

# ASTM D 2000

- A standardized system for classifying rubber physical properties.
- The basis for most of our testing methods.
- The backbone of our Product Data Sheets

This classification system is based on the premise that the properties of rubber products can be arranged into characteristic material designations. Materials must meet basic requirements. They may also need to meet additional requirements specified by “callouts”.

Many other ASTM standards are referenced by ASTM D 2000. They call out specific Test Methods and Practices. These include D 395, D 412, D 429, D 430, D 471, D 573, D 575, D 624, D 865, D 925, D 945, D 1053, D 1171, D 1329, D 1349, D 1418, D 2137, D 2240, D 3183, D 5964. These specifications are the basis for most our Material Testing methods at Precision Associates.

2 BG 725 B14 B34 EO14 EO34 EF21 EA14

4 CA 720 A25 B35 EA14 F19 G21

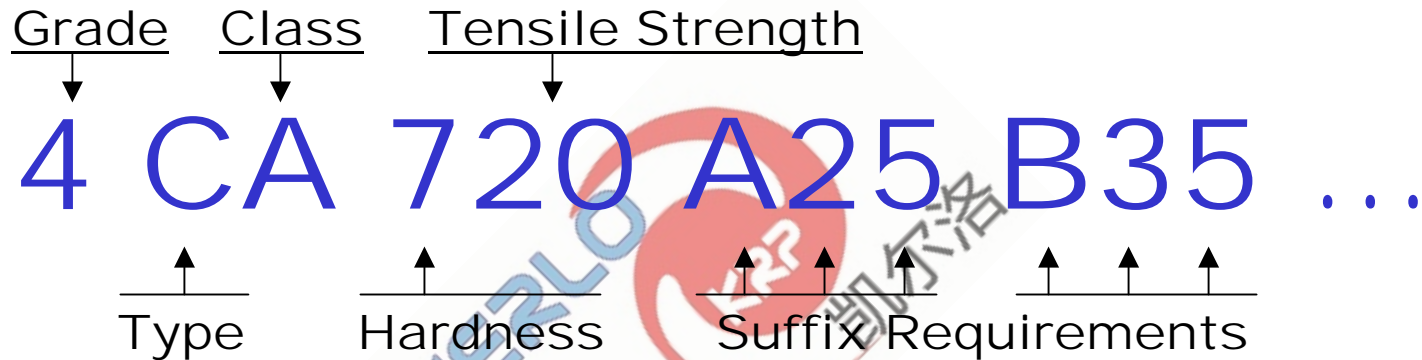
7 GE 707 A19 B37 EO16 EO36 EA14 G11 F19

M 6 HK 710 A1-10 A1-11 B31 B38 EO88

## These Numbers & Letters are a code

At first glance the ASTM D2000 call-outs look like a disorganized jumble of letters and numbers. Working with the spec can be frustrating if you do not understand the meaning of all of these *CODES*.

4 CA 720 A25 B35 EA14 F19 G21



Rubber specifications are referenced by a “Callout”. There is a definite structure to the callout. Each bit has a different meaning, but many share similar properties.

There is always a core group of numbers and letters: First is the Grade, followed by the Type & Class, then comes the Hardness & Tensile Strength. These three groups are all that is necessary to specify a rubber material.

Most often, the product designer will require additional properties for their application. When this is the case a number of suffix requirements is added to call for these special requirements.

M 6 HK 710 A1-10 A1-11 B31 B38 E088

SI (Indicates MPa Tensile Designation)

M 6 HK 710 A1-10 ...

Most designers in the USA prefer to write ASTM D 2000 call-outs with English tensile requirements (psi). When specifying MegaPascals (MPa), the SI prefix is added to indicate metric tensile requirement.

# Basic Requirements for Establishing Type by Temperature

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Type	Test Temperature	
	°C	°F
A	70	158
B	100	212
C	125	257
D	150	302
E	175	347
F	200	392
G	225	437
H	250	482
J	275	527

**Type** is based on changes in tensile strength of not more than +/-30%, elongation of not more than -50%, and hardness of not more than +/- 15 points after heat aging for 70 hours at the temperature specified for the **Type**.

