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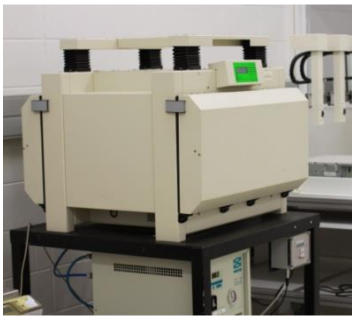

THERMAL INSULATION REPORT

DI0563/DU02

THERMAL RESISTANCE OF REALWOOL INSULATION R3.2

CLIENT
Textile Products 1971 Ltd
22 Miami Parade
Onehunga
Auckland 1061
New Zealand

IANZ ACCREDITED LABORATORY
ACCREDITATION Nº: 37

All tests and procedures reported herein, unless indicated, have been performed in accordance with the laboratory's scope of accreditation.

TEST SUMMARY

Objective

Determine if the thermal performance of a sampled lot of an insulation product is consistent with (equal or greater than) the thermal performance specified on the label.

Test sponsor

Textile Products 1971 Ltd
22 Miami Parade
Onehunga
Auckland 1061
New Zealand

Test results

Table 1 Assessment of product compliance with labelled specifications

Compliance Requirement	Pass/Fail
Packaging & labelling compliance with AS/NZS 4859.1 Section 3*	Pass
Result compared with declared R-value (AS/NZS 4859.1 clause 2.3.3.7 prgph 1)	-
Combined	-

** Note – The pass requirement includes that there is a manufacturer address present but BRANZ has not necessarily checked that it is the address where the product is actually made. The results are only valid for the plant where the test sample was manufactured.*

See also notes at bottom of Table 7 and Table 8 and the results from Table 9 and Table 10.

LIMITATION

The results reported here relate only to the item/s tested.

TERMS AND CONDITIONS

This report is issued in accordance with the Terms and Conditions as detailed and agreed in the BRANZ Service Agreement for this work.

CONTENTS

FIGURE

TABLES

SIGNATORIES

Author

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IANZ Approved Signatory

Reviewer

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Senior Technician Materials
IANZ Approved Signatory

1. DESCRIPTION OF TEST SAMPLES

Material was supplied in packs. See Table 5 for a description of label. For segmented (batting) products at least 15m² is required and for roll product 27m².

Table 2 Weight of test sample packs

Net pack weights (kg) (of the test sample)				
24.6	23.4	23.7	-	-

Five samples were selected from the supplied material, in accordance with ASTM C167-09 and the modifications required by AS/NZS 4859.1-02.

2. DESCRIPTION OF TEST EQUIPMENT

Table 3 Apparatus

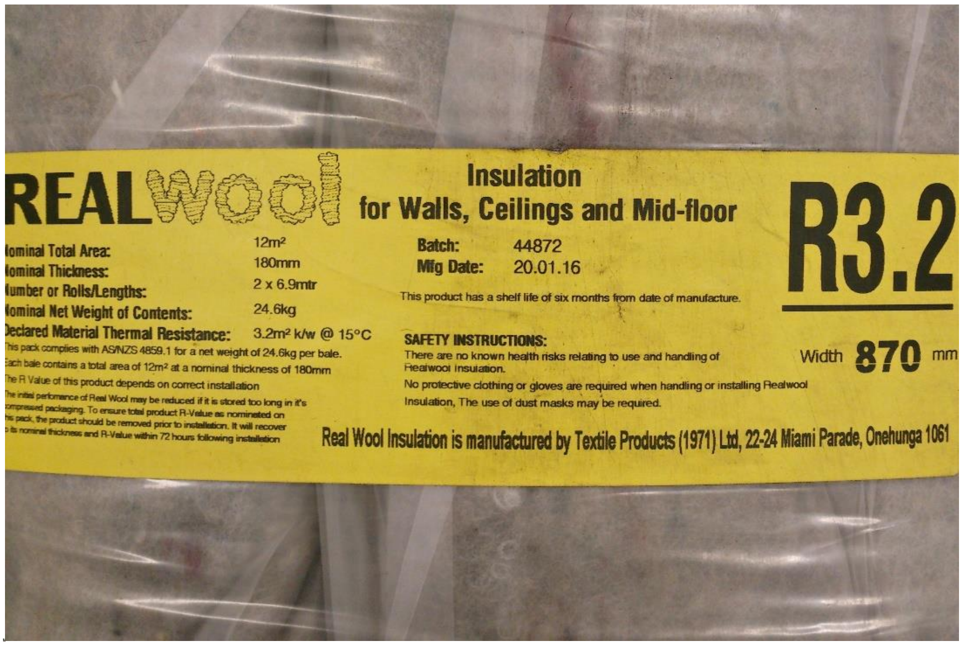
Heat Flow Meter		Maximum sample dimensions	Maximum sample thickness	Number of heat flux transducers
●	LaserComp Fox 600	610 mm x 610 mm	200 mm	2 (one per plate)
	~~LaserComp Fox 801~~	~~760 mm x 760 mm~~	~~300 mm~~	~~2 (one per plate)~~

