

Specification

## Supply, receiving and handling of non metallic seals

970120323

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## 1 Introduction

### 1.1 Purpose

This specification establishes the requirements for supply, receiving and handling of non-metallic components and assemblies that contain those components.

### 1.2 Clarifications

All references made to FMC are to be changed to Oceaneering.

The PSL value is found on the Data Card for the part.

### 1.3 Terms and Abbreviations

All abbreviations used throughout the specification shall be listed in the table.

Abbreviation	Full Name
PSL	Product Service Level

## 1.4 Reference and standards

Doc.no	Description
	ISO 2859-1
	API 6A
	API 17D
	SAE AS 568
	ASTM D 2240
	ASTM D 1415
	ISO 48
	DIN 53519
	DIN 53505
	ISO 1629
	ASTM D 1418

## 2 Specification Supply, receiving and handling of non metallic seals

### 2.1 Reference specification

Reference FMC specification doc no: Q03805 rev N

### 2.2 Clarification

All references made to FMC are to be changed to Oceaneering.

The PSL value is found on the Data Card for the part.

### 3 Specification Supply, receiving and handling of PSL-3 Elastomeric and plastic seals

#### 3.1 Reference specification

Reference FMC specification doc no: Q03803 rev N

#### 3.2 Clarification

All references made to FMC are to be changed to Oceaneering.

Components information is found on the Data Card for the part instead of the DBI

### 4 Appendix

Appendix 1: FMC Specification Q03805

Appendix 2: FMC Specification Q03803

Appendix 3: FMC Specification E50407

Appendix 4: FMC Specification E50417

Appendix 5: FMC Specification E50307

Appendix 6: FMC Specification E50309

Appendix 7: FMC Specification E50317

Appendix 8: FMC Specification E50178

Appendix 9: FMC Specification E50227

Appendix 11: FMC Specification E50709

Appendix 12: FMC Specification E53908

Appendix 13: FMC Specification E50124

Appendix 14: FMC Specification E50207

Appendix 15: FMC Specification E50208

Appendix 17: FMC Specification E50209

Appendix 18: FMC Specification E50218

Appendix 19: FMC Specification E50003



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Appendix 20: FMC Specification E50004

Appendix 21: FMC Specification E50007

Appendix 22: FMC Specification E50009

Appendix 23: FMC Specification E50019

Appendix 24: FMC Specification E50029

Appendix 25: FMC Specification E50037

Appendix 26: FMC Specification E50038

Appendix 28: FMC Specification E50039

Appendix 29: FMC Specification E50048

Appendix 30: FMC Specification E50058

Appendix 31: FMC Specification E50059

Appendix 32: FMC Specification E50111

Appendix 33: FMC Specification E50112

Appendix 34: FMC Specification E50113

Appendix 35: FMC Specification E50122

Appendix 36: FMC Specification E50123

Appendix 37: FMC Specification E50138

Appendix 38: FMC Specification E50157

Appendix 39: FMC Specification E50158

Appendix 40: FMC Specification E50159

Appendix 41: FMC Specification E50187

Appendix 42: FMC Specification E50188

Appendix 43: FMC Specification E50189

Appendix 44: FMC Specification E50509

Appendix 45: FMC Specification E51109

Appendix 46: FMC Specification E51119

Appendix 47: FMC Specification E53009

Appendix 48: FMC Specification E50002

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Appendix 49: FMC Specification E50106

Appendix 50: FMC Specification E50107

Appendix 51: FMC Specification E50108

Appendix 52: FMC Specification E50109

Appendix 53: FMC Specification E50117

Appendix 54: FMC Specification E50119

Appendix 55: FMC Specification E50126

Appendix 56: FMC Specification E50127

Appendix 57: FMC Specification E50129

Appendix 58: FMC Specification E50130

Appendix 59: FMC Specification E50137

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Appendix 62: FMC Specification E50169

Appendix 63: FMC Specification E50197

Appendix 64: FMC Specification E50198

Appendix 65: FMC Specification E50199

Appendix 66: FMC Specification E50237

Appendix 67: FMC Specification E50239

Appendix 68: FMC Specification E52007

Appendix 69: FMC Specification E52009

Appendix 70: FMC Specification E56002

Appendix 71: FMC Specification E54217

Appendix 72: FMC Specification E54218

Appendix 73: FMC Specification E54219

Appendix 74: FMC Specification E54229

Appendix 75: FMC Specification E54238

Appendix 76: FMC Specification E54319

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Appendix 77: FMC Specification E56001

Appendix 78: FMC Specification E50139

Appendix 79: FMC Specification E55201

Appendix 80: FMC Specification E55202

Appendix 81: FMC Specification E50104

Appendix 82: FMC Specification E50105

Appendix 83: FMC Specification E55801

Appendix 84: FMC Specification E55001

Appendix 85: FMC Specification E55002

Appendix 86: FMC Specification E55003

Appendix 87: FMC Specification E55004

Appendix 88: FMC Specification E55005

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Appendix 90: FMC Specification E55008

Appendix 91: FMC Specification E55009

Appendix 92: FMC Specification E55010

Appendix 93: FMC Specification E56201

Appendix 94: FMC Specification E56301

Appendix 95: FMC Specification E56302

Appendix 96: FMC Specification E56303

Appendix 97: FMC Specification E50121

Appendix 98: FMC Specification E55101

Appendix 99: FMC Specification E50132

Appendix 100: FMC Specification E53504

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Appendix 103: FMC Specification E55502

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Appendix 105: FMC Specification E55504

Appendix 106: FMC Specification E55505

Appendix 107: FMC Specification E55509

Appendix 108: FMC Specification E55510

Appendix 109: FMC Specification E55511

Appendix 110: FMC Specification E55512

Appendix 111: FMC Specification E55301

**SUPPLY, RECEIVING AND HANDLING OF ELASTOMERIC AND  
PLASTIC COMPONENTS AND ASSEMBLIES**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
N	1159392	28-MAY-2010	Wolff, Geoff	Glidden, Greg	RELEASED

## Summary:

This specification establishes the requirements for supply, receiving and handling of non-metallic components and assemblies that contain those components.

## 1.0 SCOPE

This specification establishes the requirements for supply, receiving and handling of elastomeric and plastic components and assemblies that contain those components. These requirements are based on API Specification 6A and 17D for non-metallic materials.

The requirements in this specification are service type dependent. FMC Houston has assigned each service type with a Product Service Level (PSL) to align with API 6A. These service types are as follows: non-sealing service (PSL 1); non-critical sealing service (PSL 2); critical sealing service (PSL 3); and ultra-critical sealing service (PSL 4).

For assemblies, the requirements are determined by the service type of the assembly. For components, the PSL value is found on the Data Base Information (DBI). For DBI's which indicate a PSL range, select the highest value. If the DBI shows "NA", then follow PSL 1.

NOTE: All components made to this specification shall be continuously molded unless spliced or machined construction is allowed on the DBI.

## 2.0 VENDOR RESPONSIBILITIES

**Table 1: Vendor requirements for non-metallic materials**

Vendor Responsibilities	Section reference for applications			
	non-sealing (PSL 1)	non-critical sealing (PSL 2)	critical sealing (PSL 3)	ultra-critical sealing (PSL 4)
Dimensional verification	2.1.1	2.1.1	2.1.1	2.1.1
Visual examination	2.1.2	2.1.2	2.1.2	2.1.2
Hardness	2.1.3	2.1.3	2.1.3	2.1.3
Age control	—	2.2	2.2	2.2
Packaging	2.3	2.3	2.3	2.3
Marking	2.4.1	2.4.2	2.4.3	2.4.3
Part number	2.4.1	2.4.2	2.4.3	2.4.3
Cure date	—	2.4.2	2.4.3	2.4.3
Batch designation	—	—	2.4.3	2.4.3
Documentation	—	2.5.2	2.5.3	2.5.4
Cure date certification	—	2.5.2	2.5.3	2.5.4
Physical property data	—	—	—	2.5.4

### 2.1 Required Inspection of Parts

Inspection sampling shall be performed to ISO 2859-1, Level II, 2.5 AQL (Table 3) for O-Rings, and 1.5 AQL (Table 2) for other elastomeric and plastic parts.

