

## Material Properties: E454 (EPDM)

Specification: NAS 1613 Revision 5

All testing done on AS568-214 unless otherwise noted

Properties	Specification	E454
<b>Original Properties</b>		
Shore M Durometer, ASTM D2240	80 ± 5	82
Tensile Strength, psi, ASTM D1414	1400 min.	2800
Ultimate Elongation, %, ASTM D1414	125 min.	155
Modulus at 100% Elongation, psi, ASTM D1414	800 min.	1390
Specific Gravity, ASTM D297	As determined	1.20
<b>High Temperature Air Oven Age, ASTM D573, 70 hours at 300°F</b>		
Hardness change, Shore M, ASTM D2240	+10 max.	+3
% Tensile Strength change, ASTM D412 Die C	-25 max.	+7.4
% Elongation change, ASTM D412 Die C	-10 max.	-1.7
<b>Low Temperature Retraction, ASTM D1329, 75% Strain</b>		
As Received, TR-10	-50 or colder	-67
TR-70	-18 or colder	-22
Fluid Soaked in Skydrol 500 B-4 for 70 hours at 160°F, TR-10, °F	-52 or colder	-62
Fluid Soaked in Skydrol 500 B-4 for 70 hours at 160°F, TR-70, °F	-3 or colder	-15
Fluid Soaked in Chevron HyJet IV-A+ for 70 hours at 160°F, TR-10, °F	-52 or colder	-58
Fluid Soaked in Chevron HyJet IV-A+ for 70 hours at 160°F, TR-70, °F	-3 or colder	-18
Fluid Soaked in Skydrol LD-4 for 70 hours at 160°F, TR-10, °F	-52 or colder	-59
Fluid Soaked in Skydrol LD-4 for 70 hours at 160°F, TR-70, °F	-3 or colder	-19
Fluid Soaked in Skydrol 5 for 70 hours at 160°F, TR-10, °F	-52 or colder	-60
Fluid Soaked in Skydrol 5 for 70 hours at 160°F, TR-70, °F	-3 or colder	-19
Fluid Soaked in Skydrol PE5 for 70 hours at 160°F, TR-10, °F	-52 or colder	-59
Fluid Soaked in Skydrol PE5 for 70 hours at 160°F, TR-70, °F	-3 or colder	-18
Fluid Soaked in Chevron HyJet V for 70 hours at 160°F, TR-10, °F	-52 or colder	-59
Fluid Soaked in Chevron HyJet V for 70 hours at 160°F, TR-70, °F	-3 or colder	-19
<b>Compression Set, ASTM D395 Method B and ASTM D1414, AS568-330 size</b>		
% Permanent Set, 22 hours at 250°F	30 max.	4.4
% Permanent Set, Immersed in Skydrol 500 B-4, 22 hours at 250°F	20 max.	0.8
% Permanent Set, Immersed in Chevron HyJet IV-A+, 22 hours at 250°F	20 max.	<0
% Permanent Set, Immersed in Chevron HyJet V, 22 hours at 250°F	20 max.	<0
% Permanent Set, Immersed in Skydrol LD-4, 22 hours at 250°F	20 max.	<0
% Permanent Set, Immersed in Skydrol 5, 22 hours at 250°F	20 max.	<0
% Permanent Set, Immersed in Skydrol PE5, 22 hours at 250°F	20 max.	<0
% Permanent Set, Immersed in Skydrol 500 B-4, 70 hours at 160°F	20 max.	0.8
% Permanent Set, Immersed in Chevron HyJet IV-A+, 70 hours at 160°F	20 max.	0
% Permanent Set, Immersed in Chevron HyJet V, 22 hours at 160°F	20 max.	<0
% Permanent Set, Immersed in Skydrol LD-4, 22 hours at 160°F	20 max.	<0
% Permanent Set, Immersed in Skydrol 5, 22 hours at 160°F	20 max.	<0
% Permanent Set, Immersed in Skydrol PE5, 22 hours at 160°F	20 max.	<0

