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3M™ Dyneon™ Fluoroelastomers  
**Compound  
Recipes**

# 3M™ Dyneon™ Fluoroelastomer Compound Recipes

**NOTE:** The purpose of this guide is to provide basic information to product users for use in evaluating, processing, and troubleshooting their use of certain 3M products. The information provided is general or summary in nature and is offered to assist the user. The information is not intended to replace the user's careful consideration of the unique circumstances and conditions involved in its use and processing of 3M products. The user is responsible for determining whether this information is suitable and appropriate for the user's particular use and intended application.

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# Basic O-Ring Compounds

## Formulation

Ingredient	Hardness				
	55	60	70	80	90
3M™ Dyneon™ FE 5640Q	100	100	100	100	100
N990	2	9	20	35	60
Ca(OH) <sub>2</sub> HP-XL HallStar®	4	6	6	6	6
MgO, Elastomag® 170	3	3	3	3	3
<b>Total Parts</b>	<b>109</b>	<b>118</b>	<b>129</b>	<b>144</b>	<b>169</b>

## Typical Physical Properties

### Post Cure, 16 hours, 232°C (450°F)

Tensile, psi	1110	1490	1945	1840	1830
Elongation, %	240	240	240	185	150
Modulus 100%, psi	220	340	565	930	1325
Hardness, Type A	55	60	70	81	91
Specific Gravity	1.85	1.85	1.86	1.85	1.85

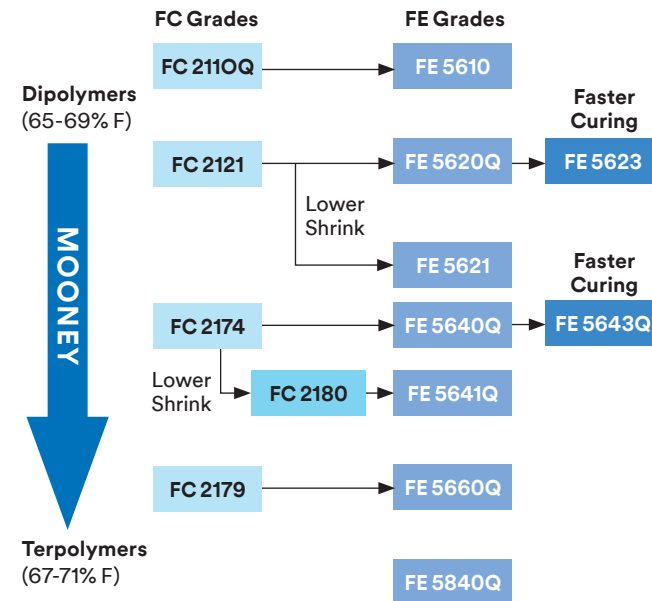
### Air Aging, 70 hours, 270°C (518°F), ASTM D573

Tensile, % change	-12	-9	-26	-22	-17
Elongation, % change	19	6	-4	-8	-10
Hardness, Type A, points change	-4	-3	-3	0	-4

### Compression Set, 70 hours, 200°C (392°F), ASTM D395

Compression Set, %, 0.139" O-ring	13	14	15	16	22
Molded ½" button, % set	16	11	13	14	18

## Suggested O-Ring Polymers



## Key Considerations:

The most important considerations for an O-ring application are usually the compression set. As a general rule, the higher the viscosity of the fluoroelastomer, the lower the compression set. Viscosity can be an important consideration when choosing 3M™ Dyneon™ Fluoroelastomer grades that will be injection molded. FE 5620Q and FE 5621 are suitable for injection molding and offer excellent compression set resistance.

