NEMO|etc.
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ENGINEER TEST CONSULT

Laboratory Report 4r-CGT-20-SSTHP-01.C

Physical Properties Testing

of

Econodek - Premium Series

produced in

Cambridge, ON

in accordance with

CGSB 37.54-95

Prepared for: **Tuff Industries, Inc.**
9570 Bottom Wood Lake Road
Lake Country, BC V4V 1S7, Canada
c/o: Bryan Hughes

Test Lab: **NEMO|etc.**
10 Mauney Court
Columbia, SC 29201

Date of Issuance: **2024-04-05**

NEMO|etc.®

LABORATORY REPORT

CUSTOMER OBJECTIVE

Establish physical property data in accordance with codified material standards.

TESTING SCOPE

Physical properties testing in accordance with CGSB 37.54-95.

SAMPLES

PRODUCT	BY	Manufacturing Location
Econodek - Premium Series	Tuff Industries	Cambridge, ON

TEST PROGRAM

PROJECT

NUMBER:	4r-CGT-20-SSTHP-01
CUSTOMER PO:	4500049149
MD NOTIFICATION:	N/A

TEST MATERIAL ROUTING

VIA:	Per Customer
BY:	Contact Customer

DURATION

AUTHORIZED:	2020-04-29
SAMPLING:	N/A
MATERIALS ON HAND:	N/A
MATERIALS RECEIVED:	2020-06-05
TEST START:	2020-07-01
TEST END:	2021-03-12

PERSONNEL

NEMO:	D. Rhodes

APPENDICES

RESULTS[1]:	Econodek - Premium Series							Cambridge, ON		CGSB 37.54-95 TYPE 4, CLASS B
PROPERTY			TEST DATA					RESULTS		CRITERIA
			1	2	3	4	5	AVG.	SD	
Thickness	mm		1.4	1.4	1.4	1.4	1.5	**1.4**	0.0	≥ 1.2
Coating thickness	mm		0.4	0.4	0.4	0.4	0.4	**0.4**	0.0	≥ 0.4
Breaking strength	kN/m	MD	58	57	57	57	57	**57**	1	≥ 35
		XMD	49	46	47	48	49	**48**	1	
Elongation at break	%	MD	29	28	28	28	29	**29**	0	≥ 15
		XMD	24	22	23	26	25	**24**	2	
Lap joint strength	kN/m	control	53	52	49	50	50	**51**	2	≥ 36 (75% of breaking strength control)
		post-BWI	40	38	35	40	36	**38**	2	≥ 33 (70% of breaking strength control)
Low temperature impact	-30°C		Pass	Pass	Pass	Pass	Pass	**Pass**	N/A	Pass 8 of 10
			Pass	Pass	Pass	Pass	Pass			
Low temperature flexibility	-40°C		Pass	Pass	Pass	–	–	**Pass**	N/A	No fractures or cracks
Water vapor transmission	g/m^2*24 hrs		1.1	1.1	1.1	–	–	**1.1**	0.0	≤ 4.0
Dimensional change without loading	%	MD	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	≤ 0.5
		XMD	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	
Dimensional change with loading	%	MD	0.2	–	–	–	–	**0.2**	N/A	≤ 0.5
		XMD	0.2	–	–	–	–	**0.2**	N/A	≤ 0.2
Cone penetration	N		460	459	461	460	460	**460**	1	≥ 30
POST-WATER ABSORPTION:										
Mass increase	%		1.4	1.7	1.2	–	–	**1.4**	0.3	≤ 3.0
Breaking strength	kN/m	MD	52	55	54	55	53	**54**	1	≥ 51 (90% of control)
		XMD	42	42	45	44	42	**43**	1	≥ 43 (90% of control)
Elongation at break	%	MD	28	29	29	29	29	**29**	0	≥ 26 (90% of control)
		XMD	28	27	28	26	26	**27**	1	≥ 22 (90% of control)
POST-HEAT AGING:										
Visual			Pass	Pass	Pass	Pass	Pass	**Pass**	N/A	No delamination
Breaking strength	kN/m	MD	60	60	59	59	56	**59**	2	≥ 51 (90% of control)
		XMD	45	44	45	46	45	**45**	1	≥ 43 (90% of control)
Elongation at break	%	MD	27	27	27	27	28	**27**	0	≥ 26 (90% of control)
		XMD	25	26	25	26	24	**25**	1	≥ 22 (90% of control)
Low temperature flexibility	-40°C		Pass	Pass	Pass	–	–	**Pass**	N/A	No fractures or cracks