# Basic Requirements for Establishing Class by Volume Swell

4 CA 720 A25 B35 ...

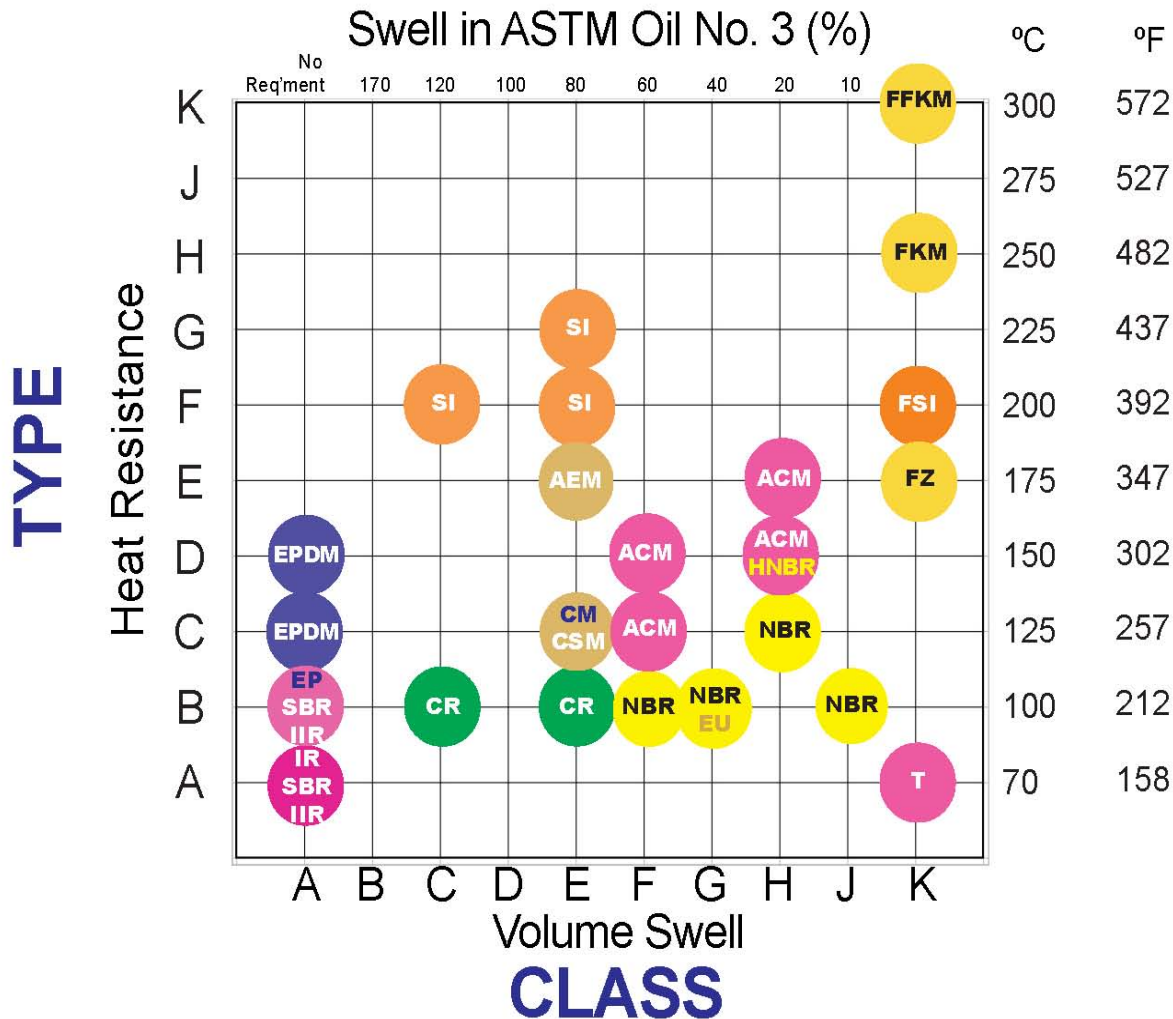
<u>Class</u>	<u>Volume Swell, max %</u>
A	No requirement
B	140
C	120
D	100
E	80
F	60
G	40
H	30
J	20
K	10