The specimen for testing is placed horizontally in the apparatus, with upwards heat flow. The edges of the specimen are insulated from the room ambient temperature. The hot and cold plates each have a 250 mm x 250 mm heat flux transducer embedded in their surface. The measured thermal resistance is based on the average heat flux. The uncertainty in individual thermal conductivity and thermal resistance measurements is estimated to be 3% provided the difference in heat flux between the transducers is less than or equal to 5%.

Table 4 Test condition set-points

Parameter	Value
Nominal upper plate temperature	10.0 °C
Nominal lower plate temperature	36.0 °C
Nominal difference in temperature	26.0 K
Nominal mean temperature	23.0 °C

Table 5 Label information (according to AS/NZS 4859.1 Table 3.1 Labelling)



Product name	Realwool Insulation R3.2	
Description of contents	Wool Insulation	
Manufacturer	Textile Products (1971) Ltd	
Traceability information		
Manufacturing address	22 Miami Parade, Onehunga 1061, Auckland	
Date of manufacture	20.01.2016	
Batch number	44872	
Safety instructions		Yes
Statement of compliance with AS/NZS 4859.1 including specifications consistent with this test sample nominal thickness and weight		Yes
Statement of performance dependence on storage time in compression package		Yes
Statement of R-value dependence on installation		Yes
Declaration of temperature conditions		Yes, 15°C
Time to achieve nominal thickness		Yes, 72 hrs
Number of pieces	(not required for rolls)	2
Total area	(m²)	12
Length	(mm or m)	6.9
Width	(mm or m)	870
R-value	(m²K/W)	3.2
Net weight	(kg for pack or g/m²)	24.6
Nominal thickness	(mm)	180

3. PROCEDURE

Five sample segments were selected and prepared, and the thickness measured, to the requirements of ASTM C167 & AS/NZS 4859.1 Appendix D. The variations from the ASTM C167-AS/NZS 4859.1 procedure were as follows:

- Fifteen individual thickness measurements were made for each determination of thickness for a segment instead of the ten described in the standard.
- These measurements were spread in an equally spaced three by five grid instead of the particular arrangement outlined in the standard.

The five sample segments were conditioned for 24 hours prior to the thermal performance measurements. Conditioning was at either 23 ± 3 °C (glasswool or rockwool), or 45 ± 3 °C (polyester or sheep wool).

The three test segments were selected from the five sample segments then cut and made up to the required test specimen size to suit the particular heat flow meter that was used. The weight ('grams per square metre') of the test specimen is assumed to be the same as the complete segment from which it is cut (approximately twice the area of the test specimen).

The specimens were tested to the requirements of ASTM C518-10 using the procedures of ASTM C653-97 including the modifications specified in AS/NZS 4859.1-02 Appendix D. A total of nine measurements of thermal resistance were made for three values of density by testing first at an initial thickness (the lesser of the mean conditioned thickness, and, the nominal thickness plus 10%), then compressing the specimen to a thickness approximately 10% less than the initial test, and finally compressing the specimen to a thickness approximately 20% less than the initial test thickness.

The best uncertainty of measurement (3%) is achieved only when the percentage difference between the heatflux transducer readings is less than 5%. If the difference is greater than 5% then the uncertainty in the measurements of thermal resistance and conductivity will be greater than 3% (see also notes at bottom of Table 7 and Table 8).

4. RESULTS

Table 6 Conditioning of five sample segments

BRANZ reference	D5933			
	Thickness (mm)			'grams per sq. metre' (g/m²)
	average	max	min	
Initial	157	172	135	2296
After conditioning for 24 hours *Polyester or sheep's wool products are conditioned at 45°C. Glasswool or rockwool products are conditioned at 23°C*	184	206	165	2232
Change	+17.1%	+19.8%	+22.7%	-2.8%
Std. dev. of 5 × 15 thickness measurements	9 mm			