# Black/Brown O-Ring Formulas

## Formulation

Ingredient	Black	Brown
3M™ Dyneon™ FC 2174	100	100
MgO, Elastomag® 170	3	3
Ca(OH) <sub>2</sub> HP-XL HallStar®	6	6
N990	30	-
Austin Black® 325	-	12
Mapico® Tan 10 (Fe <sub>2</sub> O <sub>3</sub> /ZnO)	-	15
Mapico® 617 (Fe <sub>2</sub> O <sub>3</sub> )	-	10
<b>Total Parts</b>	<b>139</b>	<b>146</b>

## Typical Physical Properties (Measured on 214 O-rings)

Press Cure, 10 minutes, 177°C (350°F) Post Cure, 16 hours, 232°C (449°F)	Black	Brown
Tensile, psi	1850	2080
Elongation, %	175	175
Hardness, Type A	75	75
Reference Fuel B, 70 hours, 25°C (77°F)	Black	Brown
Tensile, % change	-2	5
Elongation, % change	7	16
Hardness, Type A, points change	0	-1
Volume, % change	1.7	1.2

## Typical Physical Properties (continued)

Stauffer 7700 Oil, 70 hours, 175°C (347°F)		
Tensile, % change	-3	-25
Elongation, % change	15	5
Hardness, Type A, points change	-6	-5
Volume, % change	16	16
Stauffer 7700 Oil, 70 hours, 200°C (392°F)		
Tensile, % change	-9	-24
Elongation, % change	18	12
Hardness, Type A, points change	-7	-5
Volume, % change	19	20
Heat Aged, 70 hours, 250°C (482°F)		
Tensile, % change	-4	-8
Elongation, % change	0	0
Hardness, Type A, points change	2	1
Heat Aged, 70 hours, 275°C (527°F)		
Tensile, % change	-14	-25
Elongation, % change	11	-6
Hardness, Type A, points change	1	0
Compression Set, ASTM D395, Method B, ½" Molded Buttons		
22 hours, 200°C (392°F), % set	8	5
70 hours, 200°C (392°F), % set	13	12
336 hours, 200°C (392°F), % set	29	33
70 hours, 25°C (77°F), % set	6	7
166 hours, 175°C (347°F), % set	12	12

# Black Molded Goods Compounds

## Formulation

Ingredient	Hardness				
	55	60	70	80	90
3M™ Dyneon™ FE 5642	100	100	100	100	100
N990	3	10	25	40	60
Ca(OH) <sub>2</sub> HP-XL, HallStar®	6	6	6	6	6
MgO, Elastomag® 170	3	3	3	3	3
<b>Total Parts</b>	<b>112</b>	<b>119</b>	<b>134</b>	<b>149</b>	<b>169</b>

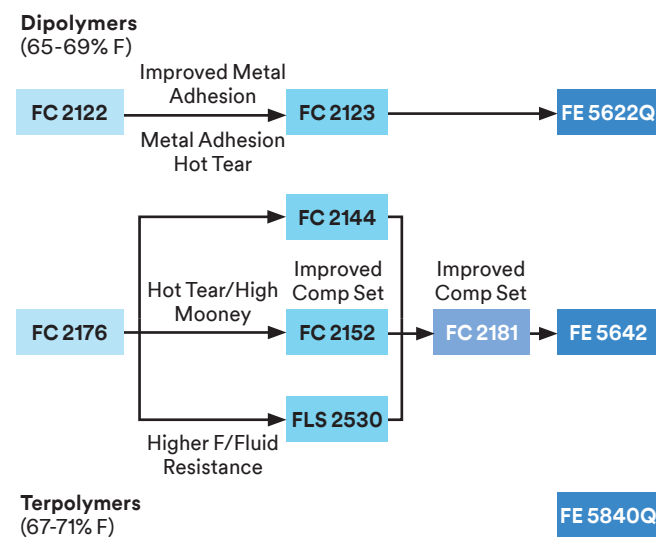
## Typical Physical Properties

Post Cure, 232°C (450°F)					
Tensile, psi	1230	1515	1965	1915	1970
Elongation, %	320	315	300	255	205
Modulus 100%, psi	175	230	450	725	1060
Hardness, Type A	52	57	69	80	89
Specific Gravity	1.85	1.85	1.85	1.85	1.85

Air Aging, 70 hours, 270°C (518°F), ASTM D573					
Tensile, % change	-14	-5	-22	-18	-27
Elongation, % change	5	10	2	-4	-7
Hardness, Type A, points change	-3	-3	-2	1	0

Compression Set, 70 hours, 200°C (392°F), ASTM D395					
Compression Set, %, 0.139" O-ring	14	15	18	20	22
Molded ½" button, % set	18	12	15	17	18

## Suggested Molded Goods Polymers



## Key Considerations:

Molded goods fall into two main categories: complex shapes and bonded seals. Typically, molded goods grade compounds have lower cross link density which affords better processing in complex geometries.

