Zusammenfassung der Ergebnisse SEMS 3

Scanning Electron Microscopy Scheme - Round 3

Sample 1 - 3SEM1 [fibres mm^{-2}]	Amphibole	Chrysotile	Other Inorganic Fibres	Total Fibres	**Total Asbestos**
CRB, Lab 1640	**0**	**0**	**1,2**	**1,2**	**0,0**
Mean					**2,9**
Median					**0,0**
Min					**0,0**
Max					**130,4**
STDev					**15,7**
RICE A, lower / upper limit					**0,0 - 3,8**

Sample 2 - 3SEM2 [fibres mm^{-2}]	Amphibole	Chrysotile	Other Inorganic Fibres	Total Fibres	**Total Asbestos**
CRB, Lab 1640	**24,4**	**0,5**	**16,6**	**41,5**	**24,9**
Mean					**23,3**
Median					**23,0**
Min					**0,0**
Max					**51,2**
STDev					**9,9**
RICE A, lower / upper limit					**10,4 - 45,6**

Sample 3 - 3SEM3 [fibres mm^{-2}]	Amphibole	Chrysotile	Other Inorganic Fibres	Total Fibres	**Total Asbestos**
CRB, Lab 1640	**160,0**	**1,0**	**12,0**	**173,0**	**161,0**
Mean					**150,1**
Median					**143,9**
Min					**45,5**
Max					**301,4**
STDev					**55,3**
RICE A, lower / upper limit					**93,5 - 223,0**

Sample 4 - 3SEM4 [fibres mm^{-2}]	Amphibole	Chrysotile	Other Inorganic Fibres	Total Fibres	**Total Asbestos**
CRB, Lab 1640	**120,5**	**1,0**	**11,5**	**133**	**121,5**
Mean					**101,2**
Median					**96,1**
Min					**10,1**
Max					**205,4**
STDev					**39,4**
RICE A, lower / upper limit					**62,5 - 149,0**

Scanning Electron Microscopy Scheme

BACKGROUND

This report covers the third round of the SEM asbestos fibre counting PT scheme. The scheme is operated by HSL, 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 HSL using the modified sputnik multi-port sampling instrument.

INTRODUCTION

A total of 51 laboratories enrolled for Round 3 and results were received from 50 laboratories. Results were also received from APC and TNO. Laboratories were able to submit up to three results per sample and many laboratories took advantage of this.

The samples were as follows:

3SEM1XX – Very low fibre density (<10 fibres/mm^2) - mainly amphibole fibres

3SEM2XX – Medium density (<50 fibres/mm^2) - mainly amphibole fibres

3SEM3XX – High density (100-200 fibres/mm^2) - mainly amphibole fibres

3SEM4XX – High density (~100 fibres/mm^2) – mainly amphibole fibres

INFORMATION SUBMITTED BY LABORATORIES

For each sample, laboratories were asked to supply the numbers of fibres counted (amphibole, chrysotile and other inorganic), the number of fields of view searched, the area of the field of view, the number of fibres <5µm in length, the magnification and the method used. Laboratories were also asked to calculate the fibre density (in fibres/mm^2) for each fibre type identified. The SEM manufacturer and model used were also submitted.

APPENDIX 1

LABORATORY ASSESSMENT

RESULTS

Screen area – The fibre densities submitted by laboratories have not been recalculated and the density calculation and therefore screen area has not been verified. However, even though it appears that all laboratories have correctly calculated the fibre densities, some of the screen areas submitted appear to be incorrect.

Magnification – As was the case in Rounds 1 and 2, some laboratories used an operating magnification outside the range defined in ISO 14966 (or VDI 3492) i.e. between 2000 – 2500x.

Magnifications of 4000x, 3000x, 1300x, 1000x and 700x 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.

Two approaches have been used to analyse the data for this round. The data have been compared against the criteria used in the UK phase contrast fibre counting proficiency testing scheme RICE and a modification of the analysis used in Rounds 1 and 2 (GLMM). Details of the analysis used can be found in Appendix 2.

Some laboratories have now analysed three rounds of the SEMS scheme and we are working on how to look at the data from each laboratory across all rounds completed. A separate short report describing this analysis will be issued separately.