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Properties	Specification	E454
Immersion in Skydrol 500 B-4, 22 hours at 250°F, ASTM D471		
Hardness change, Shore M, ASTM D2240	-10 max.	-1
Tensile Strength, psi, ASTM D1414	1350 min.	2532
Ultimate Elongation, %, ASTM D1414	125 min.	159
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1148
% Volume change, ASTM D471	0 to +18	+5.2
Immersion in Chevron HyJet IV-A+, 22 hours at 250°F, ASTM D471		
Specification		
Hardness change, Shore M, ASTM D2240	-10 max.	-2
Tensile Strength, psi, ASTM D1414	1350 min.	2460
Ultimate Elongation, %, ASTM D1414	125 min.	166
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1214
% Volume change, ASTM D471	0 to +18	+8.6
Immersion in Chevron HyJet V, 22 hours at 250°F, ASTM D471		
Hardness change, Shore M, ASTM D2240	-10 max.	-2
Tensile Strength, psi, ASTM D1414	1350 min.	2420
Ultimate Elongation, %, ASTM D1414	125 min.	171
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1220
% Volume change, ASTM D471	0 to +18	+9.4
Immersion in Skydrol LD-4, 22 hours at 250°F, ASTM D471		
Hardness change, Shore M, ASTM D2240	-10 max.	-2
Tensile Strength, psi, ASTM D1414	1350 min.	2557
Ultimate Elongation, %, ASTM D1414	125 min.	172
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1235
% Volume change, ASTM D471	0 to +18	+9.2
Immersion in Skydrol 5, 22 hours at 250°F, ASTM D471		
Hardness change, Shore M, ASTM D2240	-10 max.	-2
Tensile Strength, psi, ASTM D1414	1350 min.	2470
Ultimate Elongation, %, ASTM D1414	125 min.	167
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1181
% Volume change, ASTM D471	0 to +18	+9.6
Immersion in Skydrol PE5, 22 hours at 250°F, ASTM D471		
Hardness change, Shore M, ASTM D2240	-10 max.	-3
Tensile Strength, psi, ASTM D1414	1350 min.	2380
Ultimate Elongation, %, ASTM D1414	125 min.	169
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1092
% Volume change, ASTM D471	0 to +18	+9.5

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Properties	Specifications	E454
Immersion in Skydrol 500 B-4, 70 hours at 250°F, ASTM D471		
Hardness change, Shore M, ASTM D2240	-12 max.	-3
Tensile Strength, psi, ASTM D1414	1300 min.	2635
Immersion in Chevron HyJet IV-A+, 70 hours at 250°F, ASTM D471		
Hardness change, Shore M, ASTM D2240	-12 max.	-5
Tensile Strength, psi, ASTM D1414	1300 min.	2765
Ultimate Elongation, %, ASTM D1414	125 min.	161
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	886
% Volume change, ASTM D471	0 to +18	+13.1
Immersion in Chevron HyJet V, 70 hours at 250°F, ASTM D471		
Hardness change, Shore M, ASTM D2240	-12 max.	-5
Tensile Strength, psi, ASTM D1414	1300 min.	2496
Ultimate Elongation, %, ASTM D1414	125 min.	148
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1155
% Volume change, ASTM D471	0 to +18	+14.8
Immersion in Skydrol LD-4, 70 hours at 250°F, ASTM D471		
Hardness change, Shore M, ASTM D2240	-12 max.	-4
Tensile Strength, psi, ASTM D1414	1300 min.	2685
Ultimate Elongation, %, ASTM D1414	125 min.	156
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	925
% Volume change, ASTM D471	0 to +18	+12.8
Immersion in Skydrol 5, 70 hours at 250°F, ASTM D471		
Hardness change, Shore M, ASTM D2240	-12 max.	-5
Tensile Strength, psi, ASTM D1414	1300 min.	2500
Ultimate Elongation, %, ASTM D1414	125 min.	152
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1120
% Volume change, ASTM D471	0 to +18	+14.7
Immersion in Skydrol PE5, 70 hours at 250°F, ASTM D471		
Hardness change, Shore M, ASTM D2240	-12 max.	-4
Tensile Strength, psi, ASTM D1414	1300 min.	2520
Ultimate Elongation, %, ASTM D1414	125 min.	159
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1143
% Volume change, ASTM D471	0 to +18	+14.6

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Testing on 0.040" thru 0.103" cross section O-rings  
Testing done on AS568-022 size O-rings

Properties	Specification	E454
Immersion in Skydrol 500 B-4, 22 hours at 250°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-10 max.	-3
% Volume change, ASTM D471	0 to +18	+8.7
Immersion in Chevron HyJet IV-A+, 22 hours at 250°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-10 max.	-4
% Volume change, ASTM D471	0 to +18	+14.2
Immersion in Chevron HyJet V, 22 hours at 250°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-10 max.	-4
% Volume change, ASTM D471	0 to +18	+14.1
Immersion in Skydrol LD-4, 22 hours at 250°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-10 max.	-4
% Volume change, ASTM D471	0 to +18	+14.1
Immersion in Skydrol 5, 22 hours at 250°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-10 max.	-4
% Volume change, ASTM D471	0 to +18	+13.9
Immersion in Skydrol PE5, 22 hours at 250°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-10 max.	-4
% Volume change, ASTM D471	0 to +18	+13.8
Immersion in Skydrol 500 B-4, 70 hours at 160°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-5 max.	-3
% Volume change, ASTM D471	0 to +10	+4.2
Immersion in Chevron HyJet IV-A+, 70 hours at 160°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-5 max.	-3
% Volume change, ASTM D471	0 to +10	+9.1
Immersion in Chevron HyJet V, 70 hours at 160°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-5 max.	-3
% Volume change, ASTM D471	0 to +10	+8.8
Immersion in Skydrol LD-4, 70 hours at 160°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-5 max.	-2
% Volume change, ASTM D471	0 to +10	+8.9