# Non-Black Molded Goods Compounds

## Formulation

Ingredient	Hardness																																			
	55						60						70						80						90											
3M™ Dyneon™ FE 5642	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Ca(OH) <sub>2</sub> HP-XL, HallStar®	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
MgO, Elastomag® 170	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Min-U-Sil® 5 micron	10						20						40						62						85											
Zinc Oxide, USP#1		25						45						75						110						155										
NYAD® 400			10						22						45						70						95									
CaCO <sub>3</sub> Albacar® 5970				10						22						45						70						95								
Mapico® Tan 10A					15						25						45						72						100							
BaSO <sub>4</sub> Huberbrite® 10A						20						40						60						85						120						
<b>Total Parts</b>	<b>119</b>	<b>134</b>	<b>119</b>	<b>119</b>	<b>124</b>	<b>129</b>	<b>129</b>	<b>154</b>	<b>131</b>	<b>131</b>	<b>134</b>	<b>149</b>	<b>149</b>	<b>184</b>	<b>154</b>	<b>154</b>	<b>169</b>	<b>171</b>	<b>219</b>	<b>179</b>	<b>179</b>	<b>181</b>	<b>194</b>	<b>194</b>	<b>264</b>	<b>204</b>	<b>204</b>	<b>209</b>	<b>229</b>							

## Typical Physical Properties

Post Cure, 16 hours, 232°C (450°F)																														
Tensile, psi	1565	2160	1265	1185	1605	1560	1885	2275	1415	1445	2035	1810	2360	2620	1735	1405	2200	1865	2280	2630	1870	1530	2465	1850	2265	2100	1920	1575	2320	1575
Elongation, %	225	345	285	280	290	320	275	330	255	310	305	325	240	305	205	280	300	350	180	300	160	220	310	300	165	215	125	150	260	225
Modulus 100%, psi	260	240	250	220	245	235	370	320	430	335	390	345	810	510	1130	615	480	450	1220	655	1465	970	860	585	1405	1075	1615	1265	1125	810
Hardness, Type A	56	56	56	54	56	57	60	63	61	60	62	62	72	69	73	70	69	69	80	79	81	78	79	76	88	93	86	85	89	86
Specific Gravity	1.9	2.2	1.9	1.9	2.1	2.1	2.0	2.3	2.0	2.0	2.1	2.2	2.0	2.6	2.1	2.1	2.3	2.4	2.1	2.9	2.2	2.1	2.6	2.5	2.2	3.2	2.3	2.2	2.7	2.7

Air Aging, 70 hours, 270°C (518°F), ASTM D573																														
Tensile, % change	-41	-4	-13	-11	-20	-19	-43	-5	-21	-2	-31	-22	-47	-20	-26	8	-32	-24	-49	-29	-29	3	-45	-17	-43	-37	-28	3	-52	-17
Elongation, % change	38	-10	13	-5	19	13	7	-14	18	-10	15	6	4	-16	15	-25	8	-9	14	-32	16	-41	-8	-3	12	-33	4	-33	-10	-9
Hardness, Type A, points change	-6	2	-4	-1	-4	-4	-2	3	-3	-1	-3	-1	-3	6	-2	2	0	0	1	2	-1	4	5	1	1	2	2	3	5	0

Compression Set, 70 hours, 200°C (392°F), ASTM D1414																														
Compression Set, %, 0.139" O-ring	15	17	15	20	15	16							17	26	17	21	22	18							26	52	21	25	38	27