APPENDIX 1

Sample 1 - Total asbestos fibre density (fmm^{-2})

Lab No	Sample	Total Asbestos	RICE	GLMM
7	3 SEM 1	0.5	A	A
7	3 SEM 1	0.0	A	A
139	3 SEM 1	0.0	A	A
139	3 SEM 1	0.0	A	A
300	3 SEM 1	0.0	A	A
807	3 SEM 1	0.0	A	A
807	3 SEM 1	0.0	A	A
818	3 SEM 1	0.0	A	A
1187	3 SEM 1	0.0	A	A
1267	3 SEM 1	0.0	A	A
1267	3 SEM 1	0.0	A	A
1458	3 SEM 1	0.0	A	A
1507	3 SEM 1	0.8	A	A
1575	3 SEM 1	0.0	A	A
1579	3 SEM 1	0.0	A	A
1579	3 SEM 1	0.0	A	A
1579	3 SEM 1	0.0	A	A
1582	3 SEM 1	0.0	A	A
1582	3 SEM 1	0.0	A	A
1592	3 SEM 1	0.0	A	A
1592	3 SEM 1	0.0	A	A
1592	3 SEM 1	0.0	A	A
1620	3 SEM 1	0.0	A	A
1628	3 SEM 1	0.0	A	A
1638	3 SEM 1	0.0	A	A
1639	3 SEM 1	0.0	A	A
1640	3 SEM 1	0.0	A	A
1669	3 SEM 1	0.0	A	A
1675	3 SEM 1	0.2	A	A
1680	3 SEM 1	0.4	A	A
1680	3 SEM 1	0.9	A	A
1680	3 SEM 1	0.0	A	A
1684	3 SEM 1	0.0	A	A
1687	3 SEM 1	0.0	A	A
1714	3 SEM 1	0.0	A	A
1715	3 SEM 1	0.0	A	A
1717	3 SEM 1	0.0	A	A
1717	3 SEM 1	0.0	A	A
1717	3 SEM 1	0.0	A	A
1719	3 SEM 1	0.0	A	A
1719	3 SEM 1	0.0	A	A
1720	3 SEM 1	0.0	A	A

APPENDIX 1

1722	3 SEM 1	0.0	A	A
1722	3 SEM 1	0.0	A	A
1722	3 SEM 1	0.0	A	A
1738	3 SEM 1	0.0	A	A
1738	3 SEM 1	0.0	A	A
1745	3 SEM 1	1.9	A	A
1759	3 SEM 1	130.4	C	B
1759	3 SEM 1	45.5	C	B
1759	3 SEM 1	49.1	C	B
1761	3 SEM 1	0.0	A	A
1764	3 SEM 1	1.0	A	A
1766	3 SEM 1	3.6	A	A
1766	3 SEM 1	3.6	A	A
1766	3 SEM 1	4.5	A	A
1767	3 SEM 1	0.0	A	A
1768	3 SEM 1	0.2	A	A
1774	3 SEM 1	0.0	A	A
1776	3 SEM 1	0.0	A	A
1776	3 SEM 1	2.0	A	A
1812	3 SEM 1	0.0	A	A
1812	3 SEM 1	0.0	A	A
1812	3 SEM 1	0.0	A	A
1813	3 SEM 1	0.0	A	A
1813	3 SEM 1	0.0	A	A
1813	3 SEM 1	0.0	A	A
1814	3 SEM 1	0.0	A	A
1817	3 SEM 1	0.0	A	A
1824	3 SEM 1	-	-	-
1826	3 SEM 1	0.0	A	A
1827	3 SEM 1	0.0	A	A
1827	3 SEM 1	0.0	A	A
1827	3 SEM 1	0.0	A	A
1828	3 SEM 1	0.0	A	A
1828	3 SEM 1	0.0	A	A
1828	3 SEM 1	0.0	A	A
1829	3 SEM 1	0.0	A	A
1830	3 SEM 1	0.0	A	A
1830	3 SEM 1	0.0	A	A
1830	3 SEM 1	0.0	A	A
1831	3 SEM 1	0.0	A	A
1831	3 SEM 1	0.0	A	A
1832	3 SEM 1	0.0	A	A
1842	3 SEM 1	1.0	A	A
1852	3 SEM 1	0.0	A	A

