

Pira Consultancy Report

EN 868 test method validations

Prepared for Sterile Barrier Association

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Commercial in confidence

1 Background

The SBA have been asked by CEN to validate a range of test methods found in the annexes of EN 868 standards to determine their suitability for acceptance into ISO 11607.

The following tests are subject to review:

- Water repellency (EN 868 parts 2, 3, 6 and 7)
- Pore size (EN 868 parts 2, 3, 6 and 7)
- Chloride and sulphates content

To evaluate each method, the SBA's member laboratories that regularly perform testing based on these standards, were asked to participate in a set of inter-laboratory 'round robin' tests. The results have been used to determine the validity of each method.

2 Objective

To determine the repeatability and reproducibility of a range of test methods by means of an Interlaboratory Study.

3 Methodology

A series of precision experiments were performed and analyzed using the methods detailed in ISO 5725-2.

All testing laboratories were instructed to perform the tests in accordance with the appropriate EN 868 methods. Each test was performed at a number of levels to assess the method over its range of application.

The test samples were created from a selection of consistent materials representing those typically evaluated using each of the test methods being assessed. All test materials were preconditioned, randomised and labelled, prior to dispatch to each participating laboratory. The laboratories were then instructed to condition the samples and test them in accordance with the standard.

After testing, the results were returned to Pira for statistical analysis. The results were assessed graphically using Mandel's h and k statistics and numerically to identify any outliers using Cochran and Grubbs tests.

Any results which were identified as outliers were then excluded from the determination of the general mean, repeatability and reproducibility standard deviations for each test level.

The repeatability and reproducibility of each method were then determined over the tested range as a function of the mean measurement.

4 Statistical analysis

4.1 Pore size

4.1.1 Background

a) *Measurement method*

Method for the determination of pore size

b) *Source*

EN 868 parts 2, 3, 6 and 7

c) *Description*

The size of the interstices in the material is estimated by determining the pressure differential required to force air bubbles through the interstices, when wetted by a liquid.

Nine laboratories participated in the experiment, carrying out the analysis according to the method referenced above. All laboratories performed 10 replicate tests on four sample materials.

4.1.2 Original data

The original data can be found in Appendix 2.

4.1.3 Cell means

The cell means have been recorded in Table 1 below as pore size in μm .

Table 1 – Pore size: Cell means in μm

Laboratory i	Level j			
	1	2	3	4
1	9.1	14.4	15.7	37.0
2	6.7	10.4	10.7	39.4
3	16.3	21.3	22.0	41.4
4	13.2	20.3	24.1	52.4
5	14.4	16.6	18.5	39.5
6	<12.0	18.6	20.9	44.4
7	13.3	19.9	21.1	55.0
8	13.3	16.0	18.4	39.0
9	2.9	7.4	8.0	21.8

(a) denotes a straggler
(b) denotes a statistical outlier

4.1.4 Standard deviation

The standard deviations are shown in Table 2 below as pore size in μm .

Table 2 – Pore size: Standard deviation in μm

Laboratory i	Level j			
	1	2	3	4
1	1.9	2.5	2.4	3.9
2	1.3	1.1	1.3	5.5
3	3.0	2.3	1.4	4.7
4	1.9	3.9 (b)	3.3	4.2
5	3.3 (a)	2.4	3.8 (b)	4.1
6	0.0	2.1	2.5	2.7
7	2.6	2.3	1.8	12.0 (b)
8	0.9	0.7	0.8	1.3
9	0.1	0.6	0.3	1.1

(a) denotes a straggler
(b) denotes a statistical outlier

4.1.5 Scrutiny for consistency and outliers

The calculated Mandel's h and k statistics are graphically presented in Figures 1 and 2 respectively. The calculated values can be found in Appendix 1. Horizontal lines are shown corresponding to the value of Mandel's indicators based on nine laboratories and ten replicate tests.

All results shown on the h graph (Figure 1) were within the 1% significance level, although all of laboratory number 9's results were outside of the 5% significance level.

The k graph (Figure 2) shows a large variability between replicate test results for all laboratories except for laboratories 8 and 9.

Application of Cochran's test to the standard deviations is shown in Table 2. A straggler was identified in level 1 and a single outlier is present in levels 2, 3 and 4.

The Grubbs test applied to the mean results identified no stragglers or outliers.

Figure 1 - Pore size: Mandel's between laboratory consistency statistic, h

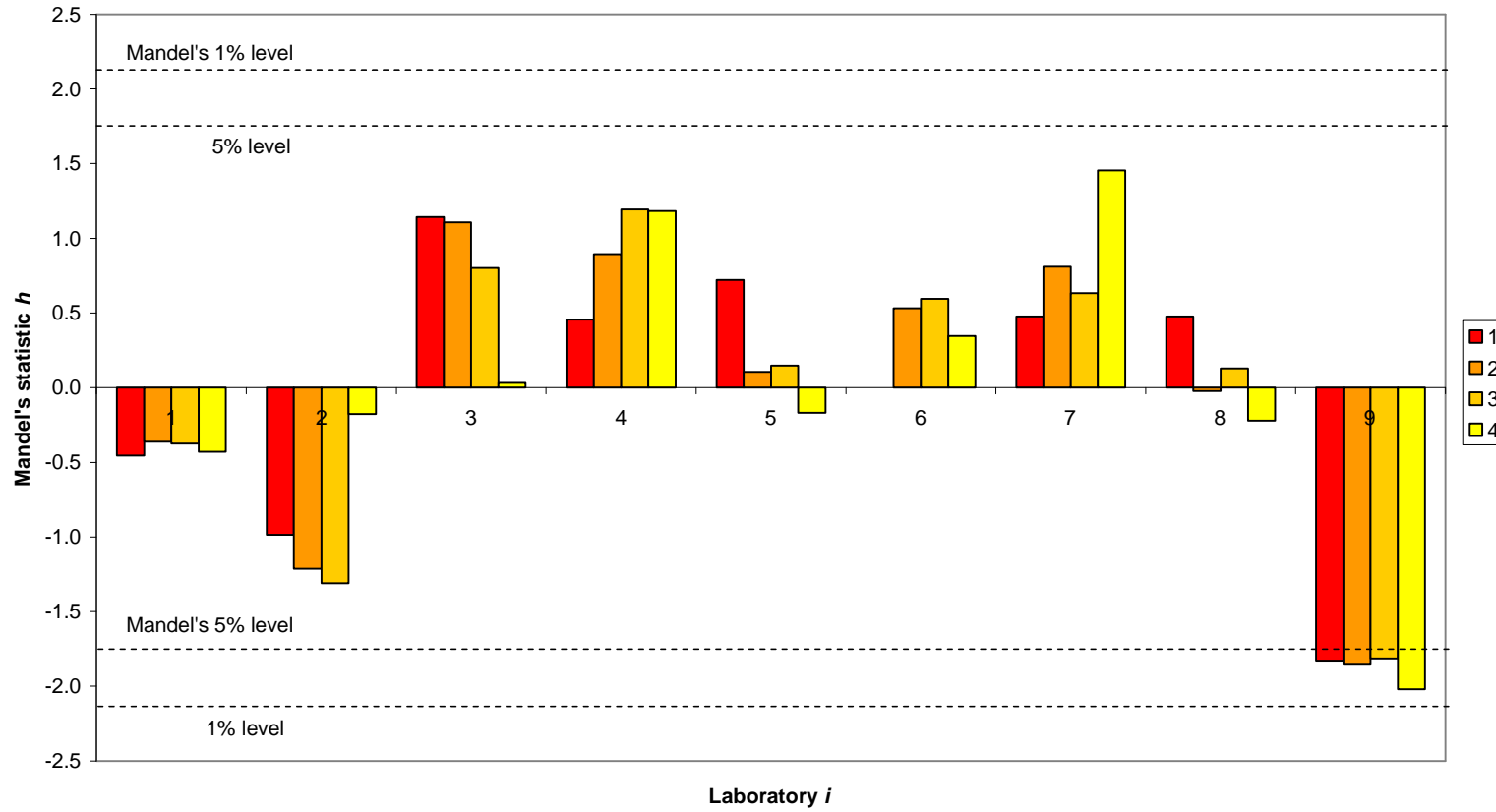
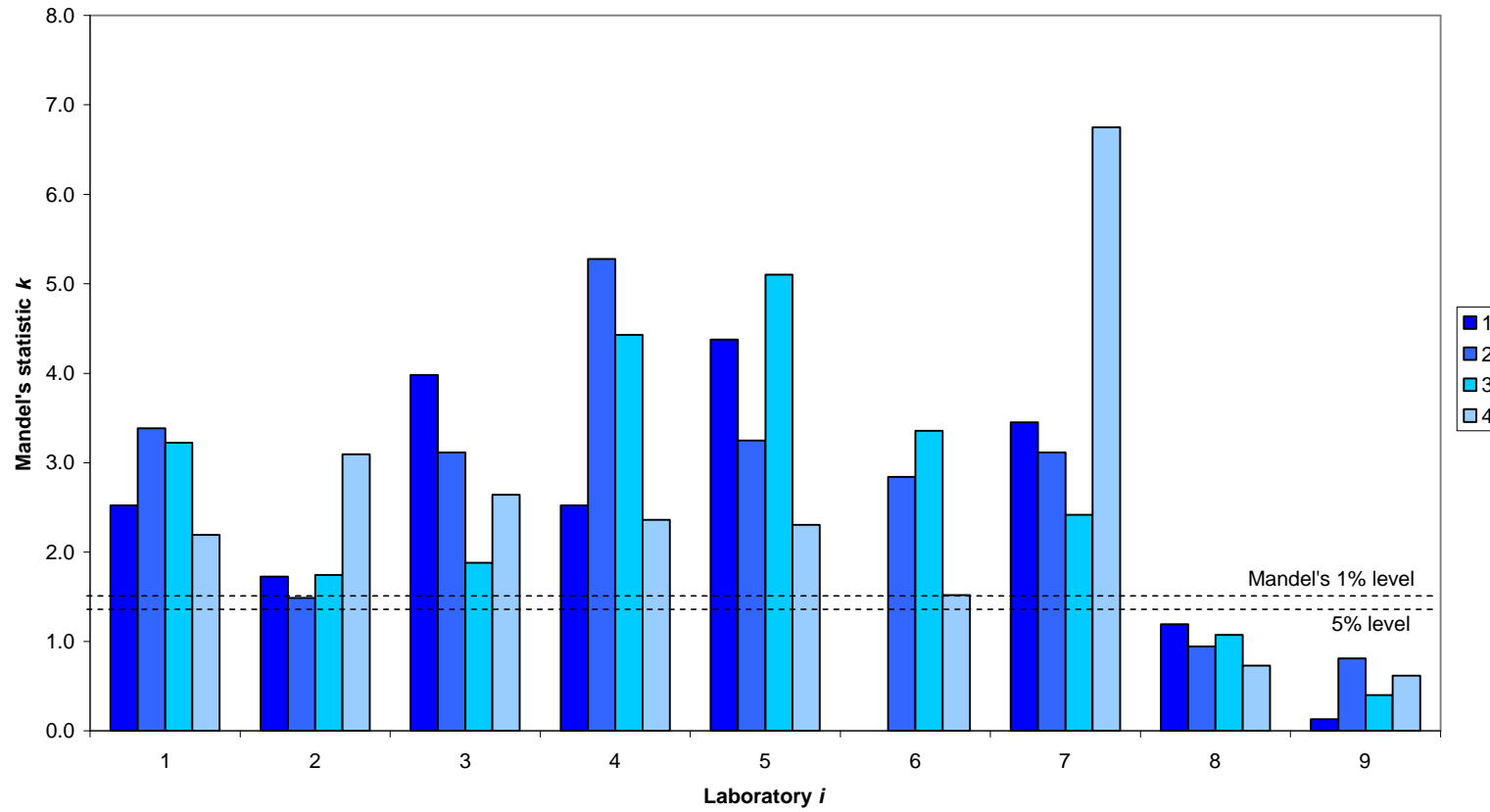


Figure 2 - Pore size: Mandel's within-laboratory consistency statistic, k



4.1.6 Computation of the general mean, repeatability and reproducibility standard deviations

Results which were found to fail the Cochran test were excluded from the determination of \hat{m}_j , s_{rj} and s_{Rj} values. The result from laboratory 6 was also excluded from level 1, as an absolute result was not reported. The pore size results for each level are shown in Table 3 below quoted in μm .