# Basic Extrusion Compounds

## Formulation

Ingredient	O-Ring Cord	Hose/Tubing
3M™ Dyneon™ FC 2174, FE 5621, FE 5641Q	100	-
3M™ Dyneon™ FC 2120, FE 5730, FE 5830Q	-	100
N990	10-50	-
N762	-	10-20
BaSO <sub>4</sub> , CaCO <sub>3</sub> , or Talc	-	20-40
Ca(OH) <sub>2</sub> , HP-XL HallStar®	6	6
MgO, Elastomag® 170	3	3
Carnauba Wax	0.5-1.0	0.5-1.5
Polyethylene Wax	-	0-0.5

### Compound Considerations:

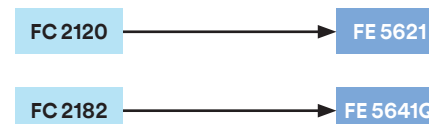
- Extrudate surface requirements
- Configuration of finished part
- Temperature capabilities of processing equipment (choose process aid that will be effective)
- End-use requirements

### Typical Recommendations:

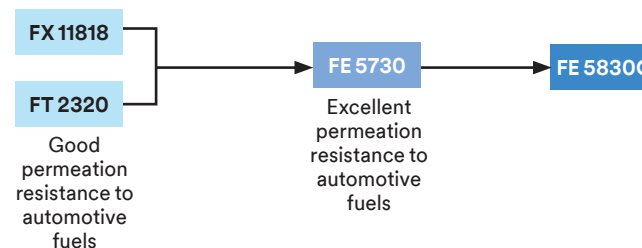
- Medium to low viscosity gum
- 1-2 phr process aid (DBS/Polyethylene/Wax)
- Barrel and die temperatures at 65 to 104°C (150 to 220°F)

## Suggested Extrusion Grade Polymers

### Dipolymers (65-69% F)



### Terpolymers (67-71% F)



# FKM Compound for Explosive Decompression

## Formulation

Ingredient	PHR
3M™ Dyneon™ FC 2179	80
3M™ Dyneon™ FC 2178	20
3M™ Dyneon™ FC 2172	1
N990 MT Carbon Black	30
N110 Carbon Black	20
Ca(OH) <sub>2</sub> , HP-XL HallStar®	6
MgO, Elastomag® 170	3
Carnauba Wax, powder	1
<b>Total Parts</b>	<b>161</b>

## Typical Physical Properties

MDR, 12 minutes, 177°C (350°F)	
MH, in-lb	39.3
ML, in-lb	7.1
t <sub>g2</sub> , min	0.9
t'50, min	4.0
t'90, min	7.7

Press Cure Properties, 10 minutes, 177°C (350°F)	
Tensile, psi	2500
Elongation, %	163
Modulus 100%, psi	1715
Hardness, Type A	89

Post Cure Properties, 16 hours, 232°C (449°F)	
Tensile, psi	2480
Elongation, %	105
Modulus 100%, psi	2345
Hardness, Type A	91

## Typical Physical Properties (continued)

Explosive Decompression Resistance, 820 psig of CO <sub>2</sub> , 120 hours, 24°C (75°F)	
Tensile, % change	-30
Elongation, % change	2
Modulus 50%, % change	-30
Hardness, Type A, points change	-9
Visual Appearance*	1

Explosive Decompression Resistance, 1000 psig of CO <sub>2</sub> , 120 hours, 121°C (249°F)	
Tensile, % change	0
Elongation, % change	0
Modulus 50%, % change	-6
Hardness, Type A, points change	-2
Visual Appearance*	1

Explosive Decompression Resistance, 2500 psig of CO <sub>2</sub> , 120 hours, 24°C (75°F)	
Tensile, % change	-14
Elongation, % change	0
Modulus 50%, % change	-22
Hardness, Type A, points change	-9
Visual Appearance*	1

### \*Visual Appearance Scaling:

- 1 = No blisters
- 2 = Blisters on < 5% of surface
- 3 = Blisters on < 20% of surface
- 4 = Blisters on < 33% of surface
- 5 = Blisters on > 50% of surface

## Key Considerations:

Many applications in high pressure environments require superior extrusion and rapid decompression resistance. To achieve optimum performance, a polymer with high viscosity utilizing reinforcing fillers and a high cross link density cure system is recommended.