**Class** is based on the resistance of the material to swelling in ASTM Oil No, 3 after 70 hours of immersion at the temperature specified by the **Type**. (The maximum test temperature used is 150° C due to the upper limit of oil stability). Maximum limits for swell are displayed.

Note: ASTM Oil No. 3 is no longer commercially available. IRM 903 Oil has replaced Oil No. 3 per D 5964, but we continue to refer to ASTM Oil No. 3 for continuity.

# Polymers Most Often Used In Meeting Material Requirements



Polymers fall into general groups based on their resistance to heat and oil. This chart shows roughly where each polymer family is positioned. While a good approximation, special recipes will produce materials which work in areas not indicated.

**Hardness is indicated by a single digit which corresponds to the Durometer**

↓  
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	Duro			Duro
2	20		6	60
3	30		7	70
4	40		8	80
5	50		9	90

**The specification recognizes Duro in multiples of 10 only unless called out specifically**

Hardness is specified in multiples of 10. The tolerance for durometer is +/- 5 points. Non-standard durometers may be called out by using a Z suffix.



# Tensile is indicated by two digits that specify minimum strength at break in psi or MPa

4 CA 720 A25 B35 ...

MPa Designation	MPa	psi Designation	psi
03	3	04	435
06	6	09	870
07	7	10	1015
08	8	12	1160
10	10	15	1450
12	12	17	1740
14	14	20	2031
17	17	25	2466
21	21	30	3046
24	24	35	3481
28	28	41	4061

The minimum allowable Tensile Strength at break is specified in psi or Mpa. To indicate Mpa, the SI indicator "M" must precede the call-out.

TABLE 6 Continued

BA MATERIALS

Basic Requirements							
Durometer Hardness, ±5 Points	Tensile Strength, min		Ultimate Elongation, min, %	Heat Aged, Test Method D 573, 70 h at 100°C	Oil Immersion, Test Method D 471, No. 3 Oil, 70 h at 100°C	Compression Set, Test Methods D 395, Solid, max, %, 22 h at 70°C	Available Suffix Grade Numbers
	MPa	psi					
30	7	1015	400				2
30	10	1450	400				2, 3, 4, 5
30	14	2031	400				2, 3, 4, 5
40	3	435	300				2, 8
40	7	1015	300				2, 8
40	10	1450	400				2, 3, 4, 5, 6
40	14	2031	400				2, 3, 4, 5
50	7	1015	300				2, 8
50	10	1450	400				2, 3, 4, 5, 6
50	14	2031	400				2, 3, 4, 5
50	17	2486	400				2, 3, 4, 5
60	3	435	250				8
60	6	870	250	Change in tensile strength, ±30 %			8
60	7	1015	300				2, 8
60	10	1450	350	Change in ultimate elongation, -50 % max	No requirement	Compression set, 50 % max	2, 3, 4, 5, 6
60	14	2031	400	Change in durometer hardness, ±15 points			2, 3, 4, 5, 6
60	17	2486	400				2, 3, 4, 5, 6
70	3	435	150				8
70	6	870	150				8
70	7	1015	200				2, 8
70	8	1180	200				8
70	10	1450	250				2, 3, 4, 5, 6
70	14	2031	300				2, 3, 4, 5
70	17	2486	300				2, 3, 4, 5
80	7	1015	100				2, 7
80	10	1450	150				2, 4
80	14	2031	200				2, 4
90	3	435	75				7
90	7	1015	100				2, 7
90	10	1450	125				2, 4

