REPORT NO. 1079

TEXTILES

PROFICIENCY TESTING PROGRAM

ROUND 3

June 2018

CONTENTS

1. FOREWORD

This report summarises the results of a proficiency testing program on the chemical and physical characteristics of textiles. It constitutes the third round of an ongoing series of programs.

Proficiency Testing Australia (PTA) conducted the program during December 2017 and April 2018. The aim of the program was to assess laboratories' ability to competently perform the nominated tests.

The Program Coordinator was Dr M Li. The Technical Adviser was
Ms N Randeni, Australian Textile Mills Pty Ltd. The report was authorised by
Mrs K Cividin, PTA Quality Manager.

2. FEATURES OF THE PROGRAM

(a)   Participating laboratories were each supplied with five textiles.

(b)   A total of 9 laboratories received samples, comprising of one Australian participant, and eight overseas participants, including Botswana, Russia, Malaysia, Spain, Argentina, Albania and Kenya.

(c)   Laboratories were requested to perform the tests according to the *Instructions to Participants* provided and to record their results along with an estimate of their measurement uncertainty (MU) for each result, on the accompanying *Results Sheet*, which was distributed with the samples. Copies of these documents appear in Appendix C.

(d)   Prior to distribution, randomly selected samples were tested for homogeneity. Based on the results of this testing, it was concluded that the samples were sufficiently homogeneous, and therefore, any results later identified as outliers could not be attributed to any significant sample variability (See Appendix B).

(e)   Each laboratory was randomly allocated a unique code number for the program to enable confidentiality of results. Reference to each laboratory in this report is made by its code number only.

(f)   Results (as reported by participants) with corresponding summary statistics (i.e. number of results, median, uncertainty of the median, normalised interquartile range, robust coefficient of variation, minimum, maximum and range) are presented in Appendix A. Measurement Uncertainty (MU) is also presented where supplied by participants. Please note that this information is presented for information purposes only and has not been used for the formal evaluation of results.

(g)   A robust statistical approach, using z-scores, was utilised to assess laboratories' testing performance (see Section 4). Robust z-scores and z-score charts relevant to each test are presented in Appendix A.

(h)   The document entitled *Guide to Proficiency Testing Australia,* 2016 (reference [1]) defines the statistical terms and details the statistical procedures referred to in this report.

(i)   A tabulated listing of laboratories (by code number) identified as having outlier results can be found on page page no. 6.

3.   FORMAT OF THE APPENDICES

(a)   Appendix A contains the analysis of results reported by laboratories for the samples. This section contains the following for each determinant, where appropriate:

- a table of results and calculated z-scores;

- a list of summary statistics; and

- ordered z-score charts;

Please note that Z-scores have been calculated on the average results.

(b)   Appendix B contains details of the homogeneity and stability testing.

(c)   Appendix C contains copies of the *Instructions to Participants* and *Results Sheet.*

4.   STATISTICAL DESIGN OF THE PROGRAM

(a)   Outlier Results and Z-scores

In order to assess laboratories' testing performance, a robust statistical approach, using z-scores, was utilised. Z-scores give a measure of how far a result is from the consensus value (i.e. the median), and gives a "score" to each result relative to the other results in the group.

A z-score close to zero indicates that the result agrees well with those from other laboratories, whereas a z-score with an absolute value greater than or equal to 3.0 is considered to be an outlier and is marked by the symbol "**§**".

The table on page page no. 6 summarises the outlier results detected.

(b)   Results Tables and Summary Statistics

Each of these tables contains the results returned by each laboratory, including the method used, and the robust z-score calculated for each result.

Results have been entered exactly as reported by participants. That is, laboratories which did not report results to the precision (i.e. number of decimal places) requested on the Results Sheet have **not** been rounded to the requested precision before being included in the statistical analysis.

A list of summary statistics appears at the bottom of each of the tables of results and consists of:

-        the <u>number</u> of results for that test/sample (*No. of Results*);

-        the <u>median</u> of these results, i.e. the middle value (*Median*);

-        the <u>uncertainty of the median</u>; a robust estimate of the standard deviation of the *Median*;

-        the <u>normalised interquartile range</u> of the results (*Normalised IQR*);

-        the <u>robust coefficient of variation</u>, expressed as a percentage (*Robust CV*) - i.e. 100 x *Normalised IQR* / *Median*;

-        the <u>minimum</u> and <u>maximum</u> laboratory results; and

-        the <u>range</u> (*Maximum - Minimum*).