### **2.1.1 Dimensional Verification**

Each sample shall be dimensionally inspected for compliance to the FMC or manufacturer drawing if the former does not exist, or lacks dimensions with tolerances. SAE AS 568 shall apply to O-Rings with no drawings. If rejections are more than that allowed in sampling, then the batch shall be rejected.

### **2.1.2 Visual Examination**

Each sample shall be visually inspected without magnification per the manufacturer's written requirements. Damage on critical surfaces such as cracks, nicks, breaks, pin holes, excessive parting line projection or indentation, mold seam mismatch, non-fill, flow marks, blisters, cold weld lines and excessive trimming are cause for rejection. If rejections are more than that allowed in sampling, then the batch shall be rejected.

### **2.1.3 Hardness Testing**

For elastomeric materials only (see Table 4). Each sample shall be hardness tested at one location per ASTM D 2240, ASTM D 1415, ISO 48, DIN 53519 or DIN 53505. If ASTM D 2240, ASTM D 1415, or DIN 53505 is used on seals, then the surface that is closest to meeting the flatness and section thickness requirements shall be tested. The hardness impression shall be made on a continuous, non-critical surface. The hardness impression on O-Rings shall be made anywhere except the flash-line. Each sample shall be inspected for compliance to the FMC E-Spec, or the manufacturer's requirements if the former doesn't exist. If rejections are more than that allowed in sampling, then the batch shall be rejected.

## **2.2 Age Control**

### **2.2.1 Non-sealing service (PSL 1)**

None

### **2.2.2 Sealing service (PSL 2-4)**

Materials shall have at least 50% of their shelf-life remaining when delivered to FMC, as defined in Tables 4 and 5.

## **2.3 Packaging of Unassembled Components**

The vendor shall package unassembled components compliant with the following:

### **2.3.1 Non-sealing service (PSL 1)**

- Parts shall be packaged in re-closeable cardboard boxes or plastic bags

### 2.3.2 Sealing service (PSL 2 – 4)

- Packaging shall be opaque to ultraviolet (UV) light. UV transparent packaging of individual parts or small groups of parts is allowed if the packaging is placed in another UV opaque container. If the packaging is opaque to UV light but transparent to visible light, then it shall be marked as so. Any packaging containing plasticizer shall not be used in contact with parts.
- Suitable packaging materials include (but not limited to) opaque polyethylene (PE) film, PE-coated craft paper and aluminum foil/paper/PE laminate. If PE is the sole packaging, it shall be at least 3 mils (.075 mm) thick.
- Packaging shall be airtight. Free access to air shall be provided to silicone parts.
- Containers with multiple parts shall have re-sealable, airtight locking packaging.
- Multiple parts packaged together shall be segregated by batch and part number.
- Parts composed entirely of plastic (see Table 5) may be individually packaged in fully enclosed cardboard boxes that are re-closeable.

The following sealing rings may be formed into three superimposed loops to save space:

- PolyPak® Seal assemblies if their ID is greater than 24" (610 mm)
- PIP® Rings not made of PTFE or PEEK if their ID is greater than 24" (610 mm)
- Elastomeric seals such as Packings (L, Dovetail and Belt) or O-Rings if their OD is greater than 10" (254 mm)
- Elastomeric S-Seals if their OD is greater than 24" (610 mm)

## 2.4 Marking

The containers the components are supplied in shall be marked with the following:

### 2.4.1 Non-sealing service (PSL 1)

- FMC P.O. number
- FMC part number and revision letter
- Manufacturer's identity

These details shall be durably marked on the exterior of each container. If the DBI or other dispensation removes the container requirement, then a label with the above information shall be attached to each part.



If drawings for molded parts require the part number to be placed on the part, then the part number shall be molded in or hand written using durable ink that is compatible with the material.

#### **2.4.2 Non-critical sealing service (PSL 2)**

Same as Section 2.4.1 plus:

- Quarter and year of cure date (for example 3Q04). The date of component with shortest shelf life (see Tables 4 and 5) shall be used. Cure date may be stated more precisely than by quarter.

#### **2.4.3 Critical & ultra-critical sealing service (PSL 3 – 4)**

Same as Section 2.4.2 plus:

- Manufacturer's batch number(s). Include for each elastomeric or plastic material in an assembly.

### **2.5 Documentation**

#### **2.5.1 Non-sealing service (PSL 1)**

None

#### **2.5.2 Non-critical sealing service (PSL 2)**

The vendor shall supply a signed letter of compliance with delivery. The letter shall certify that all FMC and manufacturer's requirements are met. The letter shall include the information in Section 2.4.2 plus:

- Manufacturer's part number (assembly p/n only if part is an assembly)
- Manufacturer's compound number(s). Include for each material in an assembly.
- Manufacturer's material specification number(s) if different from compound number. Include for each material in an assembly.

Note: The container label shall serve as the signed letter of compliance if it fulfills the above requirements as well as those in Section 2.4.

#### **2.5.3 Critical sealing service (PSL 3)**

Same as Section 2.5.2 plus information in Section 2.4.3

**2.5.4 Ultra-critical sealing service (PSL 4)**

Same as in Section 2.5.3 plus:

The vendor shall supply a copy of the physical properties test results of each batch of raw material for every compound supplied in accordance with the FMC E-spec.

**3.0 FMC RECEIVING INSPECTION RESPONSIBILITIES****3.1 Packaging, Marking, Batch, Age and Documentation****3.1.1 Non-sealing service (PSL 1)**

Receiving Inspection shall verify:

- The packaging is marked per the requirements of Section 2.4

**3.1.2 Sealing service (PSL 2 – 4)**

Same as Section 3.1.1 plus:

- The age requirements in Section 2.2 are fulfilled
- Packaging is completely opaque or is marked as opaque to UV light
- For elastomers, other than silicone, packaging is airtight; bags containing multiple parts have airtight locking that is re-sealable
- The delivery is accompanied by the documentation specified in Section 2.5

**3.2 Expanded Inspection of Parts**

FMC inspection shall be expanded beyond the requirements in Section 3.1 if:

- There is visual damage to packaging in transit
- Quality Assurance requests expanded inspection due to poor supplier performance

Additional inspection may include one or more of the following:

- Redo part or all of inspection required of the vendor in Section 2.1
- Larger sample
- More detailed visual inspection to verify compliance with specific acceptance levels in industrial standard or FMC specification referenced by the DBI

- More detailed dimensional inspection to verify compliance with tolerances in drawing, industrial standard, or FMC specification referenced by the DBI

## **4.0 FMC PROCUREMENT, QUALITY ASSURANCE AND ENGINEERING RESPONSIBILITIES**

Procurement, Quality Assurance and Engineering shall cooperate to assure the quality of parts and may initiate additional receiving inspection requirements when appropriate. (Local FMC site operating procedures specify the distribution of responsibility between Procurement, Quality Assurance and Engineering.)

Expanded inspection may be appropriate in the following situations:

- Criticality of application
- New type of product
- Non-mass produced product
- Difficult manufacturing process

When it is determined that expanded inspection is appropriate, those requirements from the list in Section 3.2 will be stated in the DBI.

## **5.0 FMC WAREHOUSE RESPONSIBILITIES**

### **5.1 Storage and Handling**

- Store in the containers in which they were delivered.
- Inventory shall be kept indoors and at temperatures between 39 and 80°F (4 and 27°C). A maximum temperature of 73°F (23°C) is recommended. If the temperature is below 59°F (15°C), then care shall be taken during the handling of products as they can stiffen and become distorted. The temperature of products taken from low-temperature storage shall be raised to room temperature before put into service.
- Store away from: direct sunlight; ozone generating equipment, e.g., electric compressors, electric pumps, electric generators; fluid contact; and radiation sources.
- Do not place elastomeric parts on bare wooden pallets.
- Store in dry conditions, i.e., not exposed to moisture/water.
- Store in a low stress state, i.e., sealing rings lying in a flat and generally round geometry. The exception being looped Sealing Rings as described in Section 2.3.