Table 3 – Pore size: Mean and standard deviations in μm

Level	Number of labs	General mean	Repeatability SD	Reproducibility SD
j	p_j	\hat{m}_j	s_{rj}	s_{Rj}
1	8	11.2	2.1	4.9
2	8	15.6	1.9	5.1
3	8	16.7	1.7	5.7
4	8	39.4	3.7	9.3

4.1.7 Dependence of precision on m

The results in Table 3 show the standard deviations increasing with higher values of m . By plotting the standard deviation against the general mean as shown in Figure 3, a linear relationship for repeatability and reproducibility has been derived.

4.1.8 Final values of precision

Repeatability standard deviation $s_r = 0.069m + 0.943$

Reproducibility standard deviation $s_R = 0.160m + 2.939$

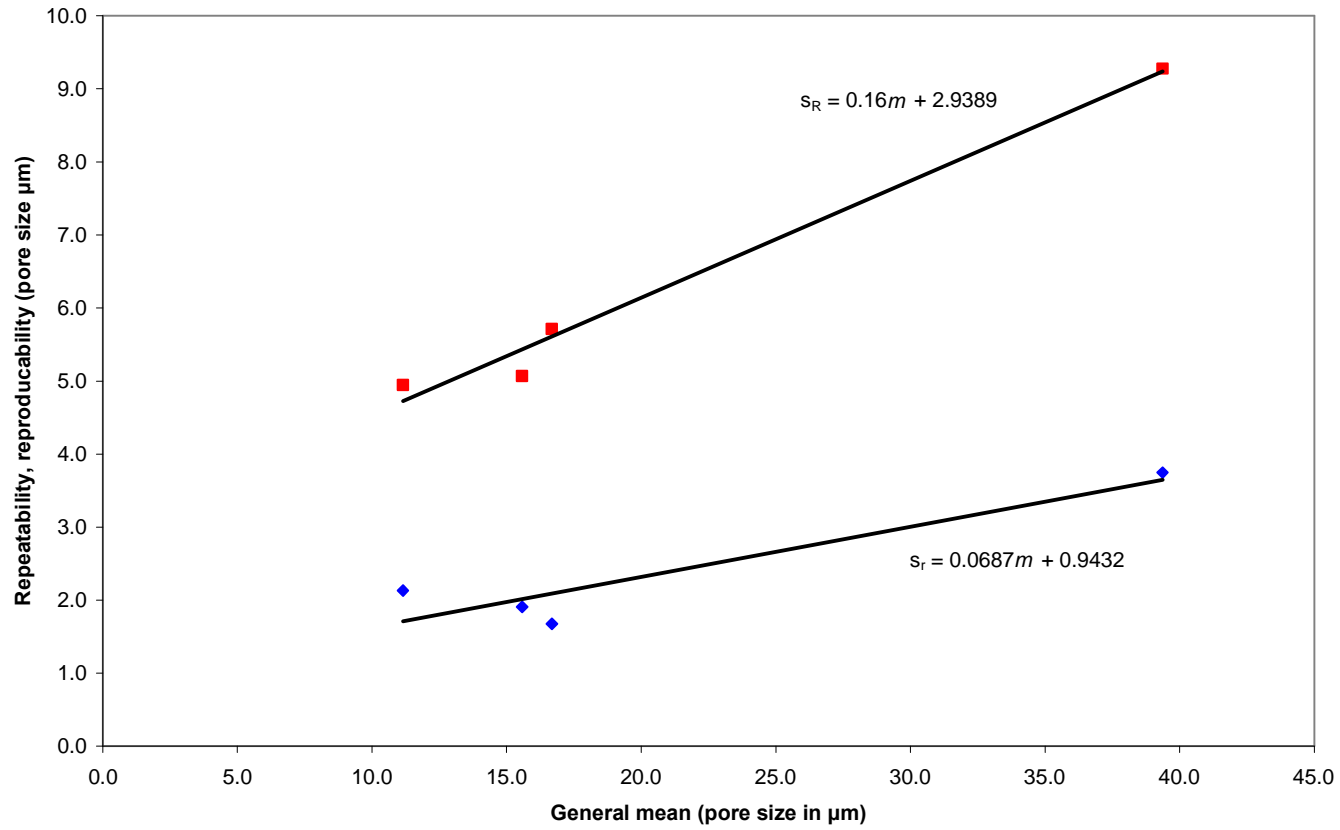
4.1.9 Comments

The cause of the outlying test results need to be understood, together with the reason for the non-absolute reporting of the level 1 by laboratory 6.

The method appears to have a high coefficient of variance.

Ideally the materials used for levels 2 and 3 would have represented a more even distribution of pore sized over the measurement range. To improve the study, it may be necessary to test further material.

Figure 3 - Pore size: Plot of repeatability and reproducibility against general mean



4.2 Water repellency

4.2.1 Background

a) *Measurement method*

Method for the determination of the water repellency

b) *Source*

EN 868 parts 2, 3, 6 and 7

c) *Description*

The water repellency of paper is determined by measuring the time in seconds for water to penetrate the material and cause a dry indicator powder to fluoresce under ultraviolet light.

4.2.2 Original data

The original data can be found in Appendix 2

4.2.3 Cell means

The cell means have been recorded in Table 4 below as water repellency in seconds.

Table 4 – Water repellency: Cell means in seconds

Laboratory i	Level j		
	1	2	3
1	16.1	32.0	43.6
2	16.1	29.3	38.0
3	15.9	30.5	40.6
4	17.5	31.5	44.2
5	16.9	30.3	41.7
6	12.7	22.8	31.2
7	15.0	30.3	46.9
8	17.0	32.3	52.3
9	16.7	32.3	46.4
10	12.4	30.9	43.7
11	16.1	32.5	44.4
12	14.5	37.8	43.2
13	14.8	29.0	39.9
14	23.3 (b)	44.9 (a)	53.8
15	15.5	33.3	43.4
16	16.6	33.3	45.0

(a) denotes a straggler
(b) denotes a statistical outlier

4.2.4 Standard deviation

The standard deviations are shown in Table 5 below as water repellency in seconds.

Table 5 – Water repellency: Standard deviation in seconds

Laboratory i	Level j		
	1	2	3
1	1.1	1.3	2.1
2	0.9	1.9	1.1
3	1.4	1.9	1.8
4	1.1	1.4	2.4
5	0.8	1.2	1.4
6	1.7	2.7	2.4
7	0.4	2.2	2.2
8	0.8	1.1	1.8
9	0.7	1.2	2.1
10	1.4	3.1	2.0
11	0.9	0.8	1.8
12	1.1	1.8	4.1 (b)
13	1.4	1.8	1.1
14	1.9 (a)	3.1	1.8
15	1.0	3.4	1.7
16	2.0 (a)	2.9	1.8

(a) denotes a straggler
(b) denotes a statistical outlier

4.2.5 Scrutiny for consistency and outliers

The calculated Mandel's h and k statistics are graphically presented in Figures 4 and 5 respectively. The calculated values can be found in Appendix 1. Horizontal lines are shown corresponding to the value of Mandel's indicators based on sixteen laboratories and ten replicate tests.

All results shown on the h graph (Figure 4) were within the 1% significance value, except for laboratory 14, levels 1 and 2 and laboratory 6's, level 3. Laboratory 14, level 3 and laboratory 6, level 2 exceeded the 5% significance level.

The k graph exhibits large variability between replicate test results for all laboratories. Only laboratory 7, level 1 was below the 5% significance level. Laboratory 11, level 2 was also below the 1% significance level.

Application of Cochran's test to the standard deviations is shown in Table 5. This resulted in stragglers identified in level 1 for laboratories 14 and 16. A single outlier was also present in level 3 for laboratory 12.

The results of the Grubbs test applied to the mean results can be seen in Figures in Table 4. This identified laboratory 14's level 1 as an outlier and level 2 as a straggler. Using the Grubbs test applied to the two largest outlying means, levels 1 and 2 identified stragglers.

Figure 4 - Water repellency: Mandel's between laboratory consistency statistic, h