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Properties	Specification	E454
Immersion in Skydrol 5, 70 hours at 160°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-5 max.	-3
% Volume change, ASTM D471	0 to +10	+8.5
Immersion in Skydrol PE5, 70 hours at 160°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-5 max.	-2
% Volume change, ASTM D471	0 to +10	+8.6
Immersion in Skydrol 500 B-4, 334 hours at 225°F, ASTM D471		
Tensile Strength, psi, ASTM D1414	1200 min.	2473
Ultimate Elongation, %, ASTM D1414	125 min.	148
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1096
% Volume change, ASTM D471	0 to +18	+6.5
Immersion in Chevron HyJet IV-A+, 334 hours at 225°F, ASTM D471		
Tensile Strength, psi, ASTM D1414	1200 min.	2271
Ultimate Elongation, %, ASTM D1414	125 min.	161
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1164
% Volume change, ASTM D471	0 to +18	+13.4
Immersion in Chevron HyJet V, 334 hours at 225°F, ASTM D471		
Tensile Strength, psi, ASTM D1414	1200 min.	2435
Ultimate Elongation, %, ASTM D1414	125 min.	138
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1280
% Volume change, ASTM D471	0 to +18	+15.3
Immersion in Skydrol LD-4, 334 hours at 225°F, ASTM D471		
Tensile Strength, psi, ASTM D1414	1200 min.	2375
Ultimate Elongation, %, ASTM D1414	125 min.	172
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1220
% Volume change, ASTM D471	0 to +18	+13.4
Immersion in Skydrol 5, 334 hours at 225°F, ASTM D471		
Tensile Strength, psi, ASTM D1414	1200 min.	2380
Ultimate Elongation, %, ASTM D1414	125 min.	140
Modulus at 100% Elongation, psi, ASTM D1414	500 min.	1190
% Volume change, ASTM D471	0 to +18	+14.9

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Longer term testing on 0.116 to 0.275" cross section O-rings

Testing on 0.139" cross section O-rings

Properties	Specification	E454
Immersion in Skydrol 500 B-4, 670 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-4
% Volume change, ASTM D471	0 to +18	+6.6
Immersion in Chevron HyJet IV-A+, 670 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+15.7
Immersion in Chevron HyJet V, 670 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+16.7
Immersion in Skydrol LD-4, 670 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-4
% Volume change, ASTM D471	0 to +18	+15.5
Immersion in Skydrol 5, 670 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-4
% Volume change, ASTM D471	0 to +18	+16.6
Immersion in Skydrol PE5, 670 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+16.1
Immersion in Skydrol 500 B-4, 1000 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-3
% Volume change, ASTM D471	0 to +18	+8.8
Immersion in Chevron HyJet IV-A+, 1000 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+13.9
Immersion in Chevron HyJet V, 1000 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+17.2

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Properties	Specification	E454
Immersion in Skydrol LD-4, 1000 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+13.7
Immersion in Skydrol 5, 1000 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+17.3
Immersion in Skydrol PE5, 1000 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+16.8
Immersion in Skydrol 500 B-4, 1440 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-4
% Volume change, ASTM D471	0 to +18	+8.5
Immersion in Chevron HyJet IV-A+, 1440 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+13.9
Immersion in Chevron HyJet V, 1440 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+17.1
Immersion in Skydrol LD-4, 1440 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+13.8
Immersion in Skydrol 5, 1440 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+16.9
Immersion in Skydrol PE5, 1440 hours at 225°F, ASTM D471		
Hardness change, IRHD, ASTM D1415	-15 max.	-5
% Volume change, ASTM D471	0 to +18	+16.7