- Do not store by hanging, use metal wire to attach tags, or hold sealing rings collapsed.
- Parts delivered to the warehouse from a department other than Receiving (e.g., return from Assembly or Field), shall be packaged to meet Sections 2.3 and 2.4.

## **5.2 Shelf Life Review**

### **5.2.1 Non-sealing service (PSL 1)**

None

### **5.2.2 Sealing service (PSL 2 – 4)**

The stock shall be reviewed by the Warehouse Supervisor in January and July. Using the cure date on the container and shelf-life as defined in Tables 4 and 5, parts with less than 1 year of shelf-life remaining shall be scrapped.

## **5.3 Issuance**

### **5.3.1 Non-sealing service (PSL 1)**

All elastomeric and plastic parts shall be issued from stock on a first in, first out basis.

### **5.3.2 Sealing service (PSL 2 – 4)**

All elastomeric and plastic parts shall be issued from stock based on the cure date on the container. The batch with the oldest cure date shall be issued first.

## 6.0 APPENDIX

### 6.1 Definitions

Vendor – either the manufacturer or final supplier to FMC of the component or assembly

Critical surface – surface where primary sealing occurs, such as the sealing lips of Lip Type Seals, all surfaces for O-Rings and the sealing bump and back face of an S-Seal

**Table 2: Sample Size and Allowable Defects for ISO 2859-1, Level II, 1.5 AQL**

Batch/Lot Size	Random Sample Size	Max. Allowed Sample Defects
2-8	2	0
9-15	3	0
16-25	5	0
26-50	8	0
51-90	13	0
91-150	20	1
151-280	32	1
281-500	50	2
501-1200	80	3
1201-3200	125	5

**Table 3: Sample Size and Allowable Defects for ISO 2859-1, Level II, 2.5 AQL**

Batch/Lot Size	Random Sample Size	Max. Allowed Sample Defects
2-8	2	0
9-15	3	0
16-25	5	0
26-50	8	0
51-90	13	1
91-150	20	1
151-280	32	2
281-500	50	3
501-1200	80	5
1201-3200	125	7

**Table 4: Maximum Shelf Life in Years for Elastomers**

Abbreviation (ISO 1629/ ASTM D 1418)*	Name	Trade Names (Examples Only)	FMC Material Specification	Shelf Life (Years)
CR	Chloroprene	Neoprene®, Bayprene®	E50407, E50417	7
ECO**	Epichlorohydrin	Hydrin®	E50307, E50309, E50317	7
EPDM	Ethylene Propylene Diene Monomer	Dutral®, Keltan®, Vistalon®, Buna EP®	E50178, E50227, E50709	10
FFKM	Perfluoroelastomer	Kalrez®, Chemraz®, Isolast®	E53908	15
FKM	Fluoroelastomer	Dai-El®, Viton®, Fluorel®, Technoflon®	E50124, E50207, E50208, E50209, E50218	10
HNBR, HSN	Hydrogenated Nitrile	Zetpol®, Therban®	E50003, E50004, E50007, E50009, E50019, E50029, E50037, E50038, E50039, E50048, E50058, E50059, E50111, E50112, E50113, E50122, E50123, E50138, E50157, E50158, E50159, E50187, E50188, E50189, E50509, E51109, E51119, E53009	10
HXNBR	Hydrogenated Carboxylated Nitrile			10
NBR	Nitrile, Buna N	Europrene-N®, Krynac®, Hycar®, Nipol®, Perbunan®, Breon®	E50002, E50106, E50107, E50108, E50109, E50117, E50119, E50126, E50127, E50129, E50130, E50137, E50149, E50167, E50169, E50197, E50198, E50199, E50237, E50239, E52007, E52009, E56002	7
FEPM, TFE/P**	Tetrafluoroethylene Propylene Copolymer	Aflas®	E54217, E54218, E54219, E54229, E54238, E54319, E56001	15
XNBR	Carboxylated Nitrile	Nitroxile®	E50139	7

\* ISO 1629 and ASTM D 1418 use the same abbreviations, except where two abbreviations are shown.

\*\* Abbreviation not yet standardized.

**Table 5: Maximum Shelf Life in Years for Plastics**

Abbreviation	Name	Trade Names (Examples Only)	FMC Material Specification	Shelf Life (Years)
	Acetal Polymer	Delrin®	E55201, E55202	5
TPV		Geolast®	E50104, E50105	10
PA	Polyamide	Nylon	E55801	10
PEEK	PolyEtherEther-Ketone	Arlon®	E55001, E55002, E55003, E55004, E55005, E55007, E55008, E55009, E55010	20
AU	Polyester Urethane	Molythane®	E56201	12
	Polyester Elastomer	Polymyte®, Hytrel®	E56301, E56302, E56303	12
PPS	Polyphenylene Sulfide	Ryton®, Fortron®	E50121, E55101	20
PTFE	PolyTetrafluoroEthylene	Teflon®, Rulon®	E50132, E53504, E55401, E55501, E55502, E55503, E55504, E55505, E55509, E55510, E55511, E55512	20
ETFE	Ethylene Tetrafluoroethylene Copolymer	Tefzel®	E55301	20

**SUPPLY, RECEIVING AND HANDLING OF PSL-3 ELASTOMERIC  
AND PLASTIC SEALS**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
N	1159392	28-MAY-2010	Wolff, Geoff	Glidden, Greg	RELEASED

## Summary:

This specification establishes the requirements for supply, receiving and handling of PSL 3 elastomeric and plastic seals.



## 1.0 SCOPE

This specification establishes the requirements for supply, receiving and handling of elastomeric and plastic seals per PSL 3 in API Specifications 6A and 17D. These seals are used in critical applications.

NOTE: All components made to this specification shall be continuously molded unless spliced or machined construction is allowed on the DBI.

## 2.0 VENDOR RESPONSIBILITIES

### 2.1 Required Inspection of Parts

Inspection sampling shall be performed to ISO 2859-1, Level II, 2.5 AQL (Table 2) for O-Rings, and 1.5 AQL (Table 1) for other elastomeric and plastic parts.

#### 2.1.1 Dimensional Verification

Each sample shall be dimensionally inspected for compliance to the FMC or manufacturer drawing if the former does not exist, or lacks dimensions with tolerances. SAE AS 568 shall apply to O-Rings when there are no drawings. If rejections are more than that allowed in sampling, then the batch shall be rejected.

#### 2.1.2 Visual Examination

Each sample shall be visually inspected without magnification per the manufacturer's written requirements. Damage on critical surfaces such as cracks, nicks, breaks, pin holes, excessive parting line projection or indentation, mold seam mismatch, non-fill, flow marks, blisters, cold weld lines and excessive trimming are cause for rejection. If rejections are more than that allowed in sampling, then the batch shall be rejected. See Appendix for section identifying locations and extents of critical surfaces.

#### 2.1.3 Hardness Testing

For elastomeric materials only, see Table 3. Each sample shall be hardness tested at one location per ASTM D 2240, ASTM D 1415, ISO 48, DIN 53519 or DIN 53505. If ASTM D 2240, ASTM D 1415, or DIN 53505 is used on seals, then the surface that is closest to meeting the flatness and section thickness requirements shall be tested. The hardness impression shall be made on a continuous, non-critical surface. The hardness impression on O-Rings shall be made anywhere except the flash-line. Each sample shall be inspected for compliance to the FMC E-Spec, or the manufacturer's requirements if the former doesn't exist. If rejections are more than that allowed in sampling, then the batch shall be rejected.

## 2.2 Age Control

The materials shall have at least 50% of their shelf-life remaining, as defined in Tables 3 and 4.