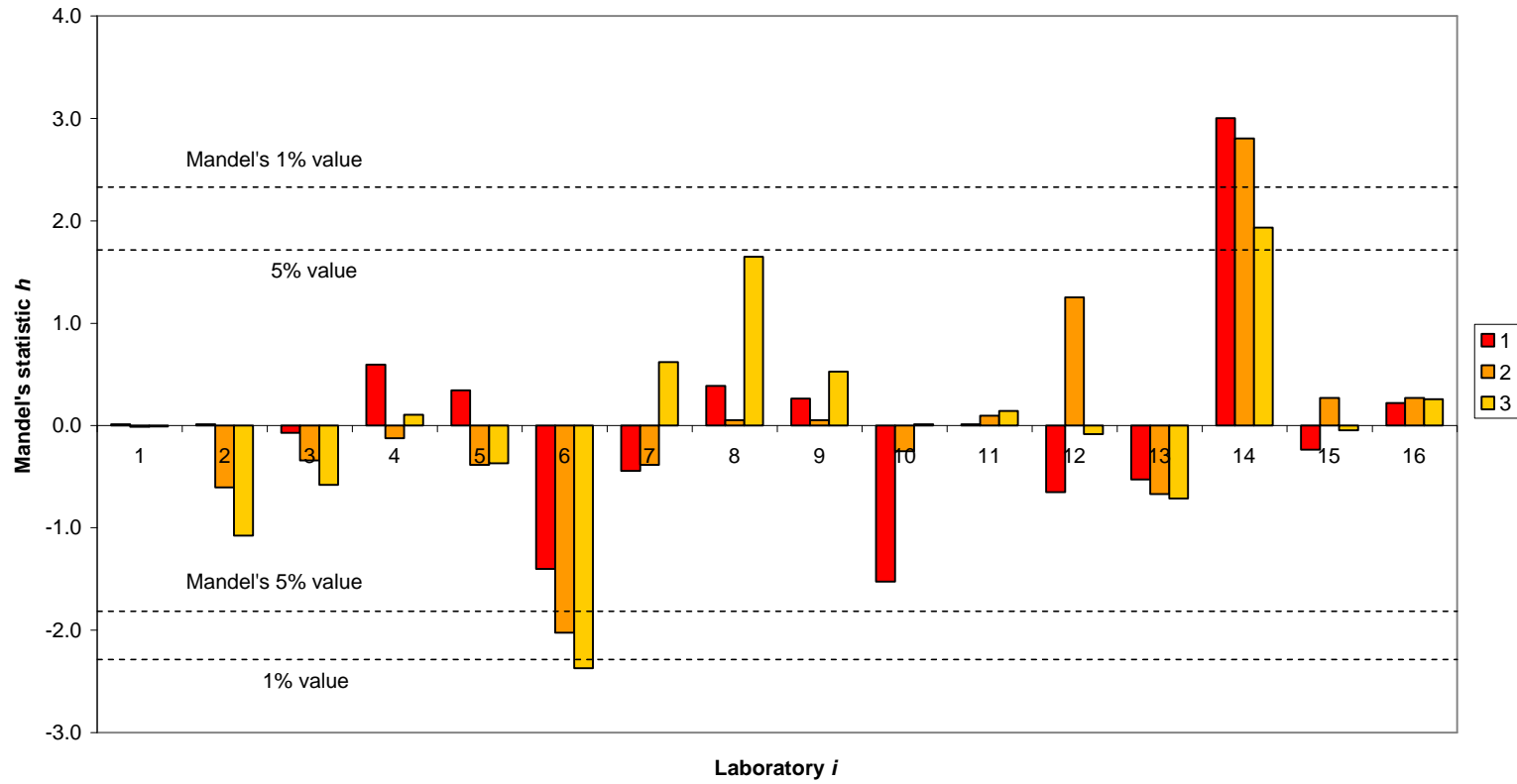
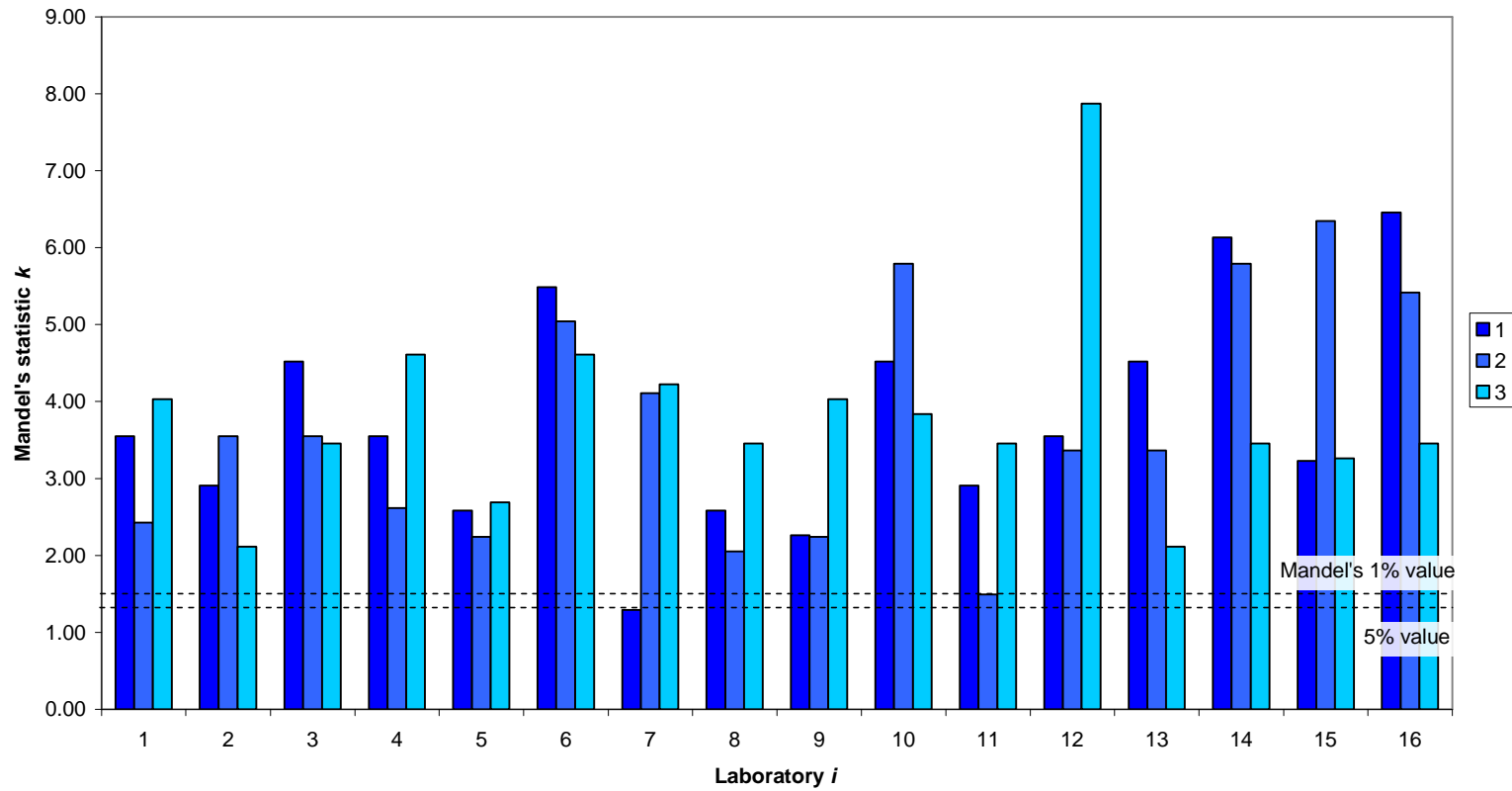


Figure 5 - Water repellency: Mandel's within-laboratory consistency statistic, k



4.2.6 Computation of the general mean, repeatability and reproducibility standard deviations

The values \hat{m} , s_{rj} and s_{Rj} were determined with all results from laboratory 14 excluded. Laboratory 12's level 3 results were also excluded. The water repellency results for each level are shown in Table 6 below quoted in seconds.

Table 6 – Water repellency: Mean and standard deviations in seconds

Level	Number of labs	General mean	Repeatability SD	Reproducibility SD
j	p_j	\hat{m}_j	s_{rj}	s_{Rj}
1	15	15.6	1.2	1.9
2	15	31.2	2.1	3.7
3	14	43.0	1.9	5.1

4.2.7 Dependence of precision on m

The results in Table 3 show the standard deviations increasing with higher values of m . By plotting the standard deviation against the general mean as shown in Figure 6, a linear relationship for repeatability and reproducibility have been derived. However, these relationships may actually be logarithmic.

4.2.8 Final values of precision

Repeatability standard deviation $s_r = 0.0322m + 0.836$

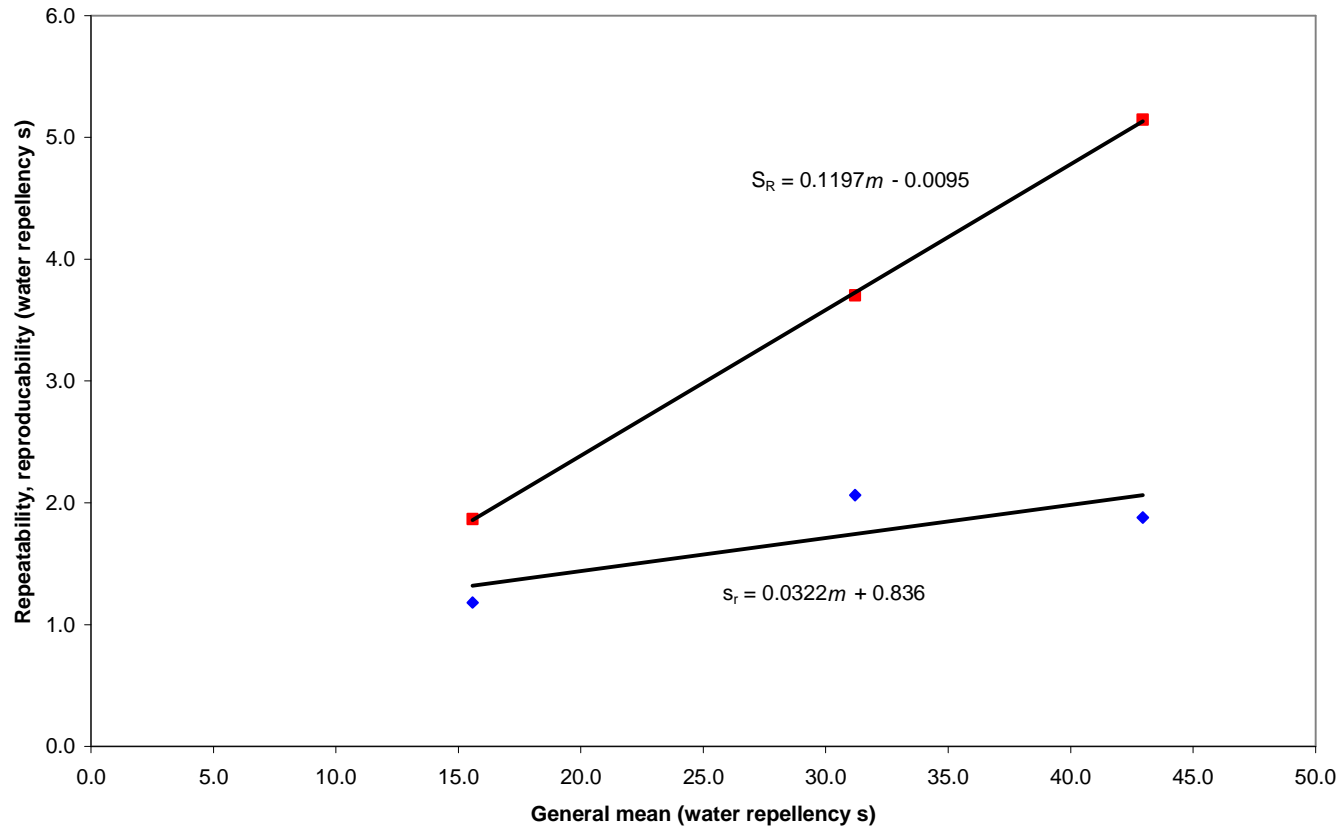
Reproducibility standard deviation $s_R = 0.1086m + 1.1091$

4.2.9 Comments

The cause of the outlying test results need to be understood.

More levels could be tested to confirm the true relationship between the standard deviations and the general mean.

Figure 6 - Water repellency: Plot of repeatability and reproducibility against general mean



4.3 Chloride content

4.3.1 Background

a) *Measurement method*

Determination of chloride content

b) *Source*

EN 868 (Based on ISO 6588-2:2005, ISO 9197)

c) *Description*

The chloride content of paper is determined using a hot extraction.

4.3.2 Original data

The original data can be found in Appendix 2.

4.3.3 Cell means

The cell means have been recorded in Table 7 below as chloride content percentage.

Table 7 – Chloride content: Cell means in percentage

Laboratory i	Level j			
	1	2	3	4
1	0.0300	0.0430	0.0230	0.0500
2	0.0325	0.0410	0.0195	0.0495
3	0.0295	0.0415	0.0190	0.0460
4	0.0180	0.0310	0.0130	0.0450
5	0.0150	0.0240	0.0080	0.0400
6	0.0149	0.0178	0.0089	0.0256
7	0.0152	0.0180	0.0092	0.0256

(a) denotes a straggler
(b) denotes a statistical outlier

4.3.4 Standard deviation

The standard deviations are shown in Table 8 below.

Table 8 – Chloride content: Cell ranges in percentage

Laboratory i	Level j			
	1	2	3	4
1	0.0028	0.0014	0.0000	0.0014
2	0.0007	0.0028	0.0021	0.0007
3	0.0007	0.0021	0.0000	0.0014
4	0.0057	0.0000	0.0014	0.0000
5	0.0021	0.0007	0.0007	0.0000
6	0.0000	0.0000	0.0004	0.0006
7	0.0004	0.0004	0.0005	0.0000

(a) denotes a straggler
(b) denotes a statistical outlier

4.3.5 Scrutiny for consistency and outliers

Calculation of Mandel's h and k statistics are graphically represented in Figures 7 and 8 below. The calculated values can be found in Appendix 1. Horizontal lines are shown corresponding to the value of Mandel's indicators based on seven laboratories and two replicate tests.

All results shown on h graph (Figure 7) were within the 5 and 1% significance values.

The k graph (Figure 8) shows the variability between replicate test results for laboratory 4, level 1 exceeded the 1% significance level. Laboratory 2, levels 2 and 3 exceeded the 5% significance level.

Application of Cochran's and Grubb's tests identified no stragglers or outliers.

