A
1680	24.1	A
1680	28.9	A
1680	29.2	A
1684	22	A
1687	57.4	B
1708	31.6	A
1708	33	A
1708	30.2	A
1715	21.78	A
1717	42.3	A
1717	24.6	A
1717	26.6	A
1718	18.5	A
1718	21.5	A
1734	51	A
1734	41	A
1734	48	A
1738	43	A
1745	24.8	A
1759	33.62	A
1759	36.13	A
1759	28.15	A
1761	25	A
1761	23	A
1761	23	A
1764	27.5	A
1764	20.5	A
1764	27	A
1767	23.08	A
1767	23.55	A
1767	18.57	A
1768	30.26	A
1774	26.3	A
1774	20.4	A

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1784	25	A
1812	25	A
1812	28.5	A
1812	27.5	A
1814	25.4	A
1817	33.5	A
1831	23.2	A
1831	25.2	A
1831	29.2	A
1832	33	A
1838	19	A
1838	14	B
1838	14	B
1852	54	A
1852	28	A
1856	40.9	A
1860	31.15	A
1866	28	A
1866	37.3	A
1868	48.2	A
1868	50	A
1868	62.4	B
1871	33.5	A
1871	45.5	A
1877	45.8	A

Mean	31.7
Median (Ref)	29
STDev	13.9
Min	7.8
Max	119.0

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
14.6	54	9.3	75.4	<9.3	>75.4

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.