APPENDIX 1

3 SEM 1

Mean	2.9
Median	0.0
STDev	15.7
Min	0.0
Max	130.4

RICE A		RICE B		RICE C	
Lower	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
0.0	3.8	0.0	10.9	0.0	>10.9

glmm mean (mixed effects model)	0.0103
Poisson lower limit of CI for mean	0
Poisson upper limit of CI for mean	3.69

APPENDIX 1

Sample 2 - Total asbestos fibre density (fmm^{-2})

Lab No	Sample	Total Asbestos	RICE	GLMM
7	3 SEM 2	13.3	A	B
7	3 SEM 2	13.8	A	B
139	3 SEM 2	22.0	A	A
139	3 SEM 2	25.0	A	A
300	3 SEM 2	10.0	B	B
807	3 SEM 2	14.8	A	B
807	3 SEM 2	10.9	A	B
818	3 SEM 2	37.2	A	B
1187	3 SEM 2	22.2	A	A
1267	3 SEM 2	26.0	A	A
1267	3 SEM 2	29.0	A	A
1458	3 SEM 2	21.2	A	A
1507	3 SEM 2	16.4	A	A
1575	3 SEM 2	12.1	A	B
1579	3 SEM 2	49.0	A	B
1579	3 SEM 2	43.5	A	B
1579	3 SEM 2	32.5	A	A
1582	3 SEM 2	18.0	A	A
1582	3 SEM 2	19.5	A	A
1592	3 SEM 2	26.0	A	A
1592	3 SEM 2	23.0	A	A
1592	3 SEM 2	23.0	A	A
1620	3 SEM 2	29.0	A	A
1620	3 SEM 2	24.5	A	A
1620	3 SEM 2	24.0	A	A
1628	3 SEM 2	21.4	A	A
1638	3 SEM 2	25.5	A	A
1639	3 SEM 2	17.0	A	A
1640	3 SEM 2	24.9	A	A
1669	3 SEM 2	23.0	A	A
1675	3 SEM 2	22.0	A	A
1680	3 SEM 2	34.0	A	A
1680	3 SEM 2	51.2	B	B
1680	3 SEM 2	36.5	A	B
1684	3 SEM 2	29.0	A	A
1687	3 SEM 2	39.9	A	A
1714	3 SEM 2	21.9	A	A
1715	3 SEM 2	19.8	A	A
1717	3 SEM 2	12.5	A	B
1717	3 SEM 2	15.1	A	A
1717	3 SEM 2	21.4	A	A
1719	3 SEM 2	12.0	A	B

APPENDIX 1

1719	3 SEM 2	12.0	A	B
1720	3 SEM 2	11.5	A	B
1722	3 SEM 2	27.5	A	A
1722	3 SEM 2	24.8	A	A
1722	3 SEM 2	29.6	A	A
1738	3 SEM 2	36.5	A	B
1738	3 SEM 2	33.5	A	A
1738	3 SEM 2	29.5	A	A
1745	3 SEM 2	13.3	A	B
1759	3 SEM 2	0.0	C	B
1759	3 SEM 2	0.0	C	B
1759	3 SEM 2	0.0	C	B
1761	3 SEM 2	15.0	A	A
1764	3 SEM 2	33.0	A	A
1766	3 SEM 2	17.9	A	A
1766	3 SEM 2	16.1	A	A
1766	3 SEM 2	15.2	A	A
1767	3 SEM 2	32.4	A	A
1768	3 SEM 2	36.7	A	A
1774	3 SEM 2	19.0	A	A
1776	3 SEM 2	28.0	A	A
1776	3 SEM 2	26.0	A	A
1812	3 SEM 2	27.5	A	A
1812	3 SEM 2	23.0	A	A
1812	3 SEM 2	24.0	A	A
1813	3 SEM 2	18.6	A	A
1813	3 SEM 2	16.6	A	A
1813	3 SEM 2	16.3	A	A
1814	3 SEM 2	9.7	B	B
1817	3 SEM 2	43.5	A	B
1824	3 SEM 2	-	-	-
1826	3 SEM 2	23.0	A	A
1827	3 SEM 2	21.0	A	A
1827	3 SEM 2	21.0	A	A
1827	3 SEM 2	21.0	A	A
1828	3 SEM 2	9.0	B	B
1828	3 SEM 2	35.5	A	B
1828	3 SEM 2	27.0	A	A
1829	3 SEM 2	29.0	A	A
1830	3 SEM 2	29.8	A	A
1830	3 SEM 2	27.8	A	A
1830	3 SEM 2	12.9	A	B
1831	3 SEM 2	24.4	A	A
1831	3 SEM 2	27.9	A	A
1832	3 SEM 2	32.5	A	A
1842	3 SEM 2	32.0	A	A
1852	3 SEM 2	23.8	A	A