BA MATERIALS

Suffix Requirements		Grade 1 <sup>a</sup>	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
A14	Heat resistance, Test Method D 573, 70 h at 100°C: Change in hardness, max, points Change in tensile strength, max, % Change in ultimate elongation, max, %			+10 -25 -25	+10 -25 -25				
B13	Compression set, Test Methods D 395, Method B, max, %, 22 h at 70°C			25			25		25
C12	Resistance to ozone, Test Method D 1171, quality retention rating, min, %		100	100	100	100	100	100	100
F17	Low-temperature brittleness, Test Methods D 2137, Method A, 9.3.2, nonbrittle after 3 min at -40°C		pass	pass	pass	pass			
F19	Low-temperature brittleness, Test Methods D 2137, Method A, 9.3.2, nonbrittle after 3 min at -55°C			pass		pass			
K11	Adhesion, Test Methods D 429, min: Method A, min, MPa			1.4	1.4	1.4	1.4		
K21	Adhesion, Test Methods D 429, min: Method B, min, kN/m			7 <sup>#</sup>	7 <sup>#</sup>	7 <sup>#</sup>			
K31	Adhesion, bond made after vulcanization								
Z	(Special requirements) Any special requirements shall be specified in detail, including test methods.								

<sup>a</sup> Basic properties only—no suffix requirements for Grade No. 1.

<sup>#</sup> Suffix K31 indicates that the material shall be free of surface conditions and compound constituents that are or may become deleterious to cement adhesion.

MATERIAL TABLE

The available callout specifications for each Type & Class are listed in a Material Table in the spec.

# Material Table

## Basic Requirements



TABLE 6 *Continued*

BA MATERIALS

**Basic Requirements**

Durometer Hardness, ±5 Points	Tensile Strength, min		Ultimate Elongation, min, %	Heat Aged, Test Method D 573, 70 h at 100°C	Oil Immersion, Test Method D 471, No. 3 Oil, 70 h at 100°C	Compression Set, Test Methods D 395, Solid, max, %, 22 h at 70°C	Available Suffix Grade Numbers
	MPa	psi					
30	7	1015	400				2
30	10	1450	400				2, 3, 4, 5
30	14	2031	400				2, 3, 4, 5
40	3	435	300				2, 8
40	7	1015	300				2, 8
40	10	1450	400				2, 3, 4, 5, 6
40	14	2031	400				2, 3, 4, 5
50	7	1015	300				2, 8
50	10	1450	400				2, 3, 4, 5, 6
50	14	2031	400				2, 3, 4, 5
50	17	2466	400				2, 3, 4, 5
60	3	435	250				8
60	6	870	250	Change in tensile strength, ±30 %			8
60	7	1015	300				2, 8
60	10	1450	350	Change in ultimate elongation, -50 % max	No requirement	Compression set, 50 % max	2, 3, 4, 5, 6
60	14	2031	400				2, 3, 4, 5, 6
60	17	2466	400	Change in durometer hardness, ±15 points			2, 3, 4, 5, 6
70	3	435	150				8

The first part of the table is concerned with the basic requirements, and the available grades. Notice that not all Grades are available for each call-out.

# Material Table

## Suffix Requirements

### BA MATERIALS

Suffix Requirements		Grade 1 <sup>A</sup>	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
A14	Heat resistance, Test Method D 573, 70 h at 100°C: Change in hardness, max, points Change in tensile strength, max, % Change in ultimate elongation, max, %			+10 -25 -25	+10 -25 -25				
B13	Compression set, Test Methods D 395, Method B, max, %, 22 h at 70°C			25			25		25
C12	Resistance to ozone, Test Method D 1171, quality retention rating, min, %		100	100	100	100	100	100	100
F17	Low-temperature brittleness, Test Methods D 2137, Method A, 9.3.2, nonbrittle after 3 min at -40°C		pass	pass	pass	pass			
F19	Low-temperature brittleness, Test Methods D 2137, Method A, 9.3.2, nonbrittle after 3 min at -55°C			pass		pass			
K11	Adhesion, Test Methods D 429, min: Method A, min, MPa			1.4	1.4	1.4	1.4		
K21	Adhesion, Test Methods D 429, min: Method B, min, kN/m			7	7	7			
K31	Adhesion, bond made after vulcanization			B	B	B			
Z	(Special requirements) Any special requirements shall be specified in detail, including test methods.								

