7. Specifications - MILSPEC's

Specifications are important. Therefore even though it may be difficult to prepare, a performance specification is recommended. Avoid specifying how to compound materials or how to process compounds. A well qualified supplier knows the materials and processes to produce the best compound for an application. However it should be understood that if one physical property of a compound is changed or adjusted by compounding, all of its other properties may be affected and it will no longer be the same compound. This is important for O-rings meeting Military Specifications. Once the specification is designated, all its requirements must be met. Even if a new compound will meet all the physical and chemical requirements of a given Military Specification, it is still impossible to certify that it meets that MILSPEC because the MILSPEC is covered by a Qualified Products List (QPL) which means all test results must be verified and approved by the U.S. Government. They will not allow a variation to a Military Specification and it will be necessary to run a complete evaluation of the new compound to all the requirements. ERIKS offers compounds approved to nearly every industry wide specification for elastomeric seals. Those specifications include military, aerospace, ASTM, SAE, automotive, petroleum industry, and commercial.
The most widely used specifications are the AN, M, MS, and NAS. This reference table is arranged by drawing number. Currently many MILSPEC's are being converted to non-military AMS spec's.

Popular military/aerospace specifications

Drawing number	Specification	Fluid	Recommended Temp. range °F		Elastomer	Comments
AS 3569	AMS 7270	Aircraft fuels	-67	+302	Nitrile	Formerly AN 123951 - AN 123040
AS 3570	AMS 7274	Petroleum based aircraft lubricating oil	-67	+302	Nitrile	Formerly AN 123851 - AN 123950
AS 3578	AMS 7271	Aircraft fuels	-58	+257	Nitrile	Formerly MS 9020 and MS 9021
AS 3582	AMS 3304	Dry heat and petroleum based lube oils	-85	+400	Silicone	Not recommended for high pressure dynamic applications
M 25988/1	MIL-R-25988 Class 1, Grade 70 I	Aircraft fuels and lubricants	-70	+392	Fluorosilicone	Blue color as required by MILSPEC. Not recommended for high pressure dynamic applications.
M 25988/2	MIL-R-25988 Class 3, Grade 75 I	Aircraft fuels and lubricants	-70	+437	Fluorosilicone	Blue color as required by MILSPEC. Higher modulus and temperature resistance
M 25988/3	MIL-R-25988 Class 1, Grade 60 I	Aircraft fuels and lubricants	-70	+392	Fluorosilicone	Blue color as required by MILSPEC. Lower hardness. For low pressure applications
M 25988/4	MIL-R-25988 Class 1, Grade 80 I	Aircraft fuels and lubricants	-70	+392	Fluorosilicone	Blue color as required by MILSPEC. Higher hardness.
M 83248/1	MIL-R-83248 Class 1 I	Aircraft fuels and lubricants	-20	+400	Fluorosilicone	Excellent resistance to compression set.
M 83248/2	MIL-R-83248 Class 2 I	Aircraft fuels and lubricants	-20	+400	Fluorosilicone	Higher hardness.
M 83461/1A	MIL-P-83461 I	MIL-H-5606	-65	+275	Nitrile	Better dynamic performance and longer service life at 257 °F.
MS 28775	MIL-P-25732 I	MIL-H-5606	-65	+275	Nitrile	MIL-H-5606 is a petroleum-based hydraulic fluid used in military aircraft. Inactive for new designs. See M 83461/1A.
MS 28900	AMS 3209	Ozone	-40	+212	Neoprene	For weather resistant seals. (Nonstandard sizes).
MS 29512 MS 29513	MIL-P-5315 I	Aircraft fuels	-65	+158	Nitrile	This drawing covers tube fitting sizes only. This drawing covers all sizes except the tube fitting sizes.
MS 29561	MIL-R-7362, Type I	Synthetic diester jet engine lubricants (MIL-L-7808)	-65	+257	Nitrile	This drawing covers all sizes except the . tube fitting sizes
MS 9385 MS 9386	AMS 7267	Dry heat and petroleum-based lube oils	-85	+500	Silicone	This drawing covers tube fitting sizes only. This drawing covers all sizes except the tube fitting sizes.
NAS 617	MIL-R-7362, Type I	Synthetic diester jet engine lubricants (MIL-L-7808)	-65	+257	Nitrile	This drawing covers all sizes except the tube fitting sizes .

7. Specifications

There are some major points which must always be considered when preparing any specification. Different size parts give different results and all parts with varying cross section or shape will not meet specific properties set up on another particular part or on test specimens cut from a standard test sheet. Therefore always use standard test specimen or the same cross section of the O-ring. It is also recommended that standard test methods be used whenever possible. ERIKS data are specified according ISO, ASTM, and DIN Test standards.