APPENDIX 1

3 SEM 2

Mean	23.3
Median	23.0
STDev	9.9
Min	0.0
Max	51.2

RICE A		RICE B		RICE C	
Lower	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
10.4	45.6	6.0	65.5	<6	>65.5

glmm mean (mixed effects model)	23.1
Poisson lower limit of CI for mean	14.6
Poisson upper limit of CI for mean	34.5

APPENDIX 1

Sample 3 - Total asbestos fibre density (fmm^{-2})

Lab No	Sample	Total Asbestos	RICE	GLMM
7	3 SEM 3	129.4	A	A
7	3 SEM 3	131.7	A	A
139	3 SEM 3	195.0	A	B
139	3 SEM 3	180.0	A	B
300	3 SEM 3	297.0	C	B
807	3 SEM 3	215.3	A	B
807	3 SEM 3	191.4	A	B
818	3 SEM 3	173.6	A	B
1187	3 SEM 3	80.4	B	B
1267	3 SEM 3	200.0	A	B
1267	3 SEM 3	150.0	A	A
1458	3 SEM 3	148.1	A	A
1507	3 SEM 3	83.7	B	B
1575	3 SEM 3	93.9	A	B
1579	3 SEM 3	242.0	B	B
1579	3 SEM 3	227.0	B	B
1579	3 SEM 3	191.5	A	B
1582	3 SEM 3	102.0	A	B
1582	3 SEM 3	138.0	A	A
1592	3 SEM 3	174.0	A	B
1592	3 SEM 3	134.0	A	A
1592	3 SEM 3	166.0	A	B
1620	3 SEM 3	190.0	A	B
1620	3 SEM 3	115.5	A	A
1620	3 SEM 3	112.0	A	B
1628	3 SEM 3	138.1	A	A
1638	3 SEM 3	159.8	A	A
1639	3 SEM 3	161.0	A	B
1640	3 SEM 3	161.0	A	B
1669	3 SEM 3	184.1	A	B
1675	3 SEM 3	130.1	A	A
1680	3 SEM 3	188.5	A	B
1680	3 SEM 3	204.5	A	B
1680	3 SEM 3	178.5	A	B
1684	3 SEM 3	256.0	B	B
1687	3 SEM 3	301.4	C	B
1714	3 SEM 3	75.6	B	B
1715	3 SEM 3	72.3	B	B
1717	3 SEM 3	135.1	A	A
1717	3 SEM 3	143.9	A	A
1717	3 SEM 3	151.8	A	A

APPENDIX 1

1719	3 SEM 3	84.0	B	B
1719	3 SEM 3	87.0	B	B
1720	3 SEM 3	100.0	A	B
1722	3 SEM 3	158.8	A	A
1722	3 SEM 3	154.6	A	A
1722	3 SEM 3	135.3	A	A
1738	3 SEM 3	172.0	A	B
1738	3 SEM 3	212.0	A	B
1738	3 SEM 3	194.0	A	B
1745	3 SEM 3	90.1	B	B
1759	3 SEM 3	234.0	B	B
1759	3 SEM 3	185.7	A	B
1759	3 SEM 3	283.9	B	B
1761	3 SEM 3	45.5	C	B
1764	3 SEM 3	153.8	A	A
1766	3 SEM 3	76.8	B	B
1766	3 SEM 3	72.3	B	B
1766	3 SEM 3	74.1	B	B
1767	3 SEM 3	53.3	C	B
1768	3 SEM 3	137.7	A	A
1774	3 SEM 3	132.0	A	A
1776	3 SEM 3	179.6	A	B
1776	3 SEM 3	140.7	A	A
1812	3 SEM 3	122.5	A	A
1812	3 SEM 3	105.5	A	B
1812	3 SEM 3	108.0	A	B
1813	3 SEM 3	147.2	A	A
1813	3 SEM 3	148.8	A	A
1813	3 SEM 3	160.1	A	A
1814	3 SEM 3	67.8	C	B
1817	3 SEM 3	235.8	B	B
1824	3 SEM 3	-	-	-
1826	3 SEM 3	92.0	B	B
1827	3 SEM 3	136.0	A	A
1827	3 SEM 3	139.7	A	A
1827	3 SEM 3	140.0	A	A
1828	3 SEM 3	175.9	A	B
1828	3 SEM 3	117.9	A	A
1828	3 SEM 3	143.9	A	A
1830	3 SEM 3	107.6	A	B
1830	3 SEM 3	114.6	A	A
1830	3 SEM 3	139.1	A	A
1831	3 SEM 3	188.6	A	B
1831	3 SEM 3	234.9	B	B
1832	3 SEM 3	221.2	A	B
1842	3 SEM 3	93.0	B	B
1852	3 SEM 3	56.2	C	B