# Shaft Seal Compounds

## Formulation

Ingredient	A	B	C
3M™ Dyneon™ FC 2144	100	100	–
3M™ Dyneon™ FC 2123	–	–	100
MgO, Elastomag® 170	3	3	3
Ca(OH) <sub>2</sub> HP-XL HallStar®	6	6	6
CaCO <sub>3</sub>	45	–	–
NYAD® 400	–	40	45
Carnauba Wax	1	1	1
Mapico® 617	3	3	3
N990 MT Black	2	2	2
<b>Total Parts</b>	<b>160</b>	<b>155</b>	<b>160</b>

## Typical Physical Properties

Original Properties	A	B	C
Tensile, psi	1540	1675	1780
Elongation, %	350	250	185
Hardness, Type A	70	70	75

### Heat Aging (air), 70 hours, 260°C (500°F)

Tensile change, %	-5	-11	-14
Elongation change, %	-24	-5	-12
Hardness, Type A, points change	0	-1	2

### Compression Set, 70 hours, 200°C (392°F), ASTM D1414

Compression Set, %, 0.139" O-ring	22	23	21
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### Oil Immersion, 500 hours, 150°C (302°F), ASTM #3

Tensile, % change	-15	-25	-8
Elongation, % change	-14	-2	-5
Hardness, Type A, points change	-1	-1	-1
Volume, % change	2.4	2.4	1.0

## Key Considerations:

Compounds for shaft seals should have good bond strength to mating components and good dynamic wear resistance.

# FKM Compounds for Aerospace

## - AMS 3216G & AMS 7276H

### Formulation

Ingredient	FC 2174	FE 5640Q
3M™ Dyneon™ FC 2174	100	–
3M™ Dyneon™ FE 5640Q	–	100
N990 MT Black	30	30
Ca(OH) <sub>2</sub> , HP-XL HallStar®	6	6
MgO, Elastomag® 170	3	3
Struktol® WS-280	0.5	–
Carnauba Wax	–	0.5
<b>Total Parts</b>	<b>139.5</b>	<b>139.5</b>

### Typical Physical Properties

	FE 5640Q	FC 2174	AMS 3216G	AMS 7276H*
<b>MDR, 12 minutes, 177°C (350°F)</b>				
ML, in-lb	1.3	1.3	Report	Report
MH, in-lb	26.6	26.7	Report	Report
TS <sub>2</sub> , minutes	1.1	2.4	Report	Report
T' 50, minutes	1.3	3.0	Report	Report
T' 90, minutes	1.9	4.6	Report	Report
<b>ODR, 12 minutes, 177°C (350°F)</b>				
ML, in-lb	11.3	10.0	Report	Report
MH, in-lb	110.6	114.2	Report	Report
tS <sub>2</sub> , minutes	1.9	3.8	Report	Report
t'50, minutes	2.9	5.7	Report	Report
t'90, minutes	3.1	6.2	Report	Report
<b>Press Cure, 10 minutes, 662°C (350°F)</b>				
<b>Post Cure, 16 hours, 232°F (450°C)</b>				
Tensile, psi	2280	1750	1600 min.	1400 min.
Elongation, %	194	170	125 min.	125 min.
Hardness, Type A	78	77	75±5	75±5
Specific Gravity	1.83	1.83	Report	Report

### Typical Physical Properties (continued)

ASTM Fuel Resistance: Reference Fuel B, 70 hours, 23°C (75°F)	FC 2174	FE 5640Q	AMS 3216G	AMS 7276H*
Tensile, % change	-8.0	1.5	-20% max.	-20% max.
Elongation, % change	3.1	0	-20% max.	-20% max.
Hardness, Type A, points change	0	-1	-5 to 5	-5 to 5
Volume, % change	1.4	2.9	0 to 5	0 to 5

### ASTM Fuel Resistance: AMS Oil 3023, 70 hours, 200°C (392°F)

Tensile, % change	-23.4	-17.2	-35% max.	-35% max.
Elongation, % change	-3.1	10.2	-20% max.	-20% max.
Hardness, Type A, points change	-10	-9	-15 to 0	-15 to 0
Volume, % change	16.0	19.9	1 to 25	1 to 25
Compression Set, %, 0.139" O-ring	8	3	20 max.	10 max.