The median is a measure of the centre of the data.

The normalised IQR is a measure of the spread of the results. It is calculated by multiplying the interquartile range (IQR) by a correction factor which converts the IQR to an estimate of the standard deviation. The IQR is the difference between the upper and lower quartiles (i.e. the values above and below which a quarter of the results lie, respectively).

For normally distributed data, the uncertainty of the median is approximated by:

$$\sqrt{\frac{\pi}{2}} \times \frac{normIQR}{\sqrt{n}} \qquad\qquad n = \text{number of results}$$

Please see reference [1] for further details on these robust summary statistics.

(c)   Ordered Z-Score Charts

On these charts each laboratory's robust z-score is shown, in order of magnitude, and is marked with its code number.   From these charts, each laboratory can readily compare its performance relative to the other laboratories.

These charts contain solid lines at +3.0 and -3.0, so that outliers are clearly identifiable as those laboratories whose "bar" extends beyond these "cut-off"

lines. The y-axis of these charts has been limited, so very large z-scores appear to extend beyond the chart boundary.

Please see reference [1] for further details on these robust summary statistics.

The following table summarises the results submitted by participants for the program.

TABLE A: Summary Statistics

Test	No. of Results	Median	Normalised IQR
Quantitative Fibre Analysis Polyester (%)	7	80.517	0.452
Quantitative Fibre Analysis Cotton (%)	7	19.567	2.338
Threads per unit length - Warp (cm)	8	51.750	0.64
Threads per unit length - Weft (cm)	8	23.980	0.26
Breaking load Warp (N)	6	580.796	181.57
Extension * Warp (%)	5	n/a	n/a
Mass per unit area (g/m^2)	8	152.683	1.36

* Statistical analysis was not applied to extension due to an insufficient number of results.

5. PTA AND TECHNICAL ADVISER'S COMMENTS

Metrological Traceability and Measurement Uncertainty of Assigned Values

Consensus values (medians) derived from the participants' results are used in this program. These values are not metrologically traceable to any external reference.

As the assigned value for this program is the median of the results submitted by the participants, the uncertainty of the median has been calculated and is presented as part of the summary statistics.

Analysis of Results by Method Groups

In order for methods to be grouped for analysis, PTA requires at least 11 sets of results from the same method group. As there were less than 11 results submitted for each method, reliable conclusions cannot be drawn from analysing grouped methods on this occasion. Therefore, results from all method groups have been pooled for analysis.

General Comments

Considering reported MUs, the overall performance of participants was satisfactory. Three laboratories reported one or more outliers. It was noted that not all participants reported an MU for each test.

The variation within laboratories was better than the variation between laboratories. Generally, having a greater variation of results between laboratories is to be expected due to more sources of error.

Although different test methods were used, all methods are internationally based standards. Even though the methods may vary slightly, the variability of results should not be significant.

In this round, six outliers were reported. Sources of error could range from the instruments, method application or simply from blunders.

Quantitative Fibre Analysis

The textile sample was a blend of Polyester and Cotton. All laboratories correctly identified both fibre types. Laboratory code 9 reported two outliers.

Threads per unit length

For the warp direction, laboratory code 1 reported one outlier. For the weft direction, laboratory code 1and laboratory code 2, each reported one outlier.

Breaking load

For breaking load, all laboratories reported satisfactory results.

Extension

Statistical analysis was not applied to extension due to an insufficient number of results.

Mass per unit area

For mass per unit area, laboratory code 1 reported one outlier.

<u>Conclusions</u>

It is noted that limited precision data is currently available, however, laboratories have generally shown good reproducibility. No notable variation appears to exist between the major test methods used in the program.

General sources of error revolve around sample preparation and a poor understanding of the method. The standard used should always be consulted prior to conducting a test.

The sample used appeared to be suitable for the program, and the the majority of laboratories showed a high level proficiency in performing the tests.

