



APLAC T053

Final Report

Thermal Insulation Proficiency Testing Program

November 2010

Acknowledgements

The APLAC secretariat wishes to acknowledge gratefully Japan Testing Center for Construction Materials, Headquarters to Performance Evaluation, for coordinating the supply, packaging and homogeneity testing of the test samples and technical advice for this program.

– Table of Contents –

1. Introduction	3
2. Operation of the Program	3
2.1 Coordinator.....	3
2.2 Collaborator	3
2.3 Time Schedule of the Program	3
2.4 Participating Laboratories	4
3. Format of Appendices	4
4. Statistical Design of the Program.....	4
5. Test Samples.....	5
5.1 Feature of Test Specimen and Sample Package	5
5.2 Homogeneity Test	5
6. Test Methods and Apparatus	5
7. Procedures for Evaluation of Results	6
7.1 Evaluation Criteria	6
7.2 Performance Evaluation and Data Analysis.....	6
8. Test Results and Statistical Analysis	6
9. Outliers	7
10. Technical Comments:	7
10.1 Sample Homogeneity	7
10.2 Comments on Reported Results	8
10.3 Uncertainty Analysis	9
Appendix A Summary of Proficiency Test Results	10
Appendix B Homogeneity Test Results	46
Appendix C Instructions to Accreditation Bodies.....	55

1. Introduction

This report summarises the results of the APLAC Thermal Insulation Proficiency Testing Program (APLAC T053).

This proficiency testing program was coordinated by the International Accreditation Japan (hereinafter referred to as "IAJapan") in accordance with the interlaboratory testing scheme specified in ISO/IEC Guide 43-1:1997.

The aim of the program was to provide opportunity to participating laboratories to demonstrate their technical competence to perform applicable/relevant tests. It also provides the APLAC members, regional co-operation members and stakeholders an opportunity to confirm consistency of technical competence of the laboratories among their accreditation bodies, thus providing confidence in the accreditation process.

2. Operation of the Program

2.1 Coordinator

IAJapan, National Institute of Technology and Evaluation
2-49-10, Nishihara, Shibuya-ku, Tokyo, 151-0066, Japan
TEL: +81-3-3481-1939
FAX: +81-3-3481-1937

2.2 Collaborator

The homogeneity test of the test specimens for this proficiency testing program was performed by the following institute:

Japan Testing Center for Construction Materials
Central Laboratory
5-21-20, Inari, Soka City, Saitama, 340-0003, Japan

2.3 Time Schedule of the Program

This proficiency testing program was stated in 2006. The time schedule of the program is shown in Table 1.

Table 1 Time Schedule of the Program

Submission of proposal to APLAC PT committee for approval	Jan 2006
Preparation of sample	Feb 2006
Invitation to participating laboratories	Feb 2006 - Mar 2006
Dispatch of samples	Mar 2006
Thermal insulation testing by the laboratories	Mar 2006 - Apr 2006
Homogeneity testing by collaborator	Mar 2006 - Mar 2007
Deadline for test results submission from the laboratories	28 Apr 2006
Statistical analysis	May 2006 - Jun 2010
Preparation of draft final report	Jul 2010 - Sep 2010
Circulation of draft final report to APLAC PT committee for approval	Sep 2010 - Nov 2010
Publication of the final report	Nov 2010

2.4 Participating Laboratories

A total of 30 laboratories had been nominated in this proficiency testing program. Among them, three laboratories did not report the results of the test with various reasons. Four laboratories reported more than one result. To avoid arbitrary selection of results, all the reported results (34 results in total) were used for the statistical analysis and each of the results was equally evaluated in the program except the case where a laboratory reported two results of density for test data of thermal conductivity. The numbers of participating laboratories per economy are shown in Table 2.

Table 2 Numbers of Participating Laboratories per Economy

Economy	No. of Labs	Economy	No. of Labs	Economy	No. of Labs
Australia	1	Germany	1	Slovakia	1
Canada	1	Japan	2	Spain	1
China	3	Jordan	1	South Africa	1
Czech Republic	3	Lithuania	2	Thailand	1
Estonia	1	New Zealand	1	U. S. A	5
Finland	1	Portugal	1		

3. Format of Appendices

Appendix A: Summary of Proficiency Test Results

Appendix B: Homogeneity Test Results

Appendix C: Instructions to Accreditation Bodies

4. Statistical Design of the Program

Two different types of test samples (see Section 5) had been prepared for this proficiency testing program. Participating laboratories were instructed to test each sample for their density and thermal conductivity at three ambient temperatures i.e., 283.15 K (10 °C), 293.15 K (20 °C), and 313.15 K (40 °C) in accordance with the test method standards specified in the program.

Performance of participating laboratories is evaluated by z -score specified in ISO/IEC Guide 43-1. The z -score is calculated for data of each sample at each specified temperature level.

A split level statistical analysis is also designed for participating laboratories to review their trend of measurement in this proficiency testing program. A 'Youden plot' is provided for a set of measurement.

As shown in the homogeneity test results (see Appendix B), the thermal conductivity of sample B (acrylic resin: approximately 0.17 W/(m·K)) is nearly five times of that of sample A (glass wool: approximately 0.035 W/(m·K)). For this particular case, the distribution of data (with significantly different level of property value) in Youden plot is very much dependent on the dispersion of sample A and may not appropriately disclose the trend of measurement.

However, material and thickness of sample are chosen to minimise the thermal expansion and other source of thermal transfer so that the variation of material properties caused by the ambient temperature is relatively small, and thus no significant variance of the test results is observed.

Therefore, “split level” is set for the difference of temperature in this proficiency testing program.

5. Test Samples

5.1 Feature of Test Specimen and Sample Package

Two types of test specimens, high density glass wool board and acrylic resin board, were prepared for this proficiency testing program. Each type of test specimen was prepared 100 pieces. Each participating laboratory received a sample package which contained two types of test specimens, as detailed in Table 3. Fifty sets of a sample package were prepared for the distribution of samples.

Table 3 Contents of a Sample Package and Features of the Test Specimens

Sample	Material	No. of specimens	Code	Nominal size
A	High density glass wool	2	GW	300 mm x 300 mm x 25 mm (thickness)
B	Acrylic resin	2	AR	300 mm x 300 mm x 15 mm (thickness)

5.2 Homogeneity Test

Prior to the distribution of samples, seven test specimens each for both sample A and sample B were randomly picked up for homogeneity test (see Appendix B).

In the homogeneity test, density and thermal conductivity of test specimens at 293.15 K (20 °C) were measured and determined in accordance with JIS A 1412-1:1999 “Test method for thermal resistance and related properties of thermal insulations – Part 1: Guarded hot plate apparatus” which is equivalent to ISO 8302:1991. The details of the homogeneity test are shown in Appendix B.

6. Test Methods and Apparatus

A sample package associated with the instructions was distributed to each participating laboratory. Participating laboratories were requested to perform tests for density and thermal conductivity of test specimens based on the test methods which laboratories adopted from those specified in ISO 8301:1991, ISO 8302:1991 or equivalent regional/national standards. The test methods actually adopted by the participating laboratories are shown in the tables (Table A-1, A-3, A-5, A-7, A-9, and A-11) in Appendix A.

Participating laboratories were also instructed to report the test results in the form of the results sheet shown in the instructions (see Appendix C).

7. Procedures for Evaluation of Results

7.1 Evaluation Criteria

The 'z-score' specified in ISO/IEC Guide 43-1:1997 Appendix A is used as the evaluation criteria in this proficiency testing program. The criteria for "Satisfactory", "Questionable" and "Unsatisfactory" are as follows.

$|z| \leq 2$: Satisfactory,
 $2 < |z| < 3$: Questionable,
 $|z| \geq 3$: Unsatisfactory

7.2 Performance Evaluation and Data Analysis

As mentioned in section 4, z-score was calculated for each measurement result of 'Density' and 'Thermal Conductivity' of test specimen. The performance of participating laboratories was primary evaluated by the z-score.

Besides the z-score evaluation, a 'Youden plot' was prepared for a pair of measurement results of thermal conductivity of the same sample at each specified ambient temperature. It gave additional information on the trend of measurement which might help participating laboratories having unsatisfactory or questionable results to investigate the cause. They are shown in the Appendix A. The figure numbers of Youden plot for pairs of measurement are shown in Table 4.

Table 4 Figure Number of Youden Plot

Sample	Pairs of ambient temperature levels		
	283.15 K vs 293.15 K	283.15 K vs 313.15 K	293.15 K vs 313.15 K
A	Fig 13	Fig 14	Fig 15
B	Fig 16	Fig 17	Fig 18

In addition, participating laboratories were requested to report their uncertainty of measurement for each measurement. Reported uncertainty were analysed and evaluated in association with the data variance. The results of the uncertainty evaluation are reported in section 10.3.

8. Test Results and Statistical Analysis

Tables A-1 through A-12 in Appendix A show the reported test results. The summary statistics for calculation of z-scores of the test results for density and thermal conductivity are shown in Table 5 and Table 6 respectively.

Table 5 Summary Statistics – Density ρ (kg/m³)

	Sample A			Sample B		
	283.15 K	293.15 K	313.15 K	283.15 K	293.15 K	313.15 K
No. of results	30	32	29	28	30	27
Median	215.0	215.0	214.6	1186.9	1186.1	1185.3
Norm IQR	4.4	5.4	5.4	3.1	5.6	7.0
Robust CV (%)	2.1	2.5	2.5	0.26	0.48	0.59
Range	22.2	23.79	22.1	23.26	52.346	24.47

Table 6 Summary Statistics - Thermal Conductivity λ (W/(m·K))

	Sample A			Sample B		
	283.15 K	293.15 K	313.15 K	283.15 K	293.15 K	313.15 K
No. of Results	31	33	30	29	31	28
Median	0.0343	0.0353	0.0374	0.159	0.161	0.160
Norm IQR	0.0010	0.0010	0.0009	0.017	0.0194	0.021
Robust CV (%)	2.9	2.7	2.5	10.7	12.0	12.8
Range	0.005134	0.005001	0.006343	0.11809	0.15245	0.12283

9. Outliers

The code numbers of participating laboratories with unsatisfactory results (z -score ≥ 3) in this proficiency testing program are shown in Table 7.

Table 7 Outliers

Test Item		Laboratory code number	
		Sample A	Sample B
Density	283.15 K (10 °C)	None	2, 14, 23(B2), 25, 28
	293.15 K (20 °C)	None	7, 25
	313.15 K (40 °C)	None	None
Thermal conductivity	283.15 K (10 °C)	None	14
	293.15 K (20 °C)	None	7, 14
	313.15 K (40 °C)	30	14

As shown above, 7 (25.9 %) laboratories out of the 27 participating laboratories reported one or more outlying results. The total 12 (3.4 %) out of 358 results subject to the z -score evaluation) were identified as outliers.

10. Technical Comments

10.1 Sample Homogeneity

The details of the homogeneity test of samples are shown in Appendix B. The density of all test specimens was measured before distribution (see Tables B-3 and B-4 in Appendix B). No significant difference of variance in the measurement of specimens density between the results of the homogeneity test and the test results of participating laboratories is observed. This implies that the sample variance may dominate the uncertainty factors in the density measurements.

As to the measurement of thermal conductivity, however, variance of the homogeneity tests was sufficiently small compared with that of the results of participating laboratories (standard deviation < 0.3 IQR). Therefore, it was concluded that the target property (thermal conductivity) of samples were well homogeneous and met the requirements of the program design.

10.2 Comments on Reported Results

a) Analysis of difference amongst test methods

Test methods and standards used by the participating laboratories in this proficiency testing program are shown in Table 8.

Table 8 Test Methods Selected for the Proficiency Testing Program

Test method group	Type of test apparatus	Number of laboratories adopted
ISO 8301	Single-specimen	13 (38.2 %)
	Two-specimen	2 (5.9 %)
ISO 8302	Single-specimen	6 (17.6 %)
	Two-specimen	2 (5.9 %)
EN 12667	Single-specimen	4 (11.8 %)
ASTM C 518	Single-specimen	7 (20.6 %)
Total		34

To investigate any effects of the test methods on the test results, all data were split in the groups of the test methods above and the median and NIQR were calculated for each of the group. Then t-test was done on the groups between ISO 8301 and other test methods. According to the results of the t-test, no significant difference was observed amongst the test methods (see Table A-17 in Appendix A).

b) Data reported by Lab with Code 7

The laboratory with Code 7 participated only in the measurement at 293.15 K (20 °C) of both sample A and B. The laboratory had outlying results in the measurement of density and thermal conductivity of sample B. It is recommended to review the measurement results of sample B and investigate correlation with the thermal conductivity measurement results of sample B.

c) Data reported by Lab with Code 14

The laboratory with Code 14 participated in all the measurements and had outlying results in the measurement of density and thermal conductivity of sample B at all the levels of testing temperature. All test results of density and thermal conductivity of sample B reported by the laboratory were significantly low compared with those reported by other participating laboratories. As shown in Fig 16 through Fig 18, this laboratory may have some systematic error in their measurement.

10.3 Uncertainty Analysis

Participating laboratories were requested to report relative expanded uncertainty of measurement for the test of thermal conductivity.

Among 27 participating laboratories (34 results), 19 laboratories (26 results) reported their uncertainty of measurement associated with the test results. The averages of the uncertainty of measurement for sample A at each measurement point of the three testing temperatures were in the range of 2.6 % - 2.9 %, and for sample B were in the range of 3.4 % - 4.0 %. There were some participating laboratories that reported relative expanded uncertainty of measurement for thermal conductivity equal to or bigger than 5.0 %. They may have room to improve their uncertainty of measurement in the test of thermal conductivity. On the other hand, there were a few laboratories reported relative expanded uncertainty of measurement equal to or less than 1.0 %. As shown in the results of homogeneity test (see Appendix B), coefficients of variance of sample A and B are 0.9 % and 0.6 % respectively. This implies that it is difficult to achieve such small uncertainties.

Appendix A

Summary of Proficiency Test Results

APLAC T053 Thermal Insulation Proficiency Testing Program

Table A-1 Test Results of Sample A at 283.15 K (10 °C) - Density

Lab Code	Test Method	Test Apparatus	Mass	Dimension (X)		Thickness	Density
			(M)	X_1	X_2	(L)	(ρ)
			kg	mm	mm	mm	kg/cm ³
2	ISO 8301	Two-specimen	0.473	300	300	24.4	215
3	EN 12667	Single-specimen	0.464	300	301	25	205.5
4	ASTM C518	Single-specimen	-	-	-	-	-
5	ASTM C518	Single-specimen	0.4699	299.3	299.9	24.40	214.6
6	ISO 8301	Single-specimen	0.466	300.0	300.0	24.0	215.7
7	ASTM C518	Single-specimen	-	-	-	-	-
8	ASTM C518	Single-specimen	0.22519	203.0	203.0	24.0	227.7
9A1	ISO 8301	Single-specimen	0.4525	299.7	299.7	24.0	209.9
9A2	ISO 8301	Single-specimen	0.4732	299.4	300.0	24.1	218.6
9A3	ISO 8302	Single-specimen	0.4523	299.7	299.7	24.0	209.8
9A4	ISO 8302	Single-specimen	0.4730	299.4	300.0	24.1	218.5
10	ASTM C518	Single-specimen	0.454	299	299	24	211
11	ISO 8301	Single-specimen	0.0480	300	300	24.8	215
12	ISO 8301	Two-specimen	-	-	-	-	-
14	ISO 8301	Single-specimen	0.47425	298.99	299.38	23.82	222.43
15	ISO 8302	Single-specimen	0.47011	299	300	24.50	213.9
16	ASTM C518	Single-specimen	-	-	-	-	-
17	ISO 8302	Single-specimen	0.4775	299.6	300.0	24.35	218.2
18	ISO 8302	Two-Specimen	0.453	299	299	23.8	213
19A1	ISO 8301	Single-specimen	0.4582	299.2	298.4	24.7	207.8
19A2	ISO 8301	Single-specimen	0.4760	299.2	298.5	24.6	216.6
20	ISO 8301	Single-specimen	0.462	299	300	23.9	216
21	EN 12667	Single-specimen	0.46699	299.3	298.6	23.19	225.3
22	ISO 8301	Single-specimen	0.463	300.000	300.002	23.463	219.258
23A1	EN 12667	Single-specimen	0.47160	297.3	289.5	23.79	223.38
23A2	EN 12667	Single-specimen	0.47524	298.1	298.6	24.66	216.51
24	ISO 8301	Single-specimen	0.46486	298.75	299.50	24.205	214.641
25	ISO 8302	Single-specimen	0.4560	299.45	298.55	24.01	212.44
27	ISO 8301	Single-specimen	0.4838	300.2	300.1	23.9	224.3
28	ISO 8301	Single-specimen	0.45502	299.5	299.5	24.5	207
29A1	ISO 8302	Single-specimen	0.45642	301.00	298.90	23.8	213.2
29A2	ISO 8302	Two-specimen	0.45670	301.00	298.90	23.8	213.3
29A3	ISO 8301	Single-specimen	0.20184	196.10	196.75	23.2	225.5
30	ASTM C518/ ISO 8301	Single-specimen	0.47638	300	300	25.05	211.3

Table A-2 Test Results of Sample A at 283.15 K (10 °C) - Thermal Conductivity

Laboratory Code	Meter Area (A)	Thickness (L)	Hot Plate Temperature (T_H)	Cold Plate Temperature (T_C)	Temperature Difference (T_m)	Heat Flow-rate (F)	Density of Heat Flow-rate (q)	Thermal Conductivity (λ)	Relative Expanded Uncertainty (U)	Mass Change	Volume Change
	m ²	mm	K	K	K	W	W/m ²	W/(m·K)	%	kg	m ³
2	-	24.4	293.15	272.95	20.2	-	-	0.0334	3	0.000	0.000
3	-	24.9	288.15	278.15	283.05	-	-	0.03314	1.78	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	-	24.41	20.02	0.02	20.00	-	28.08	0.03427	2	0.0001	0
6	-	24.0	19.37	0.66	18.71	-	26.13	0.0335	1.9	0.0	0.0
7	-	-	-	-	-	-	-	-	-	-	-
8	-	24.0	293.15	273.15	20	-	28.89	0.035	4.1	0.00001	0
9A1	-	24.0	283.16	263.16	20.00	-	30.15	0.0362	2.4	0	0
9A2	-	24.1	283.16	263.16	20.00	-	30.48	0.0367	2.4	0	0
9A3	0.0225	24.0	292.73	273.48	19.25	0.6492	28.85	0.0360	1.7	0.0001	0
9A4	0.0225	24.1	292.53	273.45	19.08	0.6469	28.75	0.0363	1.7	0.0001	0
10	-	24	297	269	28.0	-	37.5	0.032	-	0	0
11	0.0103	24.8	288.05	278.05	10.0	0.142	13.8	0.034	2.2	0.0001	-
12	-	23.4	287.35	278.55	8.8	-	12.53	0.0333	1.5	-	-
14	-	22.943	293.18	273.18	10.02	-	30.20	0.03464	-	0.00019	-0.000005
15	0.0225	24.50	298.15	268.15	30.00	0.961	42.7	0.0349	5	0.00035	-0.000004
16	-	-	-	-	-	-	-	-	-	-	-
17	0.03276	24.35	288.57	277.79	10.780	0.50775	15.499	0.03501	2.5	0	0
18	0.09006	23.8	290.67	275.66	15.01	3.839	21.3	0.0338	1.5	0	0
19A1	0.0625	24.7	288.19	278.20	9.99	-	13.717	0.0339	2.3	0.0000	-
19A2	0.0625	24.6	288.18	278.19	9.99	-	13.972	0.0343	2.3	0.0001	-
20	-	23.8	293.2	273.2	20.0	-	28.2	0.0336	1.3	<0.000	<10 ⁻¹⁰
21	-	23.00	291.55	274.75	16.80	-	24.9	0.0341	-	0.00017	0
22	-	23.463	15.010	5.010	10.000	-	-	0.033485	7.000	<0.001	<0.001
23A1	-	23.65	293.16	273.16	20.00	-	28.77	0.0340	1	0.00034	-
23A2	-	24.42	293.16	273.15	20.01	-	27.87	0.0340	1	0.00025	-
24	-	24.21	292.05	274.50	17.41	-	24.831	0.03453	0.602	0.0000	0.0000001
25	0.0225	24.01	15.00	5.34	9.66	0.3202	14.231	0.03537	-	-	-
27	-	23.9	300.2	275.2	298.2	-	393.7	0.037	5	0.00001	0
28	-	24.5	293.35	273.45	19.9	-	27.2	0.0335	-	0.00088	<0.00001
29A1	0.0225	23.8	292.85	273.45	19.40	0.6444	28.64	0.0351	3.8	-	-
29A2	0.0450	24.1	292.85	273.85	19.00	1.2424	27.61	0.0350	3.8	-	-
29A3	-	23.2	292.85	273.35	19.50	-	29.21	0.0348	3.7	-	-
30	-	25.05	20.12	4.71	15.41	-	22.844	0.037134	0.000966	0.00014	0

APLAC T053 Thermal Insulation Proficiency Testing Program

Table A-3 Test Results of Sample A at 293.15 K (20 °C) - Density

Lab Code	Test Method	Test Apparatus	Mass (M)	Dimension (X)		Thickness (L)	Density (ρ)
				X_1	X_2		
			kg	mm	mm	mm	kg/cm ³
2	ISO 8301	Two-specimen	0.473	300	300	24.4	215
3	EN 12667	Single-specimen	0.464	300	301	25	205.5
4	ASTM C518	Single-specimen	0.4634	298.45	298.45	22.99	226.1
5	ASTM C518	Single-specimen	0.4700	299.3	299.9	24.40	214.6
6	ISO 8301	Single-specimen	0.466	300.0	300.0	24.0	215.8
7	ASTM C518	Single-specimen	0.4962	299.33	298.67	24.21	229.29
8	ASTM C518	Single-specimen	0.22520	203.0	203.0	24.0	227.7
9A1	ISO 8301	Single-specimen	0.4525	299.7	299.7	24.0	209.9
9A2	ISO 8301	Single-specimen	0.4732	299.4	300.0	24.1	218.6
9A3	ISO 8302	Single-specimen	0.4523	299.7	299.7	24.0	209.8
9A4	ISO 8302	Single-specimen	0.4730	299.4	300.0	24.1	218.5
10	ASTM C518	Single-specimen	0.454	299	299	24	211
11	ISO 8301	Single-specimen	0.0480	300	300	24.8	215
12	ISO 8301	Two-specimen	-	-	-	-	-
14	ISO 8301	Single-specimen	0.47406	299.05	299.42	23.87	221.80
15	ISO 8302	Single-specimen	0.46999	299	300	24.42	214.6
16	ASTM C518	Single-specimen	0.470	299.2	299.6	25.1	208.9
17	ISO 8302	Single-specimen	0.4775	299.6	300	24.35	218.2
18	ISO 8302	Two-Specimen	0.453	299	299	23.8	213
19A1	ISO 8301	Single-specimen	0.4582	299.2	298.4	24.7	207.8
19A2	ISO 8301	Single-specimen	0.4760	299.2	298.5	24.6	216.6
20	ISO 8301	Single-specimen	0.462	299	300	23.9	216
21	EN 12667	Single-specimen	0.46701	299.3	298.6	23.20	225.2
22	ISO 8301	Single-specimen	0.463	300.000	300.002	23.463	219.258
23A1	EN 12667	Single-specimen	0.46495	297.8	298.9	23.79	219.56
23A2	EN 12667	Single-specimen	0.46788	298.3	298.9	24.62	213.10
24	ISO 8301	Single-specimen	-	-	-	-	-
25	ISO 8302	Single-specimen	0.4559	299.50	298.60	24.01	212.32
27	ISO 8301	Single-specimen	0.4835	300.2	300.1	23.9	224.3
28	ISO 8301	Single-specimen	0.45590	299.5	299.5	24.5	207
29A1	ISO 8302	Single-specimen	0.45642	301.00	298.90	23.8	213.2
29A2	ISO 8302	Two-specimen	0.45670	301.00	298.90	23.8	213.3
29A3	ISO 8301	Single-specimen	0.20184	196.10	196.75	23.2	225.5
30	ASTM C518/ ISO 8301	Single-specimen	0.47638	300	300	25.05	211.30