[1] All properties except overall thickness reflect performance of nominal 50-mil material, which has been found through criticality testing and analysis to be extendable to the nominal 60-mil material.

RESULTS[2]:	Econodek - Premium Series						Cambridge, ON		CGSB 37.54-95 TYPE 4, CLASS B
PROPERTY		TEST DATA					RESULTS		CRITERIA
		1	2	3	4	5	AVG.	SD	
POST-ACCELERATED WEATHERING 1 (XENON ARC LIGHT EXPOSURE 5,000 HOURS):									
Visual		Pass	Pass	Pass	Pass	Pass	**Pass**	N/A	No cracks, blisters, or color change
Breaking strength kN/m	XMD	46	46	45	46	45	**45**	1	N/A
Elongation at break %	XMD	21	21	21	21	25	**22**	2	≥ 22 (90% of control)
Low temperature impact	-20°C	Pass	Pass	Pass	Pass	Pass	**Pass**	N/A	Pass 8 of 10
		Pass	Pass	Pass	Pass	Pass			
Low temperature flexibility	-40°C	Pass	Pass	Pass	–	–	**Pass**	N/A	No fractures or cracks
POST-ACCELERATED WEATHERING 2 (UV EXPOSURE 5,000 HOURS):									
Visual		Pass	Pass	Pass	Pass	Pass	**Pass**	N/A	No cracks, blisters, or color change
Breaking strength kN/m	XMD	46	48	49	49	48	**48**	1	N/A
Elongation at break %	XMD	22	24	21	21	21	**22**	1	≥ 22 (90% of control)
Low temperature impact	-20°C	Pass	Pass	Pass	Pass	Pass	**Pass**	N/A	Pass 8 of 10
		Pass	Pass	Pass	Pass	Pass			
Low temperature flexibility	-40°C	Pass	Pass	Pass	–	–	**Pass**	N/A	No fractures or cracks

COMPLIANCE STATEMENT

Econodek - Premium Series, as produced in Cambridge, ON, Canada has demonstrated compliance with requirements of CGSB 37.54-95, Type 4, Class B.

Signed: _____ **Signed:** _____

David Carey
Small Scale Section Lead

Robert Nieminen, P.E.
President

REPORT HISTORY:

DATE	EVENT	NOTES	AUTHORIZATION
2024-04-05	FINAL	New report per directive of program sponsor, supported by SPE	RN

-END OF REPORT-

[2] All properties except overall thickness reflect performance of nominal 50-mil material, which has been found through criticality testing and analysis to be extendable to the nominal 60-mil material.

APPENDIX 1: STATEMENT OF LIMITATION

The results presented are applicable solely to the products tested herein.

APPENDIX 2: DECISION RULE 1

All results reported to the customer reflect observed values without incorporating measurement uncertainty. Determination of conformity to specifications will depend on acceptance limits, where results will be declared to pass if within the limits, and fail if outside the limits.

APPENDIX 3: MANUFACTURING TRACEABILITY & TEST MATERIAL ROUTING

Manufacturing traceability for component tests is confirmed by counter-signed contractual agreement or by signed statement from customer, retained in the custody of NEMO|etc.

Test materials routing is included if randomly sampled, or if the sample bears NEMO|cert. certification mark. Random sampling is acceptable if conducted by an ISO/IEC 10720 or ISO/IEC 10725 accredited entity, which includes sampling on its Scope of Accreditation, and is independent of the manufacturer and the customer. If conducted by NEMO|etc., third-party random sampling is conducted in accordance with the sampling plan detailed in SOP-0005, and as stated in ICC-ES AC85.