6. OUTLIER RESULTS

Laboratories reporting outlier results are listed in the following table:

TABLE B: Summary of Statistical Outlier

Test	Lab Code
Quantitative Fibre Analysis- Polyester (%)	9
Quantitative Fibre Analysis - Cotton (%)	9
Threads per unit length - Warp (cm)	2
Threads per unit length - Weft (cm)	1, 2
Breaking load - Warp (N)	nil
Extension Warp (%) *	n/a
Mass per unit area (g/m2)	1

*   Statistical analysis was not applied to Extension due to an insufficient number of results.

7. REFERENCE

[1] *Guide to Proficiency Testing Australia*, 2016.
This document can be found on the PTA website at www.pta.asn.au under Programs/Documents

APPENDIX A

Summary of Results

A1

Quantitative Fibre Analysis (Polyester) %

Lab Code	Result 1	Result 2	Result 3	Result 4	Average	MU	Z-Score	Method
2	80.5	80.1	80.7		80.43	0.1	-0.18	TOCT ISO 1833 - 11:2011
3	80.7224	80.7784	80.7873		80.76	0.8	0.54	ISO 1833 Part II: 2006
4	80	82.4	81.6		81.33		1.81	ISO 1833 - 11:2011
5	80.7	80.6	80.3	80.6	80.55	0.30	0.07	ISO 1833.II: 2006
6	79.74	79.88	80.01		79.88	0.078	-1.42	ISO 1833-11:2010
7	80.62	80.39	80.54		80.52		0.00	ASTM D629
9	62.4	62.0			62.20	0.6	-40.55 §	ASTM D629

No. Results 7
Median 80.517
NormIQR 0.452
Robust CV 0.6%
Min 62.200
Max 81.333
Range 19.133
Uncertainty (Median) 0.214

Note: § denotes an outlier (i.e. |z-score| ≥ 3.0)
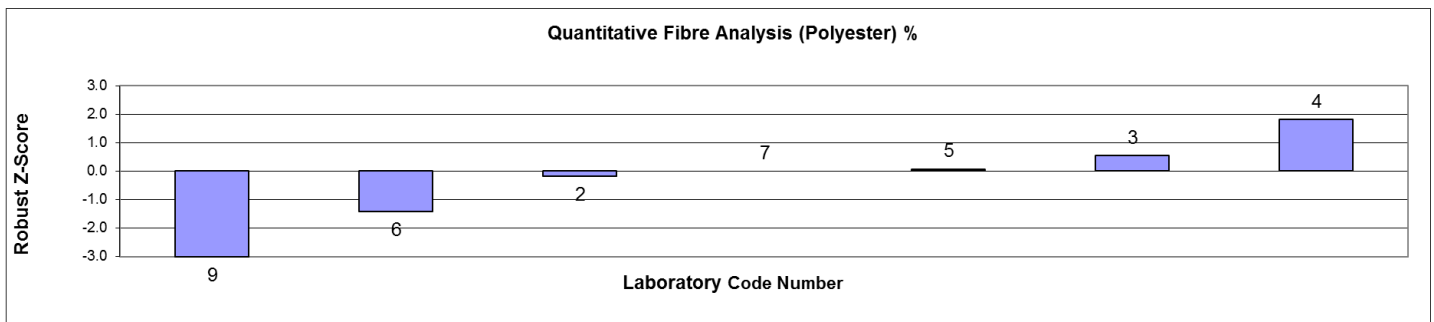
Quantitative Fibre Analysis (Cotton) %

Lab Code	Result 1	Result 2	Result 3	Result 4	Result 5	Average	MU	Z-Score		Method
2	19.5	19.9	19.3			19.57	0.1	0.00		TOCT ISO 1833 - 11:2011
3	19.2776	19.2216	19.2127			19.24	0.8	-0.14		ISO 1833 Part II: 2006
4	24	24	24	24	24	24.00		1.90		ISO 1833 - 11:2011
5	19.3	19.4	19.7	19.4		19.45	0.30	-0.05		ISO 1833.II: 2006
6	20.26	20.12	19.99			20.12	0.078	0.24		ISO 1833-11:2010
7	19.38	19.61	19.46			19.48		-0.04		ASTM D629
9	37.4	38.0				37.70	0.6	7.76	§	ASTM D629