Table 7 Measured results for the three test specimens

BRANZ reference		D5933A			D5933B			D5933D		
'grams per sq. metre' (of segment from which test specimen is cut)	g/m²	2176			2119			2368		
Test date		09-Feb	09-Feb	09-Feb	10-Feb	10-Feb	10-Feb	11-Feb	11-Feb	11-Feb
Test thickness	mm	184	167	150	179	163	146	195	178	160
Density at test thickness (of segment from which test specimen is cut)	kg/m³	11.83	13.03	14.51	11.84	13.00	14.51	12.14	13.30	14.80
Temperature difference	K	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
Mean temperature	°C	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
Heat-flux	W/m²	8.06	8.41	8.85	8.22	8.46	8.92	7.67	7.84	8.23
Thermal resistance	m²K/W	3.228	3.091	2.938	3.166	3.074	2.916	3.391	3.316	3.161
Thermal conductivity	mW/mK	57.0	54.0	51.1	56.5	53.0	50.1	57.5	53.7	50.6
Difference between heat flux transducers	%	7.2	7.8	6.3	13.3	10.0	4.7	14.1	11.0	8.6
Difference between transducers less than or equal to 5% for at least 5 of the 9 results								~~Yes~~ No		

The results represent the average of at least 18 minutes of measurements taken after equilibrium of heat flow is achieved. Equilibrium conditions are maintained for at least 12 minutes before the averaging of results is started. Actual times are available on request.
If the difference between transducers is not less than or equal to 5% for at least 5 of the 9 results then the overall measurement uncertainty will be greater than 3%.

Calibration check date 08-Feb-16 Calibration sample SR 17

The analysis of the results was in accordance with the guidelines in ASTM C653-97. The relationship between thermal conductivity and density for an insulation material can be represented by an equation of the form:

Thermal conductivity (W/mK) $\boldsymbol{\lambda} = \boldsymbol{a} + \boldsymbol{b}.\boldsymbol{\rho} + \frac{\boldsymbol{c}}{\boldsymbol{\rho}}$ where $\boldsymbol{\rho}$ is density (kg/m^3)

Over the range of densities created with the test specimens, the coefficients have been determined by regression fit through the results and are listed in Table 8. The best fit equation for the results is plotted in Figure 1.

Table 8 Regression fit for measurements at 23°C mean temperature

Thermal Conductivity		$\lambda = a + b.\rho + \frac{c}{\rho}$		
	a	b	c	
Specimen 1	0.0154	0.00037	0.441	
Specimen 2	-0.0555	0.00293	0.915	
Specimen 3	-0.0736	0.00344	1.085	
Combined results	-0.0379	0.00225	0.813	
Standard error in combined results				1.5%
Uncertainty in individual thermal conductivity measurements				unknown
Overall uncertainty in use of above equation to determine conductivity				unknown

The uncertainty in individual thermal conductivity and thermal resistance measurements is estimated to be 3% provided the difference in heat flux between the transducers is less than or equal to 5%. If the difference between transducers is not less than or equal to 5% for at least 5 of the 9 results then the overall measurement uncertainty will be higher.

Table 9 presents an analysis of results as measured at a mean temperature of 23 °C. The analysis is based on the lesser of conditioned and nominal thickness.

Table 10 presents the results when adjusted to nominal weight (‘grams per square metre’) and the specification temperature (if not 23 °C).