Figure 7 - Chloride content: Mandel's between laboratory consistency statistic, h

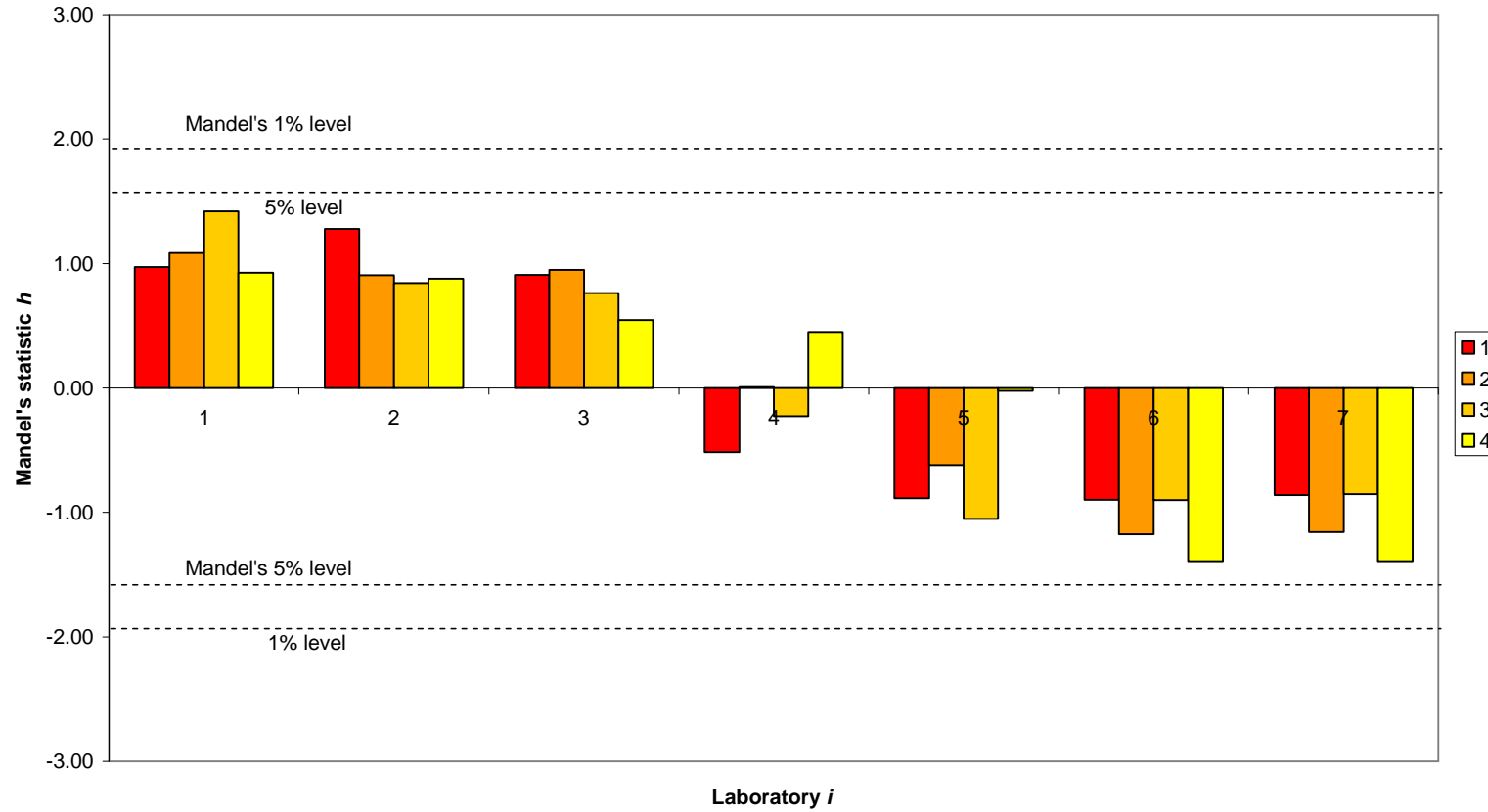
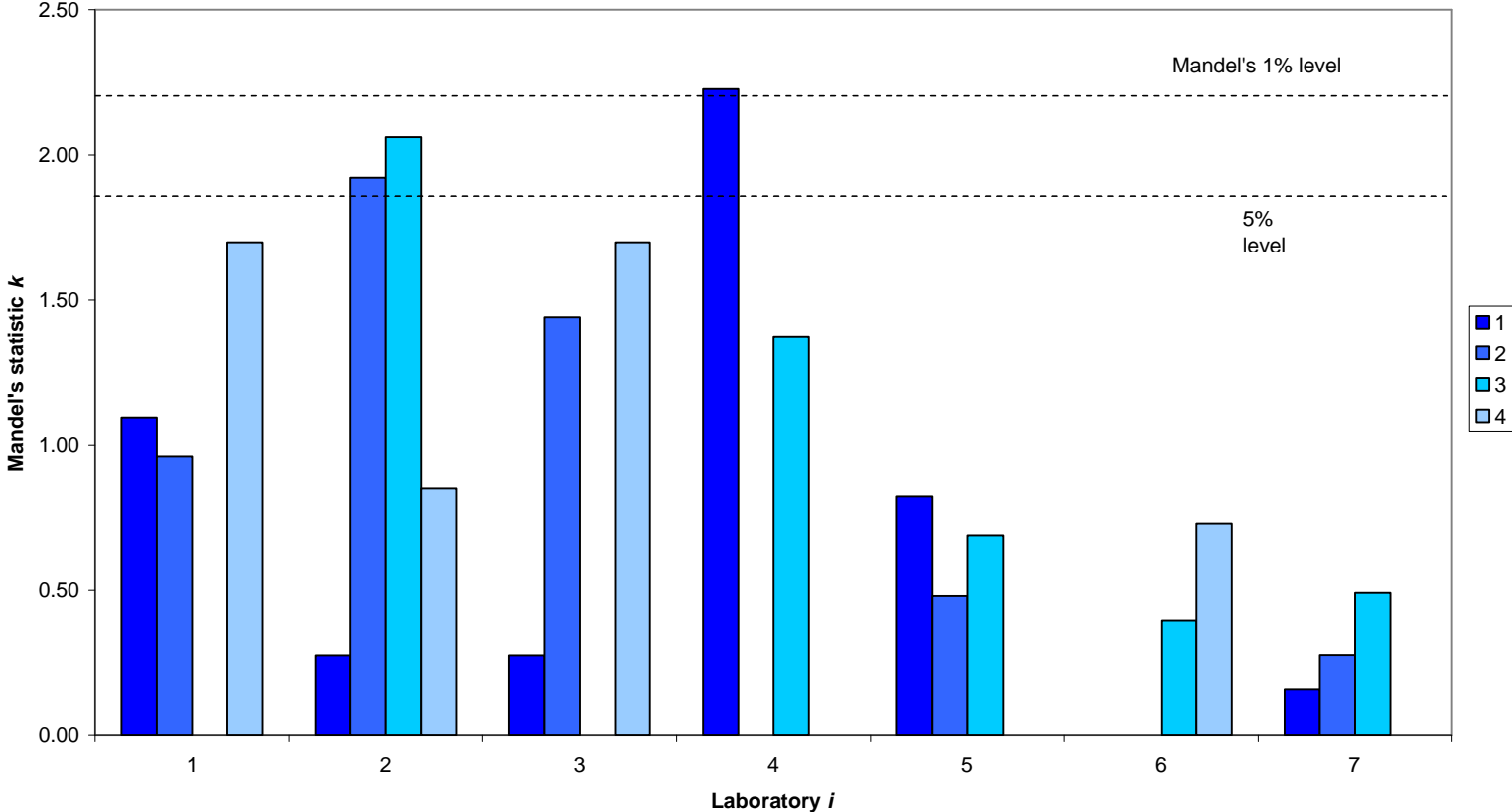


Figure 8 - Chloride content: Mandel's within-laboratory consistency statistic, k



4.3.6 Computation of the general mean, repeatability and reproducibility standard deviations

The values \hat{m} , s_{rj} and s_{Rj} were determined using all of the test results received. The chloride content results for each level are shown in Table 9 below, quoted as a percentage.

Table 9 – Chloride content: Mean and standard deviation in percentage

Level	Number of labs	General mean	Repeatability SD	Reproducibility SD
j	p_j	\hat{m}_j	s_{rj}	s_{Rj}
1	7	0.022	0.00181	0.0082
2	7	0.031	0.00103	0.0112
3	7	0.014	0.00072	0.0061
4	7	0.040	0.00058	0.0105

4.3.7 Dependence of precision on m

The results in Table 9 indicate that the reproducibility standard deviation increases with higher values of m . The repeatability standard deviation does not increase with the general mean. By plotting the standard deviations against the general mean as shown in Figure 9, a linear relationship for repeatability and reproducibility can be established.

4.3.8 Final values of precision

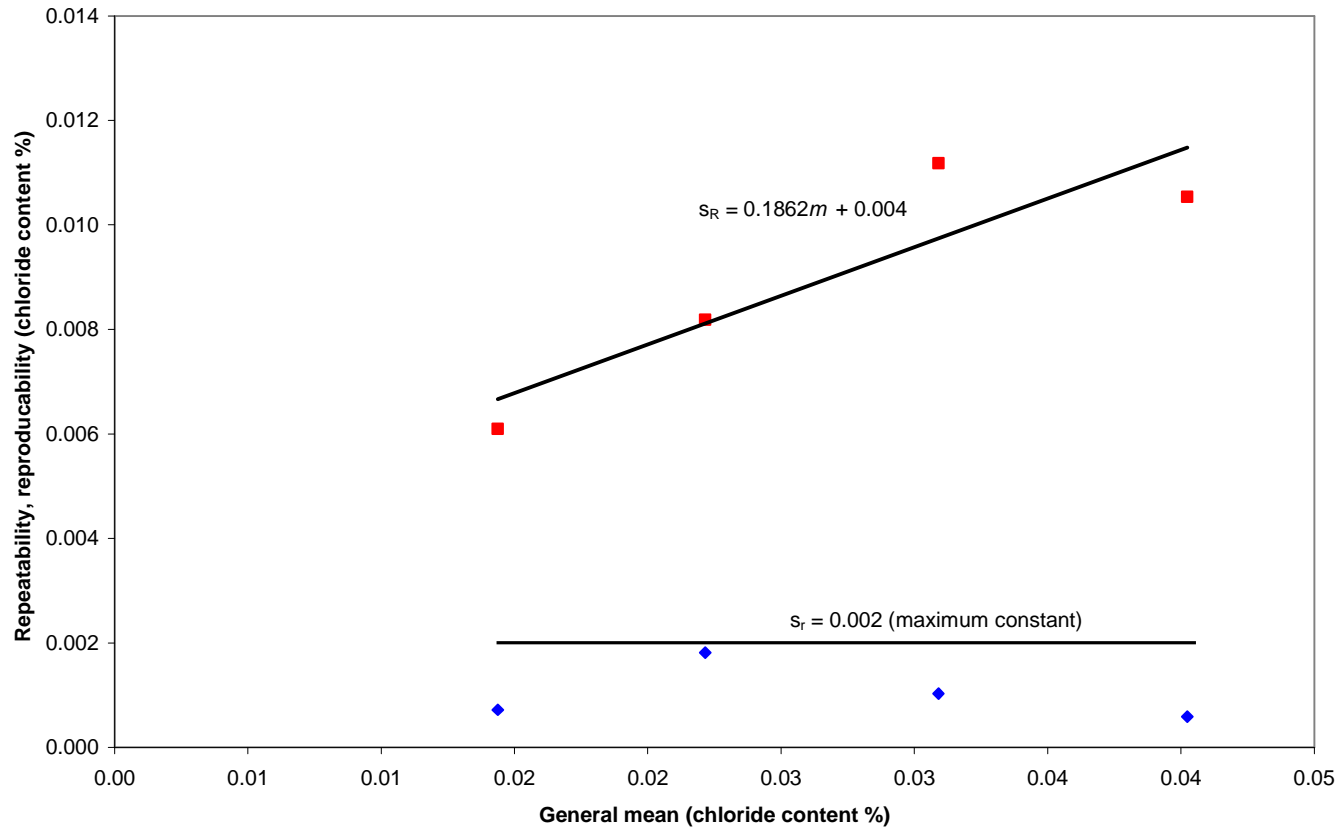
Repeatability standard deviation $s_r = 0.002$

Reproducibility standard deviation $s_R = 0.1862m + 0.004$

4.3.9 Comment

More levels could be tested to confirm the true relationship between the standard deviations and the general mean.