## 2.3 Packaging

The vendor shall package parts in accordance with the following:

- Packaging shall be opaque to ultraviolet (UV) light. UV transparent packaging of individual parts or small groups of parts is allowed if the packaging is placed in another UV opaque container. If the packaging is opaque to UV light but transparent to visible light, then it shall be marked as so. Any packaging containing plasticizer shall not be used in contact with parts.
- Suitable packaging materials include (but not limited to) opaque polyethylene (PE) film, PE-coated craft paper and aluminum foil/paper/PE laminate. If PE is the sole packaging, it shall be at least 3 mils (.075 mm) thick.
- Packaging shall be airtight. Free access to air shall be provided to silicone parts.
- Containers with multiple parts shall have re-sealable, airtight locking packaging.
- Multiple parts packaged together shall be segregated by batch and part number.
- Parts composed entirely of plastic (see Table 4) may be individually packaged in fully enclosed cardboard boxes that are re-closeable.

The following sealing rings may be formed into three superimposed loops to save space:

- PolyPak® Seal assemblies if their ID is greater than 24" (610 mm)
- PIP® Rings not made of PTFE or PEEK if their ID is greater than 24" (610 mm)
- Elastomeric seals such as Packings (L, Dovetail and Belt) or O-Rings if their OD is greater than 10" (254 mm)
- Elastomeric S-Seals if their OD is greater than 24" (610 mm)

## 2.4 Marking

The containers in which parts are supplied shall be marked with the following:

- FMC P.O. number
- FMC part number and revision letter
- Quarter and year of cure date (for example 3Q04). The date of component with shortest shelf life (see Tables 3 and 4) shall be used. Cure date may be stated more precisely than by quarter.

- Manufacturer's batch number(s). Include for each elastomeric or plastic material in an assembly.
- Manufacturer's identity

These details shall be durably marked on the exterior of each container. If a container is not required in the DBI or other dispensation, then a label with the above information shall be attached to each part.

If drawings for molded parts require the part number to be placed on the part, then the part number shall be molded in or hand written using durable ink that is compatible with the material.

## **2.5 Documentation**

The vendor shall supply a signed letter of compliance with delivery. The letter shall certify that all FMC and manufacturer's requirements are met. The letter of compliance shall include the information in Section 2.4 plus:

- Manufacturer's part number (assembly p/n only if part is an assembly)
- Manufacturer's compound number(s). Include for each material in an assembly.
- Manufacturer's material specification number(s) if different from compound number. Include for each material in an assembly.

## **3.0 SEAL RECEIVING INSPECTION RESPONSIBILITIES**

### **3.1 Packaging, Marking, Batch, Age and Documentation**

Receiving Inspection shall verify that:

- Packaging is completely opaque or is marked as opaque to UV light
- For elastomers, other than silicone, packaging is airtight; bags containing multiple parts have airtight locking that is re-sealable
- Large seals, if formed into loops, are formed into three equal superimposed loops
- Packaging is marked per Section 2.4
- Age requirements in Section 2.2 are fulfilled
- The delivery is accompanied by the documentation specified in Section 2.5

### **3.2 Expanded Inspection of Parts**

FMC inspection shall be expanded beyond the requirements in Section 3.1 if:

- There is visual damage to packaging in transit
- Quality Assurance requests it through local work processes due to poor vendor performance

Additional inspection may include one or more of the following:

- Repeat part or all of the inspection required of vendor in Section 2.1
- Larger inspection sample
- More detailed visual inspection to verify compliance with acceptance levels in industrial standard or FMC specification referenced by the DBI
- More detailed dimensional inspection to verify compliance with tolerances in drawing, industrial standard, or FMC specification referenced by the DBI

## **4.0 FMC PROCUREMENT, QUALITY ASSURANCE, AND ENGINEERING RESPONSIBILITIES**

Procurement, Quality Assurance, and Engineering shall cooperate to assure the quality of parts and may initiate additional receiving inspection requirements when appropriate. (Local FMC site operating procedures specify the distribution of responsibility between Procurement, Quality Assurance, and Engineering.)

Expanded inspection may be appropriate due to the following conditions:

- Criticality of application
- New type of product
- Non-mass produced product
- Difficult manufacturing process

When it is determined that expanded inspection is appropriate, the additional requirements from section 3.2 shall be stated in the DBI.

## **5.0 SEAL WAREHOUSE RESPONSIBILITIES**

### **5.1 Storage and Handling**

- Store in the containers in which they were delivered.
- Inventory shall be kept indoors and at temperatures between 39 and 80°F (4 and 27°C). A maximum temperature of 73°F (23°C) is recommended. If the temperature is below 59°F (15°C), then care shall be taken during the handling of products as they can stiffen and become distorted. The temperature of products taken from low-temperature storage shall be raised to room temperature before put into service.
- Store away from direct sunlight; ozone generating equipment, e.g., electric compressors, electric pumps, and electric generators; fluid contact; and radiation sources.
- Store in dry conditions, i.e., not exposed to moisture/water.
- Do not place elastomeric parts on bare wooden pallets.
- Store in a low stress state, i.e., sealing rings lying in a flat and generally round geometry. The exception being looped Sealing Rings as described in Section 2.3.
- Do not store by hanging, use metal wire to attach tags, or hold sealing rings collapsed.
- Parts delivered to the warehouse from a department other than Receiving (e.g., return from Assembly or Field), shall be packaged to meet Sections 2.3 and 2.4.

### **5.2 Shelf-Life Review**

The stock shall be reviewed twice a year by the Warehouse Supervisor in January and July. Using the cure date on the container and shelf-life defined in Table 3 and Table 4, parts with less than 1 year remaining shall be scrapped.

### **5.3 Issuance**

All elastomeric and plastic parts shall be issued from stock based on the cure date on the container. The batch with the oldest cure date shall be issued first.

## 6.0 APPENDIX

### 6.1 Definitions

**Vendor** – either the manufacturer or final supplier to FMC of the component or assembly

**Critical surface** – surface where primary sealing occurs and a backup (or redundant) sealing surface is not available, such as the sealing lips of Lip Type Seals, all surfaces for O-Rings, the sealing bump of an S-Seal and the middle of the ID & OD of Packings for Casing Hangers.

**Table 1: Sample Size and Allowable Defects for ISO 2859-1, Level II, 1.5 AQL**

Batch/Lot Size	Random Sample Size	Max. Allowed Sample Defects
2-8	2	0
9-15	3	0
16-25	5	0
26-50	8	0
51-90	13	0
91-150	20	1
151-280	32	1
281-500	50	2
501-1200	80	3
1201-3200	125	5

**Table 2: Sample Size and Allowable Defects for ISO 2859-1, Level II, 2.5 AQL**

Batch/Lot Size	Random Sample Size	Max. Allowed Sample Defects
2-8	2	0
9-15	3	0
16-25	5	0
26-50	8	0
51-90	13	1
91-150	20	1
151-280	32	2
281-500	50	3
501-1200	80	5
1201-3200	125	7

**Table 3: Maximum Shelf Life in Years for Elastomers**

Abbreviation (ISO 1629/ ASTM D 1418)*	Name	Trade Names (Examples Only)	FMC Material Specification	Shelf Life (Years)
CR	Chloroprene	Neoprene®, Bayprene®	E50407, E50417	7
ECO**	Epichlorohydrin	Hydrin®	E50307, E50309, E50317	7
EPDM	Ethylene Propylene Diene Monomer	Dutral®, Keltan®, Vistalon®, Buna EP®	E50178, E50227, E50709	10
FFKM	Perfluoroelastomer	Kalrez®, Chemraz®, Isolast®	E53908	15
FKM	Fluoroelastomer	Dai-El®, Viton®, Fluorel®, Technoflon®	E50124, E50207, E50208, E50209, E50218	10
HNBR, HSN	Hydrogenated Nitrile	Zetpol®, Therban®	E50003, E50004, E50007, E50009, E50019, E50029, E50037, E50038, E50039, E50048, E50058, E50059, E50111, E50112, E50113, E50122, E50123, E50138, E50157, E50158, E50159, E50187, E50188, E50189, E50509, E51109, E51119, E53009	10
HXNBR	Hydrogenated Carboxylated Nitrile			10
NBR	Nitrile, Buna N	Europrene-N®, Krynac®, Hycar®, Nipol®, Perbunan®, Breon®	E50002, E50106, E50107, E50108, E50109, E50117, E50119, E50126, E50127, E50129, E50130, E50137, E50149, E50167, E50169, E50197, E50198, E50199, E50237, E50239, E52007, E52009, E56002	7
FEPM, TFE/P**	Tetrafluoroethylene Propylene Copolymer	Aflas®	E54217, E54218, E54219, E54229, E54238, E54319, E56001	15
XNBR	Carboxylated Nitrile	Nitroxile®	E50139	7

\* ISO 1629 and ASTM D 1418 use the same abbreviations, except where two abbreviations are shown.