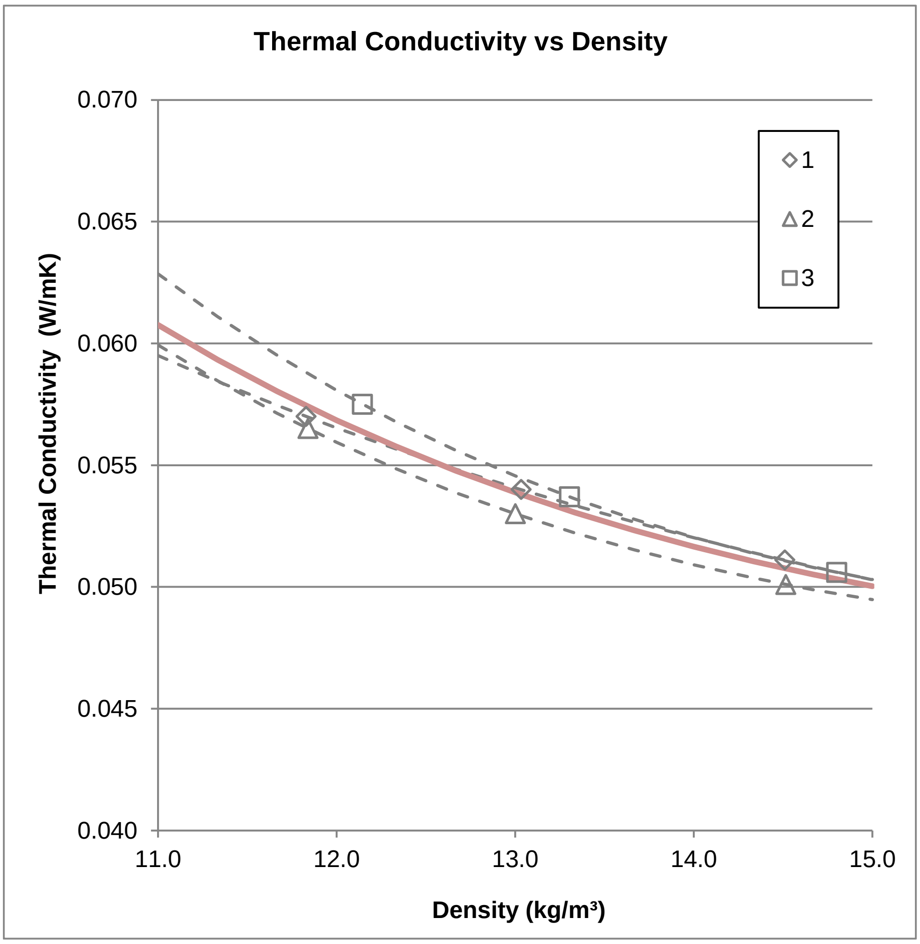


Figure 1 Thermal conductivity measurements at 23°C mean temperature

Table 9 Analysis of results

Parameter	Value
Nominal thickness	180 mm
Mean thickness of the five sample segments after conditioning	184 ± 2 mm
Nominal 'grams per square metre' of product	2049 g/m²
Mean 'grams per square metre' of the five sample segments (before cutting & making up to test specimen size)	2232 ± 20 g/m²
Mean density of the five (un-cut) sample segments	12.4 ± 0.3 kg/m³
Mean test temperature	23.0 ± 0.1 °C
Estimated thermal conductivity of sample pack(s)	0.0556 W/mK
Estimated thermal resistance of sample pack(s)	3.24 m²K/W
Density, estimated thermal conductivity, and estimated thermal resistance are at:	~~Conditioned thickness~~ Nominal thickness

See BRANZ info sheet 'Glossary of terms used in Thermal Insulation Reports'

Table 10 Results adjusted to nominal weight and specification temperature

Parameter	Value
Estimated thermal conductivity of sample pack(s)	0.0538 W/mK
Estimated thermal resistance of sample pack(s)	3.34 m^2K/W
Density at nominal weight	11.4 kg/m^3
Estimated thermal conductivity at nominal weight	0.0572 W/mK
Nominal R-value of product	3.2 m^2K/W
Estimated thermal resistance at nominal weight	3.2 m^2K/W
Estimated thermal conductivity, estimated thermal resistance, and nominal R-value are at:	~~23 °C~~ 15 °C
Density, estimated thermal conductivity and estimated thermal resistance are at:	~~Conditioned thickness~~ Nominal thickness

See BRANZ info sheet 'Glossary of terms used in Thermal Insulation Reports'

See AS/NZS 4859.1 Section 2.3.3.3 Figure 2.1 Effect of mean temperature on R-value. Assuming thermal conductivity sensitivity of 0.5 %/K for fibrous glasswool or mineral fibre and 0.4%/K for fibrous polyester or sheepwool.

$$thermal\ conductivity\ @\ 15°C\ = \frac{thermal\ conductivity\ @\ 23°C}{f_t}$$

$$thermal\ resistance\ @\ 15°C = f_t\ \times\ (thermal\ resistance\ @\ 23°C)$$

where:

$$temperature\ correction\ factor\ f_t = \frac{100 + 8°C\ \times\ \text{conductivity sensitivity}}{100} = 1.040\ for\ glasswool\ or\ mineral\ fibre$$

$$= 1.032\ for\ polyester\ or\ sheepwool$$

The test method was in accordance with ASTM C653 and AS/NZS 4859.1:02 Appendix D, including the alternative thickness probe diameter of 25 mm and pressure of 25 Pa allowed for in Amendment 1 (2006) of AS/NZS 4859.1

These measurements comply with the requirements of ASTM C518. The uncertainty in the measurements of thermal conductivity and thermal resistance are estimated to be ± 3%.

5. REFERENCES

AS/NZS 4859.1:02	*Materials for the thermal insulation of buildings; Part 1: General criteria and technical provisions*. Standards Australia, Sydney, Standards New Zealand, Wellington, 2002.
Amendment 1 to AS/NZS 4859.1:02	Standards Australia, Sydney, Standards New Zealand, Wellington, 2006.
ASTM C167-09	*Standard Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations*. American Society for Testing and Materials, Philadelphia, PA, 2009.
ASTM C653-97 (2012)	*Standard Guide for Determination of the Thermal Resistance of Low-Density Blanket-Type Mineral Fiber Insulation*. American Society for Testing and Materials, Philadelphia, PA, 2012.
ASTM C518-10	*Standard Test Method for Steady-State Heat Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*. American Society for Testing and Materials, Philadelphia, PA, 2010.
BRANZ Info. sheet	*Glossary of terms used in Thermal Insulation Reports*. BRANZ, 2014.