Figure 9 - Chloride content: Plot of repeatability and reproducibility against general mean



4.4 Sulphate content**4.4.1 Background****a) Measurement method**

Determination of the sulphate content

b) Source

EN 868 (Based on ISO 6588-2:2005, ISO 9198)

c) Description

The sulphate content of paper is determined using a hot extraction.

4.4.2 Original data

The original data is found in Appendix 2.

4.4.3 Cell means

The cell means have been recorded in Table 10 below, quoted as percentage sulphate content.

Table 10 – Sulphate content: Cell means percentage

Laboratory i	Level j			
	1	2	3	4
1	0.0740	0.0455	0.0195	0.0645
2	0.0955	0.0425	0.0235	0.0450
3	0.0800	0.0360	0.0240	0.0360
4	0.0390	0.0060	0.0070	0.0110
5	0.0430	0.0040	0.0040	0.0110
6	0.0538	0.0080	0.0097	0.0119
7	0.0518	0.0084	0.0088	0.0137

(a) denotes a straggler
(b) denotes a statistical outlier

4.4.4 Standard deviation

The standard deviations are shown in Table 11 below.

Table 11 – Sulphate content: cell ranges in percentage

Laboratory i	Level j			
	1	2	3	4
1	0.0127	0.0064	0.0021	0.0106
2	0.0021	0.0235	0.0106	0.0028
3	0.0071	0.0042	0.0042	0.0000
4	0.0184	0.0021	0.0000	0.0000
5	0.0078	0.0000	0.0000	0.0000
6	0.0016	0.0006	0.0019	0.0016
7	0.0006	0.0003	0.0002	0.0004

(a) denotes a straggler
(b) denotes a statistical outlier

4.4.5 Scrutiny for consistency and outliers

The calculated Mandel's h and k statistics are graphically represented in Figures 10 and 11 below. The calculated values can be found in Appendix 1. Horizontal lines are shown corresponding to the value of Mandel's indicators based on seven laboratories and two replicate tests.

All results shown on the h graph (Figure 10) shows that all results were within the 1% significance level however laboratory 1, level 4 exceeded the 5% significance level.

The k graph (Figure 11) shows the variability between replicate test results for laboratory 1, level 4 and laboratory 2, levels 2 and 3 exceeded the 1% significance level. Laboratory 4, level 1 exceeded the 5% significance level.

Application of Cochran's and Grubb's tests identified no stragglers or outliers.

Figure 10 - Sulphate content: Mandel's between laboratory consistency statistic, h

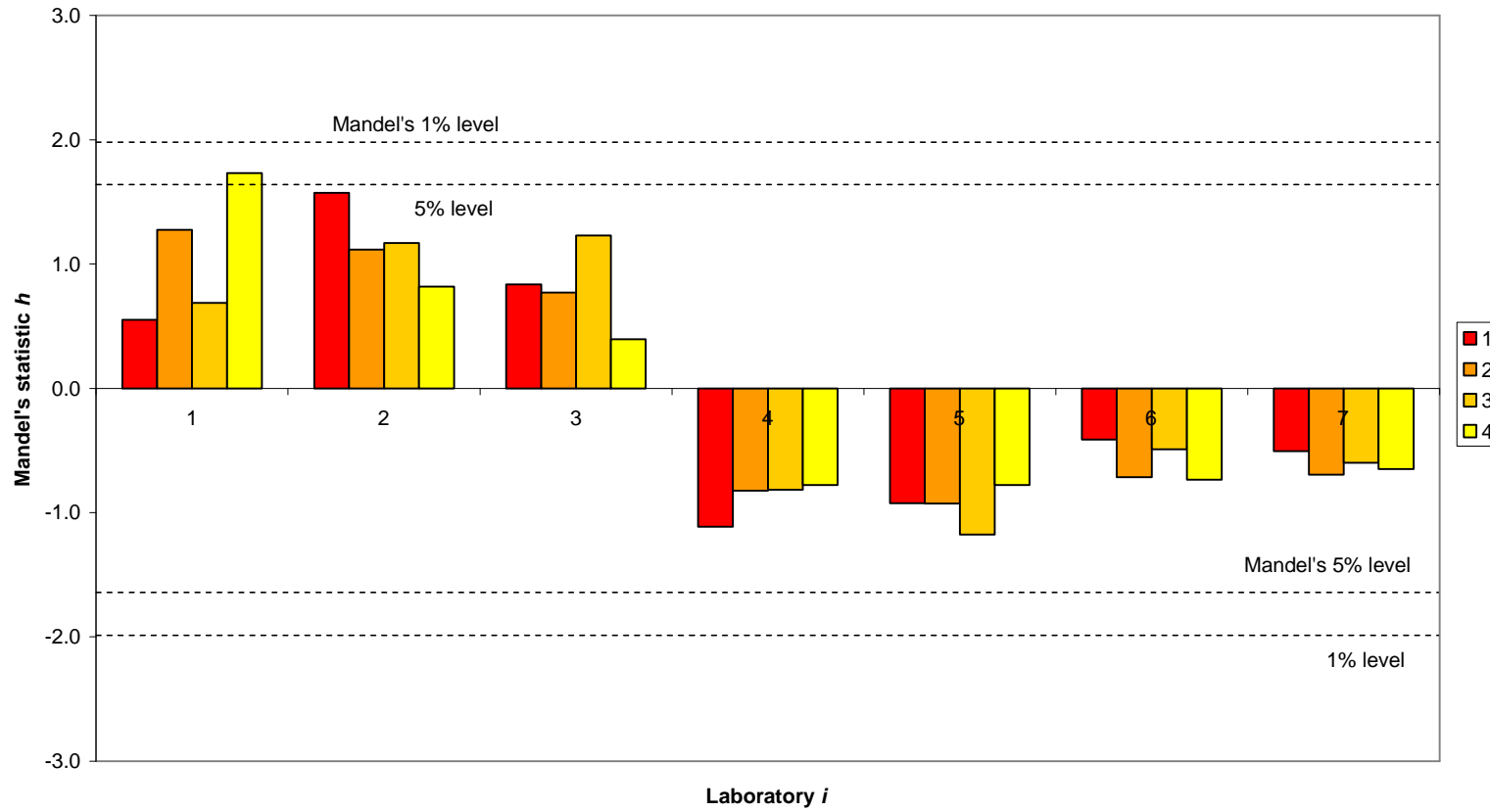
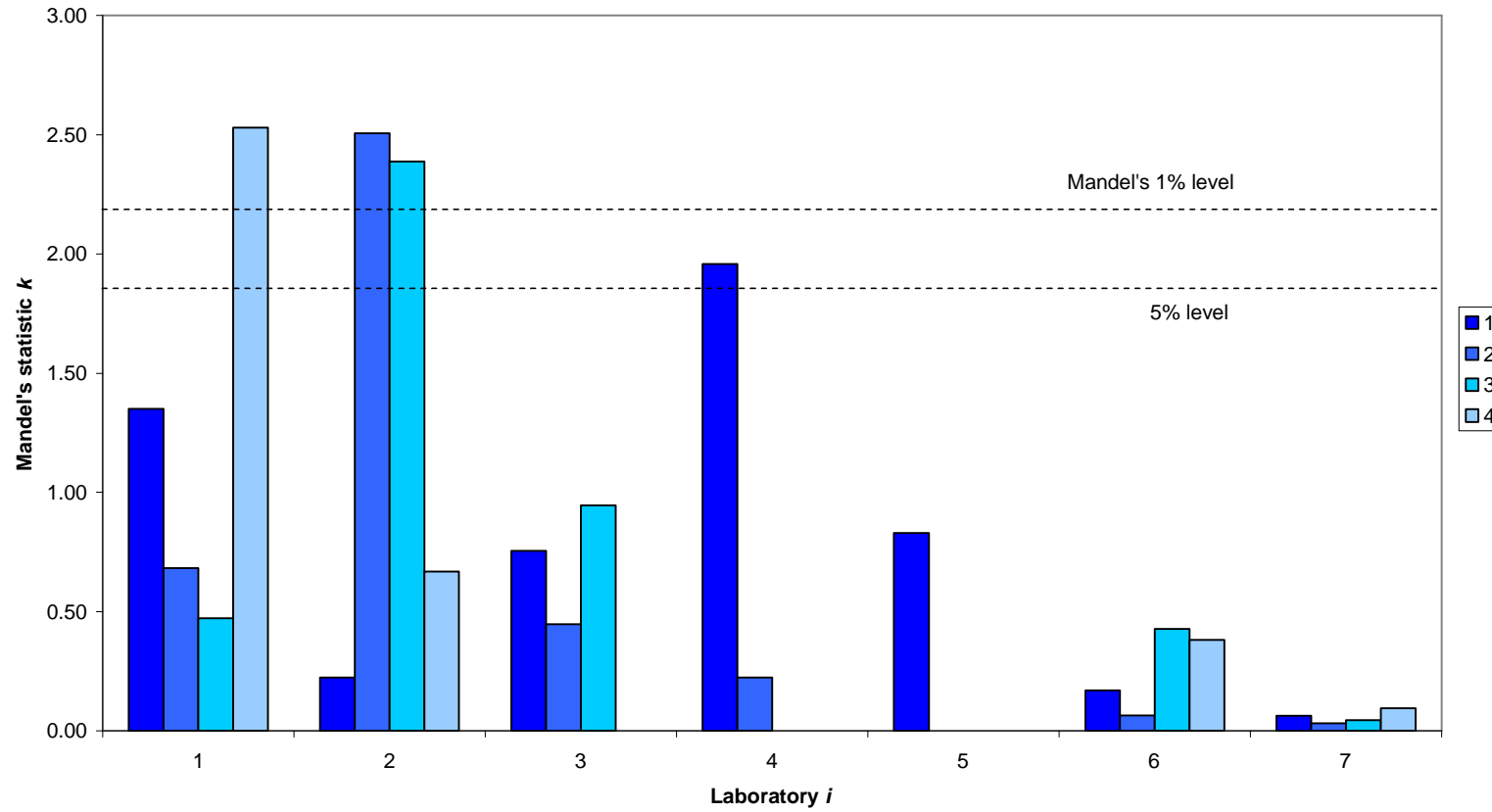


Figure 11 - Sulphate content: Mandel's within-laboratory consistency statistic, k



4.4.6 Computation of the general mean, repeatability and reproducibility standard deviations

The values \hat{m} , s_{rj} and s_{Rj} were determined using all of the test results received. The sulphate content results for each level are shown in Table 12 below quoted as a percentage.

Table 12 – Sulphate content: Mean and standard deviation as a percentage

Level	Number of labs	General mean	Repeatability SD	Reproducibility SD
j	p_j	\hat{m}_j	s_{rj}	s_{Rj}
1	7	0.055	0.0062	0.0298
2	7	0.019	0.0062	0.0195
3	7	0.012	0.0029	0.0093
4	7	0.024	0.0028	0.0221

4.4.7 Dependence of precision on m

The results in Table 12 show the reproducibility standard deviation increasing with higher values of m . The repeatability standard deviation does not seem to increase with the general mean. By plotting the standard deviations against the general mean as shown in Figure 12, a linear relationship for repeatability and reproducibility can be established.