Table A-4 Test Results of Sample A at 293.15 K (20 °C) - Thermal Conductivity

Laboratory Code	Meter Area (A) m^2	Thickness (L) mm	Hot Plate Temperature (T_H) K	Cold Plate Temperature (T_C) K	Temperature Difference (T_m) K	Heat Flow-rate (F) W	Density of Heat Flow-rate (q) W/m^2	Thermal Conductivity (λ) $W/(m \cdot K)$	Relative Expanded Uncertainty (U) $\%$	Mass Change kg	Volume Change m^3
2	-	24.4	303.25	283.05	20.2	-	-	0.0342	2	0.000	0.000
3	-	25.1	298.15	288.15	282.95	-	-	0.03416	1.7	-	-
4	0.08907	22.99	303.71	291.36	12.45	-	-	0.0355	-	0.0002	0.00021
5	-	24.41	30.02	10.02	20.00	-	28.95	0.03533	2	0.0001	0
6	-	24.0	29.99	10.12	19.88	-	28.50	0.0344	2.0	0.0	0.0
7	-	24.21	310.97	283.16	27.81	-	40.7	0.03546	1.5	0.0006	0
8	-	24.0	303.15	283.15	20	-	29.76	0.036	4.3	0.00001	-
9A1	-	24.0	303.17	283.16	20.01	-	30.75	0.0369	2.4	-	-
9A2	-	24.1	303.17	283.16	20.01	-	31.10	0.0375	2.4	-	-
9A3	0.0225	24.0	302.41	283.46	18.95	0.6529	29.02	0.0368	1.7	-	-
9A4	0.0225	24.1	302.37	283.41	18.96	0.6555	29.13	0.0370	1.7	-	-
10	-	24	307	279	28.0	-	38.9	0.033	-	0	0
11	0.0103	24.8	297.85	287.95	9.9	0.1490	14.1	0.035	2.2	0.0001	-
12	-	23.4	297.15	309.35	7.8	-	11.50	0.0343	1.5	0.230	0.001
14	-	22.847	303.18	283.17	20.02	-	31.20	0.03562	-	0.00015	-0.000007
15	0.0225	24.42	308.15	278.15	30.0	0.998	44.3	0.0361	5	0.00026	0
16	-	24.9	310.9	283.2	27.7	-	-	0.0346	-	-	-
17	0.03276	24.35	302.02	287.98	11.042	0.54373	15.597	0.03660	2.5	0	0
18	0.09006	23.8	300.61	285.60	15.01	3.952	21.9	0.0348	1.5	0	0
19A1	0.0625	24.7	298.26	288.06	10.20	-	14.360	0.0347	2.3	0.0002	-
19A2	0.0625	24.6	298.18	288.14	10.04	-	14.416	0.0353	2.3	-0.0001	-
20	-	23.8	303.2	283.2	20.0	-	29.2	0.0347	1.3	<0.000	<10 ⁻¹⁰
21	-	23.12	301.55	284.75	16.80	-	25.5	0.0352	-	-0.00006	0
22	-	23.463	30.020	10.010	20.010	-	-	0.03441	7.000	<0.001	<0.001
23A1	-	23.64	303.17	283.15	20.02	-	29.70	0.0351	1	0.00004	-
23A2	-	24.42	303.17	283.16	20.01	-	28.75	0.0351	1	0.00001	-
24	-	-	-	-	-	-	-	-	-	-	-
25	0.0225	24.01	30.00	10.29	19.71	0.6535	29.04	0.03538	-	-	-
27	-	23.9	298.2	288.2	298.2	-	432.1	0.037	5	0.00028	0
28	-	24.5	302.55	282.65	19.9	-	28.0	0.0345	-	0.00029	<0.00001
29A1	0.0225	23.8	303.15	283.05	20.10	0.6799	30.22	0.0358	3.8	-	-
29A2	0.0450	24.1	303.15	283.35	19.80	1.3060	29.02	0.0353	3.8	-	-
29A3	-	23.2	302.75	283.35	19.40	-	29.95	0.0358	3.7	-	-
30	-	25.05	31.10	11.03	20.07	-	30.466	0.038001	0.000994	0.00014	0

APLAC T053 Thermal Insulation Proficiency Testing Program

Table A-5 Test Results of Sample A at 313.15 K (40 °C) - Density

Lab Code	Test Method	Test Apparatus	Mass	Dimension (X)		Thickness	Density
			(M)	X_1	X_2	(L)	(ρ)
			kg	mm	mm	mm	kg/cm ³
2	ISO 8301	Two-specimen	0.473	300	300	24.4	215
3	EN 12667	Single-specimen	0.464	300	301	25	205.5
4	ASTM C518	Single-specimen	-	-	-	-	-
5	ASTM C518	Single-specimen	0.4699	299.3	299.9	24.40	214.6
6	ISO 8301	Single-specimen	0.466	300.0	300.0	24.0	215.8
7	ASTM C518	Single-specimen	-	-	-	-	-
8	ASTM C518	Single-specimen	0.22519	203.1	203.0	24.0	227.6
9A1	ISO 8301	Single-specimen	0.4525	299.7	299.7	24.0	209.9
9A2	ISO 8301	Single-specimen	0.4732	299.4	300.0	24.1	218.6
9A3	ISO 8302	Single-specimen	0.4523	299.7	299.7	24.0	209.8
9A4	ISO 8302	Single-specimen	0.4730	299.4	300.0	24.1	218.5
10	ASTM C518	Single-specimen	0.454	299	299	24	211
11	ISO 8301	Single-specimen	0.0480	300	300	24.8	215
12	ISO 8301	Two-specimen	-	-	-	-	-
14	ISO 8301	Single-specimen	0.47343	299.4	299.38	23.73	222.85
15	ISO 8302	Single-specimen	0.46987	299	300	24.42	214.5
16	ASTM C518	Single-specimen	0.470	299.2	299.6	25.1	208.9
17	ISO 8302	Single-specimen	-			-	-
18	ISO 8302	Two-Specimen	0.453	299	299	23.8	213
19A1	ISO 8301	Single-specimen	0.4584	299.2	298.4	24.7	207.9
19A2	ISO 8301	Single-specimen	0.4760	299.2	298.5	24.6	216.6
20	ISO 8301	Single-specimen	0.462	299	300	23.9	216
21	EN 12667	Single-specimen	0.46707	299.3	298.6	23.21	225.2
22	ISO 8301	Single-specimen	0.463	300.000	300.002	23.463	219.258
23A1	EN 12667	Single-specimen	0.46455	297.5	298.8	23.67	220.79
23A2	EN 12667	Single-specimen	0.46740	298.0	299.1	24.55	213.60
24	ISO 8301	Single-specimen	-	-	-	-	-
25	ISO 8302	Single-specimen	0.4560	299.60	298.66	24.01	212.30
27	ISO 8301	Single-specimen	0.4834	300.2	300.1	23.9	224.3
28	ISO 8301	Single-specimen	0.45619	299.5	299.5	24.5	208
29A1	ISO 8302	Single-specimen	0.45642	301.00	298.90	23.8	213.2
29A2	ISO 8302	Two-specimen	0.45670	301.00	298.90	23.8	213.3
29A3	ISO 8301	Single-specimen	0.20184	196.10	196.75	23.2	225.5
30	ASTM C518/ ISO 8301	Single-specimen	0.47646	300	300	25.05	211.34

Table A-6 Test Results of Sample A at 313.15 K (40 °C) - Thermal Conductivity

Laboratory Code	Meter Area (A) m ²	Thickness (L) mm	Hot Plate Temperature (T _h) K	Cold Plate Temperature (T _c) K	Temperature Difference (T _m) K	Heat Flow-rate (F) W	Density of Heat Flow-rate (q) W/m ²	Thermal Conductivity (λ) W/(m·K)	Relative Expanded Uncertainty (U) %	Mass Change kg	Volume Change m ³
2	-	24.4	323.25	303.15	20.1	-	-	0.0360	3	0.000	0.000
3	-	25.0	318.15	308.15	282.85	-	-	0.03708	1.58	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	-	24.41	50.02	30.02	20.00	-	30.62	0.03737	2	-0.0005	0
6	-	24.0	50.16	29.55	20.51	-	31.61	0.0370	2.1	0.0	0.0
7	-	-	-	-	-	-	-	-	-	-	-
8	-	24.0	323.15	303.15	20	-	31.43	0.038	4.9	0.00001	0.000004
9A1	-	24.0	323.17	303.17	20.00	-	31.86	0.0382	2.4	-	-
9A2	-	24.1	323.17	303.17	20.00	-	32.35	0.0390	2.4	-	-
9A3	0.0225	24.0	322.31	303.38	18.93	0.6792	30.19	0.0383	1.6	-	-
9A4	0.0225	24.1	322.71	303.36	19.35	0.6874	30.55	0.0381	1.6	-	-
10	-	24	327	299	28.0	-	42.9	0.036	-	0	0
11	0.0103	24.8	318.25	308.25	10.0	0.158	15.3	0.038	2.2	0.0001	-
12	-	23.4	317.95	307.85	10.1	-	15.15	0.0359	1.5	-	-
14	-	22.835	323.18	303.18	40.02	-	32.84	0.03749	-	-0.00063	-0.000013
15	0.0225	24.42	328.15	298.15	30.0	1.061	47.2	0.0384	5	0.00024	0.000007
16	-	24.9	326.1	299.9	26.2	-	-	0.0348	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-
18	0.09006	23.8	321.24	305.65	15.59	4.366	24.2	0.0370	1.5	0	0
19	0.0625	24.7	318.17	308.11	10.06	-	14.987	0.0368	2.3	0.0000	-
19-A2	0.0625	24.5	318.15	308.09	10.06	-	15.225	0.0373	2.3	0.0000	-
20	-	23.8	323.2	303.2	20.0	-	30.5	0.0367	1.2	<0.000	<10 ⁻¹⁰
21	-	23.24	323.15	303.45	19.70	-	31.4	0.0371	-	-0.00063	0
22	-	23.463	50.020	30.020	20.000	-	-	0.036310	7.000	<0.001	<0.001
23	-	23.64	323.16	303.17	19.99	-	32.07	0.0379	-	0.00035	-
23-A2	-	24.43	323.18	303.17	20.01	-	31.10	0.0380	-	0.00017	-
24	-	-	-	-	-	-	-	-	-	-	-
25	0.0225	24.01	40.00	0.40	39.60	1.3251	58.893	0.03571	-	-	-
27	-	23.9	345.6	300.6	297.8	-	472.8	0.038	5	0.00045	0
28	-	24.5	323.15	303.15	20.0	-	29.9	0.0365	-	0.00001	<0.00001
29A1	0.0225	23.8	323.45	302.85	20.60	0.7474	33.22	0.0384	3.8	-	-
29A2	0.0450	24.1	323.35	302.85	20.50	1.4430	32.07	0.0377	3.8	-	-
29A3	-	23.2	323.15	303.95	19.20	-	31.20	0.0377	3.7	-	-
30	-	25.05	51.13	31.19	19.94	-	32.750	0.041143	0.001095	0.00005	0

APLAC T053 Thermal Insulation Proficiency Testing Program

Table A-7 Test Results of Sample B at 283.15 K (10 °C) - Density

Lab Code	Test Method	Test Apparatus	Mass	Dimension (X)		Thickness	Density
			(M)	X_1	X_2	(L)	(ρ)
			kg	mm	mm	mm	kg/cm ³
2	ISO 8301	Two-specimen	1.607	301	301	15.1	1175
3	EN 12667	Single-specimen	1.596	300.1	300.3	14.9	1188
4	ASTM C518	Single-specimen	-	-	-	-	-
5	ASTM C518	Single-specimen	1.6021	299.9	300.0	15.0	1187
6	ISO 8301	Single-specimen	1.592	300	300.0	14.9	1187.2
7	ASTM C518	Single-specimen	-	-	-	-	-
8	ASTM C518	Single-specimen	0.72384	203.0	203.0	14.80	1186.8
9A1	ISO 8301	Single-specimen	1.5838	300.2	300.0	14.8	1188
9A2	ISO 8301	Single-specimen	1.5937	300.1	300.0	14.9	1188
9A3	ISO 8302	Single-specimen	1.5836	300.2	300.0	14.8	1188
9A4	ISO 8302	Single-specimen	1.5935	300.1	300.0	14.9	1188
10	ASTM C518	Single-specimen	1.58	300	300	14.8	1186
11	ISO 8301	Single-specimen	1.606	300	300	15	1190
12	ISO 8301	Two-specimen	-	-	-	-	-
14	ISO 8301	Single-specimen	1.58430	300.5	300.3	14.95	1177.17
15	ISO 8302	Single-specimen	1.5936	300	300	14.86	1192
16	ASTM C518	Single-specimen	-	-	-	-	-
17	ISO 8302	Single-specimen	1.602	300.0	300.0	15.0	1186
18	ISO 8302	Two-Specimen	1.597	300	299	15.0	1187
19A1	-	-	-	-	-	-	-
19A2	-	-	-	-	-	-	-
20	ISO 8301	Single-specimen	1.583	300	300	14.8	1188
21	EN 12667	Single-specimen	1.5960	300.34	300.27	14.92	1186.1
22	ISO 8301	Single-specimen	1.584	300.010	300.000	14.815	1187.946
23A1	EN 12667	Single-specimen	1.60704	300	300	15.14	1179.39
23A2	EN 12667	Single-specimen	1.60566	300	300	15.20	1173.73
24	ISO 8301	Single-specimen	1.58364	300	300	14.823	1187.074
25	ISO 8302	Single-specimen	1.582	300.0	300.0	15.04	1168.74
27	ISO 8301	Single-specimen	1.593	300.2	300.2	14.8	1191
28	ISO 8301	Single-specimen	1.59426	300.5	301.0	14.98	1177
29B1	ISO 8302	Two-Specimen	1.59124	300.30	300.10	14.9	1185.0
29B2	ISO 8301	Single-specimen	1.59124	300.30	300.10	14.9	1185.0
29B3	ISO 8302	Single-specimen	0.71933	201.90	202.60	14.9	1180.2
30	ASTM C518/ ISO 8301	Single-specimen	1.6	300	300	15	1185.19

Table A-8 Test Results of Sample B at 283.15 K (10 °C) - Thermal Conductivity

Laboratory Code	Meter Area (A) m ²	Thickness (L) mm	Hot Plate Temperature (T _h) K	Cold Plate Temperature (T _c) K	Temperature Difference (T _m) K	Heat Flow-rate (F) W	Density of Heat Flow-rate (q) W/m ²	Thermal Conductivity (λ) W/(m·K)	Relative Expanded Uncertainty (U) %	Mass Change kg	Volume Change m ³
2	-	15.1	293.25	272.95	20.3	-	-	0.140	3	-	-
3	-	15.2	288.15	278.15	281.95	-	-	0.14920	0.38	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	-	15.00	11.8	8.4	3.34	-	42.3	0.190	12	-	-
6	-	14.9	15.89	4.08	11.81	-	125.94	0.159	5.1	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	-	14.80	293.15	273.15	20	-	199.0	0.148	8.6	-	-
9B1	-	14.8	293.16	273.16	20.00	-	185.5	0.137	2.2	-	-
9B2	-	14.9	293.26	273.17	20.09	-	187.7	0.139	2.2	-	-
9B3	0.0225	14.8	292.38	274.99	17.39	3.620	160.9	0.137	1.3	-	-
9B4	0.0225	14.9	292.98	274.94	18.04	3.772	167.6	0.138	1.3	-	-
10	-	14.8	297	269	28.0	-	238	0.127	-	-	-
11	0.0103	30	287.98	277.97	10.0	0.567	55.06	0.165	2.2	-	-
12	-	0.015	286.25	280.95	5.3	-	56.21	0.159	1.3	-	-
14	-	14.707	293.17	273.17	10.01	-	122.25	0.08991	-	-	-
15	0.0225	14.86	293.15	273.15	20	5.39	239.6	0.178	6	-	-
16	-	-	-	-	-	-	-	-	-	-	-
17	0.03276	15.0	286.73	278.34	8.390	3.0219	92.243	0.1649	2.5	-	-
18	0.09006	15.0	290.72	275.59	15.13	33.24	184.5	0.183	2.6	-	-
19B1	-	-	-	-	-	-	-	-	-	-	-
19B2	-	-	-	-	-	-	-	-	-	-	-
20	-	14.8	288.2	278.2	10.0	-	116.2	0.172	2.6	-	-
21	-	14.83	289.65	276.55	13.10	-	138.7	0.157	-	-	-
22	-	14.815	15.010	5.010	10.000	-	-	0.15245	7.000	-	-
23B1	-	15.04	293.16	273.17	19.99	-	211.2	0.159	1	-	-
23B2	-	15.05	293.15	273.17	19.98	-	210.7	0.159	1	-	-
24	-	14.86	287.633	278.525	9.11	-	105.458	0.17209	1.14	-	-
25	0.0225	15.04	15.00	5.58	9.42	2.3416	104.07	0.16605	-	-	-
27	-	14.8	302.0	275.9	299.2	-	2365	0.208	5	0.00001	0
28	-	14.98	289.95	275.05	14.9	-	161.5	0.162	-	-	-
29B1	0.0225	14.9	292.75	273.85	18.90	4.8405	215.1	0.170	3.8	-	-
29B2	0.0450	14.9	292.95	273.95	19.00	9.7352	216.3	0.170	3.8	-	-
29B3	-	14.9	290.55	275.75	14.80	-	170.0	0.171	3.7	-	-
30	-	15.0	18.01	10.88	7.13	-	83.275	0.175192	0.004557	-	-

APLAC T053 Thermal Insulation Proficiency Testing Program

Table A-9 Test Results of Sample B at 293.15 K (20 °C) - Density

Lab Code	Test Method	Test Apparatus	Mass	Dimension (X)		Thickness	Density
			(M)	X_1	X_2	(L)	(ρ)
			kg	mm	mm	mm	kg/cm ³
2	ISO 8301	Two-specimen	1.607	301	301	15.1	1175
3	EN 12667	Single-specimen	1.596	300.1	300.1	14.9	1188
4	ASTM C518	Single-specimen	1.595	298.45	298.45	14.89	1202.6
5	ASTM C518	Single-specimen	1.6021	300.1	300.1	15.0	1186
6	ISO 8301	Single-specimen	1.592	300.0	300.0	14.9	1187.2
7	ASTM C518	Single-specimen	1.5839	300.33	300.16	15.27	1150.254
8	ASTM C518	Single-specimen	0.72384	203.0	203.0	14.80	1186.8
9A1	ISO 8301	Single-specimen	1.5838	300.2	300.0	14.8	1188
9A2	ISO 8301	Single-specimen	1.5937	300.1	300.0	14.9	1188
9A3	ISO 8302	Single-specimen	1.5836	300.2	300.0	14.8	1188
9A4	ISO 8302	Single-specimen	1.5935	300.1	300.0	14.9	1188
10	ASTM C518	Single-specimen	1.58	300	300	14.8	1186
11	ISO 8301	Single-specimen	1.606	300	300	15	1190
12	ISO 8301	Two-specimen	-	-	-	-	-
14	ISO 8301	Single-specimen	1.58420	300.15	300.14	14.98	1173.91
15	ISO 8302	Single-specimen	1.5935	300	300	14.86	1191
16	ASTM C518	Single-specimen	1.603	300.3	300.2	15.1	1177
17	ISO 8302	Single-specimen	1.602	300.0	300.0	15.0	1186
18	ISO 8302	Two-Specimen	1.597	300	300	15.0	1187
19A1	-	-	-			-	-
19A2	-	-	-			-	-
20	ISO 8301	Single-specimen	1.583	300	300	14.8	1188
21	EN 12667	Single-specimen	1.5959	300.34	300.27	14.92	1186.1
22	ISO 8301	Single-specimen	1.584	300.010	300.00	14.815	1187.946
23A1	EN 12667	Single-specimen	1.60707	300	300	15.12	1180.97
23A2	EN 12667	Single-specimen	1.60570	300	300	15.19	1174.53
24	ISO 8301	Single-specimen	-	-	-	-	-
25	ISO 8302	Single-specimen	1.582	300.20	300.20	15.04	1167.18
27	ISO 8301	Single-specimen	1.593	300.2	300.2	14.8	1191
28	ISO 8301	Single-specimen	1.59426	300.5	301.0	14.98	1177
29B1	ISO 8302	Two-Specimen	1.59124	300.30	300.10	14.9	1185.0
29B2	ISO 8301	Single-specimen	1.59124	300.30	300.10	14.9	1185.0
29B3	ISO 8302	Single-specimen	0.71933	201.90	202.60	14.9	1180.2
30	ASTM C518/ ISO 8301	Single-specimen	1.6	300	300	15	1185.19