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Properties	Specification	E454
Corrosion and Adhesion, 92% Relative Humidity, 96 hours at 68°F, AS568-214 O-rings, Dry rings		
Aluminum alloy per AMS-QQ-A-250/4	No corrosion or adhesion	Pass
Brass per ASTM B 36/B 36M	No corrosion or adhesion	Pass
Phosphor Bronze per ASTM B139	No corrosion or adhesion	Pass
Steel per AMS 6345	No corrosion or adhesion	Pass
Aluminum Bronze per ASTM B150	No corrosion or adhesion	Pass
Corrosion and Adhesion, 92% Relative Humidity, 96 hours at 68°F, AS568-214 O-rings, Immersed in Skydrol 500 B-4 and drained prior to humidity test		
Aluminum alloy per AMS-QQ-A-250/4	No corrosion or adhesion	Pass
Brass per ASTM B 36/B 36M	No corrosion or adhesion	Pass
Phosphor Bronze per ASTM B139	No corrosion or adhesion	Pass
Steel per AMS 6345	No corrosion or adhesion	Pass
Aluminum Bronze per ASTM B150	No corrosion or adhesion	Pass
Corrosion and Adhesion, 92% Relative Humidity, 96 hours at 68°F, AS568-214 O-rings, Immersed in Chevron HyJet IV-A+ and drained prior to humidity test		
Aluminum alloy per AMS-QQ-A-250/4	No corrosion or adhesion	Pass
Brass per ASTM B 36/B 36M	No corrosion or adhesion	Pass
Phosphor Bronze per ASTM B139	No corrosion or adhesion	Pass
Steel per AMS 6345	No corrosion or adhesion	Pass
Aluminum Bronze per ASTM B150	No corrosion or adhesion	Pass
Corrosion and Adhesion, 92% Relative Humidity, 96 hours at 68°F, AS568-214 O-rings, Immersed in Skydrol LD-4 and drained prior to humidity test		
Aluminum alloy per AMS-QQ-A-250/4	No corrosion or adhesion	Pass
Brass per ASTM B 36/B 36M	No corrosion or adhesion	Pass
Phosphor Bronze per ASTM B139	No corrosion or adhesion	Pass
Steel per AMS 6345	No corrosion or adhesion	Pass
Aluminum Bronze per ASTM B150	No corrosion or adhesion	Pass
Corrosion and Adhesion, 92% Relative Humidity, 96 hours at 68°F, AS568-214 O-rings, Immersed in Skydrol 5 and drained prior to humidity test		
Aluminum alloy per AMS-QQ-A-250/4	No corrosion or adhesion	Pass
Brass per ASTM B 36/B 36M	No corrosion or adhesion	Pass
Phosphor Bronze per ASTM B139	No corrosion or adhesion	Pass
Steel per AMS 6345	No corrosion or adhesion	Pass
Aluminum Bronze per ASTM B150	No corrosion or adhesion	Pass
Corrosion and Adhesion, 92% Relative Humidity, 96 hours at 68°F, AS568-214 O-rings, Immersed in Skydrol PE5 and drained prior to humidity test		
Aluminum alloy per AMS-QQ-A-250/4	No corrosion or adhesion	Pass
Brass per ASTM B 36/B 36M	No corrosion or adhesion	Pass
Phosphor Bronze per ASTM B139	No corrosion or adhesion	Pass
Steel per AMS 6345	No corrosion or adhesion	Pass
Aluminum Bronze per ASTM B150	No corrosion or adhesion	Pass

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Properties	Specification	E454
Corrosion and Adhesion, 92% Relative Humidity, 96 hours at 68°F, AS568-214 O-rings, Immersed in Chevron HyJet V and drained prior to humidity test		
Aluminum alloy per AMS-QQ-A-250/4	No corrosion or adhesion	Pass
Brass per ASTM B 36/B 36M	No corrosion or adhesion	Pass
Phosphor Bronze per ASTM B139	No corrosion or adhesion	Pass
Steel per AMS 6345	No corrosion or adhesion	Pass
Aluminum Bronze per ASTM B150	No corrosion or adhesion	Pass
Dynamic Endurance Tests per NAS-1613 Rev. 5 - Testing conducted at Boeing Laboratories		
Tested in Skydrol 500 B-4, Cold cycle at -65°F	<1 cc per gland	0
Tested in Skydrol 500 B-4, 70,000 cycles at 160°F	<1 cc per gland	0
Tested in Skydrol 500 B-4, 90,000 cycles at 225°F	<1 cc per gland	0
Tested in Skydrol 500 B-4, Cold cycle at -65°F	<1 cc per gland	0
Tested in Chevron HyJet IV-A+, Cold cycle at -65°F	<1 cc per gland	0
Tested in Chevron HyJet IV-A+, 70,000 cycles at 160°F	<1 cc per gland	0
Tested in Chevron HyJet IV-A+, 90,000 cycles at 225°F	<1 cc per gland	0
Tested in Chevron HyJet IV-A+, Cold cycle at -65°F	<1 cc per gland	0
Tested in Skydrol 5, Cold cycle at -65°F	<1 cc per gland	0
Tested in Skydrol 5, 70,000 cycles at 160°F	<1 cc per gland	0
Tested in Skydrol 5, 90,000 cycles at 225°F	<1 cc per gland	0
Tested in Skydrol 5, Cold cycle at -65°F	<1 cc per gland	0

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