\*\* Abbreviation not yet standardized.

**Table 4: Maximum Shelf Life in Years for Plastics**

Abbreviation	Name	Trade Names (Examples Only)	FMC Material Specification	Shelf Life (Years)
-	Acetal Polymer	Delrin®	E55201, E55202	5
TPV	-	Geolast®	E50104, E50105	10
PA	Polyamide	Nylon	E55801	10
PEEK	PolyEtherEther-Ketone	Arlon®	E55001, E55002, E55003, E55004, E55005, E55007, E55008, E55009, E55010	20
AU	Polyester Urethane	Molythane®	E56201	12
	Polyester Elastomer	Polymyte®, Hytrel®	E56301, E56302, E56303	12
PPS	Polyphenylene Sulfide	Ryton®, Fortron®	E50121, E55101	20
PTFE	PolyTetrafluoroEthylene	Teflon®, Rulon®	E50132, E53504, E55401, E55501, E55502, E55503, E55504, E55505, E55509, E55510, E55511, E55512	20
ETFE	Ethylene Tetrafluoroethylene Copolymer	Tefzel®	E55301	20



## 6.2 Critical Surfaces by Seal Family

Section 2.1.2, titled Visual Examination, defines requirements unique to the critical surfaces of non-metallic seals. The locations and extents of these critical surfaces are as follows by seal family:

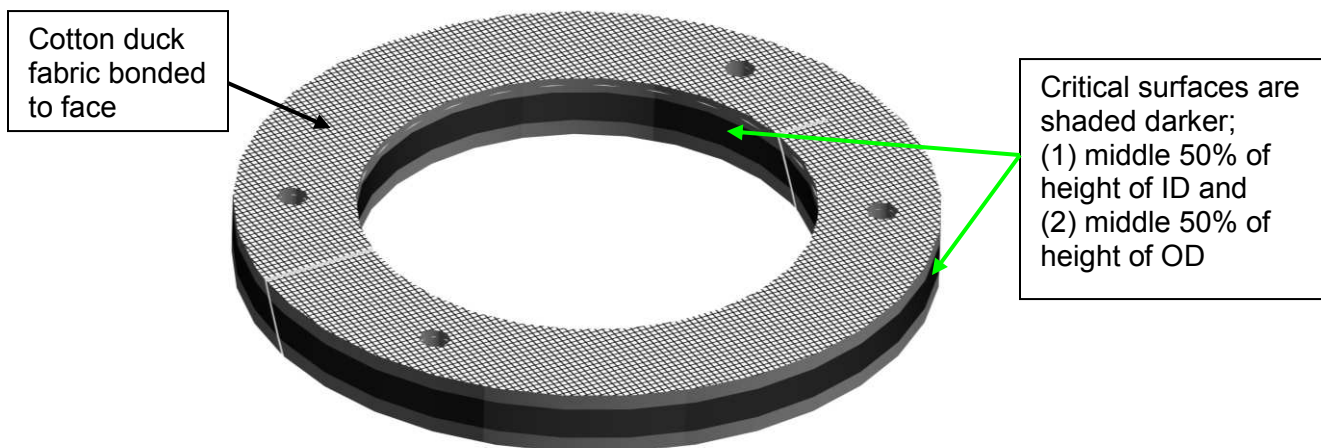


Figure 1: Packing for C-22 Casing Hanger

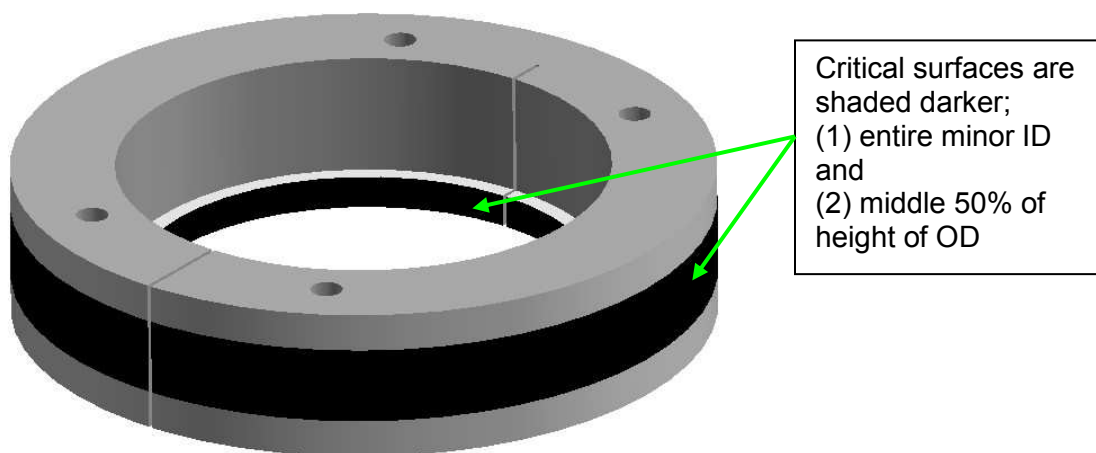


Figure 2: Packing for C-29 Casing Hanger

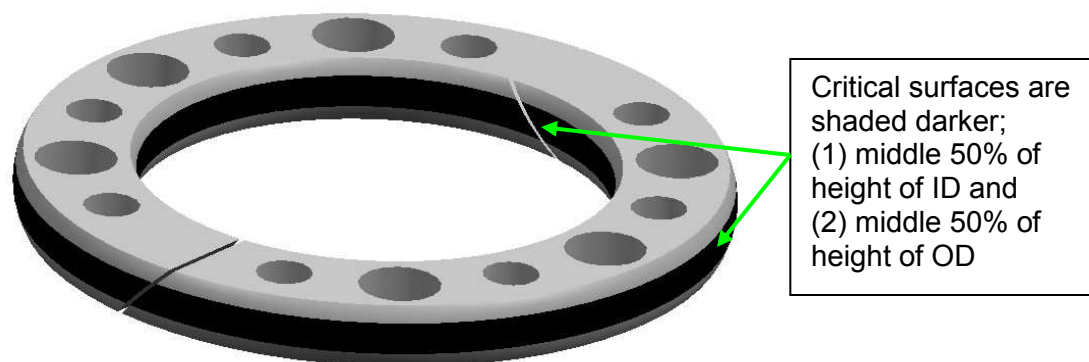


Figure 3: Packing for C-121-S Casing Hanger

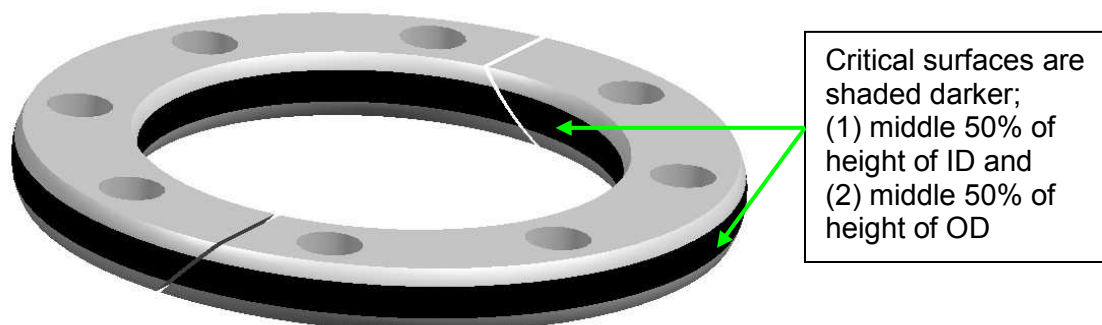


Figure 4: Packing for C-122 Casing Hanger

**CHLOROPRENE RUBBER, -40 TO 250 DEG F, 50 DUROMETER, FOR  
EXTERNAL USE ONLY**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
F	1118898	20-APR-2007	Wolff, Geoff	Parrish, John	RELEASED

## Summary:

This specification is for a chloroprene rubber compound used for external use only, not as a sealing member. Seal configuration is for flange protectors **ONLY**.