### Dry Heat Resistance: 70 hours, 270°C (518°F)

Tensile, % change	-26.8	-20.8	-35% max.	-35% max.
Elongation, % change	-9.8	21.3	-15% max.	-15% max.
Hardness, Type A, points change	2	-4	-5 to 10	-5 to 10
Weight Loss, %	-3.9	-2.4	-10 max.	-10 max.

### Compression Set Resistance: Plied Disks, 22 hours, 200°C (392°F)

Compression Set, %	12	9	15 max.	15 max.
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### Compression Set Resistance: Plied Disks, 336 hours, 200°C (392°F)

Compression Set, %	34	29	45 max.	45 max.
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### Low Temperature Resistance: TR-10

TR-10, °C	-18	-18	-15 min.	-15 min.
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\* AMS 7276H calls for testing on o-rings. Data presented is from tensile sheets.

# LTFE for Aerospace - AMS 7379

## Formulation

Ingredient	PHR	MDR, 6 minutes, 177°C (350°F)	
3M™ Dyneon™ LTFE 6400Z	100	ML, in-lbs	4.4
N990 MT Carbon Black	50	MH, in-lbs	18.6
ZnO, USP #1	5	t <sub>g</sub> 1, min	0.4
TAIC, (72%) DLC	4	t <sub>g</sub> 2, min	0.5
Varox® DBPH-50	2.5	t'50, min	0.8
Struktol® WS-280	1	t'90, min	2.5
<b>Total Parts</b>	<b>162.5</b>	Tand, ML	0.497
		Tand, MH	0.116

## Typical Physical Properties

Original Properties	Test Method	LTFE 6400Z	AMS 7379*
Hardness, Type A	D2240	74	75 ± 5
Tensile strength, psi, min.	D412	1772	1300
Ultimate elongation, %, min.	D412	151	120
Specific gravity	D297	1.86	Qual value ±0.02
TR-10, °C (°F), max.	D1329	-38	-38 (-37)

Differential Scanning Calorimetry	Test Method	LTFE 6400Z	AMS 7379
Glass Transition Point (T <sub>g</sub> ), °C (°F), midpoint max.	D7426	-40	-38 (-36)

Fluid Aging: Reference Fuel B, 70 hours, 23°C (73 °F)	Test Method	LTFE 6400Z	AMS 7379
Hardness, Type A, pts change, max.	D2240	-4	-10
Tensile strength, % change, max.	D471	-22	-35
Ultimate elongation, % change, max.	D471	8	-20
Volume, % change	D471	3	1 to 10

## Typical Physical Properties (continued)

Fluid Aging: Reference Oil 300 (AMS 3085), 70 hours, 200°C (392 °F)	Test Method	LTFE 6400Z	AMS 7379
Hardness, Type A, points change, max.	D2240	-6	-10
Tensile strength, % change, max.	D471	-8	-30
Ultimate elongation, % change, max.	D471	28	-20
Volume, % change	D471	5	0 to 10
Compression set, %, 0.139" O-ring, ASTM D1414			
70 hours, 200°C (392 °F)	D1414	18	25
336 hours, 200°C (392 °F)	D1414	44	55

Fluid Aging: Mobil™ Jet Oil 254, 70 hours, 200°C (392 °F)	Test Method	LTFE 6400Z	AMS 7379
Hardness, Type A, points change, max.	D2240	-6	-10
Tensile strength, % change, max.	D471	-10	-30
Ultimate elongation, % change, max.	D471	19	-20
Volume, % change	D471	5	0 to 10
Compression set, %, 0.139" O-ring, ASTM D1414			
70 hours, 200°C (392 °F)	D1414	22	25
336 hours, 200°C (392 °F)	D1414	40	55