APPENDIX 4: TESTS, STANDARDS, EQUIPMENT & OUTSOURCED LOG

CGSB 37.54-95				TEST EQUIPMENT		CALIBRATION	
PROPERTY		SECTION	BASE METHOD	DESCRIPTION	ASSET #	PRE-TEST	NEXT
Thickness		7.3.1, 7.3.2	D751	E.J. Cady micrometer	0637	2020-04-28	2021-04-28
Coating thickness		7.3.2		Meiji microscope	0232	–	–
Load/Strain properties		7.3.4	D751	Instron 5969	0595	2020-04-01	2021-04-30
Lap joint strength		7.3.5	D751	Instron 4465	0235	2020-04-01	2021-04-30
Boiling water immersion (BWI)	7 days, 100°C	7.3.5		–	–	–	–
Lap joint strength	post-BWI	7.3.5	D751	Instron 4465	0235	2020-04-01	2021-04-30
Low temperature impact	-30°C	7.3.6	D1790	SPI impact tester	0625	–	–
				Veritas balance	0526	2020-03-17	2021-03-17
Low temperature flexibility	-40°C	7.3.8	D2136	So Low freezer	0604	2020-03-17	2021-03-17
				NEMO 1-in. mandrel	0626	–	–
Water vapor transmission		7.3.10	E96	Ohaus balance	0234	2020-03-17	2021-03-17
Water Absorption (WA)	7 days, 70°C	7.3.11	D570	Boekel water bath	0522	2020-03-17	2021-03-17
Mass increase	post-WA	7.3.11		Ohaus balance	0234	2020-03-17	2021-03-17
Load/Strain properties	post-WA	7.3.4	D751	Instron 5969	0595	2020-04-01	2021-04-30
Dimensional change without loading		7.3.12		Fischer Scientific oven	0212	2020-03-17	2021-03-17
				Caliper	0511	2020-03-17	2021-03-17
Dimensional change with loading		7.3.13		Fischer Scientific oven	0212	2020-03-17	2021-03-17
				Caliper	0511	2020-03-17	2021-03-17
Cone penetration		7.3.14		Instron 5969	0595	2020-04-01	2021-04-30
Heat Aging (HA)	60 days, 80°C	7.3.7		Fischer Scientific oven	0212	2020-03-17	2021-03-17
Load/Strain properties	post-HA	7.3.4	D751	Instron 5969	0595	2020-04-01	2021-4-30
Low temperature flexibility -40°C	post-HA	7.3.8	D2136	So Low freezer	0604	2020-03-17	2021-03-17
				NEMO 1-in. mandrel	0626	–	–
Accelerated Weathering 1 (AW1)	5000 hrs	7.3.7	D2565	Xenon Arc Lamp	0599	2019-02-02	2023-02-02
Load/Strain properties	post-AW1	7.3.4	D751	Instron 5969	0595	2020-04-01	2021-04-30
Low temperature impact -20°C	post-AW1	7.3.6	D1790	SPI impact tester	0625	Verified	Verified
				Veritas balance	0526	2020-03-17	2021-03-17
Low temperature flexibility -40°C	post-AW1	7.3.8	D2136	So Low freezer	0604	2020-03-17	2021-03-17
				Nemo 1-in. mandrel	0626	Verified	Verified
Accelerated Weathering 2 (AW2)	5000 hrs	7.3.7	G53, G154	QUV-SE	0596	–	–
Load/Strain properties	post-AW2	7.3.4	D751	Instron 5969	0595	2020-04-01	2021-04-30
Low temperature impact -20°C	post-AW2	7.3.6	D1790	SPI impact tester	0625	Verified	Verified
				Veritas balance	0526	2020-03-17	2021-03-17
Low temperature flexibility -40°C	post-AW2	7.3.8	D2136	So Low freezer	0604	2020-03-17	2021-03-17
				NEMO 1-in. mandrel	0626	Verified	Verified