No. Results	7
Median	19.567
NormIQR	2.338
Robust CV	11.9%
Min	19.237
Max	37.700
Range	18.463
Uncertainty (Median)	1.107

Note: § denotes an outlier (i.e. |z-score| ≥ 3.0)

Quantitative Fibre Analysis (Cotton) %
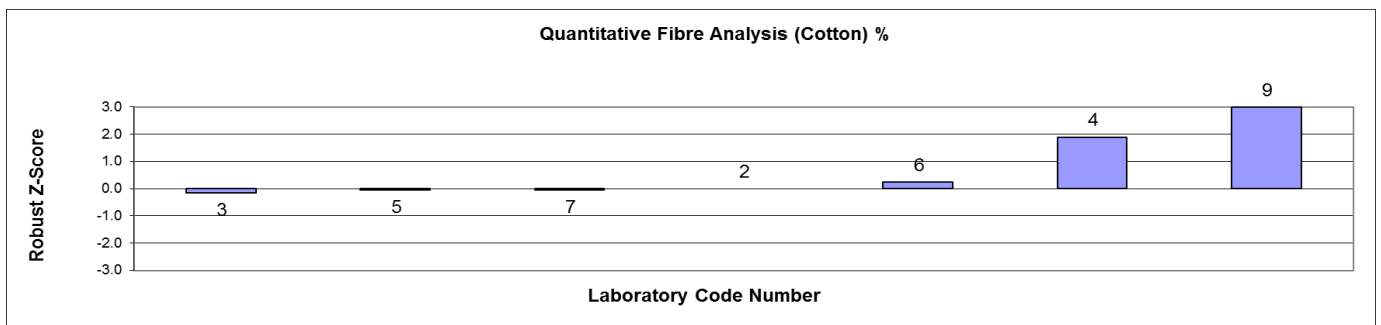
Threads per unit length ((Warp) cm

Lab Code	Result 1	Result 2	Result 3	Result 4	Result 5	Average	MU	Z-Score		Method
1	53	51	52	51	50	51.40		-0.55		ISO 7211/2
2	240	240	245	260		246.25		304.63	§	TOCT 29104.3-91
3	51.5	51.5	51.5	52	52	51.70		-0.08		ISO 7211 - 2:1984 Method A
4	51	51	51	51	51	51.00		-1.17		ISO 7211 - 2:1984
5	52	51	52	52	50	51.40		-0.55		ISO 7211 - 2:1984
6	52.2	52.1	52	52.6	52.1	52.20	0.105	0.70		ISO 7211 - 2:1984 Method A
7	52.5	52.0	52.0	52.0	52.0	52.10		0.55		ISO 7211 - 2:1984
9	52	51	52	51	53	51.80	2.0	0.08		ISO 7211/2

No. Results	8
Median	51.75
NormIQR	0.64
Robust CV	1.2%
Min	51.00
Max	246.25
Range	195.25
Uncertainty (Median)	0.28

Note: § denotes an outlier (i.e. |z-score| ≥ 3.0)
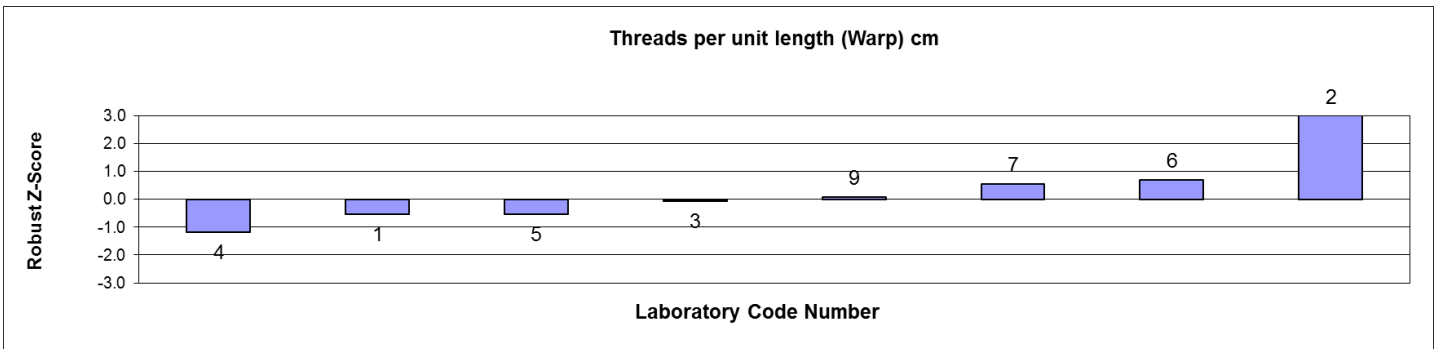
Threads per unit length (Weft) cm