4.4.8 Final values of precision

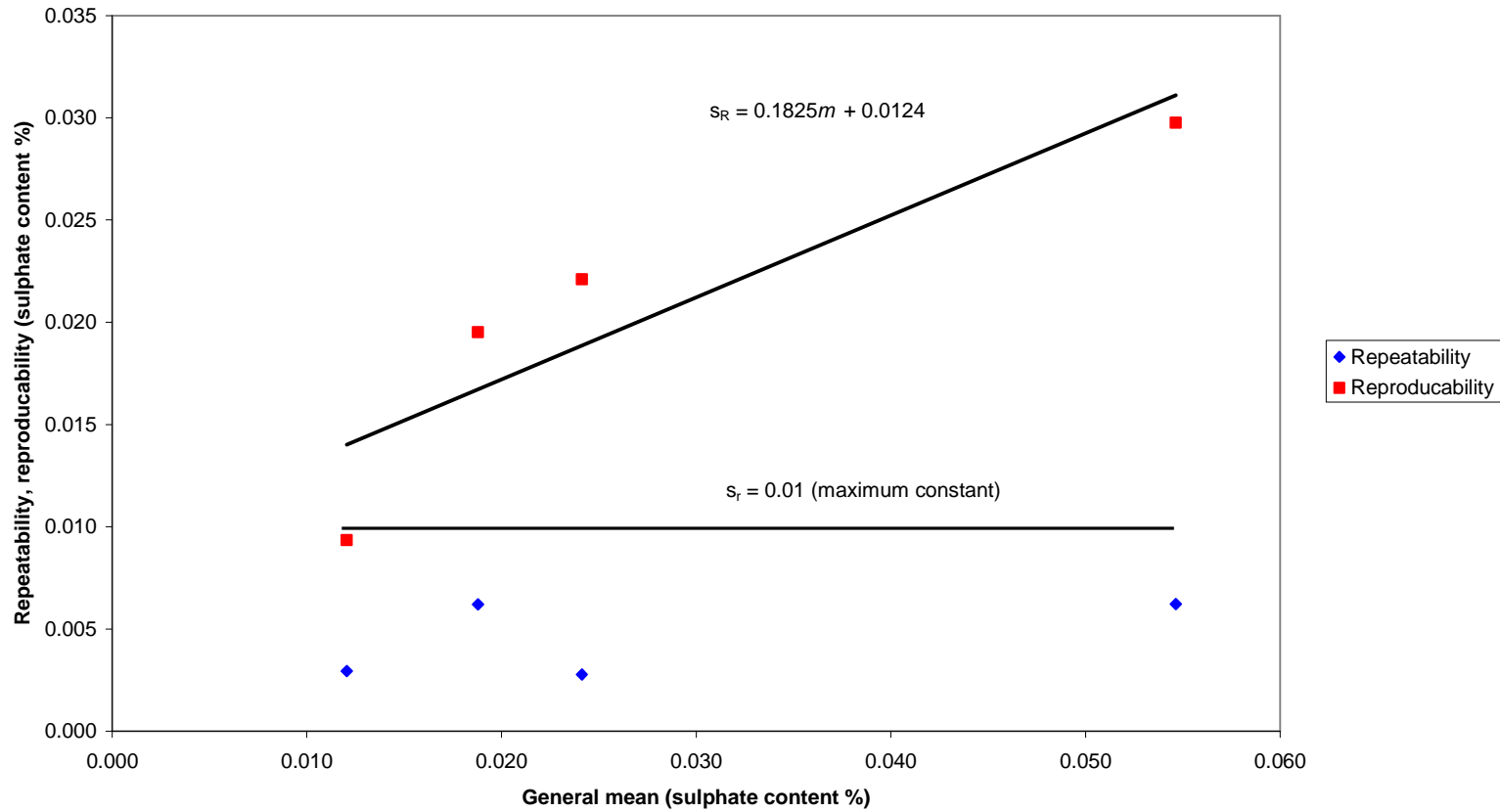
Repeatability standard deviation $s_r = 0.01$

Reproducibility standard deviation $s_R = 0.1825m + 0.0124$

4.4.9 Comment

More levels could be tested to confirm the true relationship between the standard deviations and the general mean.

Figure 12 - Sulphate content: Plot of repeatability and reproducibility against general mean



5 Summary/Conclusion

Table 13 below summarises the repeatability and reproducibility standard deviations for each of the methods analysed. The repeatability and reproducibility are expressed as a function of measurement value and also as a percentage of the EN 868 specification value.

Table 13 – Results summary

Test	Units	EN 868 specification	Repeatability s_r		Reproducibility s_R	
			Relative to mean result	Expressed as % of specification limit	Relative to mean result	Expressed as % of specification value
Pore size	μm	< 50	$0.069m + 0.943$	8.8	$0.160m + 2.939$	16.0
Water repellency	s	Not < 20	$0.0322m + 0.836$	7.4	$0.1197m - 0.0095$	11.9
Chloride content	%	Not > 0.05	0.002	4.0	$0.1862 m + 0.004$	26.6
Sulphate content	%	Not > 0.25	0.01	4.0	$0.1825 m + 0.0124$	23.2

The results show that the repeatability and reproducibility are very significant when referenced to the measured value at the specification limit. It may, therefore, be appropriate to allow for this when specifying material tolerances within ISO 11607.

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Appendix 1 - Test statistics

The following tables detail the Mandel's h and k statistics together with the Cochran and Grubb's results for each test method.

Pore size

Pore size: Mandel's h values

Lab	Level			
	1	2	3	4
1	-0.45	-0.36	-0.38	-0.43
2	-0.99	-1.21	-1.31	-0.18
3	1.14	1.11	0.80	0.03
4	0.45	0.89	1.19	1.18
5	0.72	0.11	0.15	-0.17
6	-	0.53	0.60	0.35
7	0.48	0.81	0.63	1.45
8	0.48	-0.02	0.13	-0.22
9	-1.83	-1.85	-1.81	-2.02
5% level	1.78	1.78	1.78	1.78
1% level	2.13	2.13	2.13	2.13

Pore size: Mandel's k values

Lab	Level			
	1	2	3	4
1	2.52	3.38	3.22	2.19
2	1.72	1.49	1.74	3.09
3	3.98	3.11	1.88	2.64
4	2.52	5.28	4.43	2.36
5	4.38	3.25	5.10	2.31
6	-	2.84	3.36	1.52
7	3.45	3.11	2.42	6.75
8	1.19	0.95	1.07	0.73
9	0.13	0.81	0.40	0.62
5% level	1.35	1.35	1.35	1.35
1% level	1.50	1.50	1.50	1.50

Pore size: Cochran statistics

Lab	Level			
	1	2	3	4
1	0.099	0.141	0.128	0.059
2	0.046	0.027	0.038	0.118
3	0.247	0.119	0.044	0.086
4	0.099	0.344	0.242	0.069
5	0.299	0.130	0.321	0.066
6	0.000	0.100	0.139	0.028
7	0.186	0.119	0.072	0.562
8	0.022	0.011	0.014	0.007
9	0.000	0.008	0.002	0.005
Stragglers	0.2829	0.2568	0.2568	0.2568
Outliers	0.3248	0.2950	0.2950	0.2950

Pore size: Grubbs statistic

Level	Single low	Single high	Double low	Double high
1	1.828	1.141	0.195	0.657
2	1.851	1.106	0.220	0.676
3	1.813	1.193	0.201	0.671
4	2.019	1.454	0.360	0.437
Stragglers	2.215	2.215	0.1492	0.1492
Outliers	2.387	2.387	0.0851	0.0851

Water repellency***Water repellency: Mandel's h values***

Lab	Level		
	1	2	3
1	0.01	-0.01	-0.01
2	0.01	-0.60	-1.08
3	-0.07	-0.34	-0.58
4	0.59	-0.12	0.11
5	0.35	-0.39	-0.37
6	-1.40	-2.02	-2.37
7	-0.44	-0.39	0.62
8	0.39	0.05	1.65
9	0.26	0.05	0.53
10	-1.52	-0.25	0.01
11	0.01	0.10	0.14
12	-0.65	1.25	-0.08
13	-0.53	-0.67	-0.71
14	3.00	2.80	1.94
15	-0.24	0.27	-0.05
16	0.22	0.27	0.26
5% level	1.86	1.86	1.86
1% level	2.33	2.33	2.33

Water repellency: Mandel's k values

Lab	Level		
	1	2	3
1	3.55	2.43	4.03
2	2.91	3.55	2.11
3	4.52	3.55	3.46
4	3.55	2.61	4.61
5	2.58	2.24	2.69
6	5.49	5.04	4.61
7	1.29	4.11	4.22
8	2.58	2.05	3.46
9	2.26	2.24	4.03
10	4.52	5.79	3.84
11	2.91	1.49	3.46
12	3.55	3.36	7.87
13	4.52	3.36	2.11
14	6.13	5.79	3.46
15	3.23	6.35	3.26
16	6.46	5.42	3.46
5% level	1.36	1.36	1.36
1% level	1.52	1.52	1.52

Water repellency: Cochran statistics

Lab	Level		
	1	2	3
1	0.049	0.023	0.063
2	0.033	0.049	0.017
3	0.080	0.049	0.047
4	0.049	0.027	0.083
5	0.026	0.020	0.028
6	0.118	0.099	0.083
7	0.007	0.066	0.070
8	0.026	0.016	0.047
9	0.020	0.020	0.063
10	0.080	0.131	0.058
11	0.033	0.009	0.047
12	0.049	0.044	0.242
13	0.080	0.044	0.017
14	0.147	0.131	0.047
15	0.041	0.157	0.042
16	0.163	0.115	0.047
Stragglers	0.1671	0.1671	0.1671
Outliers	0.1918	0.1918	0.1918

Water repellency: Grubbs statistic

Level	Single low	Single high	Double low	Double high
1	1.524	3.003	0.674	0.313
2	2.024	2.805	0.663	0.292
3	2.371	1.936	0.491	0.508
Stragglers	2.585	2.585	0.3603	0.3603
Outliers	2.852	2.852	0.2767	0.2767

Chloride content***Chloride content: Mandel's h values***

Lab	Level			
	1	2	3	4
1	0.97	1.08	1.42	0.93
2	1.28	0.91	0.84	0.88
3	0.91	0.95	0.76	0.55
4	-0.51	0.01	-0.23	0.45
5	-0.89	-0.62	-1.05	-0.02
6	-0.90	-1.17	-0.90	-1.39
7	-0.86	-1.16	-0.85	-1.39
5% level	1.71	1.71	1.71	1.71
1% level	1.98	1.98	1.98	1.98

Chloride content: Mandel's k values

Lab	Level			
	1	2	3	4
1	1.09	0.96	0.00	1.70
2	0.27	1.92	2.06	0.85
3	0.27	1.44	0.00	1.70
4	2.23	0.00	1.37	0.00
5	0.82	0.48	0.69	0.00
6	0.00	0.00	0.39	0.73
7	0.16	0.27	0.49	0.00
5% level	1.87	1.87	1.87	1.87
1% level	2.20	2.20	2.20	2.20

Chloride content: Cochran statistics

Lab	Level			
	1	2	3	4
1	0.171	0.132	0.000	0.411
2	0.011	0.528	0.607	0.103
3	0.011	0.297	0.000	0.411
4	0.708	0.000	0.270	0.000
5	0.096	0.033	0.067	0.000
6	0.000	0.000	0.022	0.075
7	0.003	0.011	0.034	0.000
Stragglers	0.7270	0.7270	0.7270	0.7270
Outliers	0.8380	0.8380	0.8380	0.8380

Commercial in confidence

Chloride content: Grubbs statistic

Level	Single low	Single high	Double low	Double high
1	0.8979	1.2796	0.6289	0.4014
2	1.1745	1.0848	0.3660	0.5152
3	1.0490	1.4207	0.5546	0.3738
4	1.3903	0.9264	0.0980	0.6196
Stragglers	2.02	2.02	0.0708	0.0708
Outliers	2.139	2.139	0.0308	0.0308

