U. S. Department of Commerce
Frederick B. Dent
Secretary

National Bureau of Standards
[illegible] W. Roberts, Director

PREPRINT

National Bureau of Standards Certificate

Standard Reference Material 388i

Butyl Rubber

Standard Reference Material 388i has the following characteristics when tested by procedures described in the appendix overleaf. The uncertainty limits for the values reflect both variation within the lot of rubber and error of test, and are based on a confidence coefficient of 95 percent. The Mooney viscosity of the rubber is 72.5 ± 1.0 ML 1+8 (100°C), and 49.5 ± 1.0 ML 1+8 (125°C).

Characteristics of Compound	Procedure A	Procedure B Conventional units	Procedure B SI* units
Viscometer cure at 150°C			
Minimum viscosity	36.6 ± 0.5 ML	60.8 ± 1.0 ML	
Incipient cure, t_5	6.86 ± 0.05 min	5.65 ± 0.10 min.	339 ± 6 s
Cure index, Δt	2.02 ± 0.08 min	1.43 ± 0.03 min.	86 ± 2 s
Stress at 300% elongation			
Cure A	-	870 ± 30 lb/in^2	6.0 ± 0.2 MPa
Cure B	-	1260 ± 30 lb/in^2	8.7 ± 0.2 MPa
Cure C	-	1570 ± 30 lb/in^2	10.8 ± 0.3 MPa
Stress at failure			
Cure A	-	2730 ± 50 lb/in^2	18.8 ± 0.3 MPa
Cure B	-	2700 ± 50 lb/in^2	18.6 ± 0.3 MPa
Cure C	-	2780 ± 50 lb/in^2	19.2 ± 0.3 MPa
Elongation at failure			
Cure A	-	685 ± 15%	-
Cure B	-	560 ± 15%	-
Cure C	-	500 ± 15%	-
Strain at 2 MPa (290 lb/in^2)			
Cure A	-	154 ± 2%	-
Cure B	-	115 ± 2%	-
Cure C	-	97 ± 2%	-
Strain at 0.5 MPa (72.5 lb/in^2)			
Cure A	165 ± 2%	-	-
Cure B	116 ± 2%	-	-
Cure C	111 ± 2%	-	-
Oscillating Disk Curemeter at 160°C			
Minimum Torque	-	9.6 ± 0.2 lbf.in	1.08 ± 0.02 N.m
Maximum Torque	-	37.3 ± 0.3 lbf.in	4.21 ± 0.03 N.m
Incipient Cure (1 unit rise)	-	3.50 ± 0.05 min.	210 ± 3 sec.
Cure Time (50 percent)	-	8.60 ± 0.15 min.	516 ± 9 sec.
Cure Time (90 percent)	-	33.8 ± 0.5 min.	2028 ± 30 sec.

*International System of Units (Systeme International)

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Mechanical Properties of Compound Cured at 150°C

	Certified Value	Standard Error	Standard Deviation
Stress at 300% Elongation (MPa)			
1200 second cure	5.4	0.14	0.28
2400 second cure	7.9	0.08	0.21
4800 second cure	10.1	0.38	0.79
Stress at Failure (MPa)			
1200 second cure	19.2	0.21	0.52
2400 second cure	19.3	0.49	1.08
4800 second cure	19.3	0.39	0.81
Elongation at Failure (%)			
1200 second cure	711	3.0	7.4
2400 second cure	602	6.4	14.6
4800 second cure	527	5.9	17.3
60 Second Strain at 2.0 MPa Stress (%)			
1200 second cure	166	0.8	2.0
2400 second cure	122	1.1	2.8
4800 second cure	104	1.0	2.6

This lot of rubber was evaluated in the NBS Institute for Materials Research by G. W. Bullman, G. E. Decker and G. B. McKenna.

The technical and support aspects involved in the certification and issuance of this Standard Reference Material were coordinated thru the Office of Standard Reference Materials by T. W. Mears and W. P. Reed.

Washington, D.C. 20234
January 2, 1978

J. Paul Cali, Chief
Office of Standard Reference Materials

This lot of rubber was evaluated in the NBS Institute for Applied Technology by G.W. Bullman, A.M. Brown, and G.E. Decker.

Washington, D.C. 20234
August 16, 1974

J. Paul Cali, Chief
Office of Standard Reference Material

APPENDIX TO CERTIFICATE FOR STANDARD REFERENCE MATERIAL 388i

MATERIAL: Standard Reference Material 388i was selected from a lot of IIR Type 218. Bales of the dried rubber weighing approximately 34 kg were wrapped with ploye thylene film, and packaged in cardboard cartons. To evaluate the lot, 1000-gram portions were taken at the start and during the filling of each fifth container.

TESTS: Two determinations of Mooney viscosity were made on each portion according to the procedure described in ASTM Designation D1646-68.

Procedure A - Twenty four compounds were prepared from six portions in accordance with the formulation and mixing procedure described in ASTM D15-72 for Standard Formula 1E in a room conditioned at 23 $\pm$ 1°C and 35 $\pm$ 3% relative humidity.

Procedure B - Sixteen compounds were prepared from four portions in accordance with the formulation and mixing procedure described in ASTM Designation D3188-73 for Standard Formula 1A. The oil furnace black (SRM 378a) was dried for one hour at 125°C before weighing and the mixing was done in a roon conditioned at 23 $\pm$ 1°C and 35 $\pm$ 3% relative humidity.

The following NBS Standard Reference Materials were used to prepare the compounds: Zinc Oxide - 370c, Sulfur - 371f, Stearic Acid - 372g, Benzothiazyl-disulfide - 373e, Tetramethylthiuramdisulfide - 374b, and Oil Furnace Black - 378a.

The viscometer cure characteristics of each compound were determined at 150°C according to ASTM Designation D1646-68 selecting the time required to increase the cure index from 5 to 35 points above the minimum. The vulcanization characteristics were determined with an oscillating disk curemeter at 160°C according to ASTM Designation D2084. The remaining compound was vulcanized at 150°C, as described in ASTM Designation D3182-73, in a four-cavity mold that was machined directly in the hot plates of the press. The vulcanizing times were as follows:

Procedure A - 15, 30, and 40 minutes for cures A, B, and C, respectively;

Procedure B - 20, 40, and 80 minutes for cures A, B, and C, respectively.

Stress at given elongation, stress at failure, and elongation at failure were measured on vulcanizates prepared by Procedure B in accordance with ASTM Designation D412-68 using Die C. Strain was measured as described in ASTM Designation D1456-68 using a stress of 0.5 MPa for those prepared by Procedure A and 2 MPa for vulcanizates prepared by Procedure B.