Lab Code	Result 1	Result 2	Result 3	Result 4	Result 5	Average	MU	Z-Score		Method
1	22	24	24	23	22	23.00		-3.77	§	ISO 7211/2
2	520	515	530	520	550	527.00		1936.20	§	ГОСТ 29104.3-91
3	23.8	24	24	24	24	23.96		-0.08		ISO 7211 - 2:1984 Method A
4	24	24.0	24.0	24	24	24.00		0.08		ISO 7211 - 2:1984
5	24	24	24	24	24	24.00		0.08		ISO 7211 - 2:1984
6	23.8	24	23.8	24	24	23.88	0.049	-0.38		ISO 7211 - 2:1984 Method A
7	23.7	23.8	23.7	24	24	23.78		-0.77		ISO 7211 - 2:1984
9	25	25	24	24	25	24.60	1	2.39		ISO 7211/2

No. Results 8
Median 23.98
NormIQR 0.26
Robust CV 1.1%
Min 23.0
Max 527.0
Range 504.0
Uncertainty (Median) 0.12

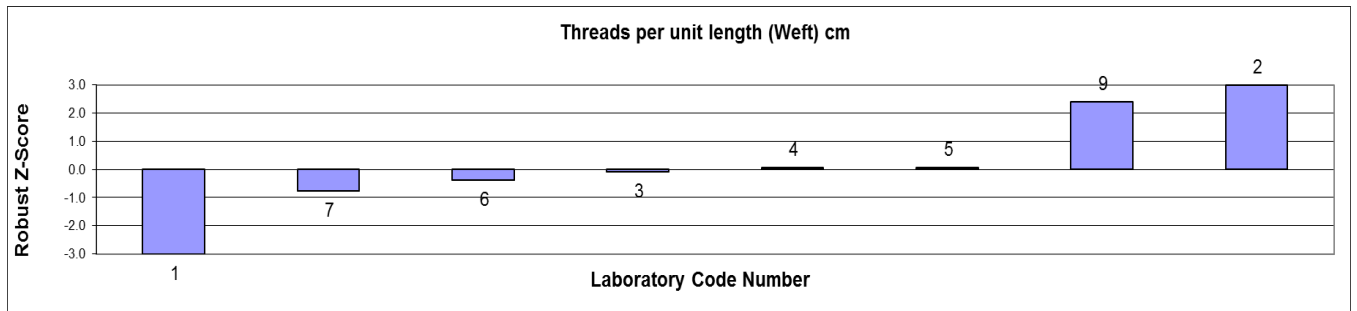**Note: §** denotes an outlier (i.e. |z-score| ≥ 3.0)

Breaking Load (Warp Only) N

Lab Code	Result 1	Result 2	Result 3	Result 4	Result 5	Average	MU	Z-Score	Method
2	828	831	792	830	811	818.40		1.31	TOCT P HCO 13934-1-2015
3	944	936	922	940	934	935.20	12	1.95	ISO 13934-1:2013
4	557.5	560.6	608.3	570.6	544.4	568.28	50.3	-0.07	ASTM D5034
6	572.66	548.57	558.99	580.11	587.63	569.59	7.07	-0.06	ASTM D5034
7	298	303	285	290	294	294.00		-1.58	ISO 13934-1:2013
9	622	600	569	578	591	592.00	15	0.06	ASTM D5034

No. Results	6
Median	580.80
NormIQR	181.57
Robust CV	31.26%
Min	294.00
Max	935.20
Range	641.20
Uncertainty (Median)	92.90