Table A-10 Test Results of Sample B at 293.15 K (20 °C) - Thermal Conductivity

Laboratory Code	Meter Area (A)	Thickness (L)	Hot Plate Temperature (T _h)	Cold Plate Temperature (T _c)	Temperature Difference (T _m)	Heat Flow-rate (F)	Density of Heat Flow-rate (q)	Thermal Conductivity (λ)	Relative Expanded Uncertainty (U)	Mass Change	Volume Change
	m ²	mm	K	K	K	W	W/m ²	W/(m·K)	%	kg	m ³
2	-	15.1	303.35	283.05	20.3	-	-	0.143	2	-	-
3	-	15.2	298.15	288.15	281.95	-	-	0.15176	1.11	-	-
4	0.08907	14.89	303.59	294.93	8.66	-	-	0.14471	-	-	-
5	-	15.00	21.8	18.5	3.26	-	-	0.200	12	-	-
6	-	14.9	26.48	13.45	13.03	-	-	0.161	5.8	-	-
7	-	15.27	310.97	283.16	27.81	-	-	0.06055	1.50	-	-
8	-	14.80	303.15	283.15	20	-	-	0.149	9.1	-	-
9B1	-	14.8	303.17	283.16	20.01	-	-	0.137	2.2	-	-
9B2	-	14.9	303.17	283.16	20.01	-	-	0.136	2.2	-	-
9B3	0.0225	14.8	302.25	284.94	17.31	3.627	161.2	0.138	1.3	-	-
9B4	0.0255	14.9	302.58	284.84	17.74	3.736	166.0	0.139	1.3	-	-
10	-	14.8	307	279	28.0	-	-	0.138	-	-	-
11	0.0103	30	298.20	298.22	10.0	0.572	55.56	0.167	2.2	-	-
12	-	0.015	296.35	291.15	5.2	-	-	0.160	1.3	-	-
14	-	14.688	303.18	283.17	20.01	-	-	0.08840	-	-	-
15	0.0225	14.86	303.15	283.15	20.0	5.63	250.4	0.186	6	-	-
16	-	15.1	302.1	292.1	9.9	-	-	0.1882	-	-	-
17	0.03276	15.0	297.96	289.25	8.711	3.2046	97.821	0.16844	2.5	-	-
18	0.09006	15.0	300.66	285.64	15.02	33.20	184.3	0.184	2.6	-	-
19B1	-	-	-	-	-	-	-	-	-	-	-
19B2	-	-	-	-	-	-	-	-	-	-	-
20	-	14.8	298.2	288.2	10.0	-	-	0.172	2.6	-	-
21	-	14.92	299.65	286.85	12.80	-	-	0.158	-	-	-
22	-	14.815	30.020	10.010	20.010	-	-	0.14960	7.000	-	-
23B1	-	15.01	303.17	283.16	20.01	-	-	0.161	1	-	-
23B2	-	15.02	303.17	283.16	20.01	-	-	0.161	1	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	0.0225	15.04	30.00	10.70	19.30	4.3989	195.51	0.15233	-	-	-
27	-	14.8	309.0	283.5	298.6	-	-	0.213	5	0.00028	0
28	-	14.98	301.35	286.25	15.0	-	-	0.165	-	-	-
29B1	0.0225	14.9	302.95	283.35	19.60	5.0101	222.7	0.169	3.8	-	-
29B2	0.0450	14.9	303.05	283.65	19.40	10.0046	222.3	0.171	3.8	-	-
29B3	-	14.9	300.65	285.95	14.70	-	-	0.173	3.7	-	-
30	-	15.0	30.93	18.53	12.40	-	-	0.16138	0.00425	-	-

APLAC T053 Thermal Insulation Proficiency Testing Program

Table A-11 Test Results of Sample B at 313.15 K (40 °C) - Density

Lab Code	Test Method	Test Apparatus	Mass	Dimension (X)		Thickness	Density
			(M)	X_1	X_2	(L)	(ρ)
			kg	mm	mm	mm	kg/cm ³
2	ISO 8301	Two-specimen	1.607	301	301	15.1	1175
3	EN 12667	Single-specimen	1.596	300.1	300.3	14.9	1188
4	ASTM C518	Single-specimen	-	-	-	-	-
5	ASTM C518	Single-specimen	1.6021	300.4	300.4	15.0	1184
6	ISO 8301	Single-specimen	1.592	300.0	300.0	14.9	1187.2
7	ASTM C518	Single-specimen	-	-	-	-	-
8	ASTM C518	Single-specimen	0.72383	203.1	203.1	14.82	1184.6
9A1	ISO 8301	Single-specimen	1.5838	300.2	300.0	14.8	1188
9A2	ISO 8301	Single-specimen	1.5937	300.1	300.0	14.9	1188
9A3	ISO 8302	Single-specimen	1.5836	300.2	300.0	14.8	1188
9A4	ISO 8302	Single-specimen	1.5935	300.1	300.0	14.9	1188
10	ASTM C518	Single-specimen	1.58	300	300	14.8	1186
11	ISO 8301	Single-specimen	1.606	300	300	15	1190
12	ISO 8301	Two-specimen	-	-	-	-	-
14	ISO 8301	Single-specimen	1.58430	300.45	300.47	14.93	1175.45
15	ISO 8302	Single-specimen	1.5936	300	300	14.86	1192
16	ASTM C518	Single-specimen	1.603	300.3	300.2	15.1	1177
17	ISO 8302	Single-specimen	-	-	-	-	-
18	ISO 8302	Two-Specimen	1.597	300	299	15.0	1187
19A1	-	-	-	-	-	-	-
19A2	-	-	-	-	-	-	-
20	ISO 8301	Single-specimen	1.583	300	300	14.8	1188
21	EN 12667	Single-specimen	1.5959	300.34	300.27	14.93	1185.3
22	ISO 8301	Single-specimen	1.584	300.010	300.000	14.815	1187.946
23A1	EN 12667	Single-specimen	1.60679	300	300	15.18	1176.10
23A2	EN 12667	Single-specimen	1.60559	300	300	15.20	1173.68
24	ISO 8301	Single-specimen	-	-	-	-	-
25	ISO 8302	Single-specimen	1.583	300.55	300.55	15.02	1167.53
27	ISO 8301	Single-specimen	1.593	300.2	300.2	14.8	1191
28	ISO 8301	Single-specimen	1.59428	300.5	301.0	14.98	1177
29B1	ISO 8302	Two-Specimen	1.59124	300.30	300.10	14.9	1185.0
29B2	ISO 8301	Single-specimen	1.59124	300.30	300.10	14.9	1185.0
29B3	ISO 8302	Single-specimen	0.71933	201.90	202.60	14.9	1180.2
30	ASTM C518/ ISO 8301	Single-specimen	1.6	300	300	15	1185.19

Table A-12 Test Results of Sample B at 313.15 K (40 °C) - Thermal Conductivity

Laboratory Code	Meter Area (A) (m ²)	Thickness (L) (mm)	Hot Plate Temperature (T _h) (K)	Cold Plate Temperature (T _c) (K)	Temperature Difference (T _m) (K)	Heat Flow-rate (F) (W)	Density of Heat Flow-rate (q) (W/m ²)	Thermal Conductivity (λ) (W/(m·K))	Relative Expanded Uncertainty (U) (%)	Mass Change (kg)	Volume Change (m ³)
2	-	15.1	323.15	303.15	20.0	-	-	0.146	3	-	-
3	-	15.4	318.15	308.15	281.85	-	-	0.15896	0.57	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	-	15.00	41.8	38.5	3.38	-	45.3	0.201	12	-	-
6	-	14.9	46.45	33.25	13.20	-	146.74	0.166	6.1	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	-	14.82	323.15	303.15	20	-	204.2	0.151	10.2	-	-
9B1	-	14.8	323.17	303.20	19.97	-	184.4	0.137	2.2	-	-
9B2	-	14.9	323.17	303.17	20.00	-	184.6	0.138	2.2	-	-
9B3	0.0225	14.8	322.10	304.67	17.43	3.632	161.4	0.137	1.3	-	-
9B4	0.0225	14.9	321.61	304.66	16.95	3.668	163.0	0.143	1.4	-	-
10	-	14.8	327	299	28.0	-	265	0.142	-	-	-
11	0.0103	30	318.03	308.05	10.0	0.589	57.22	0.172	2.2	-	-
12	-	0.015	316.05	310.25	5.8	-	66.80	0.173	1.3	-	-
14	-	14.738	323.18	303.18	40.02	-	116.90	0.08617	-	-	-
15	0.0225	14.86	323.15	303.15	20.0	6.12	271.9	0.202	6	-	-
16	-	15.1	322.0	304.4	17.6	-	-	0.1592	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-
18	0.09006	15.0	320.57	305.73	14.84	33.14	184.0	0.186	2.6	-	-
19B1	-	-	-	-	-	-	-	-	-	-	-
19B2	-	-	-	-	-	-	-	-	-	-	-
20	-	14.8	318.2	308.2	10.0	-	116.9	0.173	2.6	-	-
21	-	15.22	320.95	305.65	15.30	-	155.2	0.154	-	-	-
22	-	14.815	50.010	30.020	19.990	-	-	0.15200	7.000	-	-
23B1	-	15.06	323.17	303.17	20.00	-	214.0	0.161	-	-	-
23B2	-	15.04	323.17	303.16	20.01	-	219.9	0.165	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	0.0225	15.02	40.00	1.04	38.96	7.5311	334.72	0.12909	-	-	-
27	-	14.8	311.1	285.8	298.4	-	2581	0.209	5	0.00045	0
28	-	14.98	321.35	306.35	15.0	-	169.8	0.170	-	-	-
29B1	0.0225	14.9	323.35	303.15	20.20	5.3160	236.3	0.174	3.8	-	-
29B2	0.0450	14.9	323.45	303.55	19.90	10.3915	230.9	0.173	3.8	-	-
29B3	-	14.9	320.85	306.35	14.50	-	171.4	0.176	3.7	-	-
30	-	15.0	51.02	38.18	12.84	-	135.804	0.15865	0.00426	-	-

Table A-13 z-scores - Density (Sample A)

Laboratory Code	283.15 K (10 °C)			293.15 K (20 °C)			313.15 K (40 °C)		
	ρ_s (kg/m ³)	z-score		ρ_s (kg/m ³)	z-score		ρ_s (kg/m ³)	z-score	
2	215	0.00		215	0.00		215	0.07	
3	205.5	-2.14	?	205.5	-1.76		205.5	-1.69	
4	–	–		226.1	2.06	?	–	–	
5	214.6	-0.09		214.6	-0.07		214.6	0.00	
6	215.7	0.16		215.8	0.15		215.8	0.22	
7	–	–		229.29	2.65	?	–	–	
8	227.7	2.86	?	227.7	2.36	?	227.6	2.42	?
9A1	209.9	-1.15		209.9	-0.95		209.9	-0.87	
9A2	218.6	0.81		218.6	0.67		218.6	0.74	
9A3	209.8	-1.17		209.8	-0.97		209.8	-0.89	
9A4	218.5	0.79		218.5	0.65		218.5	0.72	
10	211	-0.90		211	-0.74		211	-0.67	
11	215	0.00		215	0.00		215	0.07	
12	–	–		–	–		–	–	
14	222.43	1.67		221.80	1.26		222.85	1.53	
15	213.9	-0.25		214.6	-0.07		214.5	-0.02	
16	–	–		208.9	-1.13		208.9	-1.06	
17	218.2	0.72		218.2	0.59		–	–	
18	213	-0.45		213	-0.37		213	-0.30	
19A1	207.8	-1.62		207.8	-1.34		207.9	-1.24	
19A2	216.6	0.36		216.6	0.30		216.6	0.37	
20	216	0.23		216	0.19		216	0.26	
21	225.3	2.32	?	225.2	1.89		225.2	1.97	
22	219.258	0.96		219.258	0.79		219.258	0.87	
23A1	223.38	1.89		219.56	0.85		220.79	1.15	
23A2	216.51	0.34		213.10	-0.35		213.60	-0.19	
24	214.641	-0.08		–	–		–	–	
25	212.44	-0.58		212.32	-0.50		212.30	-0.43	
27	224.3	2.09	?	224.3	1.73		224.3	1.80	
28	207	-1.80		207	-1.48		208	-1.23	
29A1	213.2	-0.41		213.2	-0.33		213.2	-0.26	
29A2	213.3	-0.38		213.3	-0.32		213.3	-0.24	
29A3	225.5	2.36	?	225.5	1.95		225.5	2.03	?
30	211.3	-0.83		211.30	-0.69		211.34	-0.61	

No of Results	30	32	29
Median	215.0	215.0	214.6
First Quartile	212.6	212.1	211.3
Third Quartile	218.6	219.3	218.6
Norm IQR	4.4	5.4	5.4
Robust CV (%)	2.1	2.5	2.5
Minimum	205.5	205.5	205.5
Maximum	227.7	229.29	227.6
Range	22.2	23.79	22.1

Table A-14 z-scores - Density (Sample B)

Laboratory Code	283.15 K (10 °C)			293.15 K (20 °C)			313.15 K (40 °C)		
	ρ_s (kg/m ³)	z-score		ρ_s (kg/m ³)	z-score		ρ_s (kg/m ³)	z-score	
2	1175	-3.82	§	1175	-1.96		1175	-1.48	
3	1188	0.35		1188	0.35		1188	0.39	
4	–	–		1202.6	2.93	?	–	–	
5	1187	0.03		1186	-0.01		1184	-0.19	
6	1187.2	0.10		1187.2	0.20		1187.2	0.27	
7	–	–		1150.254	-6.35	§	–	–	
8	1186.8	-0.03		1186.8	0.13		1184.6	-0.10	
9A1	1188	0.35		1188	0.35		1188	0.39	
9A2	1188	0.35		1188	0.35		1188	0.39	
9A3	1188	0.35		1188	0.35		1188	0.39	
9A4	1188	0.35		1188	0.35		1188	0.39	
10	1186	-0.29		1186	-0.01		1186	0.10	
11	1190	1.00		1190	0.70		1190	0.67	
12	–	–		–	–		–	–	
14	1177.17	-3.13	§	1173.91	-2.15	?	1175.45	-1.41	
15	1192	1.64		1191	0.88		1192	0.96	
16	–	–		1177	-1.60		1177	-1.19	
17	1186	-0.29		1186	-0.01		–	–	
18	1187	0.03		1187	0.17		1187	0.24	
19A1	–	–		–	–		–	–	
19A2	–	–		–	–		–	–	
20	1188	0.35		1188	0.35		1188	0.39	
21	1186.1	-0.26		1186.1	0.01		1185.3	0.00	
22	1187.946	0.34		1187.946	0.34		1187.946	0.38	
23A1	1179.39	-2.41	?	1180.97	-0.90		1176.10	-1.32	
23A2	1173.73	-4.23	§	1174.53	-2.04	?	1173.68	-1.67	
24	1187.074	0.06		–	–		–	–	
25	1168.74	-5.83	§	1167.18	-3.35	§	1167.53	-2.55	?
27	1191	1.32		1191	0.88		1191	0.82	
28	1177	-3.18	§	1177	-1.60		1177	-1.19	
29A1	1185.0	-0.61		1185.0	-0.19		1185.0	-0.04	
29A2	1185.0	-0.61		1185.0	-0.19		1185.0	-0.04	
29A3	1180.2	-2.15	?	1180.2	-1.04		1180.2	-0.73	
30	1185.19	-0.55		1185.19	-0.15		1185.19	-0.02	

No of Results	28	30	27
Median	1186.9	1186.1	1185.3
First Quartile	1183.8	1180.4	1178.6
Third Quartile	1188.0	1188.0	1188.0
Norm IQR	3.1	5.6	7.0
Robust CV (%)	0.26	0.48	0.59
Minimum	1168.74	1150.254	1167.53
Maximum	1192	1202.6	1192
Range	23.26	52.346	24.47

Table A-15 z-scores - Thermal Conductivity (Sample A)

Laboratory Code	283.15 K (10 °C)			293.15 K (20 °C)			313.15 K (40 °C)		
	λ (W/(m·K))	z-score		λ (W/(m·K))	z-score		λ (W/(m·K))	z-score	
2	0.0334	-0.90		0.0342	-1.14		0.0360	-1.51	
3	0.03314	-1.15		0.03416	-1.18		0.03708	-0.37	
4	–	–		0.0355	0.21		–	–	
5	0.03427	-0.03		0.03533	0.03		0.03737	-0.06	
6	0.0335	-0.80		0.0344	-0.93		0.0370	-0.45	
7	–	–		0.03546	0.17		–	–	
8	0.035	0.70		0.036	0.73		0.038	0.60	
9A1	0.0362	1.89		0.0369	1.66		0.0382	0.81	
9A2	0.0367	2.39	?	0.0375	2.28	?	0.0390	1.66	
9A3	0.0360	1.69		0.0368	1.56		0.0383	0.92	
9A4	0.0363	1.99		0.0370	1.76		0.0381	0.71	
10	0.032	-2.29	?	0.033	-2.39	?	0.036	-1.51	
11	0.034	-0.30		0.035	-0.31		0.038	0.60	
12	0.0333	-1.00		0.0343	-1.04		0.0359	-1.62	
14	0.03464	0.34		0.03562	0.33		0.03749	0.06	
15	0.0349	0.60		0.0361	0.83		0.0384	1.03	
16	–	–		0.0346	-0.73		0.0348	-2.78	?
17	0.03501	0.71		0.03660	1.35		–	–	
18	0.0338	-0.50		0.0348	-0.52		0.0370	-0.45	
19A1	0.0339	-0.40		0.0347	-0.62		0.0368	-0.67	
19A2	0.0343	0.00		0.0353	0.00		0.0373	-0.14	
20	0.0336	-0.70		0.0347	-0.62		0.0367	-0.77	
21	0.0341	-0.20		0.0352	-0.10		0.0371	-0.35	
22	0.033485	-0.81		0.03441	-0.92		0.036310	-1.18	
23A1	0.0340	-0.30		0.0351	-0.21		0.0379	0.50	
23A2	0.0340	-0.30		0.0351	-0.21		0.0380	0.60	
24	0.03453	0.23		–	–		–	–	
25	0.03537	1.07		0.03538	0.08		0.03571	-1.82	
27	0.037	2.69	?	0.037	1.76		0.038	0.60	
28	0.0335	-0.80		0.0345	-0.83		0.0365	-0.98	
29A1	0.0351	0.80		0.0358	0.52		0.0384	1.03	
29A2	0.0350	0.70		0.0353	0.00		0.0377	0.29	
29A3	0.0348	0.50		0.0358	0.52		0.0377	0.29	
30	0.037134	2.82	?	0.038001	2.80	?	0.041143	3.93	§

No of Results	31	33	30
Median	0.0343	0.0353	0.0374
First Quartile	0.0337	0.0347	0.0367
Third Quartile	0.0351	0.0360	0.0380
Norm IQR	0.0010	0.0010	0.0009
Robust CV (%)	2.9	2.7	2.5
Minimum	0.032	0.033	0.0348
Maximum	0.037134	0.038001	0.041143
Range	0.005134	0.005001	0.006343

Fig 1 Thermal Conductivity Histogram - Sample A (283.15 K)

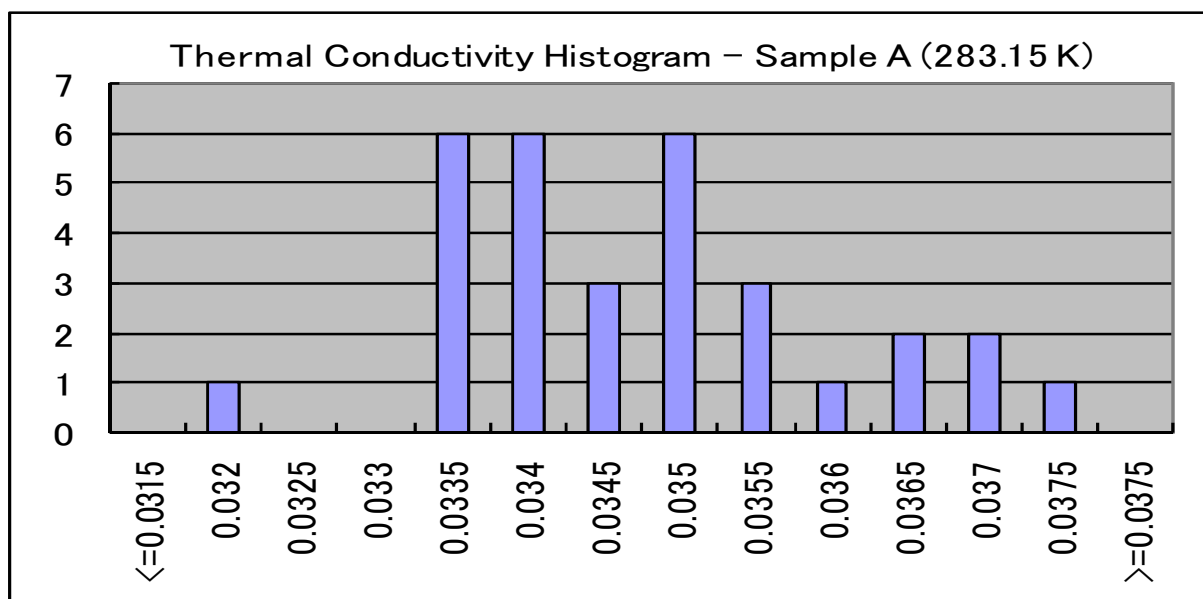


Fig 2 Thermal Conductivity Histogram - Sample A (293.15 K)

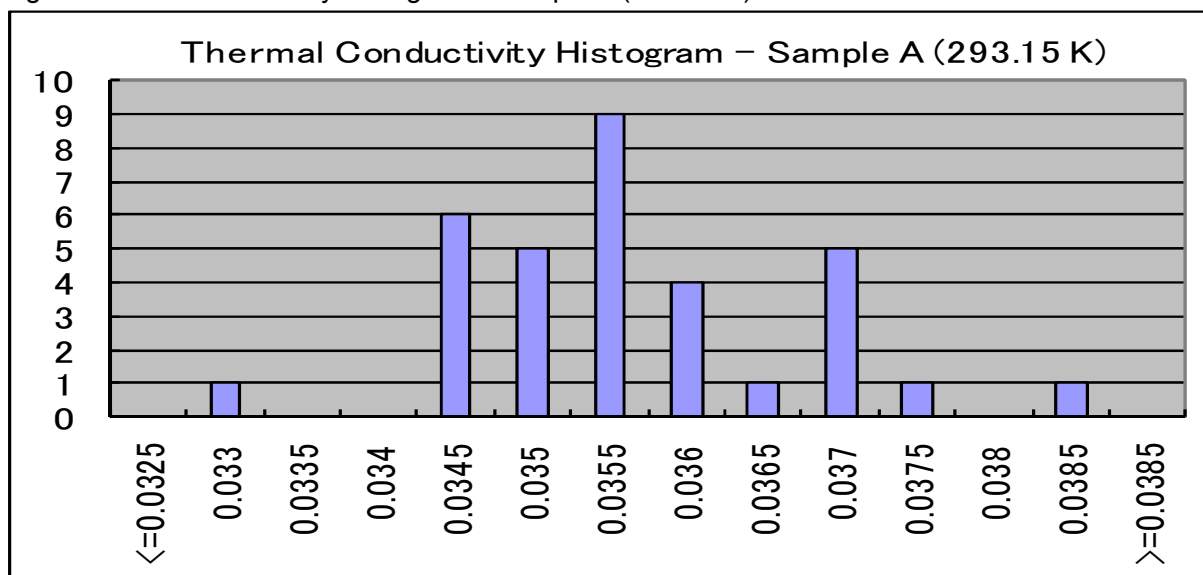


Fig 3 Thermal Conductivity Histogram - Sample A (313.15 K)