APPENDIX 1

3SEM 3

Mean	150.1
Median	143.9
STDev	55.3
Min	45.5
Max	301.4

RICE A		RICE B		RICE C	
Lower	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
93.5	223.0	72.0	287.8	<72	>287.8

glmm mean (mixed effects model)	137.1
Poisson lower limit of CI for mean	115.0
Poisson upper limit of CI for mean	162.0

APPENDIX 1

Sample 4 - Total asbestos fibre density (fmm^{-2})

Lab No	Sample	Total Asbestos	RICE	GLMM
7	3 SEM 4	91.0	A	A
7	3 SEM 4	96.1	A	A
139	3 SEM 4	159.0	B	B
139	3 SEM 4	136.0	A	B
300	3 SEM 4	110.0	A	A
807	3 SEM 4	166.0	A	B
807	3 SEM 4	115.7	A	B
818	3 SEM 4	151.7	A	B
1187	3 SEM 4	68.8	A	B
1267	3 SEM 4	79.0	A	A
1267	3 SEM 4	92.0	A	A
1458	3 SEM 4	84.7	A	A
1507	3 SEM 4	21.9	C	B
1575	3 SEM 4	64.8	A	B
1579	3 SEM 4	123.0	A	B
1579	3 SEM 4	81.5	A	A
1579	3 SEM 4	91.0	A	A
1582	3 SEM 4	63.0	A	B
1582	3 SEM 4	71.0	A	B
1592	3 SEM 4	85.0	A	A
1592	3 SEM 4	102.0	A	A
1592	3 SEM 4	95.0	A	A
1620	3 SEM 4	95.0	A	A
1620	3 SEM 4	103.0	A	A
1620	3 SEM 4	115.0	A	B
1628	3 SEM 4	83.7	A	A
1638	3 SEM 4	124.3	A	B
1639	3 SEM 4	148.0	A	B
1640	3 SEM 4	121.5	A	B
1669	3 SEM 4	157.5	B	B
1675	3 SEM 4	104.3	A	A
1680	3 SEM 4	148.6	A	B
1680	3 SEM 4	182.2	B	B
1680	3 SEM 4	147.7	A	B
1684	3 SEM 4	132.0	A	B
1687	3 SEM 4	141.5	A	B
1714	3 SEM 4	10.1	C	B
1715	3 SEM 4	67.3	A	B
1717	3 SEM 4	107.7	A	A
1717	3 SEM 4	91.6	A	A
1717	3 SEM 4	89.1	A	A
1719	3 SEM 4	64.0	A	B

