

APPENDIX 1 :

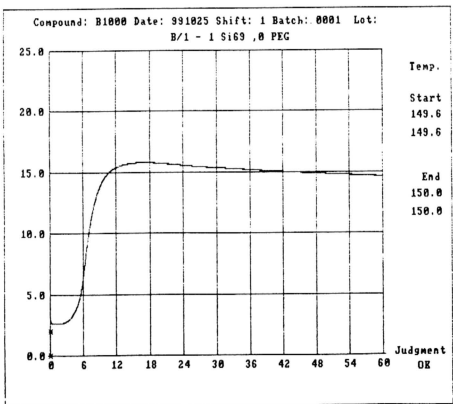
Sample of a Rheometer Chart

SIME DARBY TYRE TECHNOLOGY CENTRE

COMPOUND:	B1000	SHIFT:	1	DATE:	10/25/
DESCRIPTION:	B/1 - 1 S169 ,0 PEG	RANGE:	25	TEMPERATURE:	1
TEST TIME:	60:00				

Rheometer Gates														
	ML	MH	TS2	TC10	TC20	TC30	TC40	TC50	TC60	TC70	TC80	TC90	TC95	oper
Lo	0.00	0.00	0:00	0.00	0.00	0.00	0.00	0:00	0.00	0.00	0.00	0.00	0.00	
Hi	0.00	0.00	0:00	0.00	0.00	0.00	0.00	0:00	0.00	0.00	0.00	0.00	0.00	

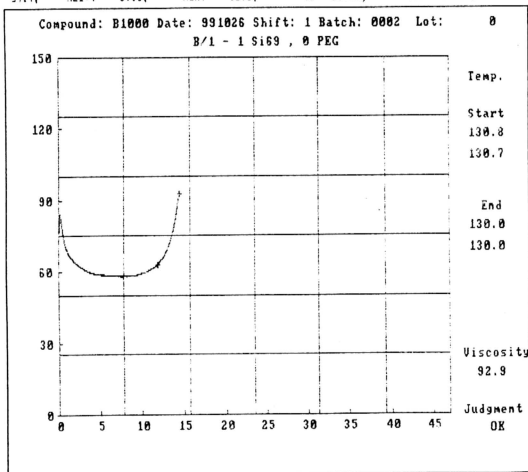
Batch	ML	MH	TS2	TC10	TC20	TC30	TC40	TC50	TC60	TC70	TC80	TC90	TC95	oper
0001	2.58	15.81	5:20	4.85	5.65	6.12	6.47	6:50	7.27	7.82	8.57	9.87	11.15	NH



APPENDIX 2 :

Sample of a Mooney Scorch Chart

Temp. = 130; MW # = A; Mill = B; Lot = 0; Oper = NM ;
IV = 84.4; MLI+4 = 59.5; MinV = 58.1; t5 = 11:50; t35 = 14:25; Cure = 2:05;



APPENDIX 3 :**Test Data Showing Equilibrium Swelling Attained After 24 Hours**

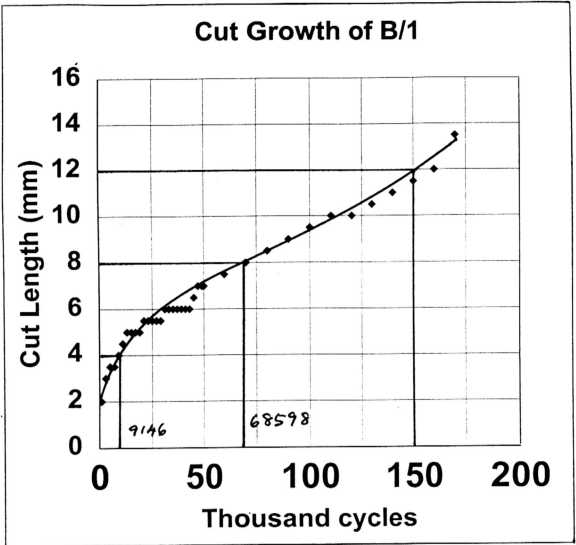
Compound	Test Piece	W_o	W_t (24 hours)	W_t (25 hours)
B/1	1	0.5883	1.1127	1.1128
	2	0.5697	1.0731	1.0734
B/2	1	0.5000	0.9500	0.9501
	2	0.5216	0.9903	0.9902
B/3	1	0.5726	1.0900	1.0901
	2	0.5465	1.0405	1.0407
B/4	1	0.5233	0.9929	0.9926
	2	0.5023	0.9535	0.9539
B/5	1	0.5293	1.0007	1.0004
	2	0.5098	0.9618	0.9619

Note : Only data for B compounds are shown here.