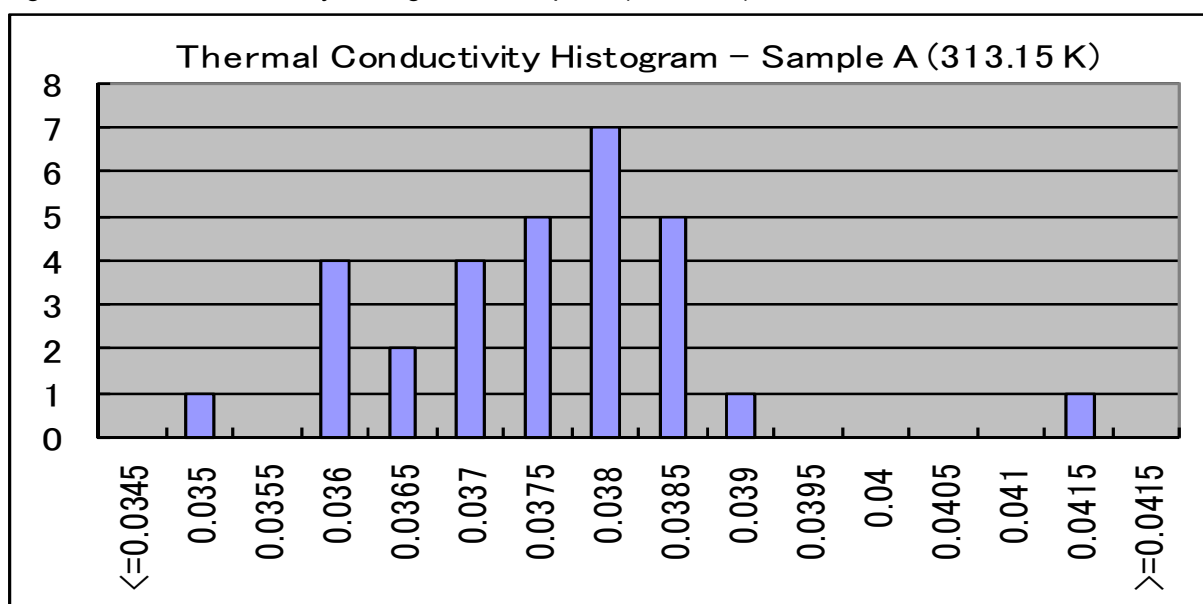
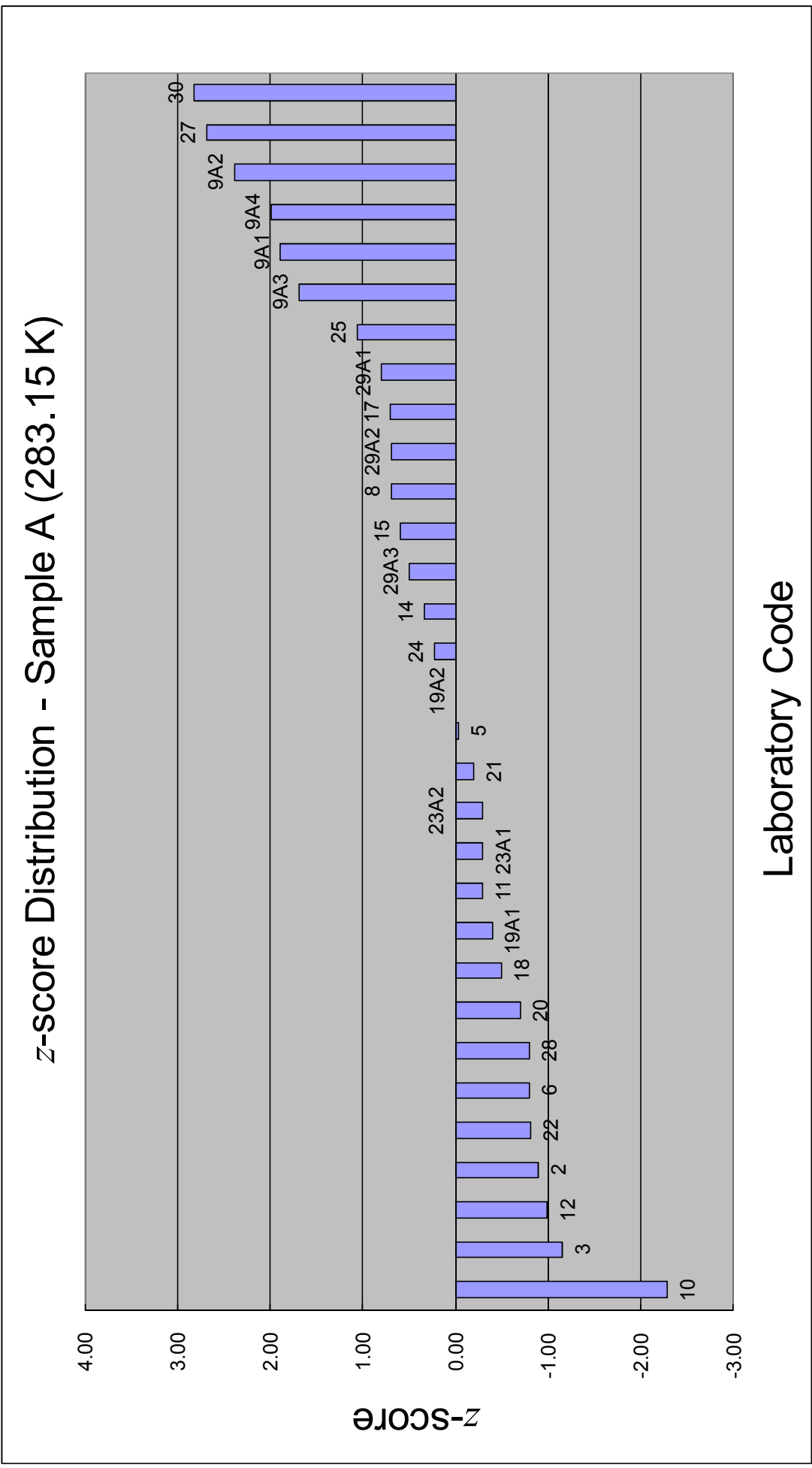


Fig 4 z-score Distribution - Thermal Conductivity - Sample A (283.15 K)



Laboratory Code

Fig 5 z-score Distribution - Thermal Conductivity - Sample A (293.15 K)

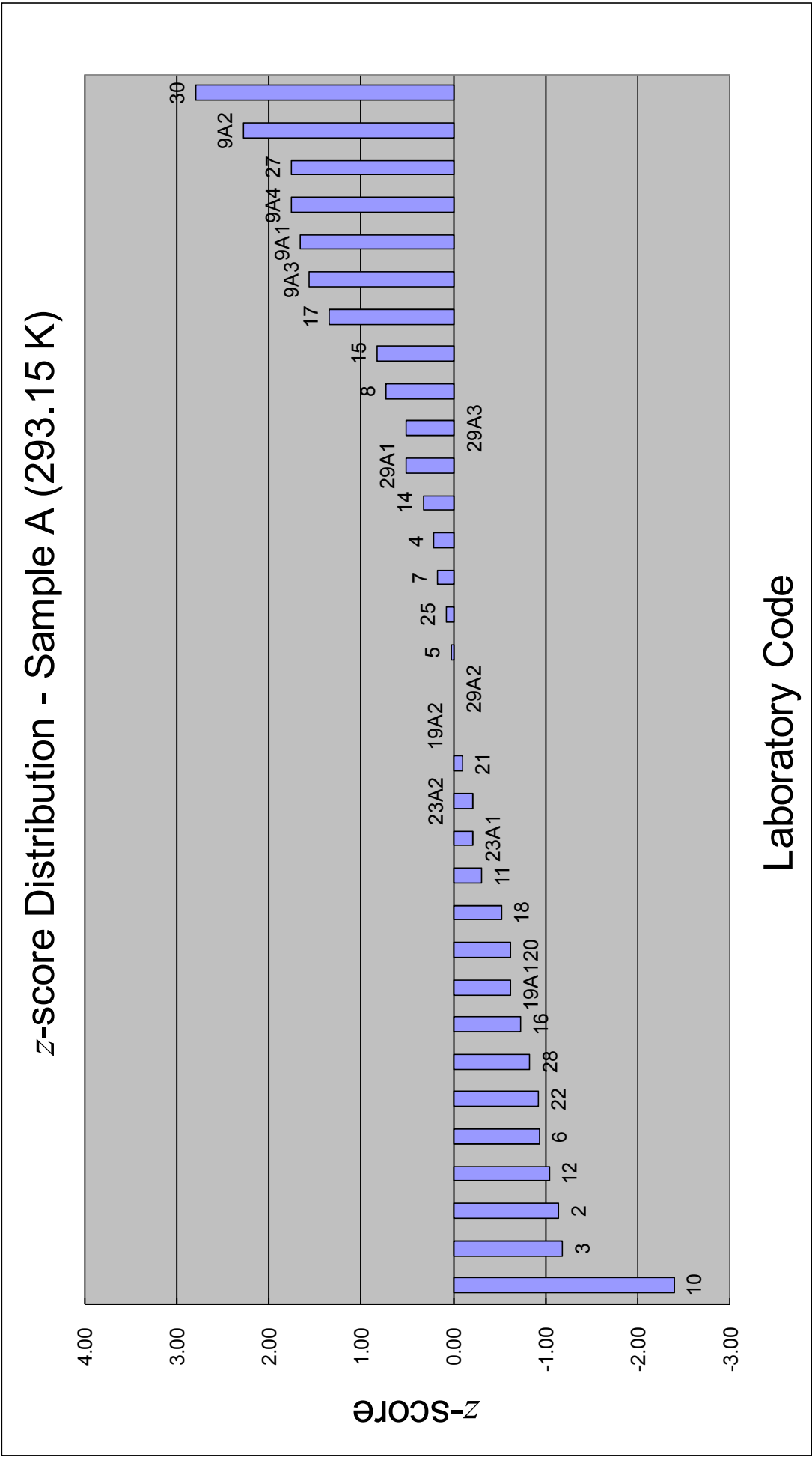
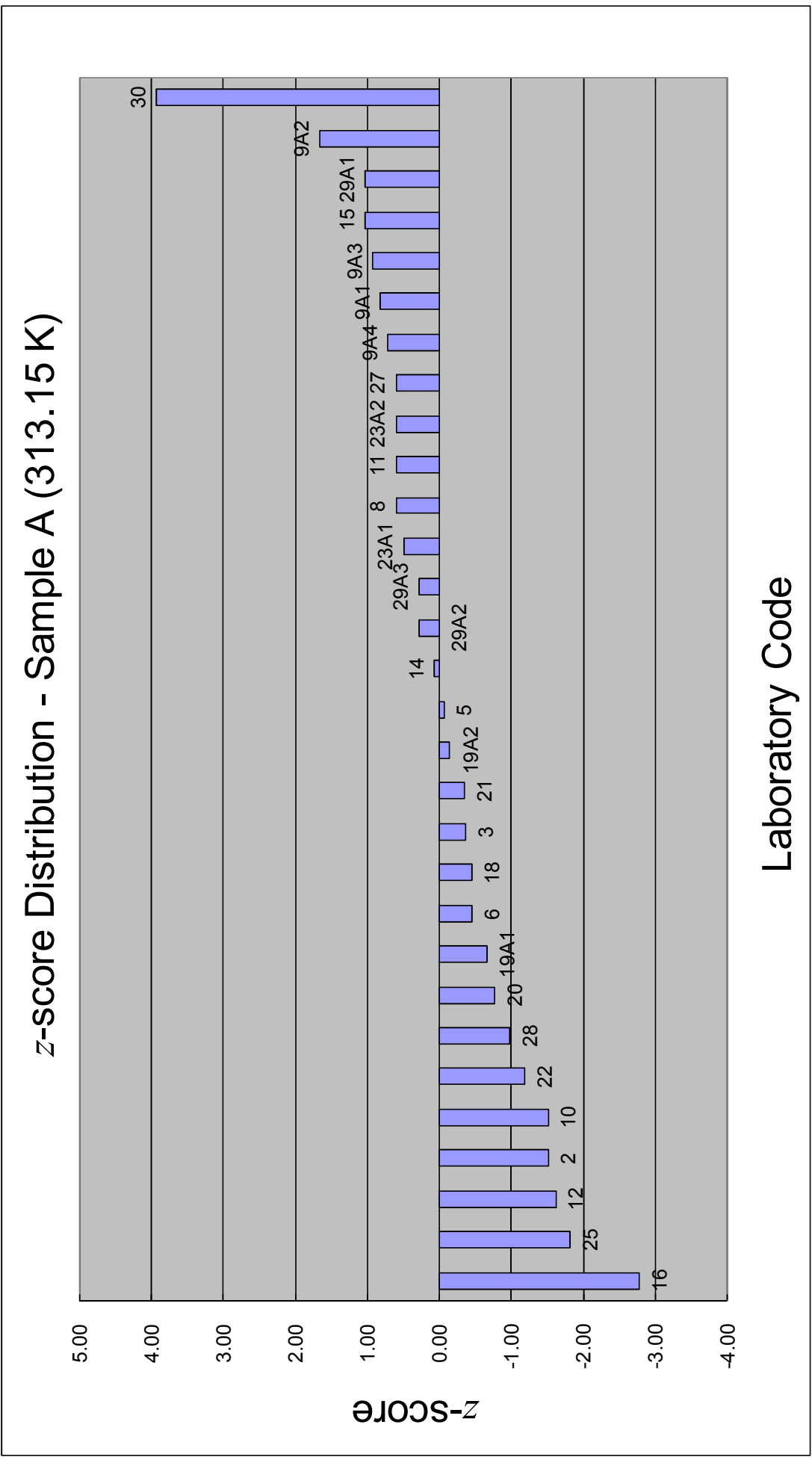


Fig 6 z-score Distribution - Thermal Conductivity - Sample A (313.15 K)



Laboratory Code

Table A-16 z-scores - Thermal Conductivity (Sample B)

Laboratory Code	283.15 K (10 °C)			293.15 K (20 °C)			313.15 K (40 °C)		
	λ (W/(m·K))	z-score		λ (W/(m·K))	z-score		λ (W/(m·K))	z-score	
2	0.140	-1.11		0.143	-0.93		0.146	-0.69	
3	0.14920	-0.57		0.15176	-0.48		0.15896	-0.06	
4	–	–		0.14471	-0.84		–	–	
5	0.190	1.82		0.200	2.01	?	0.201	1.99	
6	0.159	0.00		0.161	0.00		0.166	0.29	
7	–	–		0.06055	-5.18	§	–	–	
8	0.148	-0.65		0.149	-0.62		0.151	-0.44	
9A1	0.137	-1.29		0.137	-1.24		0.137	-1.12	
9A2	0.139	-1.17		0.136	-1.29		0.138	-1.07	
9A3	0.137	-1.29		0.138	-1.19		0.137	-1.12	
9A4	0.138	-1.23		0.139	-1.14		0.143	-0.83	
10	0.127	-1.88		0.138	-1.19		0.142	-0.88	
11	0.165	0.35		0.167	0.31		0.172	0.58	
12	0.159	0.00		0.160	-0.05		0.173	0.63	
14	0.08991	-4.05	§	0.08840	-3.75	§	0.08617	-3.59	§
15	0.178	1.11		0.186	1.29		0.202	2.04	?
16	–	–		0.1882	1.40		0.1592	-0.04	
17	0.1649	0.35		0.16844	0.38		–	–	
18	0.183	1.41		0.184	1.19		0.186	1.26	
19A1	–	–		–	–		–	–	
19A2	–	–		–	–		–	–	
20	0.172	0.76		0.172	0.57		0.173	0.63	
21	0.157	-0.12		0.158	-0.15		0.154	-0.30	
22	0.15245	-0.38		0.14960	-0.59		0.15200	-0.39	
23A1	0.159	0.00		0.161	0.00		0.161	0.04	
23A2	0.159	0.00		0.161	0.00		0.165	0.24	
24	0.17209	0.77		–	–		–	–	
25	0.16605	0.41		0.15233	-0.45		0.12909	-1.51	
27	0.208	2.87	?	0.213	2.68	?	0.209	2.38	?
28	0.162	0.18		0.165	0.21		0.170	0.48	
29A1	0.170	0.65		0.169	0.41		0.174	0.68	
29A2	0.170	0.65		0.171	0.52		0.173	0.63	
29A3	0.171	0.70		0.173	0.62		0.176	0.77	
30	0.175192	0.95		0.16138	0.02		0.15865	-0.07	

No of Results	29	31	28
Median	0.159	0.161	0.160
First Quartile	0.148	0.144	0.145
Third Quartile	0.171	0.170	0.173
Norm IQR	0.017	0.019	0.021
Robust CV (%)	10.7	12.0	12.8
Minimum	0.08991	0.06055	0.08617
Maximum	0.208	0.213	0.209
Range	0.11809	0.15245	0.12283

Fig 7 Thermal Conductivity Histogram - Sample B (283.15 K)

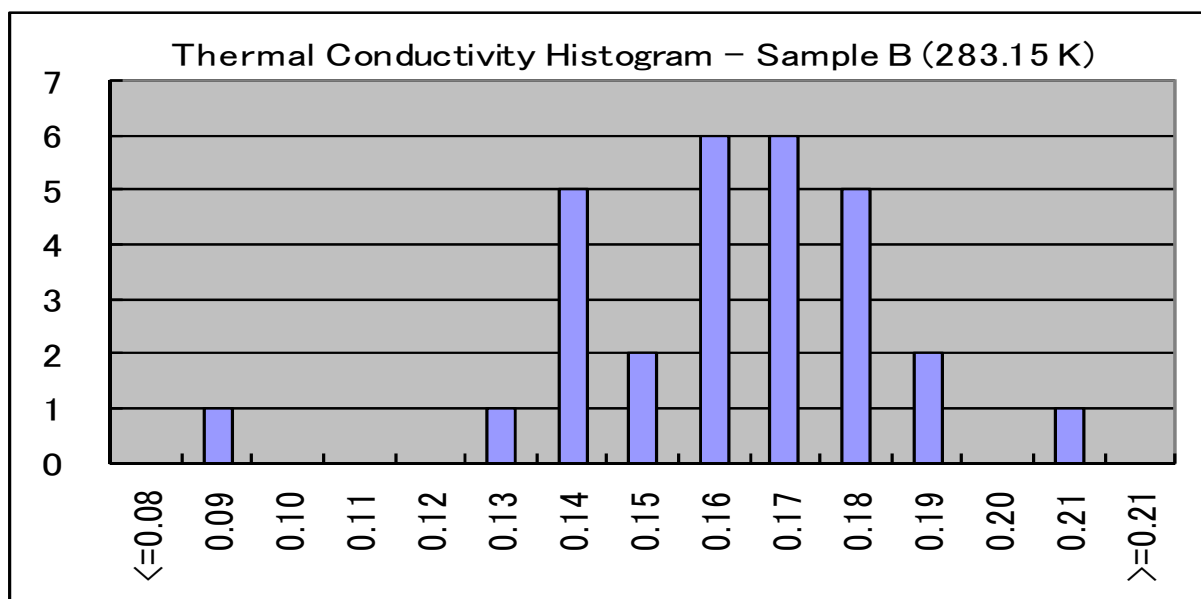


Fig 8 Thermal Conductivity Histogram - Sample B (293.15 K)

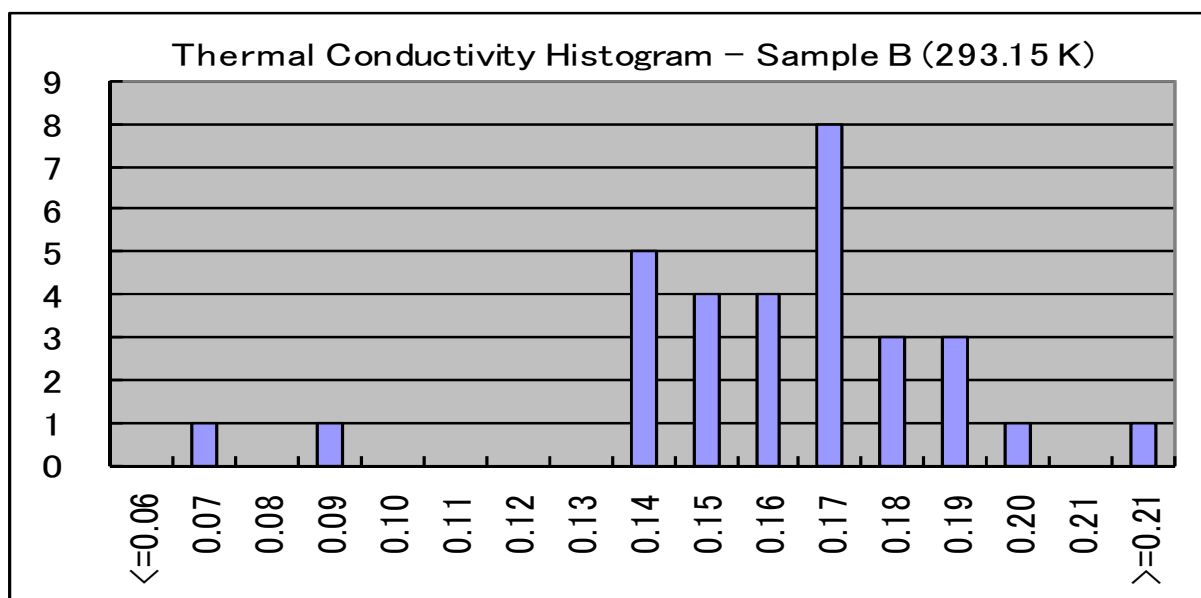


Fig 9 Thermal Conductivity Histogram - Sample B (313.15 K)