Breaking Load (Warp Only) N
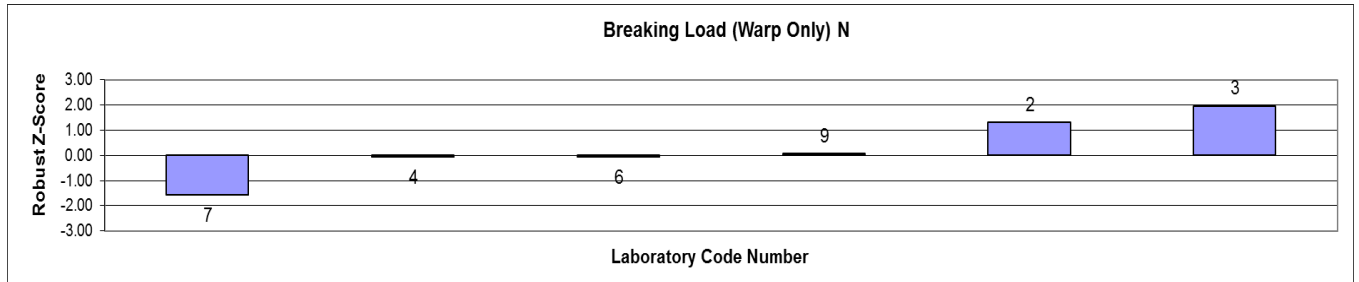
Extension (Warp Only) %

| Lab Code	Result 1	Result 2	Result 3	Result 4	Result 5	Average	MU	Method
2	12.8	12.7	12.5	13.1	12.9	12.80	1.6	TOCT P HCO 13934-1-2015
4	11.6	11.4	11.5	11.5	11.5	11.50	4.5	ISO 13934-1:2013
6	9.52	9.22	9.31	9.08	9.21	9.27	0.1	ISO 13934-1:2013
7	15.05	14.6	14.8	15.05	14.8	14.86		ASTM D 5034-9
9	11	12.1	11.8	12.3	12.2	11.94	0.2	ISO 13934-1

No. Results 5

No statistical analysis was performed due to an insufficient number of results.

Mass per unit area g/m^2

Lab Code	Result 1	Result 2	Result 3	Result 4	Result 5	Average	MU	Z-Score		Method
1	1.53	1.51	1.53	1.51	1.55	1.53		-111.27	§	EN12127
2	150.500	152.100	151.500	154.200	156.600	152.98		0.22		TOCT 3811-72
3	153.9	154.9	153.8	154.8	154.9	154.46	0.3	1.31		ISO 3801:1977 Method 5
4	152.29	152.5	151.9	153.2	151.6	152.29	1.9	-0.29		EN12127:1998
5	153.17	154.14	154.30	153.28	153.20	153.62	3.2	0.69		EN12127:1997
6	154.74	152.42	151.48	150.96	152.33	152.39	0.6	-0.22		EN ISO 12127:1997
7	151.0	153.9	151.6	152.1	152.8	152.28		-0.30		EN12127
9	158.0	153.4	155.0	155.1	153.3	154.96	0.6	1.68		EN12127

No. Results 8
Median 152.68
NormIQR 1.358
Robust CV 0.9%
Min 1.53
Max 154.96
Range 153.43
Uncertainty (Median) 0.60