APPENDIX 4 :**Sample Calculation for Cut Growth Resistance****Test Data for Compound B/1**

No.	Cycles	Test Piece 1	Test Piece 2	Test Piece 3	Median
		Cut Length (mm)			
1	0	2	2	2	2
2	1,000	2	2	2	2
3	3,000	3	3	3	3
4	5,000	3.5	3.5	3	3.5
5	7,000	3.5	3.5	3	3.5
6	9,000	4	4	3.5	4
7	11,000	5	4.5	4	4.5
8	13,000	5	5	4	5
9	15,000	5	5	4	5
10	17,000	5	5	4.5	5
11	19,000	5	5	4.5	5
12	21,000	5.5	5.5	4.5	5.5
13	23,000	5.5	5.5	4.5	5.5
14	25,000	5.5	6	5	5.5
15	27,000	5.5	6	5	5.5
16	29,000	5.5	6	5	5.5
17	31,000	6	6	5	6
18	33,000	6	6	5	6
19	35,000	6	6	5	6
20	37,000	6	6	5	6
21	39,000	6	6	5	6
22	41,000	6	6	5	6
23	43,000	6.5	6	5.5	6
24	45,000	6.5	6.5	5.5	6.5
25	47,000	7	7	5.5	7
26	49,000	7	7	5.5	7
27	50,000	7	7	5.5	7
28	60,000	7.5	7.5	6	7.5
29	70,000	8	8	7	8
30	80,000	9	8.5	7.5	8.5
31	90,000	9.5	9	8.5	9
32	100,000	9.5	9.5	9	9.5
33	110,000	10	10	9.5	10
34	120,000	10	10	10	10
35	130,000	10.5	10.5	10.5	10.5
36	140,000	11	11	11	11
37	150,000	12	11.5	11.5	11.5
38	160,000	13	11.5	12	12
39	170,000	14	13.5	13	13.5
40	180,000				

Graph of Cut Length versus Flexing Cycles



Calculations :

Initial cut length, $L = 2$ mm

No of cycles for the cut to extend from L to $(L+2)$ mm = 9,146 cycles

No of cycles for the cut to extend from $(L+2)$ to $(L+6)$ mm = $68,598 - 9,146$
 = 59,452 cycles

No of cycles for the cut to extend from $(L+6)$ to $(L+10)$ mm = $150,000 - 68,598$
 = 81,402 cycles

APPENDIX 5 :

Summary of Compound Properties for 1 pphr Si-69 at Different Levels of PEG

		Control	0PEG B/1	0.5PEG B/2	1.5PEG B/3	3PEG B/4	5PEG B/5
1	Vulcanization Properties at 150°C						
	ML, inlb	3.09	2.58	2.50	2.61	2.47	2.54
	MH, inlb	19.17	15.81	15.46	15.43	14.81	14.79
	t ₅₂ , mins	3.50	5.33	3.80	3.48	3.10	3.28
	t ₅₀ , mins	3.25	6.83	5.08	4.65	4.25	4.45
	t ₉₀ , mins	7.37	9.87	7.58	7.02	6.63	6.90
	t ₉₅ , mins	8.48	11.15	8.63	8.02	7.72	7.95
2	Mooney Scorch and Viscosity						
	t ₅ mins, 130°C	8.00	11.83	7.13	7.12	6.05	6.32
	t ₃₅ mins, 130°C	10.35	14.42	9.57	9.60	8.23	8.72
	ML (1+4), 130°C	63.5	59.5	62.9	60.3	61.1	60.8
3	Specific Gravity	1.11	1.12	1.11	1.12	1.12	1.12
4	State of Cure						
	Crosslink density, g/mol RH (x 10 ⁻⁴)	2.130	2.549	2.530	2.480	2.450	2.490
	Δ(Torque), MH-ML, in lb	16.08	13.23	12.96	12.82	12.34	12.25
5	Tensile Stress-strain Properties						
	<u>Unaged</u>						
	Tensile Strength, MPa	30.7	29.0	29.3	29.3	27.2	27.4
	Elongation at Break, %	540	540	520	560	540	540
	Modulus 300%, MPa	14.9	13.9	14.9	13.3	12.6	12.9
	<u>Aged (70°C / 3 days)</u>						
	Tensile Strength, MPa	30.1	28.7	28.8	29.1	29.0	27.3
Elongation at Break, %	490	470	500	510	530	510	
Modulus 300%, MPa	17.3	17.9	15.7	15.7	14.7	14.7	