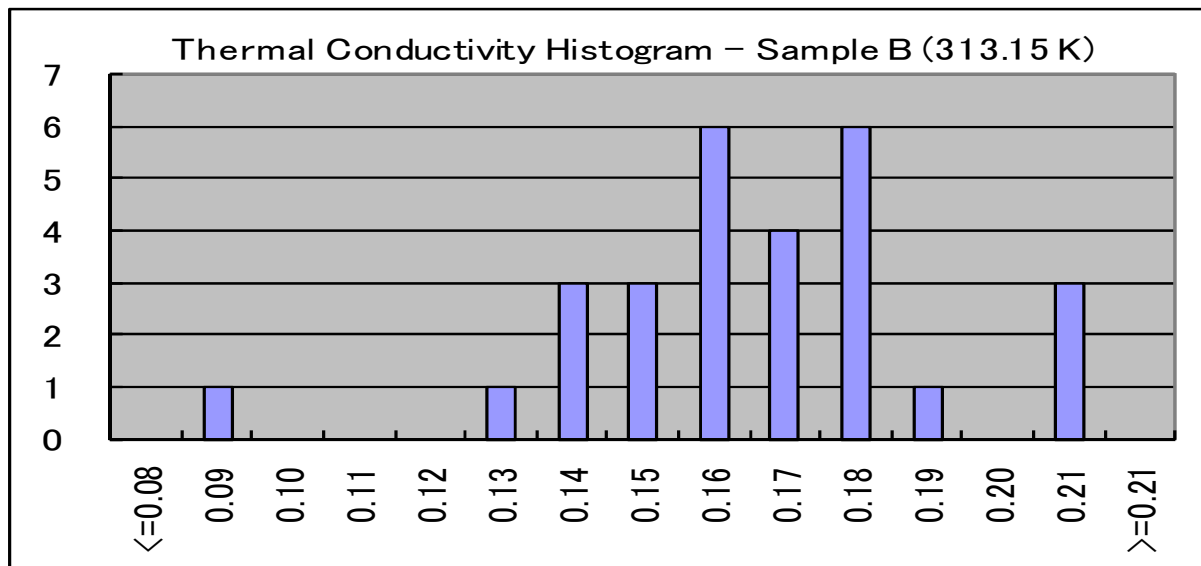
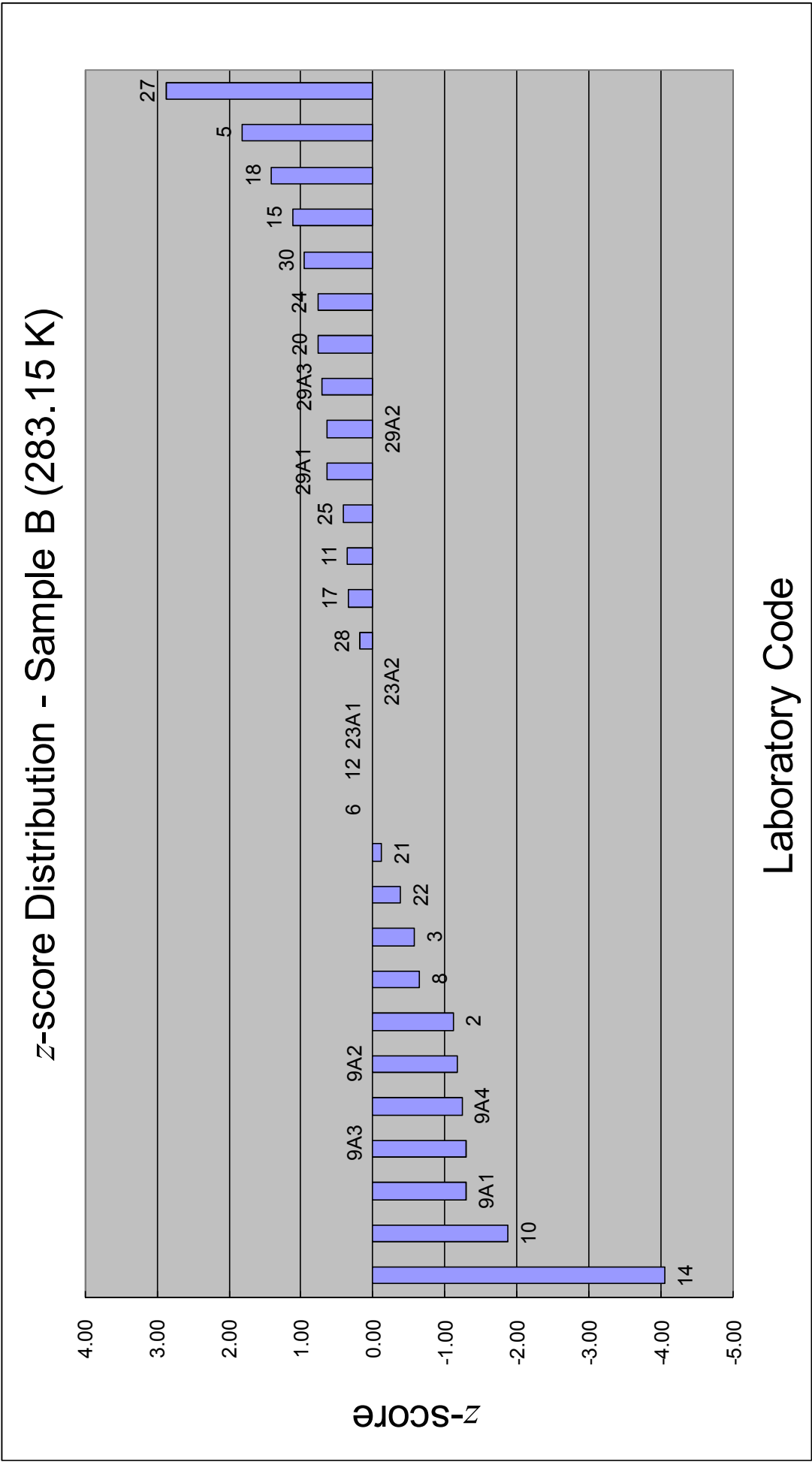
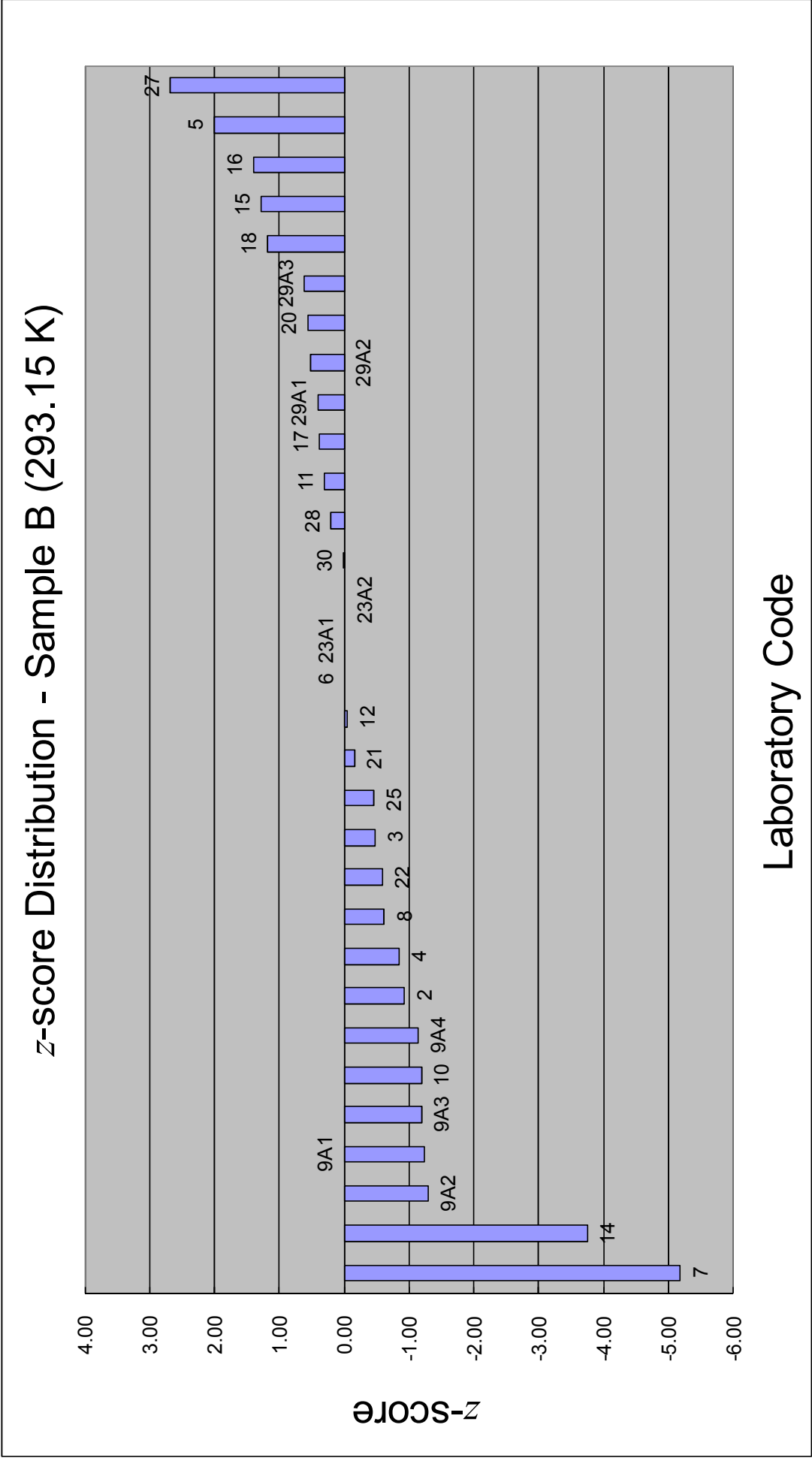


Fig 10 z-score Distribution - Thermal Conductivity - Sample B (283.15 K)



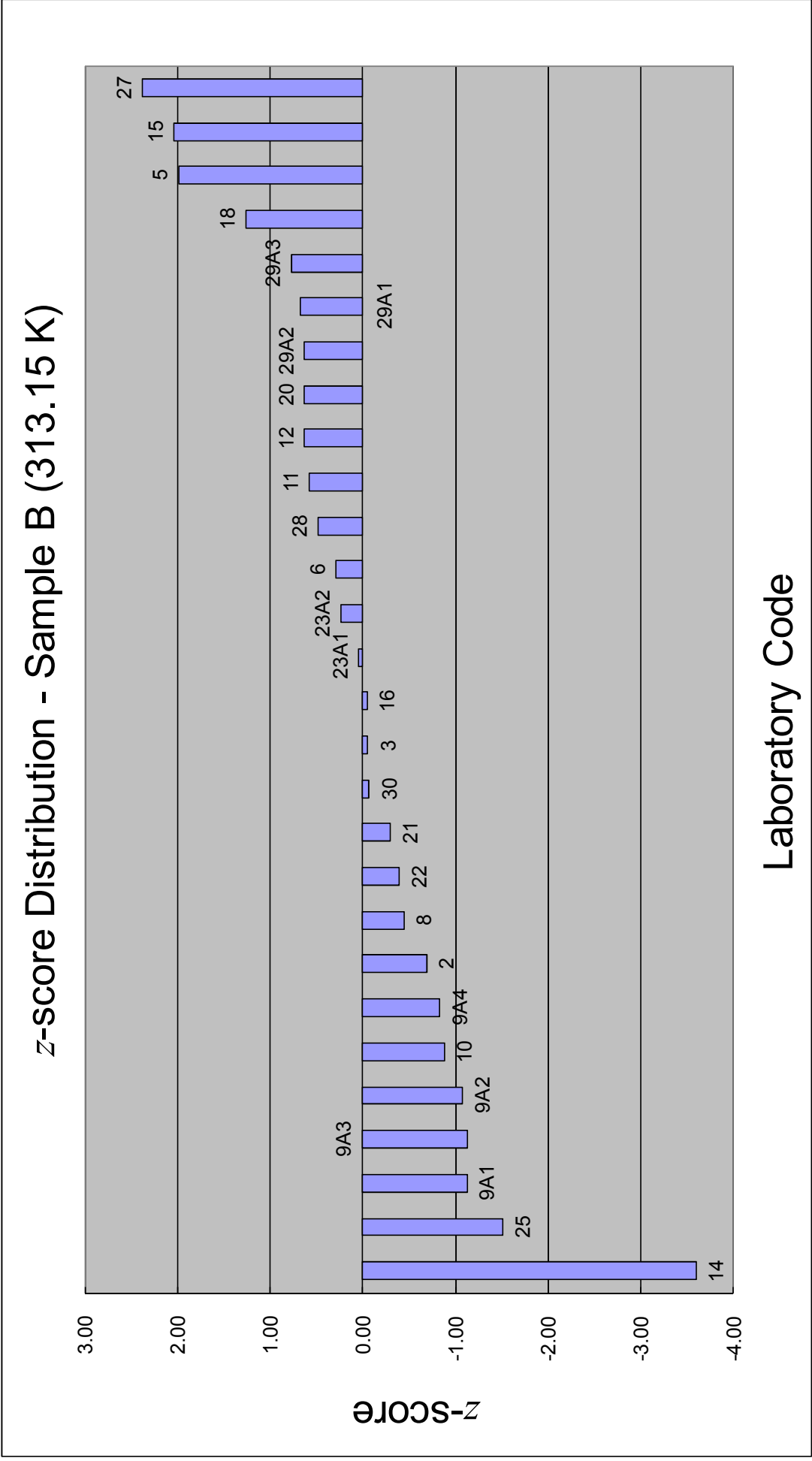
Laboratory Code

Fig 11 z-score Distribution - Thermal Conductivity - Sample B (293.15 K)



Laboratory Code

Fig 12 z-score Distribution - Thermal Conductivity - Sample B (313.15 K)



Laboratory Code

Fig 13 Youden Plot - Thermal Conductivity (Sample A: 283.15 K vs 293.15 K)

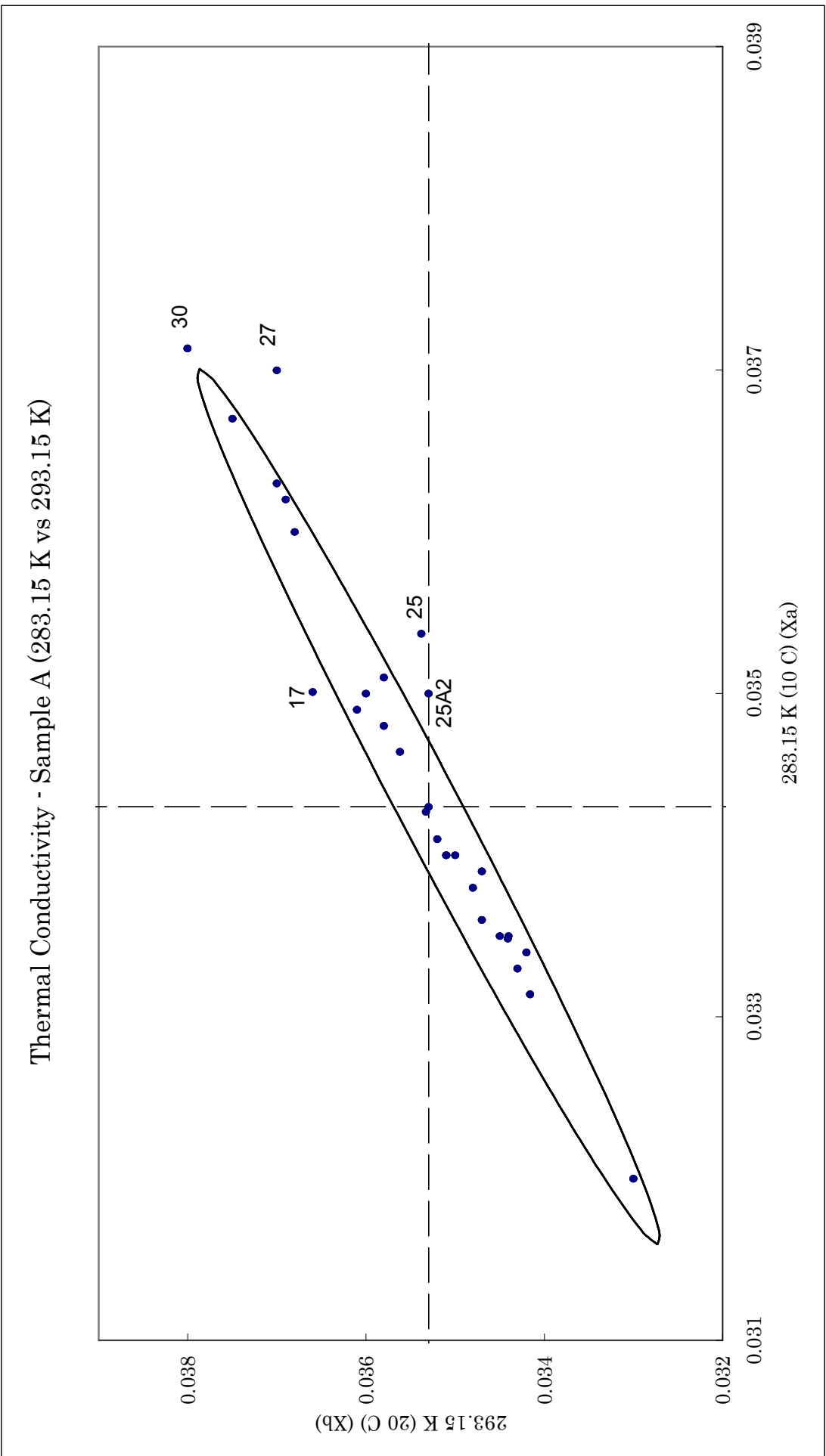


Fig 14 Youden Plot - Thermal Conductivity (Sample A: 283.15 K vs 313.15 K)

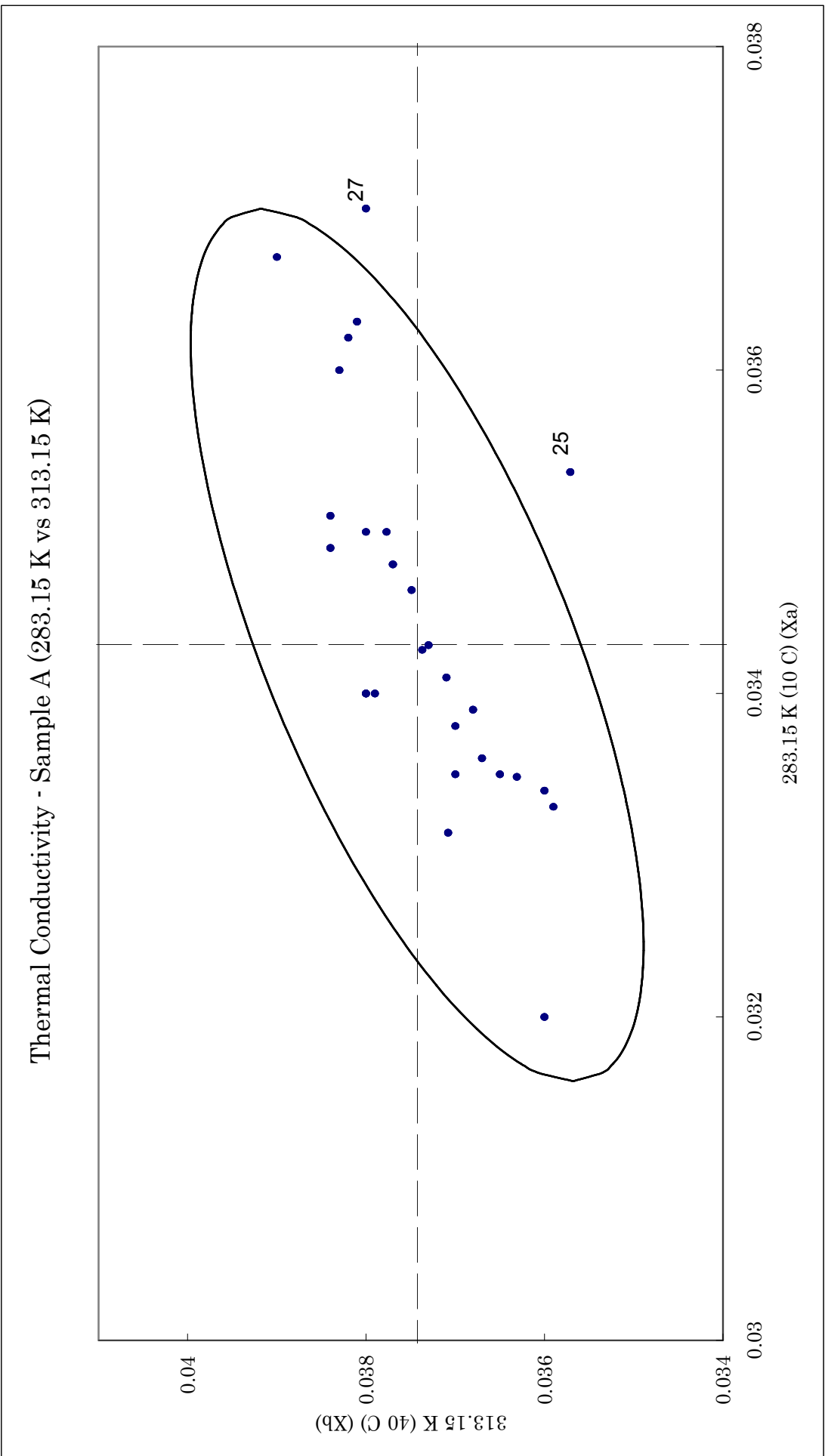


Fig 15 Youden Plot - Thermal Conductivity (Sample A: 293.15 K vs 313.15 K)

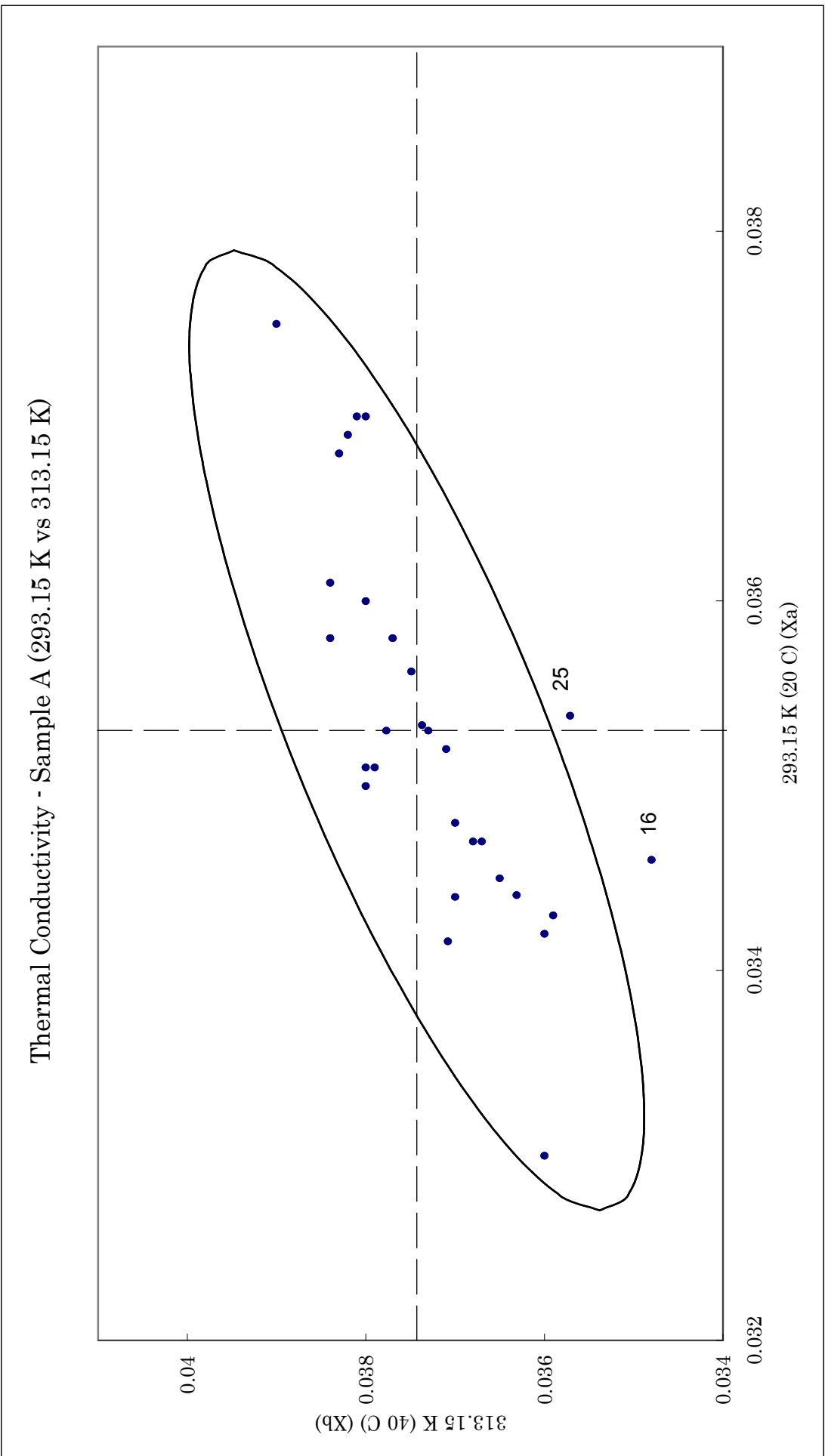


Fig 16 Youden Plot - Thermal Conductivity (Sample B: 283.15 K vs 293.15 K)