FOR EXTERNAL USE ONLY, NOT FOR PRESSURE CONTROL

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---

## 1.0 Scope

This specification is for a chloroprene rubber compound used for external use only, not as a sealing member. Seal configuration is for flange protectors **ONLY**.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits

API 6A, Table 302.2 and Table G1 Temperature Class ..... P to U  
Nominal Temperature Rating ..... -40 to 250°F (-40 to 151°C)

#### 2.1.2 Pressure Limits

Static ..... 0 psi, Liquid/0 psi, Gas  
Dynamic ..... 0 psi, Liquid/0 psi, Gas

### 2.2 Chemical Compatibility

H<sub>2</sub>O, Water ..... yes  
Hydrocarbons ..... yes  
CH<sub>4</sub>, Methane ..... no  
N<sub>2</sub>, Nitrogen Gas ..... yes  
CO<sub>2</sub>, Carbon Dioxide ..... yes  
H<sub>2</sub>S, Hydrogen Sulfide ..... no  
Amines ..... no  
Chlorides ..... yes  
HCl, Hydrochloric Acid ..... yes, if < 37%  
H<sub>2</sub>SO<sub>4</sub>, Sulfuric Acid ..... yes, if < 50%  
H<sub>2</sub>CO<sub>3</sub>, Carbonic Acid ..... unknown  
O<sub>2</sub>, Oxygen ..... no  
Steam ..... no

### 2.3 Seal Configuration

Flange protectors ONLY

### **3.0 Material Properties**

#### **3.1 Mechanical and Physical Properties**

Hardness, Shore A ..... 60 ± 10 pts ASTM D 2240  
Tensile Strength, min ..... 1000 psi ASTM D 412  
Elongation, min ..... 225% ASTM D 412  
100% Modulus, min ..... 575 psi ASTM D 412  
Specific Gravity ..... N/A ASTM D 792, Method A  
Compression set, max ..... 50% ASTM D 395, Method B 22 hrs @ 350°F

#### **3.2 Critical Transition Temperatures**

TR-10, max ..... -40°F (-40°C) Temperature Retraction, ASTM D 1329

### **4.0 Approved Vendors, Facilities, and Materials**

For rubber lining of metal parts:

Lining Applicator: DuraQuest Elastomer Products, 3901 FM 1485, Conroe, TX  
77306

Compound: DuraQuest Compound 107-PC

No other vendors are approved for application of rubber lining on metal parts. All approval inquiries are to be directed to the CTG Materials Engineering Group.

**ENGINEERING SPECIFICATION**

<b>CHLOROPRENE RUBBER, -40 TO 200 DEG F, 70 DUROMETER +-5, F/STRIPPER PACKOFFS ONLY</b>
---

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1086578	01-NOV-85	MALIGAS	DC	RELEASED

Summary: This specification is for a Chloroprene rubber compound used for stripper packoffs only.

## 1.0 MATERIAL

This specification is for a Chloroprene rubber compound used for stripper packoffs only.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....CC

API 6A, Table 302.3,  
Material Class.....AA to CC

API 6A, Table 302.2  
Temperature Class.....P to T

Temperature Rating.....-40 to 200°F

#### 2.1.2 Pressure Limits:

Static..... 0 psi, liquid  
..... 0 psi, gas

Dynamic..... 0 psi, liquid  
..... 0 psi, gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes, limited
CH <sub>4</sub> , Methane	no
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	no
Amines	no
Chlorides	yes
HCl, Hydrochloric Acid	yes, if < 37%
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, if < 25%
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	no
O <sub>2</sub> , Oxygen	no
Steam	no



**3.0 MATERIAL PROPERTIES****3.1 Mechanical Properties**

Hardness, Shore A.....70 ± 10 pts  
ASTM D2240

Tensile Strength, min.....2400 psi  
ASTM D412

Elongation, min.....280%  
ASTM D412

100% Modulus, min.....400 psi  
ASTM D412

Specific Gravity.....N/A  
ASTM D792 Method A

Compression Set, ASTM D395 Method B  
22 hrs @ 350°F, max.....50%

**3.2 Critical Transition Temperatures**

TR-10, max.....-40°F (-40°C)  
Temperature Retraction  
ASTM D1329

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION**

**OBSOLETE AND SUPERSEDED BY E50197 - HYDRIN 200 -50 DEG F  
TO 250 DEG F, 70 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
H	1087515	08-OCT-84	MALIGAS	HAEBERLE	RELEASED

Summary:

**Obsolete and Superseded by E50197**

**OBSOLETE AND SUPERSEDED BY E50197**

\* \* \* End of Document \* \* \*

**ENGINEERING SPECIFICATION**

**OBSOLETE AND REPLACED BY E50199 - HYDRIN 200, -50 TO 300  
DEG F, 90 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1086578	27-AUG-84	MALIGAS	RB	RELEASED

Summary: OBSOLETE AND REPLACED BY E50199

\*\*\* End of Document \*\*\*

**ENGINEERING SPECIFICATION**

**OBSOLETE AND SUPERSEDED BY E50107 - HYDRIN 100 -20 DEG F  
TO +300 DEG F, 70 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1087515	27-AUG-84	MALIGAS	RB	RELEASED

Summary:

**Obsolete and Superseded by E50107**

**OBSOLETE AND SUPERSEDED BY E50107**

**\*\*\* END OF DOCUMENT \*\*\***

**ENGINEERING SPECIFICATION****EPDM, -50 TO 550 DEG F, 85 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1086578	24-JUN-94	MALIGAS	SCHOEN	RELEASED

Summary: This specification is for a compound based on a Ethylene, Propylene and Diene Terpolymer which has been molded, cured and finished to meet all of the requirments of this specification.

MAY BE USED IN CO<sub>2</sub> < 5000 PSI

## 1.0 MATERIAL

This specification is for a compound based on a Ethylene, Propylene and Diene Terpolymer which has been molded, cured and finished to meet all of the requirements of this specification. FMC proprietary compound M1-029 meets this specification. Compounds from Parker, Seals Eastern, and Utex formulated to meet La Garde Y-267 formulation also meet this specification. This compound is recommended for geothermal or steam service.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class.....AA to HH

API 6A, Table 302.2 and Table G1  
Temperature Class.....P to X

Nominal Temperature Rating.....-50 to 550<sup>0</sup>F

#### 2.1.2 Pressure Limits:

Static.....20,000 psi, Liquid  
.....15,000 psi, Gas

Dynamic.....15,000 psi, Liquid  
.....10,000 psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	no
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes



### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A.....85 ± 5pts  
ASTM S2240

Tensile Strength, min.....1950 psi  
ASTM D4212

Elongation, min.....95%  
ASTM D412

100% Modulus, min.....1,125 psi  
ASTM D412

Compression Set, ASTM D395 Method B  
22 hours @ 350<sup>0</sup>F, max.....30%

#### 3.2 Critical Transition Temperatures

TR-10, max.....N/A  
Temperature Retraction  
ASTM D 1329

Tg.....-40<sup>0</sup>F (-40<sup>0</sup>C)  
Glass Transition Temperature  
ASTM D4065, D4092, D2231

#### 3.3 Air Aged: 70 Hours @ 250<sup>0</sup>F, ASTM D573

Hardness, Shore A.....85 ± 5 pts  
Tensile Strength, min.....1,800 psi  
Elongation, min.....100%  
100% Modulus, max.....1,800 psi

#### 3.4 Oil Aged: 70 Hours @ 257<sup>0</sup>F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....65 ± 5 pts  
Tensile Strength, min.....2,300 psi  
Elongation, max.....450%  
100% Modulus, min.....510 psi

#### 3.5 Immersions

70 hours at 392<sup>0</sup>F

## ASTM D-471 Steam

Hardness Change, Durometer A Points	0 to -8
Tensile Strength, Ult. Maximum % Change	-20
Elongation, Ultimate Maximum % Change	-10
Volume, Maximum % Change	-5 to +5
Modulus at 100% Elongation Maximum % Change	-10

\*\*\* END OF DOCUMENT \*\*\*

**EPDM RUBBER, 70 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1103582	03-NOV-2005	Jones, Warren	Parrish, John	RELEASED

**Summary:**

This specification is for a rubber compound based on a Terpolymer composed of Ethylene, Propylene and Diene (EPDM) which has been molded, cured and finished to meet all of the requirements of this specification.