APPENDIX 1

1719	3 SEM 4	64.0	A	B
1720	3 SEM 4	77.2	A	A
1722	3 SEM 4	98.7	A	A
1722	3 SEM 4	95.1	A	A
1722	3 SEM 4	96.6	A	A
1738	3 SEM 4	144.0	A	B
1738	3 SEM 4	153.0	B	B
1738	3 SEM 4	129.0	A	B
1745	3 SEM 4	81.6	A	A
1759	3 SEM 4	173.2	B	B
1759	3 SEM 4	162.5	B	B
1759	3 SEM 4	205.4	C	B
1761	3 SEM 4	46.2	C	B
1764	3 SEM 4	116.4	A	B
1766	3 SEM 4	63.4	A	B
1766	3 SEM 4	58.9	B	B
1766	3 SEM 4	59.8	B	B
1767	3 SEM 4	29.5	C	B
1768	3 SEM 4	110.9	A	B
1774	3 SEM 4	88.0	A	A
1776	3 SEM 4	109.1	A	A
1776	3 SEM 4	111.5	A	B
1812	3 SEM 4	100.0	A	A
1812	3 SEM 4	100.0	A	A
1812	3 SEM 4	55.0	B	B
1813	3 SEM 4	71.3	A	B
1813	3 SEM 4	54.2	B	B
1813	3 SEM 4	63.5	A	B
1814	3 SEM 4	34.9	C	B
1817	3 SEM 4	156.0	B	B
1824	3 SEM 4	-	-	-
1826	3 SEM 4	59.0	B	B
1827	3 SEM 4	85.0	A	A
1827	3 SEM 4	87.5	A	A
1827	3 SEM 4	83.0	A	A
1828	3 SEM 4	106.9	A	A
1828	3 SEM 4	81.4	A	A
1828	3 SEM 4	85.9	A	A
1829	3 SEM 4	98.5	A	A
1829	3 SEM 4	82.0	A	A
1830	3 SEM 4	182.5	B	B
1830	3 SEM 4	148.8	A	B
1830	3 SEM 4	140.5	A	B
1831	3 SEM 4	114.6	A	B
1831	3 SEM 4	160.7	B	B
1832	3 SEM 4	113.0	A	B
1842	3 SEM 4	45.0	C	B
1852	3 SEM 4	41.0	C	B

APPENDIX 1

3 SEM 4

Mean	101.2
Median	96.1
STDev	39.4
Min	10.1
Max	205.4

RICE A		RICE B		RICE C	
Lower	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
62.5	149.0	48.1	192.2	<48.1	>192.2

glmm mean (mixed effects model)	90.3
Poisson lower limit of CI for mean	72.4
Poisson upper limit of CI for mean	110.6

APPENDIX 2

DATA ANALYSIS – METHOD 1

Regular Inter-laboratory Counting Exchange (RICE) Criteria

Where ***R*** is the reference value – in this case the Median value.

High density slides (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 slides ($R \leq$ 63.7 fibres. mm^{-2})*

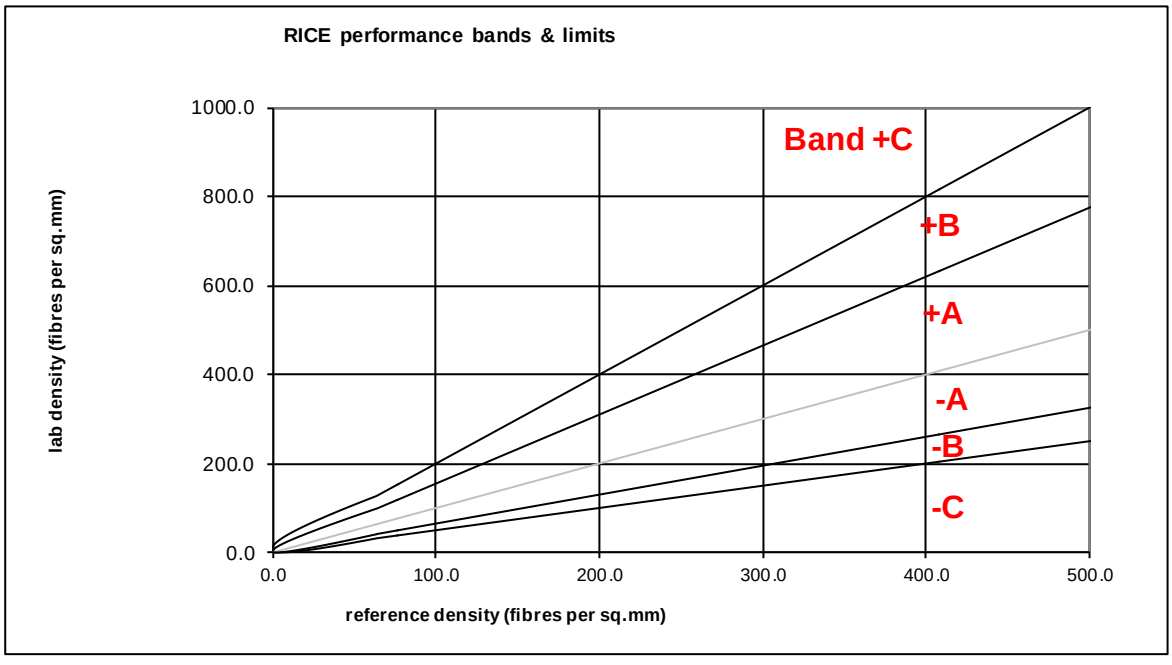
Target band A: $(\sqrt{R}-1.57)^2$ to $(\sqrt{R}+1.96)^2$ [band A]

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 per mm^2.