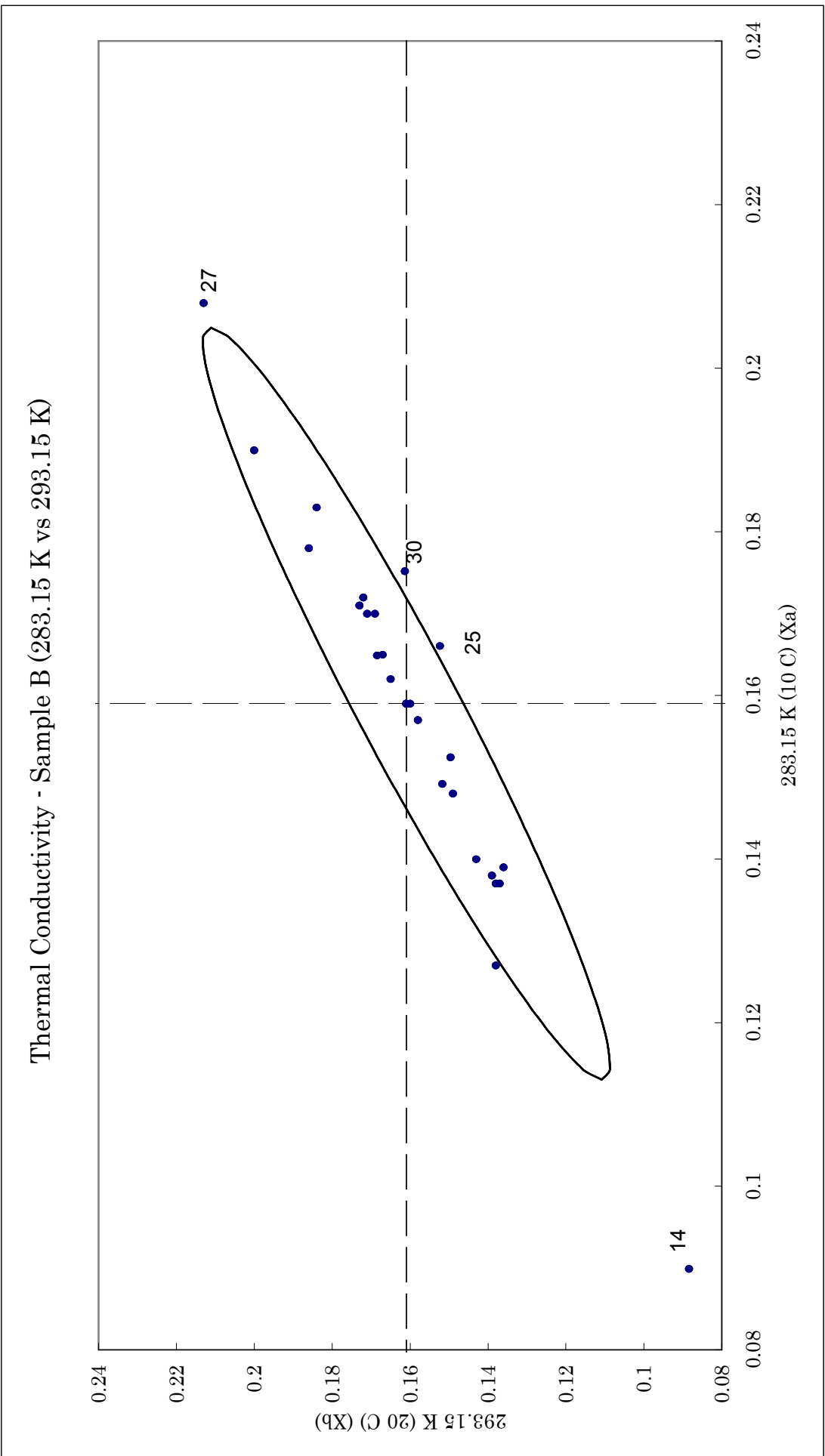


Fig 17 Youden Plot - Thermal Conductivity (Sample A: 283.15 K vs 313.15 K)

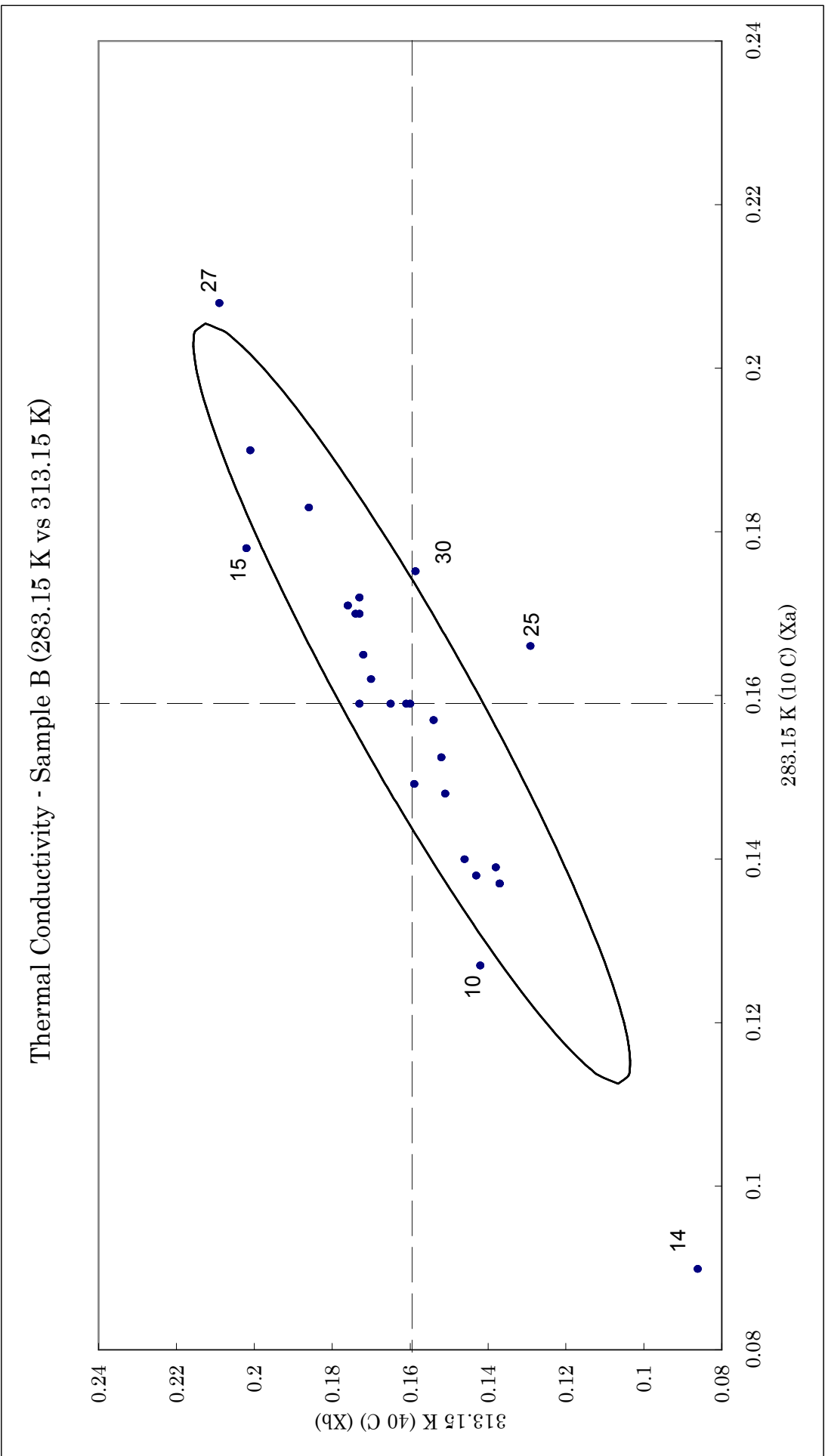


Fig 18 Youden Plot - Thermal Conductivity (Sample A: 293.15 K vs 313.15 K)

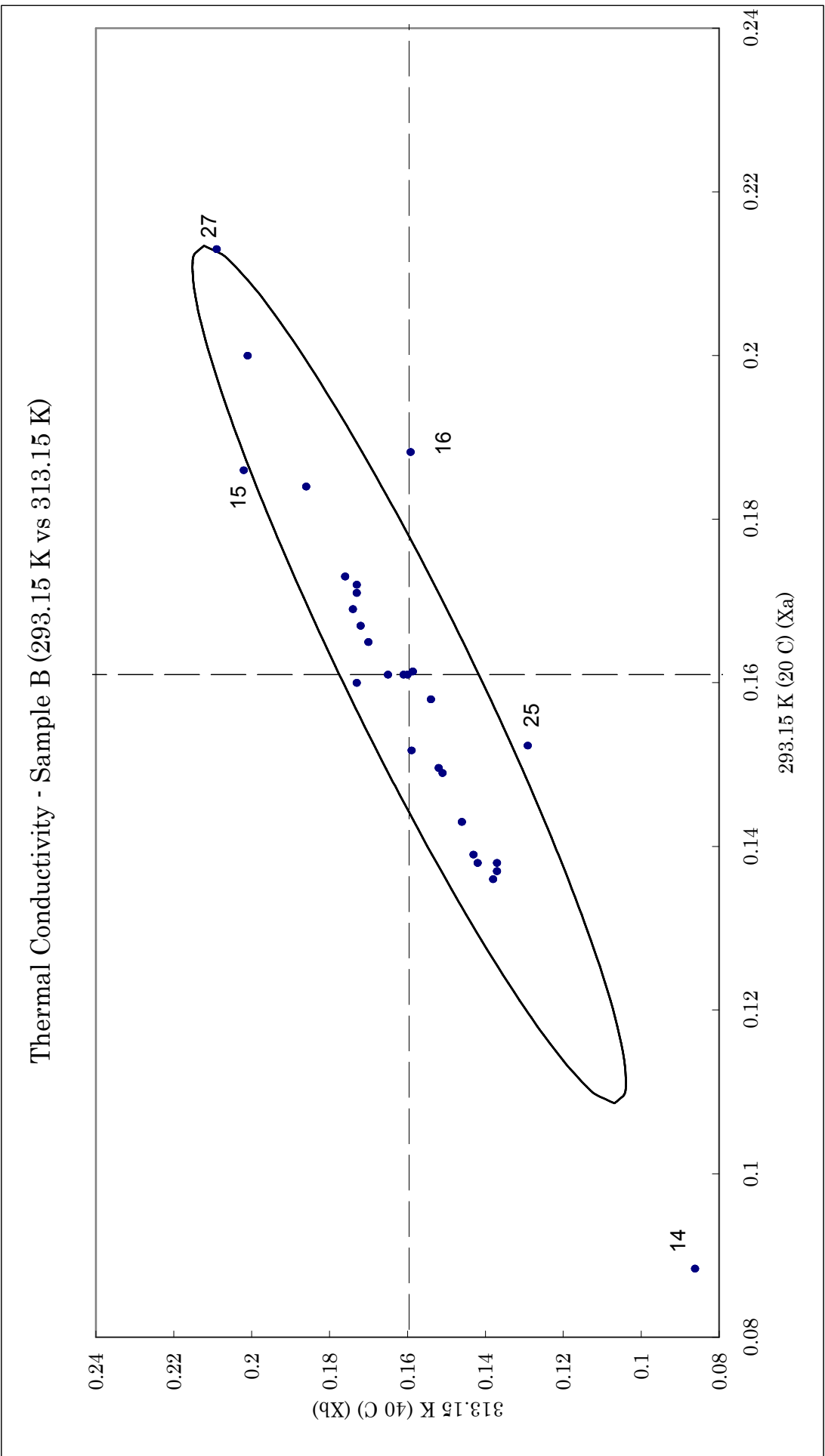


Fig 19 Uncertainty Analysis - Sample A (283.15 K) * Remarks: Solid line: Median, Dotted line: Expanded uncertainty of Median

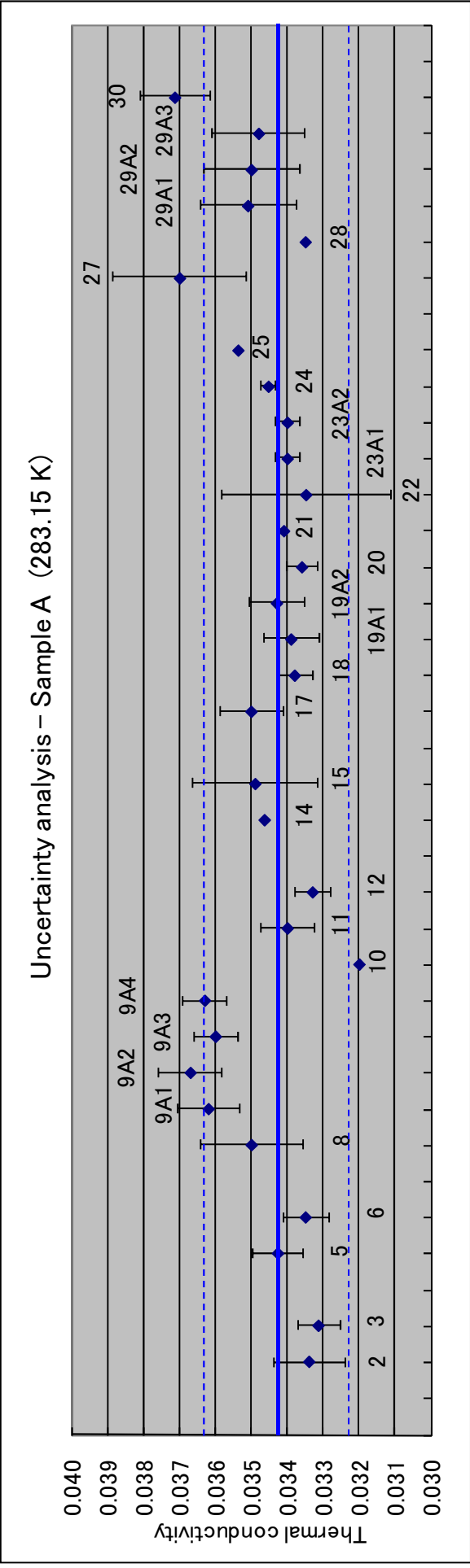


Fig 20 Uncertainty Analysis - Sample A (293.15 K) * Remarks: Solid line: Median, Dotted line: Expanded uncertainty of Median

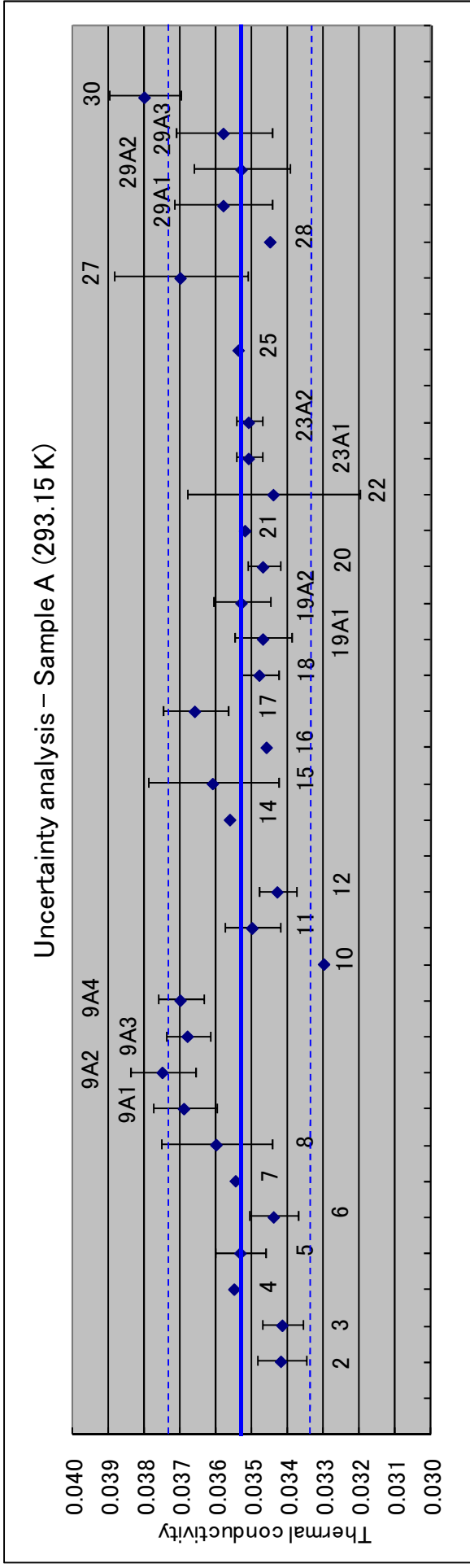


Fig 21 Uncertainty Analysis - Sample A (313.15 K) * Remarks: Solid line: Median, Dotted line: Expanded uncertainty of Median

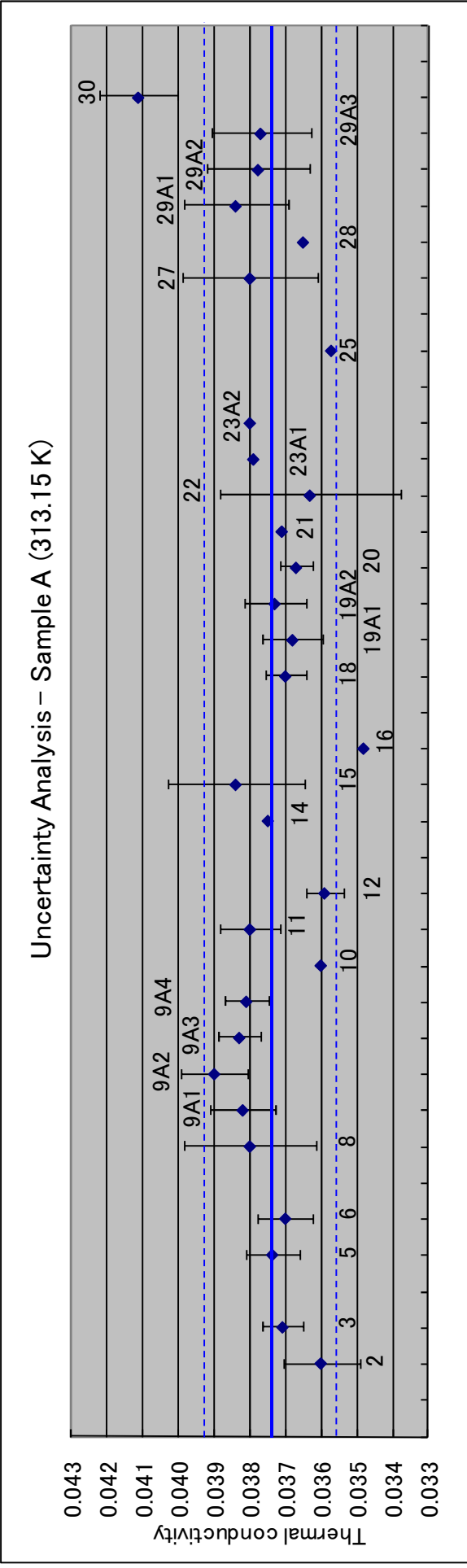


Fig 22 Uncertainty Analysis - Sample B (283.15 K) * Remarks: Solid line: Median, Dotted line: Expanded uncertainty of Median

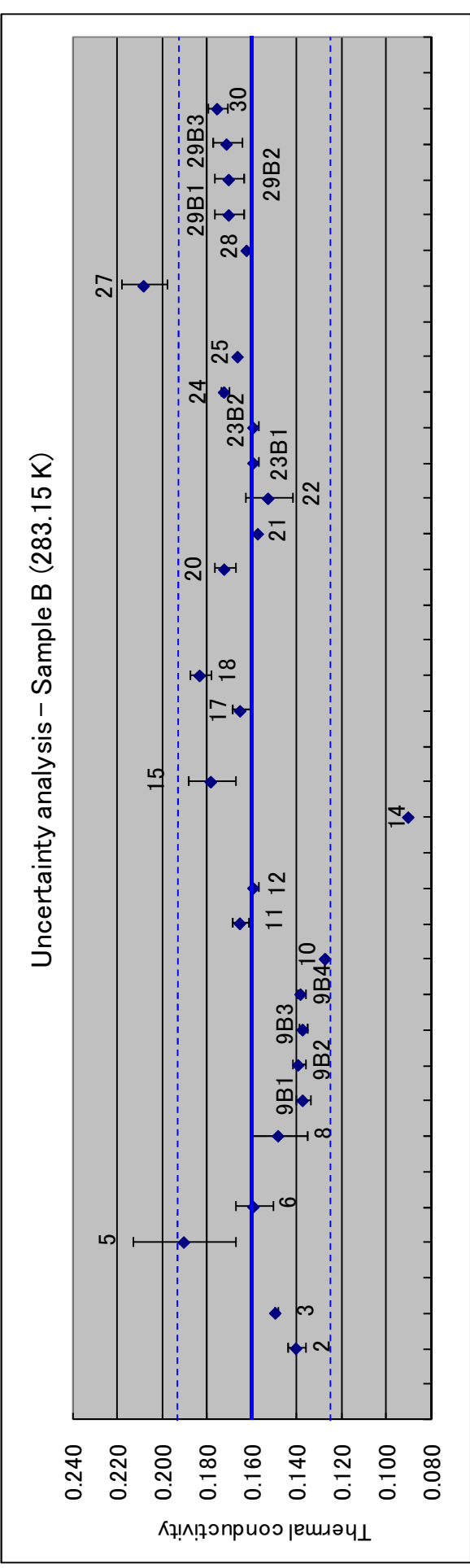


Fig 23 Uncertainty Analysis - Sample B (293.15 K) * Remarks: Solid line: Median, Dotted line: Expanded uncertainty of Median