		Control	0PEG B/1	0.5PEG B/2	1.5PEG B/3	3PEG B/4	5PEG B/5
6	Hardness Hardness, IRHD	70	65	65	64	65	63
7	Resilience Resilience, %	59	66	66	65	66	65
8	Tear Strength Along grain, N/mm Across grain, N/mm	24 33	29 38	31 42	37 32	43 32	44 37
9	Heat Build-up ΔT , °C Set, %	18 3.0	16 2.0	15 2.0	15 2.0	15 2.6	13 2.5
10	Dynamic Mechanical Properties $\tan \delta$ at 60°C (rolling resistance) $E' \times 10^7$, dyn/cm ²	0.11 -	0.07 11.3	0.07 10.5	0.07 9.67	0.07 9.34	0.06 9.73
11	De Mattia Crack Growth Number of kc for the cut to extend from: L to (L+2) mm, kc (L+2) to (L+6) mm, kc (L+6) to (L+10) mm, kc	4.8 19.5 55.7	9.1 59.5 81.4	2.4 17.0 57.6	6.5 46.6 65.9	3.6 21.2 72.1	4.8 29.1 68.5
12	Abrasion Resistance ARI, %	92	104	115	98	122	134

APPENDIX 6 :

Summary of Compound Properties for 0 pphr Si-69 at Different Levels of PEG

		0PEG C/1	0.5PEG C/2	1.5PEG C/3	3PEG C/4	5PEG C/5
1	Vulcanization Properties					
	<u>at 150°C</u>					
	ML, inlb	2.44	2.52	2.58	2.48	2.42
	MH, inlb	15.04	15.37	15.36	14.72	14.35
	t ₅₂ , mins	4.20	3.50	3.25	3.08	2.92
	t ₅₀ , mins	5.37	4.62	4.38	4.20	4.02
	t ₉₀ , mins	7.62	6.78	6.52	6.27	6.08
t ₉₅ , mins	8.40	7.57	7.27	7.00	6.80	
2	Mooney Scorch and Viscosity					
	t ₅ mins, 130°C	13.02	9.05	7.12	6.68	6.72
	t ₃₅ mins, 130°C	16.20	12.08	9.97	9.42	9.33
	ML (1+4), 130°C	64.5	65.7	66.7	67.1	64.6
3	Specific Gravity	1.12	1.12	1.12	1.12	1.12
4	State of Cure					
	Crosslink density, g/mol RH (x 10 ⁻⁴)	2.32	2.29	2.38	2.22	2.31
	Δ(Torque), MH-ML, in lb	12.6	12.85	12.78	12.24	11.93
5	Tensile Stress-strain Properties					
	<u>Unaged</u>					
	Tensile Strength, MPa	29.2	30.3	27.5	29.0	28.3
	Elongation at Break, %	550	560	540	560	570
	Modulus 300%, MPa	13.5	13.3	12.7	12.7	11.8
	<u>Aged (70°C / 3 days)</u>					
	Tensile Strength, MPa	28.1	29.0	27.5	28.5	27.8
Elongation at Break, %	530	530	530	520	540	
Modulus 300%, MPa	14.6	14.4	14.5	14.0	12.9	