APPENDIX 2

DATA ANALYSIS – METHOD 2

Mixed effects model for fibre counting

Data analysis is based upon the calculated total asbestos (amphibole & chrysotile) fibre densities 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 each sample, it has been assumed that there are no production differences between samples, and that the fibre densities are Poisson distributed with mean "λ" (λ is unknown but is estimated from the fibre counts). For samples where each lab submits just one reading, an estimate of "λ" is the observed mean density count across all participating labs. However, when laboratories submit more than one reading per sample, taking simply the mean of all the submitted results to estimate lambda may lead to a biased estimate. Therefore, although the mean may be a close approximation to "λ"; a more appropriate method would be to use a mixed effects regression model to estimate "λ". Therefore, 95% confidence limits for "λ" can also be calculated from this, whichever method is used to estimate "λ". For a Poisson random variable with mean "λ", the variance is equal to the mean, i.e. if fibre counts truly follow a Poisson distribution with mean "λ", the variance should also equal "λ".

Calculating Confidence Limits for a Poisson Mean

The fibre densities are assumed to follow a Poisson distribution with unknown mean "λ". When each lab submits just one result, the maximum likelihood estimate of "λ", (which we denote as *s*) is the mean of the observed fibre densities across all laboratories, i.e.

$$s = \frac{\sum_{i=1}^{N} x_i}{N}$$

Where x_i is the observed fibre densities and N is the number of observations.

APPENDIX 2

When some labs submit more than one result, to account for variability between labs and reduce bias, we assume the following generalised linear mixed model (glmm):

$$E(X_{ij}) = \lambda_i$$

$$\log(\lambda_i) = a + b_i$$

$$b_i \sim N(0, \sigma_b{}^2)$$

Where a is the logarithm of the general mean density (i.e. exp (a) represents the general mean density), and b_i are random effects representing the systematic differences between the general mean density and the lab's measured densities (the b_i are normally distributed with mean 0 and variance $\sigma_b{}^2$). The model presented above can be fitted using statistics software such as R, providing us with estimates of the model parameter *a,* as well as the random effects b_i. The penalised quasi-likelihood estimate of λ is simply s=exp(a), and is presented in the table below, for each round and fibre type, e.g. the estimate of λ for total fibres in Sample 1 is s=9.39, so the total fibre densities in Sample 1 are can be assumed to be Poisson distributed with an estimated mean of 9.39.

Sample	Linear mixed effects estimate of fibre density s = exp(a)	
	Total fibres	Total asbestos
1	9.39	6.60
2	3.71	2.37
3	12.42	8.32
4	1.82	1.18

Once *s* has been calculated using the maximum likelihood method or the glmm method, the 95% confidence interval for the Poisson mean can be determined:

$$\left[\frac{\chi^2_{2s,0.025}}{2}, \frac{\chi^2_{2s+2,0.975}}{2}\right]$$

Where $\chi^2_{2s,0.025}$ (lower limit of the confidence interval for the Poisson mean) and $\chi^2_{2s+2,0.975}$ (upper limit of the confidence interval for the Poisson mean) are calculated as the chi-square quantiles with lower tail probabilities 0.025 and 0.975 on 2s and 2s+2 degrees of freedom respectively.

Laboratory results have been compared against the 95% confidence intervals as follows:

1. Where the total asbestos fibre density falls within the 95% confidence intervals, the result is classified as "A"

APPENDIX 2

2. Where the total asbestos fibre density falls outside the 95% confidence intervals, the result is classified as “B”

Results for total asbestos fibre densities for each laboratory are summarised in Appendix 1.

Appendix 2 summarises the total fibre, total asbestos, amphibole, chrysotile and other inorganic fibre densities for all samples.