7. Specifications - ASTM D2000

ASTM D2000 Specification

One of the most versatile specifications in the Rubber Industry is ASTM D2000. In this specification the various classes, grades, and suffixes are used to define specific properties of elastomers.

ASTM D2000 protocol

Because there are at least as many elastomer compound choices as there are metallic products, how can one make an informed elastomer seal selection?

The relative performance capabilities of elastomers can be generally defined by a test protocol identified as American Society for Testing and Materials (ASTM) D-2000. This protocol positions an elastomer as a function of its thermal stability and oil resistance, both measured under well-defined test conditions.

Significant differences exist in the per-formance capabilities of the different elastomers. Those with more limited performance are recognized as mid- performance elastomers, including butyl rubber, chloroprene rubber (CR), ethylene propylene rubber (EDPM), and acrylonitrile-butadiene rubber (NBR).

Those with the broadest capabilities are high-performance elastomers. They include fluoroelastomers and perfluoroelastomers.
Yet, ASTM D2000 does not address resistance to harsh media and aggressive environments encountered in the chemical industry. These include acids, bases, solvents, heat-transfer fluids, oxidizers, water, steam, etc. Unlike ASTM #3 oil used in the ASTM D2000 protocol, chemical plant media may attack the elastomer's back-bone, crosslinks, and/or fillers leading to loss of resiliency (memory) and seal failure.

Although ASTM D2000 is a good predictive starting point, one must accurately identify the media to correctly select an elastomer for many applications.

The following example shows a typical ASTM D2000 callout. Below is a breakdown explaining what the different positions mean.

ASTM D2000-90 M 2 HK 7 14 A1-10, B38, C12, EF31, EO88, F15, Z1

- Z1 → Deviations from standard test procedures
- A1 → Additional requirement suffixes
- 14 → Tensile Strength (MPa if M is present; psi if not)
- 7 → Hardness (Durometer)
- HK → Type and Class
- 2 → Grade Number
- M → If present, use Metric Units
- 90 → Year of Standard revision

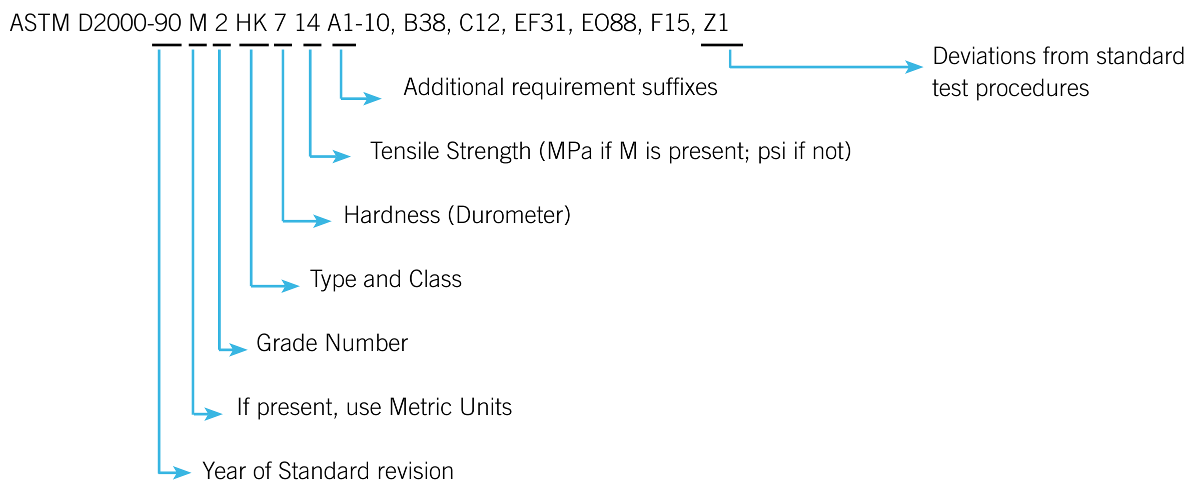
7. Specifications - ASTM D2000

Confusion often seems to start at the number 90. This just defines the revision year of ASTM D2000 to which the particular line callout makes reference. The appearance of an ‘m’ (or lack of) determines the units to be used for properties such as tensile strength, temperature or tear strength. If an M begins the line callout, SI units (metric) will be used - MPa (tensile), °C, kN/m (tear). If it is not there, English units are employed so that tensile will be in psi, temperatures in °F, and tear strength in psi.