		OPEG C/1	0.5PEG C/2	1.5PEG C/3	3PEG C/4	5PEG C/5
6	Hardness Hardness, IRHD	64	63	64	62	62
7	Resilience Resilience, %	62	63	65	66	65
8	Tear Strength Along grain, N/mm Across grain, N/mm	35 37	30 37	39 37	35 38	40 37
9	Heat Build-up ΔT , °C Set, %	16 4.0	16 4.0	15 3.5	15 3.5	15 4.5
10	Dynamic Mechanical Properties tan δ at 60°C (rolling resistance) $E' \times 10^7$, dyn/cm ²	0.08 0.91	0.08 0.98	0.08 0.93	0.08 0.98	0.07 0.88
11	De Mattia Crack Growth Number of kc for the cut to extend from: L to (L+2) mm, kc (L+2) to (L+6) mm, kc (L+6) to (L+10) mm, kc	3.3 4.8 6.2	4.2 7.5 7.5	5.1 6.9 5.2	3.3 8.1 17.7	2.6 5.1 5.0
12	Abrasion Resistance ARI, %	90	88	96	89	109

APPENDIX 7 :**Regression Analyses of Properties for 0 and 1 pphr Si-69 Compounds**

	pphr Si-69	r ²	Intercept	Correlation coefficient
Cure time, t ₉₅	1	0.448	9.626	-0.466
	0	0.746	7.940	-0.266
Scorch time, t ₅	1	0.452	9.254	-0.782
	0	0.555	10.498	-0.990
Cure rate	1	0.327	2.503	-0.042
	0	0.912	3.095	-0.107
Crosslink density	1	0.426	2.530	-0.012
	0	0.051	2.310	-0.006
Δ(Torque)	1	0.907	13.110	-0.195
	0	0.810	12.824	-0.172
Mooney viscosity	1	0.000	60.920	0.000
	0	0.000	65.720	0.000
Tensile strength	1	0.712	29.313	-0.712
	0	0.190	29.308	-0.190
Modulus at 300%	1	0.551	14.187	-0.333
	0	0.931	13.430	-0.315
Hardness	1	0.573	65.067	-0.333
	0	0.640	63.788	-0.394
Resilience	1	0.316	65.903	-0.152
	0	0.561	62.988	0.606
Tear strength	1	0.887	30.497	3.152
	0	0.406	33.315	1.242
Heat build-up	1	0.808	15.770	-0.485
	0	0.619	15.824	-0.212
Tan δ at 60°C	1	0.682	0.072	0.082
	0	0.682	-0.002	-0.002
Storage modulus, E'	1	0.526	10.700	-0.282
	0	0.143	0.952	-0.008
Abrasion resistance	1	0.661	103.146	5.727
	0	0.623	87.612	3.394

APPENDIX 8 :**Error Analyses of Typical Test Data**

Properties	Test Piece	Test Data	Average, \bar{x}	Standard deviation, σ
Tensile strength, MPa	1	28.44	29.2	0.7
	2	29.00		
	3	29.39		
	4	28.55		
	5	30.49		
Elongation at break, %	1	528.9	547.1	19.4
	2	540.7		
	3	533.2		
	4	549.3		
	5	583.4		
Modulus at 300% elongation, MPa	1	13.89	14.0	0.2
	2	13.87		
	3	14.42		
	4	13.94		
	5	13.83		
Hardness, IRHD	1	65	65	0.4
		66		
		65		
		65		
		65.5		
	2	65	65	0.3
		65.5		
		64.5		
		65		
		65		
Tear strength, N/mm	1	38	30.8	4.3
	2	28		
	3	33		
	4	26		
	5	29		

Properties	Test Piece	Test Data	Average, \bar{x}	Standard deviation, σ
Heat build-up (ΔT , °C)	0	17	15.7	1.3
	2	16		
	3	14		
Heat build-up (Set, %)	1	2.0	2.17	0.24
	2	2.0		
	3	2.5		
Abrasion resistance (Weight loss, g)	1	0.1989	0.1963	0.004
	2	0.1991		
	3	0.1910		