Note: § denotes an outlier (i.e. |z-score| ≥ 3.0)
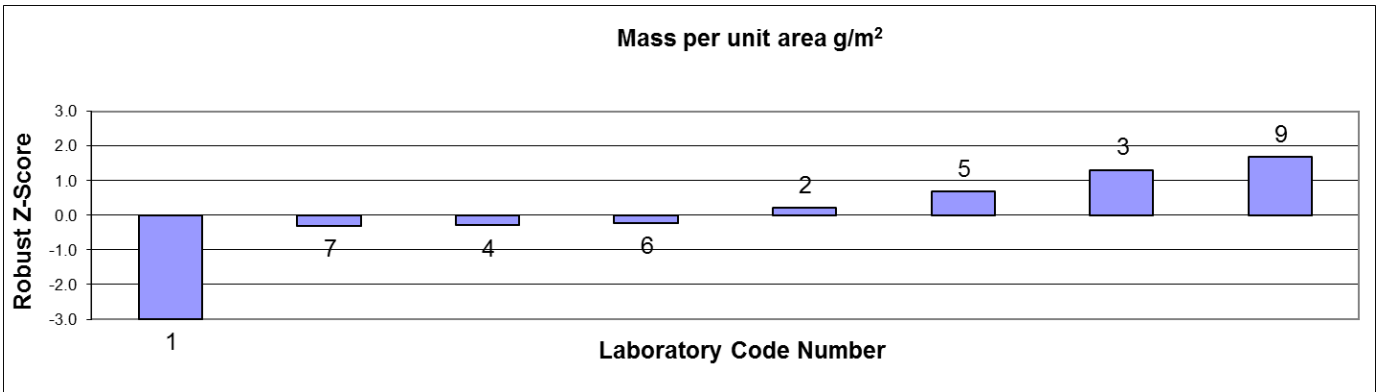
APPENDIX B

Sample Preparation and Homogeneity Testing

SAMPLE PREPARATION

Samples for this program was supplier by ILT - Interlaboratory Tes S.A. Each sample was prepared from one continuous production roll then cut into the sample size.

HOMOGENIETY TESTING

Samples were tested for homogeneity for Quantitative Fibre Analysis, Threads per unit length, Breaking load, Extension and Mass per unit area.

Statistical analysis of the results indicated that no noticeable sample variability existed. Therefore, it was concluded that any outlier results subsequently identified could not be attributed to sample variability.

Homogeneity	
	CV %
Quantitative Fibre Analysis (Polyester) %	0.37%
Quantitative Fibre Analysis (Cotton) %	1.53%
Threads per unit length (Warp) cm	0.86%
Threads per unit length (Weft) cm	0.33%
Breaking Load (Warp Only) N	4.52%
Extension (Warp Only) %	10.00%
Mass per unit area g/m^2	1.64%

STABILITY TESTING

Due to the nature of the samples it was not considered necessary to perform stability testing.

APPENDIX C

Instructions to Participants

Results Sheet

PROFICIENCY TESTING AUSTRALIA
Proficiency Testing Program

Textiles (Round 3)

INSTRUCTIONS TO PARTICIPANTS

To ensure that results from this program can be analysed properly, participants are asked to adhere carefully to the following instructions.

1) Five textile samples are supplied to each laboratory.

2) The samples are to be tested in replicate by the methods listed for the following:

   - Quantitative fibre analysis   (5 test results)
   - Threads per unit length (warp)   (5 test results)
   - Threads per unit length (weft)   (5 test results)
   - Breaking load (warp only)   (5 test results)
   - Extension (warp only)   (5 test results)
   - Mass per unit area   (5 test results)

   The results are to be recorded on the results sheet. The method used for each test is to be stated. Attach additional comments if necessary.

3) Laboratories are also requested to calculate if possible and report an estimate of uncertainty of measurement for each reported result. All estimates of uncertainty of measurement must be given as a 95% confidence interval (coverage factor k ≈ 2) and reported as a ±. Note that the estimate of uncertainty if reported is tabled in the final report only and not used to evaluate individual laboratory performance.

4) For this program your laboratory has been allocated the code number shown on the results sheet.

5) Please return the Results Sheet by **Friday 16 February 2018** to:

   Dr Michael LI
   Proficiency Testing Australia
   PO Box 7507
   Silverwater NSW 2128
   AUSTRALIA

   Phone: +61 2 9736 8397
   Fax: +61 2 9743 6664
   Email: Michael.Li@pta.asn.au

PROFICIENCY TESTING AUSTRALIA

Textiles (Round 3) - Proficiency Testing Program

Results Sheet

Test	Result 1	Result 2	Result 3	Result 4	Result 5	±MU	Method
Extension (%)							
Breaking load (N)							
Mass per unit area (g/m2)							
Quantitative Fiber Analysis (%)							
Threads per unit length (Warp - cm)							
Threads per unit length (Weft - cm)							

Signed: _____   **Date:** _____

End of Report