After the M, a Grade Number is selected that defines the test requirements to which a material of a given Type and Class can be tested. A grade of 1 indicates only basic properties are required while numbers 2-9 imply additional testing requirements such as low temperature brittleness or special heat aging tests. (Note: not all grade numbers are applicable to all material types and classes).

The various material Types and Classes available are best summarized in the following table:

Material Designation (type and class)	**Type of Polymer Most Often Used**
AA	Natural, Reclaim, SBR, Butyl, EPDM, Polyisoprene
AK	Polysulfides
BA	EPDM, High Temp SBR and Butyl Compounds
BC	Chloroprene
BE	Chloroprene
BF	NBR
BG	NBR, Urethanes
CA	EPDM
CE	Chlorosulfonated Polyethylene (Hypalon®)
CH	NBR, Epichlorohydrin
DA	EPDM
DF	Polyacrylic (Butyl acrylate type)
DH	Polyacrylic
FC	Silicones (High Temp)
FE	Silicones
FK	Fluorosilicones
GE	Silicones
HK	Fluorocarbons



7. Specifications - ASTM D2000

Next in line are three numbers used to state hardness range and minimum tensile strength requirements. The first number 7 indicates the nominal hardness 70 (in Shore A units) of the described material plus or minus 5 points. In this case the material required would be 70±5 Shore A hardness. Similarly, if a 6 was used, the material specified would be 60°±5° Shore A hardness. The next two digits are used to define the minimum tensile strength to be possessed by the material. Since the callout is metric, the 14 requires that the material supplied have a minimum tensile strength of 14 MPa. If the M was not present, the units would be in psi so the 14 would be replaced by 20 (14 MPa =2031psi; use the first two digits of the tensile strength in psi).
In most applications, however, basic properties are not enough to ensure an acceptable material.
Specialized testing is often required and this is where suffixes come into use. Suffixes are letter-number combinations that, together with a grade number, describe specific tests and performance criteria which an elastomer must pass. Below is a listing of the relationship between suffix letters and the type of test each calls out:

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 and Lubricants)
F	Low Temperature Resistance
G	Tear Resistance
H	Flex Resistance
J	Abrasion Resistance
K	Adhesion
M	Flammability Resistance
N	Impact Resistance
P	Staining Resistance
R	Resilience
Z	Any Special Requirement (Specified in Detail)

The numbers connected with each suffix letter describe the test method to be used (including time) and the test temperature.

Due to space limitations we will not go into these subtitles. Z-requirements are typically used to skew hardness range (eg; 75 ±5), tighten limits on a given test, specify color (default is black), or add additional tests designed by another party. Looking back at the original example for this particular application the callout is: A 70+5 hardness, black fluorocarbon with a minimum tensile strength of 14MPa. The material will also have to pass the limits outlined in the grade 2 column (of the 1990 revision of D2000) for Heat Resistance, Compression Set, Ozone Resistance, Fuel Immersion, Lubricating Oil Immersion, Low Temperature Resistance, and a specified Z-requirement.

Example:
2 BG 720 B14 EO14 EO34 EF11 EF21 F17 EA14 , NBR shore A 70 ± 5

2	Quality number
B	Type (based on heat resistance)
G	Class (based on swell resistance in test oil IRM 903)
7	Hardness shore A 70 ± 5
20	Tensile strength 2000 psi (13,8 MPa)
B	Compression set (Test ASTM D395)
1	Testing time: 22 hours
4	Testing temperature: 212 F° (100°C)
EO	Swelling in test oil ASTM No1 (ASTM D471)
1	Testing time: 70 hours
4	Testing temperature: 212°F (100°C)
EO	Swelling in test oil IRM 903 (test ASTM D471)
3	Testing time: 70 hours
4	Testing time: 212°F (100°C)
EF	Swelling in test fuel No.1 (Reference Fuel A) Isooctane (test ASTM D471)
1	Testing time: 1 hour
1	Testing temperature: 70°F (21°C)
EF	Swelling in test fuel Nr. 2 (Refer. Fuel B) Isooctane/Toluol 70:30 (test ASTM D471)
2	Testing time: 70 hours
1	Testing temperature: 70°F (21°C)
F	Low temperature testing (test ASTM D746), Method B
1	Testing time: 3 minutes
7	Tesing temperature: -40°F (-40°C)
EA	Swelling in water, (test ASTM D471)
1	Testing time: 70 hours
4	Testing temperature: 212°F (100°C)

(For reference test results ASTM Rubber Handbook Section 9 Volume 09.01