## 1.0 Scope

This specification is for a rubber compound based on a Terpolymer composed of Ethylene, Propylene and Diene (EPDM) which has been molded, cured and finished to meet all of the requirements of this specification. Parker O-Ring Division compound E0692-75 meets the requirements of this specification.

## 2.0 Service Compatibility

### 2.1 API 6A, ISO 10423, Temperature and Pressure Compatibility

#### 2.1.1 Temperature Rating:

Section 4.2.2.3, Table 2                      L to U (-50 to 250°F)

#### 2.1.2 Pressure Rating:

Section 4.2.1.1

Static            10,000 psi liquid, 5,000 psi gas

Dynamic        5,000 psi liquid, 2,000 psi gas

Note: Above temperature and pressure ratings do not necessarily take into consideration the results of API Spec.6A, ISO 10423, Annex F Testing or Life Estimation Testing of Seals.

### 2.2 API 6A, ISO 10423, Annex F Materials Class

None is applicable as this material is not suitable for hydrocarbon or produced wellbore fluids exposure.

### 2.3 Chemical Compatibility

H <sub>2</sub> O, Water	Yes
Hydrocarbons	No
CH <sub>4</sub> , Methane	Yes
N <sub>2</sub> , Nitrogen Gas	Yes
CO <sub>2</sub> , Carbon Dioxide	No
H <sub>2</sub> S, Hydrogen Sulfide	Yes
Amines	Yes
Chlorides	Yes
HCl, Hydrochloric Acid	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	Yes

Steam	No
O <sub>2</sub> , Oxygen	No

### 3.0 Properties

#### 3.1 Mechanical and Physical Properties

Hardness, Shore A ASTM D 2240	70 +/- 5 pts.
----------------------------------	---------------

Tensile Strength, min. ASTM D 412	1,200 psi
--------------------------------------	-----------

Elongation, min. ASTM D 412	200%
--------------------------------	------

Compression Set, max. ASTM D 395, Method B, 158°F for 22 hours	15%
---	-----

Glass Transition Temperature, max. ASTM D 4065, D 4092, & D 2231 DMA temperature sweep, -112 to 392°F, 11 Hz, 2% strain, midpoint between G'' & tan delta peaks	-50°F
--	-------

#### 3.2 Change After Exposure

Water Aged for 70 Hours @ 212°F, ASTM D 471 Volume Change, max.	+10%
--	------

Dry Air Aged for 70 Hours @ 158°F, ASTM D 573 Hardness Change, max. Tensile strength Change, max. Elongation Change, max.	+/-5 pts. +/-20% +/-20%
--	-------------------------------

### 4.0 Approved Compounds

Parker O-Ring Division compound E0692-75 meets the requirements of this specification. Other compounds are approved if they meet these requirements.

**ENGINEERING SPECIFICATION**

<b>OBSOLETE AND REPLACED BY E50178 - EPDM LA GARDE Y-267 ETHYLENE PROPYLENE DIENE CERTIFIED MATERIAL</b>
--

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1087515	20-JULY-83	JK	R. BERRY	RELEASED

Summary:

**Obsolete and Replaced by E50178**

**OBSOLETE AND REPLACED BY E50178**

**MATERIAL:** EPDM - Ethylene Propylene Diene  
La Garde Y-267 Formulation

**TRADE NAMES:** Parker E962-85

**SERVICE:** 50°F to 500°F  
H<sub>2</sub>S, CO<sub>2</sub>, Amine type corrosion inhibitors, steam, hot water, brine, HCl, phosphate, silicon greases, alcohols, Ketones.

**ORIGINAL PROPERTIES:**

Hardness, Durometer A	-	85±5
Tensile Strength, Ult.	-	1950 psi min.
Elongation, Ultimate	-	95% min.
Compression Set*	-	30% max.
Brittleness, Low Temp.**	-	-35°F
Modulus at 100% Elongation	-	1800 psi min.

**IMMERSIONS:**

70 hours at 392°F		
ASTM D-471 Steam		
Hardness Change, Durometer A Points	-	0 to -8
Tensile Strength, Ult.		
Maximum % Change	-	-20
Elongation, Ultimate		
Maximum % Change	-	-10
Volume, Maximum % Change	-	-5 to +5
Modulus at 100% Elongation		
Maximum % Change	-	-10

**CERTIFICATION:**

All elastomeric components utilizing this specification must be fully traceable through the batch number for verification of tested properties. Therefore, the following shall be provided for each order and shall be completely identified.

- (1) ASTM Slab Samples (2 min.)
- (2) ASTM Buttons (2 min.)
- (3) Document of conformance stating that the specific order is in compliance with this specification.
- (4) Batch Number, Date Molded

\* ASTM D-395 Method B 22 hrs. at 350°F

\*\* ASTM D-2137 Method A

\*\*\* End of Document \*\*\*

**ENGINEERING SPECIFICATION****KALREZ(TM) 1018, 0 TO 500 DEG F, 80 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1086578	21-NOV-84	MALIGAS	KEK	RELEASED

Summary: The chemical name for Kalrez ® is Tetrafluoroethylene-perfluoromethyl vinyl ether. Seal configurations include: O-rings, T-seals, FT rings, and Vee rings.



## 1.0 MATERIAL

The chemical name for Kalrez ® is Tetrafluoroethylene-perfluoromethyl vinyl ether. Seal configurations include: O-rings, T-seals, FT rings, and Vee rings.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class.....AA to HH

API 6A, Table 302.2 and Table G1  
Temperature Class.....S to X

Temperature Rating.....0 to 500°F

#### 2.1.2 Pressure Limits:

Static.....20,000psi, Liquid  
.....15,000psi, Gas

Dynamic.....15,000psi, Liquid  
.....10,000psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes
Steam	yes

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A.....80 ± 5 pts  
ASTM D2240

Tensile Strength, min.....2,350psi  
ASTM D412

Elongation, min.....120%  
ASTM D412

100% Modulus, min.....1,850psi  
ASTM D412

Specific Gravity.....NA  
ASTM D792 Method A

Compression Set, ASTM D395 Method B  
22 hours @ 350°F, max.....20%

#### 3.2 Critical Transition Temperatures

TR-10, max.....-30°F  
Temperature Retraction  
ASTM D1329

#### 3.3 Air Aged: 70 Hours @ 275°F, ASTM D573

Hardness, Shore A.....80 ± 10 pts  
Tensile Strength, min.....1,880psi  
Elongation, max.....140%  
100% Modulus, max.....2,220psi

\*\*\* END OF DOCUMENT \*\*\*

**FCD USE ONLY - SPECIFICATION FOR 90 DUROMETER  
FLUOROCARBON ELASTOMER (FKM) O-RINGS**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	5010941	21-Aug-98	Long, Robert	Taeuber, Ralph	RELEASED

Summary: This specification covers the requirements for 90 Durometer Fluorocarbon Elastomer (FKM) O-Rings, commonly referred to as Viton or Fluorel.