Fluid Aging: MIL-PRF-83282, 70 hours, 135°C (275 °F)	Test Method	LTFE 6400Z	AMS 7379
Hardness, Type A, points change, max.	D2240	-5	-7
Tensile strength, % change, max.	D471	-7	-25
Ultimate elongation, % change, max.	D471	16	-15
Volume, % change, max.	D471	1	6
Compression set, %, 0.139" O-ring, ASTM D1414			
70 hours, 135°C (275 °F)	D1414	11	20
336 hours, 135°C (275 °F)	D1414	19	35

Heat Aging: 70 hours, 270°C (518 °F)	Test Method	LTFE 6400Z	AMS 7379
Hardness, Type A, points change, max.	D2240	-3	-10 to 5
Tensile strength, % change, max.	D573	-33	-45
Ultimate elongation, % change, max.	D573	5	-10
Weight loss, % change, max.	D573	6	10
Compression set, %, 0.139" O-ring, ASTM D1414			
22 hours, 200°C (392 °F)	D1414	16	20
336 hours, 200°C (392 °F)	D1414	46	55

\* AMS 7379 calls for testing on O-rings. Data presented is from tensile sheets.

# PFE for Aerospace - AMS 7257E

## Formulation

Ingredient	A	B
3M™ Dyneon™ PFE 131TZ	65	93
3M™ Dyneon™ PFE 81TZ	28	–
3M™ Dyneon™ PFE 02CZ	2.5	2.5
3M™ Dyneon™ PFE 01CZ	6	6
Aerosil® R972	1.5	1.5
N550	15	15
<b>Total PHR</b>	<b>118</b>	<b>118</b>

Vulcanizates Physical Properties per ASTM D412 and D2240

Press Cured: Compression molded Tensile Sheets 188°C (370°F) x 15 minutes

Post Cured: 250°C (482°) x 16 hours

## Typical Physical Properties

Original Properties	A	B	AMS7257E
Tensile, psi	1865	2115	> 1500
Elongation, %	130	120	> 120
Modulus 100%, psi	1280	1560	–
Hardness, Type A	80	80	70 - 80

### Thermal Air Aging: Forced Air Oven, 70 hours, 290°C (554°F), ASTM D573

Tensile, % change, max.	-8	2	-20
Elongation, % change, max.	31	50	-5
Hardness, pts change, max.	-3	-2	-5
Weight Loss, max. %	1	1	5

### Fluid Aging: ASTM Reference Fuel B, 70 hours 25°C (77°F) ASTM D471

Tensile, % change, max.	7	-3	-20
Elongation, % change, max.	8	8	-15
Hardness, pts change, max.	-1	0	-5
Volume change, max. %	0	1	5

## Typical Physical Properties (continued)

Compression Set, 70 hours, 230°C (446°F), ASTM D1414	A	B	AMS 7257E
Compression set, %, 0.139" O-ring	21	21	< 40

### Fluid Aging: Block Oven, 70 hours, 125°C (257°F) in AS 1241 Type IV, ASTM D471

Tensile, % change, max.	-25	-23	-40
Elongation, % change, max.	-8	0	-15
Hardness, points change, max.	-6	-5	-15
Volume change, max. %	6	6	15

### Fluid Aging: Block Oven, 70 hours, 200°C (392°F) in AMS 3085, ASTM D471

Tensile, % change, max.	8	11	-10
Elongation, % change, max.	12	0	-15
Hardness, points change, max.	-2	-2	-5
Volume change, max. %	1	1	5

### Fluid Aging: Block Oven, 70 hours, 200°C (392°F) in AMS 3085, ASTM D471

Tensile, % change, max.	2	0	-10
Elongation, % change, max.	4	13	-15
Hardness, points change, max.	-3	-2	-5
Volume change, max. %	1	1	5

### Low Temperature Retraction (TR-10), ASTM D1329

TR10, max.	-1.9	-1.8	5
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# 3M™ Dyneon™ Fluoroelastomer Compound Recipes

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