<sup>A</sup> Basic properties only—no suffix requirements for Grade No. 1.

<sup>B</sup> Suffix K31 indicates that the material shall be free of surface conditions and compound constituents that are or may become deleterious to cement adhesion.

The Suffixes available for each Grade are shown. Notice that not all Suffixes are available for each Grade.

# Grade Numbers

↓  
4 CA 720 A25 B35 ...

- Grade Numbers are added to specify deviation from, or additions to the basic requirements.
- Only “Available” Grade Numbers may be specified for each Material, Tensile & Hardness

One Grade number from 1 thru 8 is included in each call-out. The Material Table should be consulted to find the Available Grades.

# Suffix Requirements

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↑ ↑ ↑     ↑ ↑ ↑  
Suffix Requirements

- Suffixes may be added to indicate additional requirements
- Each suffix indicates a test method that is consistent for all materials
- The results of these tests varies by material

The letter indicates the kind of test. The first number indicates the test method, including time. The second number, if used, specifies the test temperature.

Suffixes are not allowed for materials in Grade 1.

# Suffix Letters (Part 1)

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↓                      ↓

Suffix Letter	Test Required
A	Heat Resistance
B	Compression Set
C	Ozone or Weather Resistance
D	Compression-Deflection Resistance
EA	Fluid Resistance (Aqueous)
EF	Fluid Resistance (Fuels)
EO	Fluid Resistance (Oils & Lubes)
F	Low-Temperature Resistance
G	Tear Resistance

The Suffix Letter indicates the type of test.

## Suffix Letters (Part 2)

Suffix Letter	Test Required
H	Flex Resistance
J	Abrasion Resistance
K	Adhesion
M	Flammability Resistance
N	Impact Resistance
P	Staining Resistance
R	Resilience
Z	Any special requirement, which will be specified in detail

Z Suffixes may be added to indicate any special requirement by the user. The exact requirements must be specified in detail, including test methods.



## Suffix Numbers – 1<sup>st</sup> Number

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Each number specifies a test and duration dependant on the Suffix Letter and the Grade designated.

The example below is for Suffix Letter A – Heat Resistance

Grade	1	2	3	4
Suffix A Heat Resistance	D 573 70 hrs	D 865 70 hrs	D 865 168 hrs	D 573 168 hrs

The tests referred to are ASTM test methods.

## Suffix Numbers – 2nd Number

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Each number specifies the test temperature dependant on the Suffix Letter designated.

Temperatures applicable to Suffix Designations A, B, C, EA, EF, EO, G, & K

No	0	1	2	3	4	5	6	7	8	9	10	11
°C	*	23	38	70	100	125	150	175	200	225	250	275
°F	*	70	100	158	212	257	302	347	392	437	482	527

\* Ambient Temperature in case of outdoor testing

Test Temperature is indicated by the second digit. Temperature is not applicable to all Suffix letters. Temperatures on this page are only for the Suffix Letters indicated.

# Suffix Numbers – 2nd Number Continued

4 CA 720 A25 B35 ... F19 ↓

Temperatures applicable to Suffix Designation F

No	1	2	3	4	5	6	7	8	9	10	11	12
°C	23	0	-10	-18	-25	-35	-40	-50	-55	-65	-75	-80
°F	70	32	14	0	-13	-31	-40	-58	-67	-85	-103	-112

Suffix Letter F indicates low temperature testing, therefore the temperatures for this Suffix are much lower.