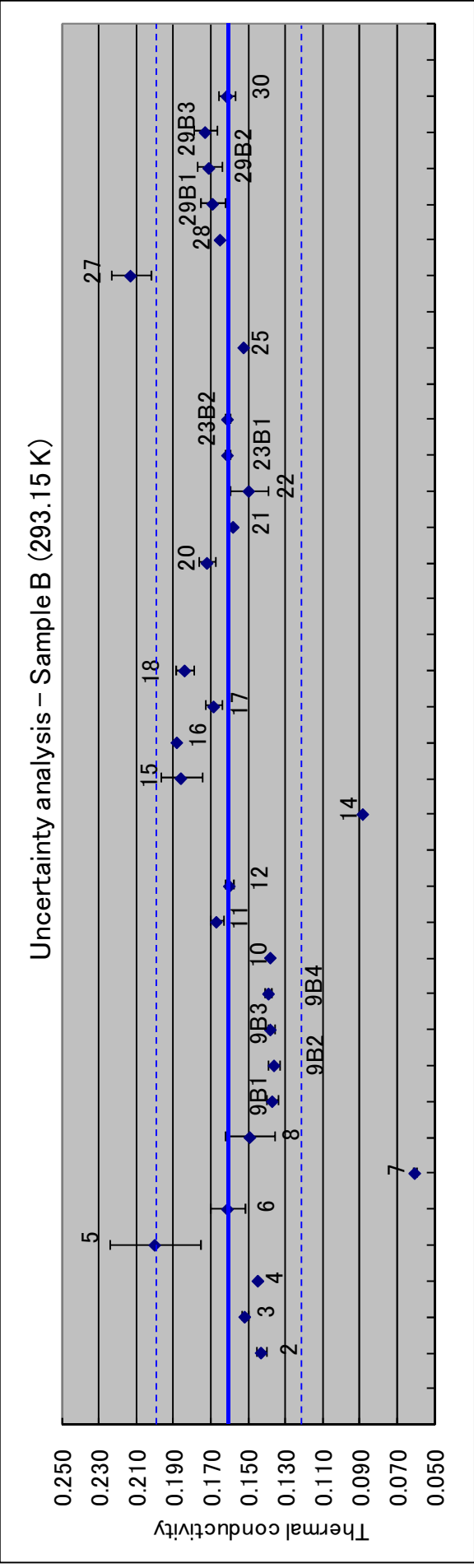
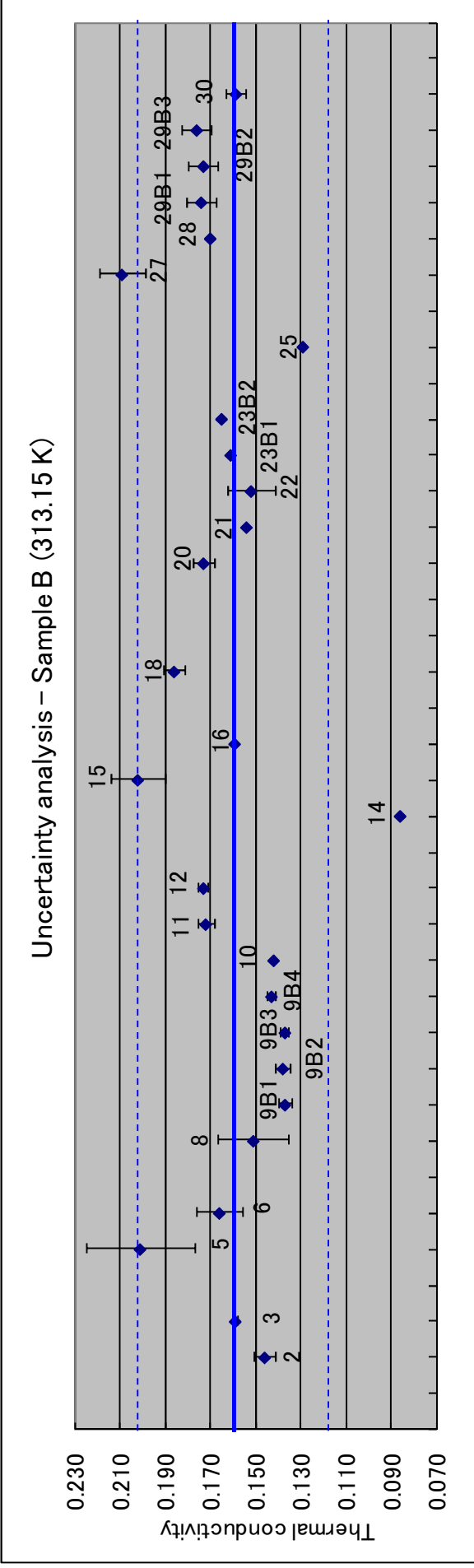


Fig 24 Uncertainty Analysis - Sample B (313.15 K) * Remarks: Solid line: Median, Dotted line: Expanded uncertainty of Median



APLAC T053 Thermal Insulation Proficiency Testing Program

Table A-17 Results of t-Test – Thermal Conductivity

Sample A (283.15K)	ISO 8301 vs ISO 8302		ISO 8301 vs EN 12667		ISO 8302 vs EN12667		ISO 8302 vs ASTM C518	
	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2
Mean	0.034457	0.035185	0.034457	0.0344748	0.035185	0.0344748	0.034457	0.033756667
Variance	1.5145E-06	5.73314E-07	1.5145E-06	2.3611E-06	5.73314E-07	2.3611E-06	1.5145E-06	2.44763E-06
No of Data	15	8	15	5	8	5	15	3
Pooled variance	1.20077E-06		1.70263E-06		1.22342E-06		1.63114E-06	
Difference of mean	0		0		0		0	
Degree of freedom	21		18		11		16	
t value	-1.517497547		-0.0264165		1.126294159		0.867019858	
t-limit (two-sided)	2.079613837		2.100922037		2.200985159		2.119905285	

Sample A (293.15K)	ISO 8301 vs ISO 8302		ISO 8301 vs EN 12667		ISO 8302 vs EN12667		ISO 8302 vs ASTM C518	
	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2
Mean	0.035445	0.0358725	0.035445	0.03489	0.0358725	0.03489	0.035445	0.035413
Variance	1.62463E-06	7.4205E-07	1.62463E-06	2.39067E-07	7.4205E-07	2.39067E-07	1.62463E-06	2.25709E-06
No of Data	14	8	14	4	8	4	14	7
Pooled variance	1.31573E-06		1.36483E-06		5.91155E-07		1.82435E-06	
Difference of mean	0		0		0		0	
Degree of freedom	20		16		10		19	
t value	-0.84091331		0.837935843		2.086729913		0.05117987	
t-limit (two-sided)	2.085963441		2.119905285		2.228138842		2.09302405	

Sample A (313.15K)	ISO 8301 vs ISO 8302		ISO 8301 vs EN 12667		ISO 8302 vs EN12667		ISO 8302 vs ASTM C518	
	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2
Mean	0.037207143	0.036872857	0.037207143	0.03752	0.036872857	0.03752	0.037207143	0.0374626
Variance	8.25037E-07	2.11516E-06	8.25037E-07	2.48267E-07	2.11516E-06	2.48267E-07	8.25037E-07	5.76784E-06
No of Data	14	7	14	4	7	4	14	5
Pooled variance	1.23244E-06		7.16893E-07		1.49286E-06		1.98805E-06	
Difference of mean	0		0		0		0	
Degree of freedom	19		16		9		17	
t value	0.650485589		-0.651743501		-0.845032181		-0.347757638	
t-limit (two-sided)	2.09302405		2.119905285		2.262157158		2.109815559	

APLAC T053 Thermal Insulation Proficiency Testing Program

Sample B (283.15K)	ISO 8301 vs ISO 8302		ISO 8301 vs EN 12667		ISO 8302 vs EN12667		ISO 8302 vs ASTM C518	
	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2
Mean	0.155803846	0.16349375	0.155803846	0.15605	0.16349375	0.15605	0.155803846	0.160048
Variance	0.000736323	0.000292852	0.000736323	2.17433E-05	0.000292852	2.17433E-05	0.000736323	0.000787929
No of Data	13	8	13	4	8	4	13	4
Pooled variance	0.000572939		0.000593407		0.000211519		0.000746644	
Difference of mean	0		0		0		0	
Degree of freedom	19		15		10		15	
t value	-0.71494683		-0.017672884		0.835797809		-0.27165107	
t-limit (two-sided)	2.09302405		2.131449536		2.228138842		2.131449536	

Sample B (293.15K)	ISO 8301 vs ISO 8302		ISO 8301 vs EN 12667		ISO 8302 vs EN12667		ISO 8302 vs ASTM C518	
	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2
Mean	0.15525	0.16372125	0.15525	0.15794	0.16372125	0.15794	0.15525	0.148834286
Variance	0.00086427	0.000349469	0.00086427	1.89744E-05	0.000349469	1.89744E-05	0.00086427	0.002042253
No of Data	12	8	12	4	8	4	12	7
Pooled variance	0.000664069		0.000683135		0.00025032		0.001280029	
Difference of mean	0		0		0		0	
Degree of freedom	18		14		10		17	
t value	-0.720213657		-0.178262325		0.596702677		0.377049175	
t-limit (two-sided)	2.100922037		2.144786681		2.228138842		2.109815559	

Sample B (313.15K)	ISO 8301 vs ISO 8302		ISO 8301 vs EN 12667		ISO 8302 vs EN12667		ISO 8302 vs ASTM C518	
	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2
Mean	0.157430833	0.16387	0.157430833	0.15974	0.16387	0.15974	0.157430833	0.16237
Variance	0.000890606	0.000760098	0.000890606	2.09371E-05	0.000760098	2.09371E-05	0.000890606	0.000515095
No of Data	12	7	12	4	7	4	12	5
-	0.000844544		0.000704248		0.000513711		0.000790469	
Difference of mean	0		0		0		0	
Degree of freedom	17		14		9		15	
t value	-0.465887779		-0.150713821		0.290718854		-0.330036781	
t-limit (two-sided)	2.109815559		2.144786681		2.262157158		2.131449536	

Appendix B

Homogeneity Test Results

APLAC T053 Thermal Insulation Proficiency Testing Program

1. Description of test

We created a high density glass wool boards and acrylic resin boards and conducted a homogeneity test per a request from the National Institute of Technology and Evaluation.

2. Test specimens

There were two types of test specimens, high density glass wool board and acrylic resin board. Both test specimens were cut to a 300 x 300 mm size from 1,000 x 2,000 mm size boards. An overview of the test specimens is shown in Table 1.

Table 1 Test specimens

Type	Code	Nominal size	Quantity		
			Fabricated	Density	Thermal conductivity
High density glass wool board	GW001 – GW100	300 x 300 mm 25 mm in thickness	100 pieces	100 pieces	7 pieces
Acrylic resin board	AR001 – AR100	300 x 300 mm 15 mm in thickness	100 pieces	100 pieces	7 pieces

3. Test method

(1) Homogeneity test (density test)

100 fabricated test specimens were randomly numbered and cured for 16 hours in an environmental chamber controlled at 23 °C and 50 %RH. Following this the density of all the fabricated test specimens were measured according to the following procedure.

(i) Gently place the test specimen in the center of a glass board (350 x 350 x 19 mm), gently place a glass board (350 x 350 x 19 mm) on the test specimen and leave it for at least 20 seconds.

(ii) Use a vernier caliper to measure the thickness of the test specimen to a precision of 5/100 mm. The thickness of the test specimen shall be the distance between the glass board above and under the test specimen. Measured locations are the four corners of the side of the test specimen and the thickness is the average value of the four corners.

(iii) Use a vernier caliper to measure the size of the test specimen to a precision of 1/10 mm. Measured locations are the center of each side of the test specimen.

(iv) Use an electronic balance to measure the mass of the test specimen. Measure the mass of the test specimen to a precision of 1/100 g.

(v) Based on the results of the measurement of thickness, size and mass, use equation (1) to calculate the density of the test specimen.

$$\rho = \frac{M}{t \times L \times W} \dots\dots\dots (1)$$

Where ρ : Density (kg/m³)

M : Mass (kg)

t : Thickness (m)

L : Length size (m)

W : Width size (m)

APLAC T053 Thermal Insulation Proficiency Testing Program

(2) Homogeneity test (Thermal conductivity test)

We chose 7 test specimens that were randomly sampled from the 100 fabricated test specimens that went through the density test and used them as samples for the thermal conductivity test. The thermal conductivity test was performed using the guarded hot plate apparatus (certification number: CG-0002) for which certification was obtained from the ASNITE Subprogram for Calibration Laboratories. Test conditions are shown in the following table.

Table 2 Thermal conductivity test condition

Test method	Test system	Heat flow direction	Mean temperature
JIS A1412-1 (Test method for thermal resistance and related properties of thermal insulations – Part 1: Guarded hot plate apparatus)	Single test specimen system	Downward	20 °C

4. Test Results

(1) Homogeneity test (density test)

The density test results are shown in Tables 3, 4 and Figs.1 and 2.

(2) Homogeneity test (thermal conductivity test)

The thermal conductivity test results are shown in Tables 5 and 6 and Figs. 3 and 4.

APLAC T053 Thermal Insulation Proficiency Testing Program

Table 3 Homogeneity test results (density test, high density glass wool board)

NO.	Mass (g)	Size (mm)	Size (mm)	Thickness (mm)	Density (kg/m ³)	NO.	Mass (g)	Size (mm)	Size (mm)	Thickness (mm)	Density (kg/m ³)
GW001	476.14	298.0	299.5	23.7	225.1	GW051	478.61	299.5	300.0	23.8	223.8
GW002	476.22	299.5	299.0	23.8	223.4	GW052	483.13	300.6	299.7	23.8	225.3
GW003	468.78	298.6	299.7	23.9	219.2	GW053	458.63	299.3	300.4	24.2	210.8
GW004	465.68	298.5	297.7	23.4	223.9	GW054	470.30	300.0	299.7	23.9	218.9
GW005	468.60	299.6	299.7	24.6	212.1	GW055	467.04	299.4	300.0	23.3	223.2
GW006	457.87	299.3	298.6	23.8	215.3	GW056	463.19	300.0	299.9	23.6	218.1
GW007	463.98	298.7	299.8	24.6	210.6	GW057	466.16	302.1	302.6	24.3	209.9
GW008	476.18	298.6	295.2	23.7	227.9	GW058	490.54	299.4	300.0	23.9	228.5
GW009	463.30	298.6	299.2	23.8	217.9	GW059	474.32	299.8	299.6	24.1	219.1
GW010	475.92	299.2	299.8	24.7	214.8	GW060	457.85	302.7	301.6	24.3	206.4
GW011	455.48	299.8	298.5	23.7	214.8	GW061	468.34	299.2	299.6	24.1	216.8
GW012	469.20	298.7	299.3	23.7	221.4	GW062	469.84	299.0	299.6	24.6	213.2
GW013	468.77	299.5	298.4	23.8	220.4	GW063	469.05	300.2	298.8	24.7	211.7
GW014	462.86	298.8	299.3	23.3	222.1	GW064	478.40	299.7	300.0	24.3	219.0
GW015	465.95	299.2	298.6	24.0	217.3	GW065	486.17	299.6	299.5	23.8	227.7
GW016	453.23	299.0	299.8	23.0	219.8	GW066	461.57	299.9	299.8	23.5	218.5
GW017	456.70	301.0	298.9	23.8	213.3	GW067	495.29	299.3	299.9	24.3	227.1
GW018	460.62	299.8	298.6	24.4	210.9	GW068	468.28	300.1	299.4	24.2	215.4
GW019	457.70	299.2	298.4	24.1	212.7	GW069	490.42	299.7	299.6	23.8	229.5
GW020	475.48	299.0	298.8	23.9	222.7	GW070	460.37	301.2	299.6	24.2	210.8
GW021	456.87	299.8	298.8	24.2	210.7	GW071	482.17	299.4	299.6	24.9	215.9
GW022	469.14	298.6	298.8	24.1	218.2	GW072	464.05	299.6	300.2	24.3	212.3
GW023	470.20	298.7	299.3	23.4	224.8	GW073	469.33	299.1	299.7	24.1	217.2
GW024	466.40	299.2	298.4	23.1	226.1	GW074	477.44	299.4	298.8	24.1	221.4
GW025	460.78	299.3	299.2	24.6	209.2	GW075	451.23	299.5	300.0	24.5	205.0
GW026	469.19	298.9	299.0	23.7	221.5	GW076	456.55	300.2	299.4	24.2	209.9
GW027	464.55	298.8	299.1	23.8	218.4	GW077	473.35	299.6	299.7	23.9	220.6
GW028	472.24	299.5	299.5	23.8	221.2	GW078	451.91	299.7	299.6	23.9	210.6
GW029	461.56	298.9	299.8	23.5	219.2	GW079	472.54	300.2	299.3	24.0	219.1
GW030	474.60	299.2	298.7	23.6	225.0	GW080	455.68	299.8	299.8	24.0	211.2
GW031	450.91	300.5	299.4	23.9	209.7	GW081	480.36	300.6	299.8	24.5	217.6
GW032	451.53	301.3	301.0	24.0	207.4	GW082	470.24	300.0	299.5	24.4	214.5
GW033	458.58	300.5	299.6	23.8	214.0	GW083	455.20	299.8	299.8	24.9	203.4
GW034	465.76	301.0	299.4	23.9	216.2	GW084	467.48	300.5	299.6	24.1	215.5
GW035	474.12	299.4	299.5	22.8	231.9	GW085	482.52	299.7	300.4	23.8	225.2
GW036	462.94	299.5	299.8	23.4	220.3	GW086	473.13	299.6	300.1	24.1	218.4
GW037	492.96	299.7	300.2	24.1	227.4	GW087	471.72	299.8	300.0	24.6	213.2
GW038	483.03	300.7	300.4	23.8	224.7	GW088	479.04	299.2	299.7	25.3	211.2
GW039	472.55	299.4	300.0	23.2	226.8	GW089	482.79	299.4	300.1	24.2	222.0
GW040	477.26	299.6	299.4	23.7	224.5	GW090	463.69	299.6	300.0	24.6	209.7
GW041	472.62	299.5	300.0	23.6	222.9	GW091	455.13	300.0	300.4	24.2	208.7
GW042	480.27	299.6	300.1	24.2	220.7	GW092	455.78	299.5	299.5	24.2	210.0
GW043	484.63	300.1	299.4	24.1	223.8	GW093	472.20	299.1	298.8	23.4	225.8
GW044	475.03	300.8	299.6	24.6	214.3	GW094	473.64	300.0	299.7	25.3	208.2
GW045	456.24	300.6	299.1	24.5	207.1	GW095	455.56	299.8	299.2	24.7	205.6
GW046	463.67	299.6	300.3	24.6	209.5	GW096	476.86	299.6	299.2	24.6	216.2
GW047	454.07	299.5	299.7	25.0	202.3	GW097	473.07	299.0	298.8	23.3	227.3
GW048	465.77	300.0	299.4	24.4	212.5	GW098	476.68	299.6	299.4	23.9	222.3
GW049	468.22	299.6	299.4	23.9	218.4	GW099	473.95	298.9	299.0	24.7	214.7
GW050	459.82	299.5	300.2	23.9	214.0	GW100	475.38	299.9	298.4	24.7	215.1
						Density average (kg/m ³)					217.3
						Density standard deviation (kg/m ³)					6.6
						Coefficient of variance (%)					3.0

APLAC T053 Thermal Insulation Proficiency Testing Program

Table 4 Homogeneity test results (density test, acrylic resin board)

NO.	Mass (g)	Size (mm)	Size (mm)	Thickness (mm)	Density (kg/m ³)	NO.	Mass (g)	Size (mm)	Size (mm)	Thickness (mm)	Density (kg/m ³)
AR001	1582.60	300.1	300.2	14.8	1187.0	AR051	1591.09	300.1	300.2	14.9	1185.3
AR002	1584.14	300.1	300.2	14.8	1188.1	AR052	1591.82	300.2	300.2	14.9	1185.5
AR003	1581.92	300.1	300.1	14.8	1186.8	AR053	1581.76	300.2	300.2	14.8	1185.9
AR004	1583.34	300.1	300.2	14.8	1187.5	AR054	1581.24	300.2	300.2	14.8	1185.5
AR005	1583.63	300.2	300.2	14.8	1187.3	AR055	1589.99	300.2	300.1	14.9	1184.5
AR006	1588.24	300.1	300.2	14.8	1191.2	AR056	1594.26	300.2	300.2	14.9	1187.3
AR007	1582.43	300.0	300.2	14.8	1187.2	AR057	1594.80	300.2	300.2	14.9	1187.7
AR008	1586.96	300.2	300.0	14.8	1190.6	AR058	1584.36	300.2	300.3	14.9	1179.5
AR009	1586.01	300.2	300.1	14.8	1189.5	AR059	1581.37	300.2	300.2	14.9	1177.7
AR010	1601.76	300.2	300.1	15.0	1185.3	AR060	1581.09	300.2	300.2	14.8	1185.4
AR011	1584.60	300.2	300.2	14.8	1188.1	AR061	1605.03	300.2	300.2	15.0	1187.3
AR012	1600.35	300.1	300.2	15.0	1184.3	AR062	1605.89	300.2	300.2	15.0	1188.0
AR013	1604.81	300.2	300.1	15.0	1187.6	AR063	1582.35	300.2	300.2	14.8	1186.4
AR014	1605.29	300.2	300.1	15.0	1187.9	AR064	1584.91	300.2	300.3	14.9	1179.9
AR015	1591.04	300.0	300.0	14.9	1186.5	AR065	1600.73	300.3	300.2	15.0	1183.8
AR016	1591.72	300.2	300.2	14.9	1185.4	AR066	1584.94	300.1	300.2	14.9	1180.7
AR017	1591.86	300.1	300.1	14.9	1186.3	AR067	1599.37	300.2	300.2	15.0	1183.1
AR018	1590.66	300.1	300.0	14.9	1185.8	AR068	1600.21	300.1	300.2	15.0	1184.2
AR019	1590.89	300.1	300.1	14.9	1185.6	AR069	1599.51	300.2	300.2	15.0	1183.2
AR020	1583.59	300.0	300.1	14.8	1188.5	AR070	1591.50	300.1	300.2	14.9	1185.6
AR021	1583.29	300.1	300.1	14.8	1187.9	AR071	1590.58	300.2	300.2	14.8	1192.5
AR022	1583.22	300.1	300.1	14.8	1187.8	AR072	1590.14	300.2	300.2	14.9	1184.2
AR023	1582.14	300.1	300.1	14.8	1187.0	AR073	1601.09	300.4	300.2	15.0	1183.6
AR024	1591.95	300.0	300.1	14.9	1186.7	AR074	1588.03	300.4	300.2	14.8	1189.8
AR025	1589.72	300.2	300.0	14.9	1184.7	AR075	1587.57	300.4	300.3	14.9	1181.1
AR026	1591.02	300.1	300.1	14.9	1185.7	AR076	1589.64	300.4	300.4	14.8	1190.2
AR027	1600.66	300.0	300.1	14.9	1193.2	AR077	1584.48	300.3	300.3	14.8	1187.2
AR028	1598.51	300.2	300.1	14.9	1190.8	AR078	1583.44	300.3	300.2	14.8	1186.8
AR029	1599.80	300.2	300.1	14.9	1191.8	AR079	1584.40	300.3	300.3	14.9	1179.1
AR030	1599.93	300.1	300.0	15.0	1184.7	AR080	1593.98	300.5	300.2	14.9	1185.9
AR031	1600.04	300.2	300.2	15.0	1183.6	AR081	1594.29	300.3	300.3	14.9	1186.5
AR032	1599.68	300.2	300.2	15.0	1183.4	AR082	1595.14	300.3	300.3	14.9	1187.1
AR033	1583.39	300.1	300.2	14.9	1179.6	AR083	1593.66	300.2	300.2	14.9	1186.8
AR034	1585.70	300.2	300.3	14.9	1180.5	AR084	1603.82	300.2	300.2	15.0	1186.4
AR035	1583.46	300.2	300.2	14.8	1187.2	AR085	1605.30	300.3	300.2	15.0	1187.1
AR036	1598.15	300.2	300.2	15.0	1182.2	AR086	1603.35	300.2	300.2	15.0	1186.1
AR037	1590.44	300.2	300.2	15.0	1176.5	AR087	1605.07	300.2	300.2	15.0	1187.4
AR038	1592.25	300.2	300.2	14.9	1185.8	AR088	1581.45	300.2	300.2	14.8	1185.7
AR039	1590.81	300.4	300.4	14.9	1183.1	AR089	1580.48	300.2	300.2	14.8	1185.0
AR040	1583.73	300.2	300.2	14.9	1179.4	AR090	1582.73	300.2	300.3	14.8	1186.3
AR041	1583.77	300.2	300.1	14.8	1187.8	AR091	1592.74	300.2	300.2	14.9	1186.1
AR042	1584.75	300.2	300.1	14.9	1180.6	AR092	1594.60	300.2	300.2	14.9	1187.5
AR043	1583.13	300.1	300.1	14.8	1187.7	AR093	1591.24	300.3	300.1	14.9	1185.0
AR044	1583.33	300.1	300.0	14.8	1188.3	AR094	1584.26	300.2	300.3	14.8	1187.4
AR045	1584.29	300.1	300.1	14.9	1180.6	AR095	1600.35	300.2	300.2	15.0	1183.9
AR046	1583.78	300.1	300.2	14.8	1187.8	AR096	1599.83	300.2	300.2	14.9	1191.4
AR047	1600.80	300.2	300.1	15.0	1184.6	AR097	1590.69	300.2	300.1	14.9	1185.0
AR048	1593.19	300.2	300.2	14.9	1186.5	AR098	1591.59	300.2	300.2	14.9	1185.3
AR049	1586.80	300.2	300.2	14.9	1181.7	AR099	1590.42	300.1	300.2	14.9	1184.8
AR050	1590.96	300.2	300.2	14.9	1184.8	AR100	1583.87	300.3	300.2	14.8	1187.1
						Density average (kg/m ³)					1185.7
						Density standard deviation (kg/m ³)					3.1
						Coefficient of variance (%)					0.3