Sulphate content**Sulphate content: Mandel's h values**

Lab	Level			
	1	2	3	4
1	0.55	1.28	0.69	1.73
2	1.57	1.12	1.17	0.82
3	0.84	0.77	1.23	0.39
4	-1.12	-0.82	-0.82	-0.78
5	-0.93	-0.93	-1.18	-0.78
6	-0.41	-0.72	-0.49	-0.74
7	-0.51	-0.69	-0.60	-0.65
5% level	1.71	1.71	1.71	1.71
1% level	1.98	1.98	1.98	1.98

Sulphate content: Mandel's k values

Lab	Level			
	1	2	3	4
1	1.35	0.68	0.47	2.53
2	0.22	2.51	2.39	0.67
3	0.76	0.45	0.95	0.00
4	1.96	0.22	0.00	0.00
5	0.83	0.00	0.00	0.00
6	0.17	0.06	0.43	0.38
7	0.06	0.03	0.05	0.10
5% level	1.87	1.87	1.87	1.87
1% level	2.20	2.20	2.20	2.20

Sulphate content: Cochran statistics

Lab	Level			
	1	2	3	4
1	0.261	0.067	0.032	0.914
2	0.007	0.897	0.814	0.064
3	0.082	0.029	0.128	0.000
4	0.547	0.007	0.000	0.000
5	0.098	0.000	0.000	0.000
6	0.004	0.001	0.026	0.021
7	0.001	0.000	0.000	0.001
Stragglers	0.7270	0.7270	0.7270	0.7270
Outliers	0.8380	0.8380	0.8380	0.8380

Sulphate content: Grubbs statistic

Level	Single low	Single high	Double low	Double high
1	1.1155	1.5729	0.5112	0.2780
2	0.9286	1.2753	0.6414	0.3308
3	1.1771	1.2286	0.5256	0.3293
4	0.7782	1.7319	0.7174	0.1722
Stragglers	2.02	2.02	0.0708	0.0708
Outliers	2.139	2.139	0.0308	0.0308

Appendix 2 – Original test results

The following pages contain the original test results. For reasons of confidentiality, the identity of each laboratory has been withheld.

Pore size - Determination of equivalent diameter (EN 868-2, 3, 6&7)

Lab number: 1

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Obtain 10 replicate measurements, performed in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Equivalent pore size diameter (μm)			
	A	B	C	D
1	9	16	14	36
2	8	12	11	32
3	10	20	18	38
4	8	16	18	40
5	8	12	14	34
6	8	12	18	36
7	6	14	16	34
8	10	14	16	46
9	12	14	14	36
10	12	14	18	38
Mean	9.1	14.4	15.7	37.0
SD	1.9	2.5	2.4	3.9

4. Please record the laboratory temperature and humidity at the time of testing.

Temperature: _____

Humidity: _____

5. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Pore size - Determination of equivalent diameter (EN 868-2, 3, 6&7)

Lab number: 2

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Obtain 10 replicate measurements, performed in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Equivalent pore size diameter (μm)			
	A	B	C	D
1	7	10	10	46
2	9	11	10	44
3	7	10	10	42
4	5	9	10	32
5	6	10	10	30
6	7	10	14	46
7	7	11	10	40
8	5	9	11	38
9	6	12	10	36
10	8	12	12	40
Mean	6.7	10.4	10.7	39.4
SD	1.3	1.1	1.3	5.5

4. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 24.2oC

Humidity: 41%

5. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Pore size - Determination of equivalent diameter (EN 868-2, 3, 6&7)

Lab number: 3

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Obtain 10 replicate measurements, performed in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Equivalent pore size diameter (µm)			
	A	B	C	D
1	15	19	22	43
2	20	20	20	45
3	14	21	22	50
4	17	20	24	41
5	14	25	22	41
6	15	21	20	39
7	15	19	21	43
8	23	23	24	43
9	16	25	22	36
10	14	20	23	33
Mean	16.3	21.3	22.0	41.4
SD	3.0	2.3	1.4	4.7

4. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 22°C

Humidity: 51%

5. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Pore size - Determination of equivalent diameter (EN 868-2, 3, 6&7)

Lab number: 4

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Obtain 10 replicate measurements, performed in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Equivalent pore size diameter (μm)			
	A	B	C	D
1	17	17	22	53
2	13	19	30	49
3	12	20	23	53
4	12	20	22	49
5	11	19	29	49
6	15	20	23	53
7	15	19	23	49
8	11	18	22	63
9	13	31	20	53
10	13	20	27	53
Mean	13.2	20.3	24.1	52.4
SD	1.9	3.9	3.3	4.2

4. Please record the laboratory temperature and humidity at the time of testing.

Temperature: _____ 23

Humidity: _____ 50

5. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Pore size - Determination of equivalent diameter (EN 868-2, 3, 6&7)

Lab number: 5

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Obtain 10 replicate measurements, performed in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Equivalent pore size diameter (μm)			
	A	B	C	D
1	19.5	14.4	16.0	38.1
2	12.7	17.2	22.5	36.5
3	13.1	16.0	19.5	46.0
4	17.9	15.2	17.2	43.8
5	15.4	16.0	17.9	41.7
6	11.1	15.7	14.4	39.8
7	11.4	15.8	15.4	39.8
8	15.4	20.4	22.5	41.7
9	9.7	14.0	14.0	32.5
10	17.9	21.4	25.1	35.1
Mean	14.4	16.6	18.5	39.5
SD	3.3	2.4	3.8	4.1

4. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 23.0

Humidity: 50.0

5. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Pore size - Determination of equivalent diameter (EN 868-2, 3, 6&7)

Lab number: 6

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Obtain 10 replicate measurements, performed in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Equivalent pore size diameter (μm)			
	A	B	C	D
1	<12	20.5	19.6	43.0
2	<12	<12	21.0	46.1
3	<12	19.2	24.4	43.8
4	<12	15.7	17.9	43.4
5	<12	19.5	25.1	46.6
6	<12	18.3	22.6	42.1
7	<12	18.4	18.8	41.7
8	<12	15.6	18.6	40.6
9	<12	22.1	21.3	47.6
10	<12	17.7	19.2	48.6
Mean		18.6	20.9	44.4
SD		2.1	2.5	2.7

4. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 24.0

Humidity: 48.0

5. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Pore size - Determination of equivalent diameter (EN 868-2, 3, 6&7)

Lab number: 7

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Obtain 10 replicate measurements, performed in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Equivalent pore size diameter (μm)			
	A	B	C	D
1	15.4	19.2	22.2	65.7
2	10.1	23.4	19.1	54.9
3	12.1	21.8	22.8	61
4	13.2	18.4	20.1	58.2
5	14.3	19	21.4	73.4
6	14.9	20	20.2	41.5
7	9.6	23.1	17.6	40.1
8	12.9	19.6	23.3	65.2
9	18.5	18.9	22	38.9
10	12	15.7	22	50.7
Mean	13.3	19.9	21.1	55.0
SD	2.6	2.3	1.8	12.0

4. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 23.1

Humidity: 52.3

5. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Pore size - Determination of equivalent diameter (EN 868-2, 3, 6&7)

Lab number: 8

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Obtain 10 replicate measurements, performed in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Equivalent pore size diameter (μm)			
	A	B	C	D
1	12.77	15.43	17.81	37.9
2	14.23	15.38	19.64	37.59
3	12.99	17.68	18.31	40.93
4	11.79	15.96	17.34	40.22
5	12.56	16.48	19.89	37.59
6	13.21	15.58	18.24	38.54
7	12.46	15.48	18.68	38.86
8	14.69	15.69	18.17	38.86
9	13.77	16.02	18.09	40.93
10	14.06	16.54	17.48	38.54
Mean	13.3	16.0	18.4	39.0
SD	0.9	0.7	0.8	1.3

4. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 22.0°C

Humidity: 44% RH

5. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Pore size - Determination of equivalent diameter (EN 868-2, 3, 6&7)

Lab number: 9

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Obtain 10 replicate measurements, performed in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Equivalent pore size diameter (μm)			
	A	B	C	D
1	2.79	7.35	7.95	23.63
2	2.83	7.15	7.84	22.88
3	2.79	6.73	7.83	21.55
4	2.95	7.97	7.87	20.89
5	2.93	6.86	8.14	23.66
6	2.89	6.71	7.48	20.96
7	2.84	7.52	8.21	21.36
8	2.86	6.98	8.42	20.67
9	2.86	8.44	7.79	21.04
10	3.1	7.79	8.04	21.31
Mean	2.9	7.4	8.0	21.8
SD	0.1	0.6	0.3	1.1

4. Please record the laboratory temperature and humidity at the time of testing.

Temperature: _____ 23

Humidity: _____ 50

5. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 1

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	14.3	32.1	47.6
	2	15.3	32.3	45.1
	3	14.7	30.2	43.0
	4	16.3	31.6	42.8
	5	15.6	31.1	43.7
Wireside down	6	16.3	34.8	42.8
	7	17.6	30.9	40.0
	8	17.4	32.5	41.9
	9	16.4	33.1	45.4
	10	16.9	32.0	43.8
	Mean	16.1	32.0	43.6
	SD	1.1	1.3	2.1

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: _____ 23

Humidity: _____ 50

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 2

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	16.0	31.1	37.8
	2	14.8	28.9	36.9
	3	16.9	30.3	36.5
	4	15.8	30.0	36.8
	5	15.9	30.5	36.9
Wireside down	6	15.7	32.4	39.2
	7	15.9	27.1	38.9
	8	18.0	28.4	38.3
	9	16.4	26.8	39.5
	10	15.4	27.1	39.1
	Mean	16.1	29.3	38.0
	SD	0.9	1.9	1.1

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 23

Humidity: 50

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 3

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	14.5	28.2	40.6
	2	14.9	33.2	41.7
	3	15.0	29.3	43.0
	4	18.4	28.6	42.7
	5	17.7	30.4	38.7
Wireside down	6	17.0	28.4	37.7
	7	15.8	30.8	39.4
	8	14.3	32.8	40.4
	9	16.1	32.9	42.3
	10	15.3	30.2	39.5
	Mean	15.9	30.5	40.6
	SD	1.4	1.9	1.8

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: _____

Humidity: _____

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 4

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	18.6	33.6	42.1
	2	16.7	31.6	42.5
	3	18.0	29.1	49.1
	4	17.0	31.4	43.9
	5	17.1	30.1	41.7
Wireside down	6	16.9	33.4	47.8
	7	19.9	32.3	42.3
	8	16.5	31.7	44.4
	9	16.1	31.1	44.2
	10	17.9	30.4	44.3
	Mean	17.5	31.5	44.2
	SD	1.1	1.4	2.4

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: _____

Humidity: _____

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 5

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	16.3	30.1	43.7
	2	17.4	31.1	40.5
	3	16.8	30.3	41.2
	4	17.6	32.3	43.3
	5	17.8	31.5	41.0
Wireside down	6	16.5	30.2	41.6
	7	15.5	28.9	40.7
	8	16.6	30.8	42.2
	9	16.6	29.9	42.9
	10	18.0	28.4	39.4
	Mean	16.9	30.3	41.7
	SD	0.8	1.2	1.4

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 23.3oC

Humidity: 47%

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 6

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	10.3	22.8	32.0
	2	12.3	27.3	31.1
	3	12.6	26.2	28.1
	4	10.1	22.2	33.5
	5	11.9	24.2	34.7
Wireside down	6	14.8	18.8	32.9
	7	13.5	21.8	31.1
	8	12.5	19.1	32.2
	9	15.1	22.8	27.3
	10	14.2	23.3	29.2
	Mean	12.7	22.8	31.2
	SD	1.7	2.7	2.4

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 22.1oC

Humidity: 38%

After all testing is finished, please return this completed spreadsheet to:

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Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 7

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	15.4	31.6	43.1
	2	15.0	32.4	47.2
	3	14.2	31.8	45.1
	4	14.5	33.7	48.7
	5	15.1	31.8	48.5
Wireside down	6	15.6	28.3	49.4
	7	15.2	29.3	45.3
	8	15.0	27.3	44.8
	9	15.6	28.2	47.7
	10	14.9	28.8	49.3
	Mean	15.0	30.3	46.9
	SD	0.4	2.2	2.2

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 21.9oC

Humidity: 37%

After all testing is finished, please return this completed spreadsheet to:

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Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 8

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	18.6	32.9	53.0
	2	16.3	33.9	55.0
	3	17.5	32.7	52.0
	4	17.4	31.9	50.0
	5	16.9	33.7	54.5
Wireside down	6	16.2	31.8	53.6
	7	16.0	32.7	51.5
	8	17.0	30.6	49.3
	9	17.5	31.1	52.2
	10	16.8	31.5	51.6
	Mean	17.0	32.3	52.3
	SD	0.8	1.1	1.8

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 22.8oC

Humidity: 42%

After all testing is finished, please return this completed spreadsheet to:

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If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 9

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	15.6	31.5	45.7
	2	16.3	34.7	49.2
	3	17.1	31.6	48.2
	4	16.9	30.5	48.0
	5	17.1	32.3	49.0
Wireside down	6	15.9	31.6	45.2
	7	16.1	32.0	45.8
	8	16.8	32.0	43.0
	9	17.5	33.6	44.2
	10	17.8	32.8	45.8
	Mean	16.7	32.3	46.4
	SD	0.7	1.2	2.1

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 23.2oC

Humidity: 41

After all testing is finished, please return this completed spreadsheet to:

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If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 10

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	14.0	33.0	45.0
	2	14.0	35.0	47.0
	3	12.0	34.0	41.0
	4	13.0	35.0	42.0
	5	14.0	30.0	42.0
Wireside down	6	11.0	28.0	43.0
	7	12.0	27.0	44.0
	8	10.0	28.0	42.0
	9	13.0	30.0	45.0
	10	11.0	29.0	46.0
	Mean	12.4	30.9	43.7
	SD	1.4	3.1	2.0

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 22.5°C

Humidity: 50%

After all testing is finished, please return this completed spreadsheet to:

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If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 11

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	18.0	33.0	45.0
	2	16.0	31.0	46.0
	3	15.0	34.0	47.0
	4	16.0	33.0	45.0
	5	17.0	32.0	43.0
Wireside down	6	16.0	32.0	46.0
	7	16.0	33.0	45.0
	8	15.0	32.0	43.0
	9	16.0	32.0	42.0
	10	16.0	33.0	42.0
	Mean	16.1	32.5	44.4
	SD	0.9	0.8	1.8

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 23°C

Humidity: 50%

After all testing is finished, please return this completed spreadsheet to:

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If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 12

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	14.0	38.0	46.0
	2	15.0	35.0	49.0
	3	14.0	36.0	48.0
	4	13.0	37.0	46.0
	5	13.0	37.0	46.0
Wireside down	6	15.0	40.0	39.0
	7	16.0	38.0	40.0
	8	16.0	41.0	40.0
	9	15.0	38.0	39.0
	10	14.0	38.0	39.0
	Mean	14.5	37.8	43.2
	SD	1.1	1.8	4.1

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 23°C

Humidity: 50%

After all testing is finished, please return this completed spreadsheet to:

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If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 13

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	13.0	30.0	40.0
	2	15.0	27.0	41.0
	3	14.0	27.0	40.0
	4	15.0	27.0	42.0
	5	13.0	27.0	40.0
Wireside down	6	14.0	30.0	40.0
	7	17.0	31.0	39.0
	8	15.0	30.0	40.0
	9	17.0	31.0	38.0
	10	15.0	30.0	39.0
	Mean	14.8	29.0	39.9
	SD	1.4	1.8	1.1

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: 23

Humidity: 50

After all testing is finished, please return this completed spreadsheet to:

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If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 14

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	25.0	44.0	56.0
	2	26.0	44.0	55.0
	3	22.0	41.0	55.0
	4	23.0	40.0	54.0
	5	20.0	44.0	50.0
Wireside down	6	24.0	47.0	55.0
	7	24.0	45.0	54.0
	8	21.0	50.0	52.0
	9	23.0	49.0	54.0
	10	25.0	45.0	53.0
	Mean	23.3	44.9	53.8
	SD	1.9	3.1	1.8

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: _____

Humidity: _____

After all testing is finished, please return this completed spreadsheet to:

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If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Water repellency - Dry indicator method for medical papers (EN 868-2, 3, 6 & 7)

Lab number: 15

1. Remove the test samples from their packaging and condition at 23°C 50%rh for at least 24 hours prior to testing.
2. Prepare 10 replicates from each sample and test 5 wireside up and 5 wireside down.
3. Perform all testing in accordance with the EN 868 method.
4. Enter the results for each sample in the table below.

Test side	Replicate	Time to general fluorescence (seconds)		
		A	B	C
Wireside up	1	14.0	39.0	45.0
	2	15.0	35.0	44.0
	3	15.0	35.0	41.0
	4	15.0	37.0	42.0
	5	16.0	33.0	43.0
Wireside down	6	16.0	28.0	46.0
	7	15.0	30.0	45.0
	8	17.0	31.0	44.0
	9	15.0	34.0	41.0
	10	17.0	31.0	43.0
	Mean	15.5	33.3	43.4
	SD	1.0	3.4	1.7

5. Please record the laboratory temperature and humidity at the time of testing.

Temperature: _____ 23

Humidity: _____ 50

After all testing is finished, please return this completed spreadsheet to:

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If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Chloride and sulphate content (ISO 6588-2, ISO 9197, ISO 9198)

Lab number: 1

1. Remove the test samples from their packaging and condition at 23°C, 50%rh for at least 24 hours prior to testing.
2. Obtain duplicate measurements for the chloride and sulphate content in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Chloride content (%)			
	A	B	C	D
1	0.0320	0.0420	0.0230	0.0510
2	0.0280	0.0440	0.0230	0.0490
Mean	0.0300	0.0430	0.0230	0.0500
sd	0.0028	0.0014	0.0000	0.0014

Replicate	Sulphate content (%)			
	A	B	C	D
1	0.0830	0.0500	0.0210	0.0720
2	0.0650	0.0410	0.0180	0.0570
Mean	0.0740	0.0455	0.0195	0.0645
SD	0.0127	0.0064	0.0021	0.0106

4. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094

Chloride and sulphate content (ISO 6588-2, ISO 9197, ISO 9198)

Lab number: 2

1. Remove the test samples from their packaging and condition at 23°C, 50%rh for at least 24 hours prior to testing.
2. Obtain duplicate measurements for the chloride and sulphate content in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Chloride content (%)			
	A	B	C	D
1	0.0330	0.0390	0.0210	0.0490
2	0.0320	0.0430	0.0180	0.0500
Mean	0.0325	0.0410	0.0195	0.0495
sd	0.0007	0.0028	0.0021	0.0007

Replicate	Sulphate content (%)			
	A	B	C	D
1	0.0940	0.0450	0.0310	0.0470
2	0.0970	0.0400	0.0160	0.0430
Mean	0.0955	0.0425	0.0235	0.0450
sd	0.0021	0.0035	0.0106	0.0028

4. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Chloride and sulphate content (ISO 6588-2, ISO 9197, ISO 9198)

Lab number: 3

1. Remove the test samples from their packaging and condition at 23°C, 50%rh for at least 24 hours prior to testing.
2. Obtain duplicate measurements for the chloride and sulphate content in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Chloride content (%)			
	A	B	C	D
1	0.0290	0.0400	0.0190	0.0470
2	0.0300	0.0430	0.0190	0.0450
Mean	0.0295	0.0415	0.0190	0.0460
sd	0.0007	0.0021	0.0000	0.0014

Replicate	Sulphate content (%)			
	A	B	C	D
1	0.0750	0.0390	0.0210	0.0360
2	0.0850	0.0330	0.0270	0.0360
Mean	0.0800	0.0360	0.0240	0.0360
sd	0.0071	0.0042	0.0042	0.0000

4. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Chloride and sulphate content (ISO 6588-2, ISO 9197, ISO 9198)

Lab number: 4

1. Remove the test samples from their packaging and condition at 23°C, 50%rh for at least 24 hours prior to testing.
2. Obtain duplicate measurements for the chloride and sulphate content in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Chloride content (%)			
	A	B	C	D
1	0.022	0.031	0.014	0.045
2	0.014	0.031	0.012	0.045
Mean	0.018	0.031	0.013	0.045
sd	0.0057	0.0000	0.0014	0.0000

Replicate	Sulphate content (%)			
	A	B	C	D
1	0.052	0.004	0.007	0.011
2	0.026	0.007	0.007	0.011
Mean	0.039	0.006	0.007	0.011
sd	0.0184	0.0021	0.0000	0.0000

4. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Chloride and sulphate content (ISO 6588-2, ISO 9197, ISO 9198)

Lab number: 5

1. Remove the test samples from their packaging and condition at 23°C, 50%rh for at least 24 hours prior to testing.
2. Obtain duplicate measurements for the chloride and sulphate content in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Chloride content (%)			
	A	B	C	D
1	0.016	0.023	0.008	0.040
2	0.013	0.024	0.007	0.040
Mean	0.015	0.024	0.008	0.040
sd	0.0021	0.0007	0.0007	0.0000

Replicate	Sulphate content (%)			
	A	B	C	D
1	0.048	0.004	0.004	0.011
2	0.037	0.004	0.004	0.011
Mean	0.043	0.004	0.004	0.011
sd	0.0078	0.0000	0.0000	0.0000

4. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Chloride and sulphate content (ISO 6588-2, ISO 9197, ISO 9198)

Lab number: 6

1. Remove the test samples from their packaging and condition at 23°C, 50%rh for at least 24 hours prior to testing.
2. Obtain duplicate measurements for the chloride and sulphate content in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Chloride content (%)			
	A	B	C	D
1	0.0149	0.0178	0.00858	0.0252
2	0.0149	0.0178	0.00912	0.026
Mean	0.0149	0.0178	0.0089	0.0256
SD	0.0000	0.0000	0.0004	0.0006

Replicate	Sulphate content (%)			
	A	B	C	D
1	0.0526	0.00842	0.00836	0.0107
2	0.0549	0.00753	0.011	0.013
Mean	0.0538	0.0080	0.0097	0.0119
SD	0.0016	0.0006	0.0019	0.0016

4. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.

Chloride and sulphate content (ISO 6588-2, ISO 9197, ISO 9198)

Lab number: 7

1. Remove the test samples from their packaging and condition at 23°C, 50%rh for at least 24 hours prior to testing.
2. Obtain duplicate measurements for the chloride and sulphate content in accordance with the EN 868 method.
3. Enter the results for each sample in the table below.

Replicate	Chloride content (%)			
	A	B	C	D
1	0.0149	0.0177	0.00958	0.0256
2	0.0154	0.0183	0.00884	0.0256
Mean	0.0152	0.0180	0.0092	0.0256
SD	0.0004	0.0004	0.0005	0.0000

Replicate	Sulphate content (%)			
	A	B	C	D
1	0.0513	0.00864	0.00896	0.014
2	0.0522	0.00815	0.00873	0.0134
Mean	0.0518	0.0084	0.0088	0.0137
SD	0.0006	0.0003	0.0002	0.0004

4. Please give a brief description of the test apparatus used.

After all testing is finished, please return this completed spreadsheet to:

chris.berry@pira-international.com

If you require any further information about this testing please contact me by email or phone on +44 (0) 1372 802094.