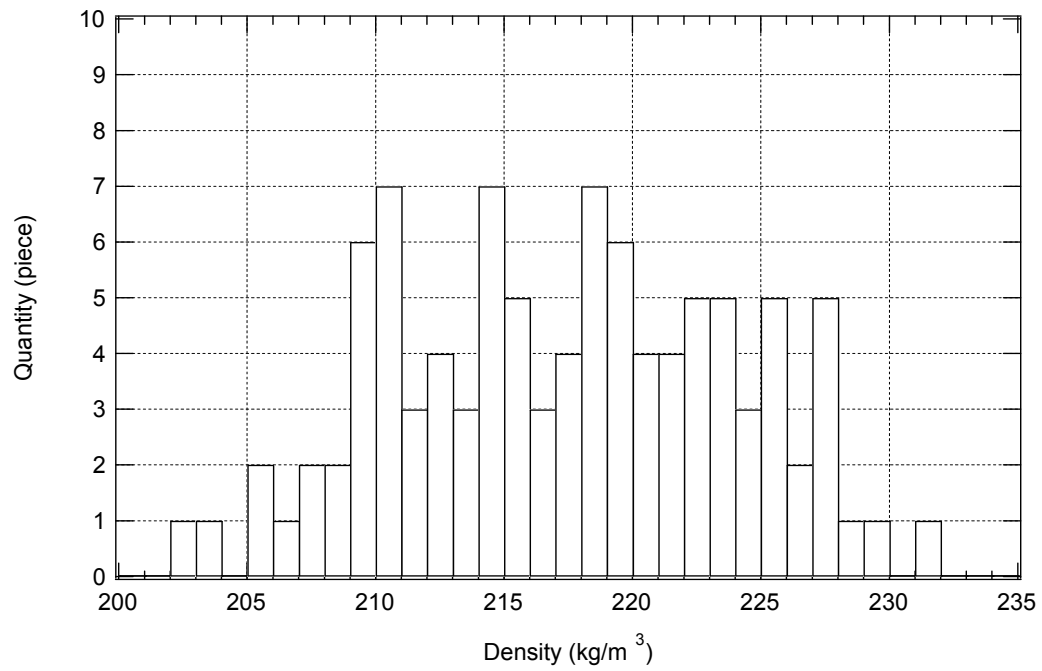


Fig.1 Density distribution (high density glass wool board)

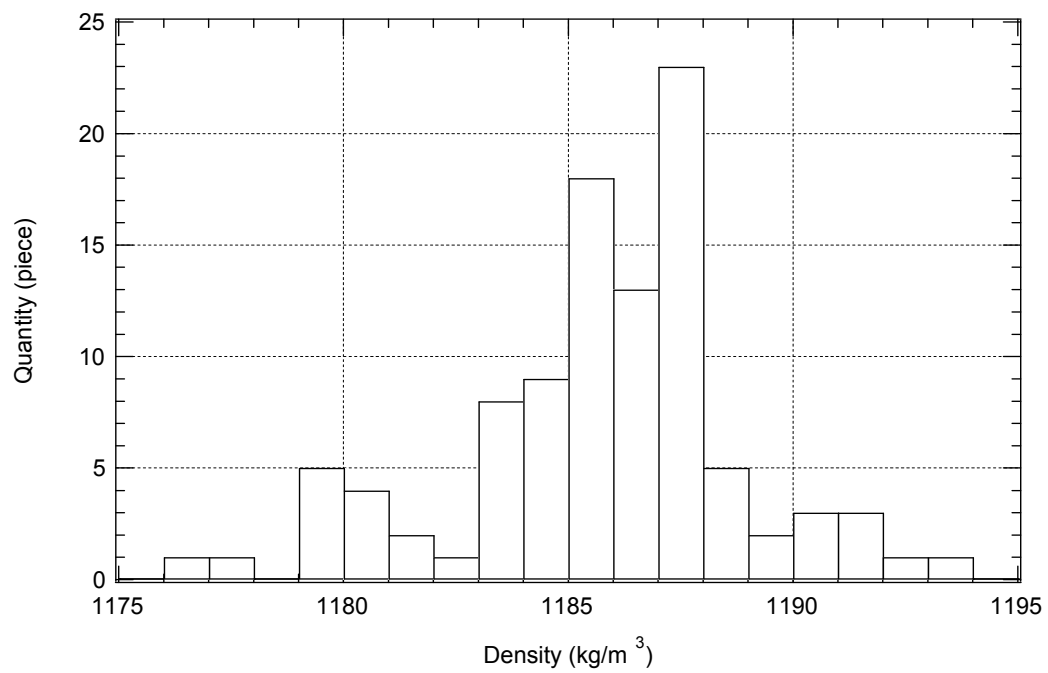


Fig. 2 Density distribution (acrylic resin board)

APLAC T053 Thermal Insulation Proficiency Testing Program

Table 5 Homogeneity test results (thermal conductivity test, high density glass wool board)

No.	Density (kg/m ³)	Mean temperature (°C)	Temperature difference (K)	Heat flow rate (W/m ²)	Thermal conductivity [W/(m·K)]
GW005	212.1	20.4	20.7	28.92	0.0344
GW010	214.8	19.8	20.3	28.65	0.0349
GW022	218.2	19.6	20.0	28.53	0.0344
GW038	224.7	19.5	19.9	29.03	0.0347
GW055	223.2	19.5	19.9	29.58	0.0346
GW063	211.7	19.8	20.6	28.54	0.0343
GW085	225.2	19.9	19.3	28.42	0.0350
Average of thermal conductivity [W/(m·K)]					0.0346
Standard deviation of thermal conductivity [W/(m·K)]					0.0003
Coefficient of variance (%)					0.9

Table 6 Homogeneity test results (thermal conductivity test, acrylic resin board)

No.	Density (kg/m ³)	Mean temperature (°C)	Temperature difference (K)	Heat flow rate (W/m ²)	Thermal conductivity [W/(m·K)]
AR033	1179.6	19.2	13.4	155.68	0.173
AR044	1180.3	19.5	13.5	155.68	0.172
AR058	1179.3	19.2	13.5	155.65	0.172
AR059	1177.9	19.5	13.7	155.67	0.169
AR062	1188.0	20.8	12.5	143.06	0.172
AR064	1179.9	19.6	13.4	155.70	0.173
AR093	1185.0	19.8	13.6	155.70	0.171
Average of thermal conductivity [W/(m·K)]					0.172
Standard deviation of thermal conductivity [W/(m·K)]					0.001
Coefficient of variance (%)					0.6

APLAC T053 Thermal Insulation Proficiency Testing Program

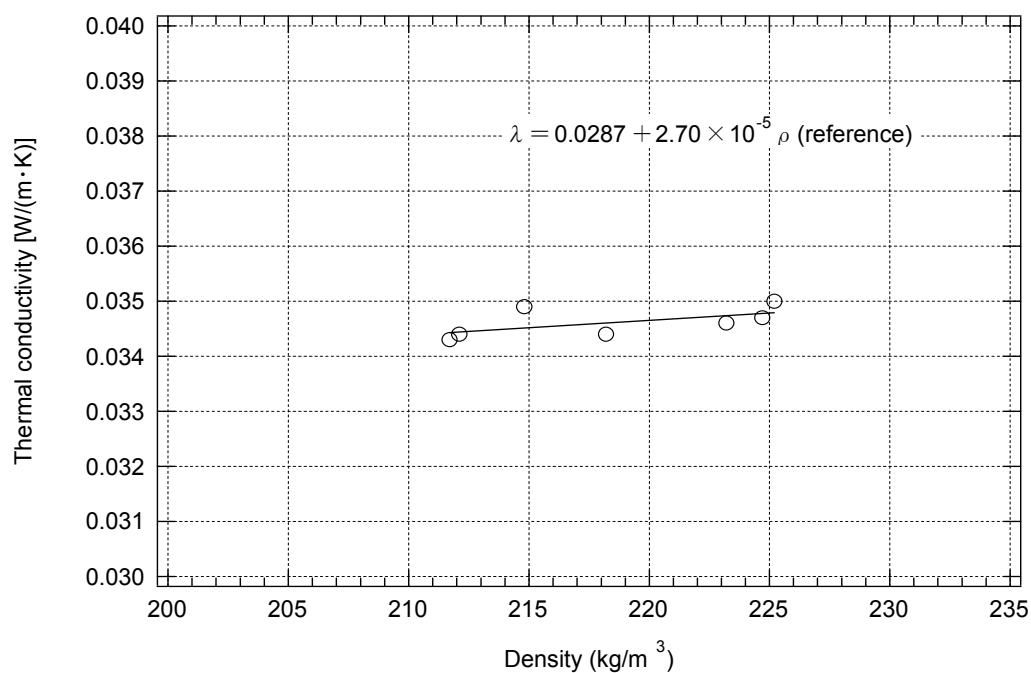


Fig. 3 Relationship between density and thermal conductivity (high density glass wool board)

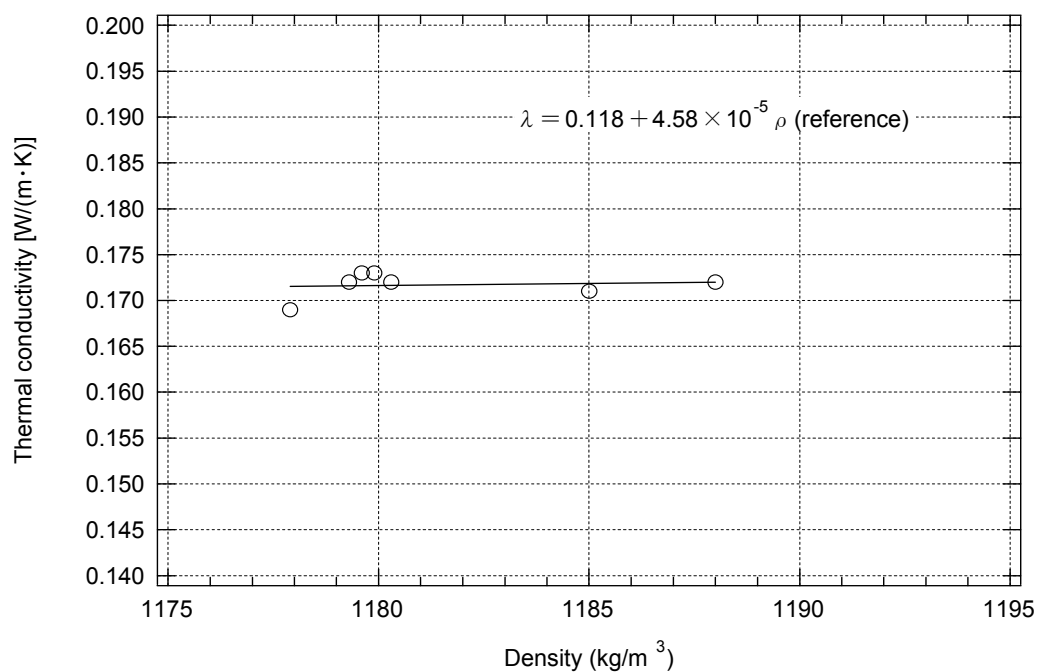


Fig. 4 Relationship between density and thermal conductivity (acrylic resin board)

APLAC T053 Thermal Insulation Proficiency Testing Program

5. Period of Test, Person in Charge and Place

Period: April 3, 2006 to January 30, 2007

Person in charge: Environmental group
Tetsuo Fujimoto, Testing Supervisor
Tetsuo Fujimoto, Testing in charge
Taichi Tasaka, Testing engineer

Place: Central Laboratory
Japan Testing Center for Construction Materials

Appendix C

Instructions to Accreditation Bodies

APLAC T053

AP-T053 THERMAL INSULATION PROFICIENCY TESTING PROGRAM

INSTRUCTIONS TO ACCREDITATION BODIES

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

1. SAMPLES

Each laboratory is supplied a sample package which contains four test pieces and the documents “INSTRUCTIONS TO PARTICIPATING LABORATORIES” and “RESULTS SHEET”. The number labeled on the package is not the confidential lab code but the identification of samples. The code number is identified on the results sheet sent to each participating laboratory. The participating accreditation bodies will also be informed of the code number for their participating laboratories at the time of sample distribution.

On receipt of the sample packages, complete the enclosed ‘RECEIPTFORM’ and send it to IAJapan (see Section 5) by fax or by email.

*) A sample package contains two pairs of samples. A sample pair consists of two test peaces made with high density formed glass wool and for the other sample pair, they are made with acrylic resin.

2. TESTS TO BE PERFORMED

Please refer to your copy of the “INSTRUCTIONS TO PARTICIPANTS” and “RESULTS SHEET” enclosed.

3. SAMPLE DISTRIBUTION

The mailing box are addressed to each participating laboratory and contain the samples, instructions and results sheet (marked with their confidential lab code No.) These are to be sent to the laboratories within one week of receipt date. There is no need to open the packaging.

4. DOCUMENTS TO BE SUBMITTED

a) **No later than 28 April 2006**, participating laboratories are requested to send the following to their accreditation body:

- i) completed results sheet;
- ii) any supporting documentation to assist in the interpretation of the results.

b) **Also no later than 28 April 2006**, participating laboratories are required to send a copy of completed results sheet and any supporting documentation by fax or by email to :

The accreditation body is required to ensure that the above information has been supplied by their laboratories and should provide translations into English where necessary.

5. GENERAL INFORMATION

APLAC T053 Thermal Insulation Proficiency Testing Program

Additional information may be obtained from:

Contact

Yoshinobu Uematsu, Mr
Program coordinator for AP-T053
Technical Manager
International Accreditation Japan (IAJapan)
National Institute of Technology and Evaluation (NITE)
2-49-10, Nishihara, Shibuya-ku
Tokyo 151-0066
JAPAN
Fax: 81 3 3481 1937
Phone: 81 3 3481 1939
E-mail: uematsu-yoshinobu@meti.go.jp

RECEIPT FORM

APLAC T053

THERMAL INSULATION PROFICIENCY TESTING PROGRAM

In order to monitor the progress of this proficiency testing program, we kindly ask you, on receipt of the samples, to fill out this RECEIPT FORM and send it by fax or by email to:

Yoshinobu Uematsu Mr
International Accreditation Japan
C/o National Institute of Technology and Evaluation (NITE)
2-49-10, Nishihara, Shibuya-ku, Tokyo 151-0066
JAPAN
FAX: 81 3 3481 1937
Email: uematsu-yoshinobu@nite.go.jp

Thank you in advance for your cooperation.

The APLAC T053 samples were received on: _____(date)

Comments:

Participating Accreditation Body: _____

Contact Person: _____ Fax: _____

**AP-T053 THERMAL INSULATION
PROFICIENCY TESTING PROGRAM**

INSTRUCTIONS TO PARTICIPATING LABORATORIES

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

1. Each participant is to receive a sample package. This sample package contains two sets of test specimens (flat board). Details of test specimens are:

Set	Number of test specimen	Nominal dimensions (unit: mm)	Material
A	2	300 * 300 * 25	high density formed glass wool
B	2	300 * 300 * 25	acrylic resin

2. The following determinations are to be performed on each sample and the results recorded on the attached *Results Sheet*:

Determination of Specimen Density

- 1) Mass (M)
- 2) Dimensions ($x_1 * x_2$)
- 3) Thickness (L)
- 4) Density of specimen(ρ)

Determination of Thermal Conductivity

- 5) Meter area (A)
 - 6) Thickness (L)
 - 7) Hot plate temperature (Td)
 - 8) Cold plate temperature (Tc)
 - 9) Temperature difference(Td)
 - 10) Heat flow-rate (Φ)
 - 11) Density of heat flow-rate (q)
 - 12) Thermal conductivity (λ)
 - 13) Relative expanded measurement uncertainty for thermal conductivity
 - 14) Mass change of specimen
 - 15) Volume change of specimen
3. All measurements, calculations, recording and reporting is to be performed in accordance with either of ISO 8301 “Thermal insulation – determination of steady-state thermal resistance and related properties – Heat flow meter apparatus” or ISO 8302 “Thermal insulation – determination of steady-state thermal resistance and related properties – Guarded hot plate apparatus” or their equivalent standards.

APLAC T053 Thermal Insulation Proficiency Testing Program

4. Report only one result based on one determination for each test on the results sheet. If the “Single-specimen test apparatus” is used for determining thermal conductivity, a specimen from a sample pair should be selected to test, thus only one result is to be reported in each cell of the tables in the *Result Sheet*. If a participating laboratory reports two or more results for a specimen, neither of them will be subject to data analysis. For each test, the results are to be reported to the accuracy specified in the relevant test standard and in the units indicated on the results sheet. It is recommended to use three decimal significant digits at the maximum for reporting each result.
5. If the “Heat Flow Meter (HFM) Apparatus” is used, neither “Meter area (#6)” nor “Heat flow-rate (#11)” of table 2 & 4 in the Results Sheet need to be filled in.
6. Participating laboratories are also encouraged to estimate the measurement uncertainty for determining thermal conductivity of the test specimen at each specified nominal mean temperature and report them as the relative expanded uncertainties at 95 % level of confidence.
7. For this program, your laboratory has been allocated the code number shown on the results sheet. All reference to your laboratory in reports associated with this program will be with this code number, thus ensuring confidentiality of results. Please note that the number labeled on the packaging is not the confidential lab code but is identification of the test samples for reference only.
8. Testing should commence as soon as possible after receiving the samples and results reported **NO LATER THAN 28 APRIL 2006**. Send the completed results sheet and any supporting documentation to your accreditation body and a copy of the results sheet by fax or by email to:

Yoshinobu Uematsu (Mr.)
Technical Manager
International Accreditation Japan (IAJapan)
C/o National Institute of Technology and Evaluation (NITE)
2-49-10, Nishihara, Shibuya-ku, Tokyo 151-0066, JAPAN
Fax: 81 3 3481 1937 / Phone: 81 3 3481 1939
E-mail: uematsu-yoshinobu@nite.go.jp

RESULTS SHEET

Laboratory Code No.

Sample A (High density glass wool)

Selected test method (check one of standards/apparatus): ☐ ISO 8401/Heat flow meter apparatus ☐ ISO 8402/Guarded hot plate apparatus ☐ National standard (name of the standard: _____)	Type of apparatus (check either of the two below): ☐ Single-specimen apparatus ☐ Two-specimen apparatus
	Test date: _____

Table 1 Determination of specimen density

#	Test item (acronym)		Unit	Nominal mean temperature		
				283.15 K (10 °C)	293.15 K (20 °C)	313.15 K (40 °C)
1	Mass (M)		kg			
2	Dimension ($x_1 * x_2$)	x_1	mm			
3		x_2	mm			
4	Thickness (L)		mm			
5	Density of specimen (ρ)		kg/m ³			

Table 2 Determination of thermal conductivity

#	Test item (acronym)	Unit	Nominal mean temperature		
			283.15 K (10 °C)	293.15 K (20 °C)	313.15 K (40 °C)
6	Meter area (A)	m ²			
7	Thickness (L)	mm			
8	Hot plate temperature (T_h)	K			
9	Cold plate temperature (T_c)	K			
10	Temperature difference (T_m)	K			
11	Heat flow-rate (ϕ)	W			
12	Density of heat flow-rate (α)	W/m ²			
13	Thermal conductivity (λ)	W/(m·K)			
14	Relative expanded uncertainty (U)	%			
15	Mass change of specimen	Kg			
16	Volume change of specimen	m ³			

Sample B (Acrylic resin)

Selected test method (check one of standards/apparatus): ☐ ISO 8401/Heat flow meter apparatus ☐ ISO 8402/Guarded hot plate apparatus ☐ National standard (name of the standard: _____)	Type of apparatus (check either of the two below): ☐ Single-specimen apparatus ☐ Two-specimen apparatus
	Test date: _____

Table 3 Determination of thermal conductivity

#	Test item (acronym)		Unit	Nominal mean temperature		
				283.15 K (10 °C)	293.15 K (20 °C)	313.15 K (40 °C)
1	Mass (M)		kg			
2	Dimension ($x_1 * x_2$)	X_1	mm			
3		X_2	mm			
4	Thickness (L)		mm			
5	Density of specimen (ρ)		kg/m ³			

Table 2 Determination of thermal conductivity - Sample B (Acrylic resin board)

Test item (acronym)		Unit	Nominal mean temperature		
			283.15 K (10 °C)	293.15 K (20 °C)	313.15 K (40 °C)
6	Meter area (A)	m ²			
7	Thickness (L)	mm			
8	Hot plate temperature (T_h)	K			
9	Cold plate temperature (T_c)	K			
10	Temperature difference (T_m)	K			
11	Heat flow-rate (ϕ)	W			
12	Density of heat flow-rate (α)	W/m ²			
13	Thermal conductivity (λ)	W/(m·K)			
14	Relative expanded uncertainty (U)	%			

Name of participating laboratory: _____

Name of laboratory personnel responsible (please print): _____

Signature : _____

Date: _____