## 1.0 SCOPE

This specification covers the requirements for 90 Durometer Fluorocarbon Elastomer (FKM) O-Rings, commonly referred to as Viton or Fluorel. O-Rings manufactured per ASTM D2000 M3HK914-A1-10 B37 EF31 E078 satisfy this specification. Please note: the tensile strength requirement called out in this specification is less than that required by the above ASTM D2000 specification.

## 2.0 APPLICABLE SPECIFICATIONS

- 2.1 ASTM D2000
- 2.2 ASTM D573
- 2.3 ASTM D395
- 2.4 ASTM D471
- 2.5 ASTM D2137
- 2.6 ASTM D2240
- 2.7 ASTM D412

## 3.0 MATERIAL PROPERTIES

- 3.1 Original Properties
  - Hardness, Shore A (ASTM D2240).....90 ± 5 points
  - Tensile Strength, min (ASTM D412) ..... 1800 psi (12.4 MPa)
  - Ultimate Elongation, min (ASTM D412) ... 100%
- 3.2 Heat Resistance(ASTM D573) - 70 hours at 250°C (482°F)
  - Change in hardness, max.....+10 points
  - Change in tensile strength, max .....-25%
  - Change in ultimate elongation, max.....-25%
- 3.3 Compression Set (ASTM D395) - 22 hours at 175°C (347°F)
  - Method B, max.....30%
- 3.4 Fluid Resistance (ASTM D471, Ref. Fuel C) - 70 hours at 23°C (73°F)
  - Change in hardness, max.....±5 points
  - Change in tensile strength, max .....-25%
  - Change in ultimate elongation, max.....-20%
  - Change in volume.....0 to +10%
- 3.5 Fluid Resistance (ASTM D471, Service Fluid 101) - 70 hours at 200°C (392°F)

Change in hardness, max .....-15 to +5 points  
Change in tensile strength, max .....-40%  
Change in ultimate elongation, max .....-20%  
Change in volume .....0 to +15%

#### **4.0 APPROVED COMPOUNDS**

- 4.1 PARKER #V709-90
- 4.2 NATIONAL #V23-90

\* \* \* End of Document \* \* \*

**ENGINEERING SPECIFICATION****FKM (A), 0 TO 350 DEG F, 70 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
H	1086578	08-OCT-84	MALIGAS	D CAIN	RELEASED

Summary: This specification is for a compound based on a Vinylidene fluoride and a Hexafluoropropylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for a compound based on a Vinylidene fluoride and a Hexafluoropropylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-016 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class.....AA to HH

API 6A, Table 302.2 and Table G1  
Temperature Class.....S to X

Temperature Rating.....0 to 350°F

#### 2.1.2 Pressure Limits:

Static.....20,000psi, Liquid  
.....15,000psi, Gas

Dynamic.....10,000psi, Liquid  
.....5,000psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes, not preferred
Amines	no
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes, if Temp <350°F
Steam	no

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A.....	70 ± 5 pts
ASTM D2240	
Tensile Strength, min.....	1,900psi
ASTM D412	
Elongation, min.....	200%
ASTM D412	
100% Modulus, min.....	450 psi
ASTM D412	
Specific Gravity.....	1.85 ± .02
ASTM D792 Method A	
Compression Set, ASTM D395 Method B	
22 hours @ 400°F, max.....	20%

#### 3.2 Critical Transition Temperatures

TR-10, max.....	5°F
Temperature Retraction	
ASTM D1329	
Tg.....	15.8°F
Glass Transition Temperature	
ASTM D4065, D4092, D2231	

#### 3.3 Air Aged: 70 Hours @ 350°F, ASTM D573

Hardness, Shore A.....	75 ± 5 pts
Tensile Strength, min.....	1520 psi
Elongation, max.....	180%
100% Modulus, max.....	500 psi

#### 3.4 Oil Aged: 70 Hours @ 350°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....	65 ± 5 pts
Tensile Strength, min.....	1,610psi
Elongation, max.....	240%
100% Modulus, max.....	500psi

\*\*\* END OF DOCUMENT \*\*\*



**ENGINEERING SPECIFICATION****FKM (A), 0 TO 350 DEG F, 80 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
F	1086578	21-NOV-84	MALIGAS	KEK	RELEASED

Summary: This specification is for a compound based on a Vinylidene fluoride and a Hexafluoropropylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for a compound based on a Vinylidene fluoride and a Hexafluoropropylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-017 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class.....AA to HH

API 6A, Table 302.2 and Table G1  
Temperature Class.....S to X

Temperature Rating.....0 to 350°F

#### 2.1.2 Pressure Limits:

Static.....20,000psi, Liquid  
.....15,000psi, Gas

Dynamic.....15,000psi, Liquid  
.....5,000psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes, not preferred
Amines	no
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes, if Temp <350°F
Steam	no

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A.....80 ± 5 pts  
ASTM D2240

Tensile Strength, min.....2,150psi  
ASTM D412

Elongation, min.....270%  
ASTM D412

100% Modulus, min.....590psi  
ASTM D412

Specific Gravity.....1.83 ± .02  
ASTM D792 Method A

Compression Set, ASTM D395 Method B  
22 hours @ 400°F, max.....30%

#### 3.2 Critical Transition Temperatures

TR-10, max.....0°F  
Temperature Retraction  
ASTM D1329

Tg.....14 to 34°F (-10 to 1°C)  
Glass Transition Temperature  
ASTM D4065, D4092, D2231

#### 3.3 Air Aged: 70 Hours @ 350°F, ASTM D573

Hardness, Shore A.....80 ± 5 pts  
Tensile Strength, min.....1,720psi  
Elongation, max.....280%  
100% Modulus, max.....890psi

#### 3.4 Oil Aged: 70 Hours @ 350°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....75 ± 5 pts  
Tensile Strength, min.....1,530psi  
Elongation, max.....320%  
100% Modulus, max.....710psi

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****VITON A, 0 TO 350 DEG F, 90 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
F	1086578	27-AUG-84	MALIGAS	RB	RELEASED

Summary: This specification is for a compound based on a Vinylidene fluoride and a Hexafluoropropylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for a compound based on a Vinylidene fluoride and a Hexafluoropropylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-022 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	HH
API 6A, Table 302.3, Material Class.....	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class.....	S to X
Temperature Rating.....	0 to 350°F

#### 2.1.2 Pressure Limits:

Static.....	20,000psi, Liquid
.....	15,000psi, Gas
Dynamic.....	15,000psi, Liquid
.....	10,000psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes, not preferred
Amines	no
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes, if Temp <350°F
Steam	no

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A.....90 ± 5 pts  
ASTM D2240

Tensile Strength, min.....1,800 psi  
ASTM D412

Elongation, min.....125%  
ASTM D412

100% Modulus, min.....1,150 psi  
ASTM D412

Specific Gravity.....1.84 ± .02  
ASTM D792 Method A

Compression Set, ASTM D395 Method B  
22 hours @ 400°F, max.....20%

#### 3.2 Critical Transition Temperatures

TR-10, max.....5°F  
Temperature Retraction  
ASTM D1329

Tg.....°F  
Glass Transition Temperature  
ASTM D4065, D4092, D2231

#### 3.3 Air Aged: 70 Hours @ 350°F, ASTM D573

Hardness, Shore A.....95 ± 5 pts  
Tensile Strength, min.....1,620psi  
Elongation, max.....1,20%  
100% Modulus, max.....1,330psi

#### 3.4 Oil Aged: 70 Hours @ 350°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....85 ± 5 pts  
Tensile Strength, min.....1,440psi  
Elongation, max.....150%  
100% Modulus, max.....1,270psi

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****FKM (B), 0 TO 450 DEG F, 85 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1086578	30-SEP-86	DC	R. WHARTON	RELEASED

Summary: This specification is for a compound based on a Vinylidene fluoride and a Hexafluoropropylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for a compound based on a Vinylidene fluoride and a Hexafluoropropylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-019 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class.....AA to HH

API 6A, Table 302.2 and Table G1  
Temperature Class.....S to X

Temperature Rating.....0 to 450°F

#### 2.1.2 Pressure Limits:

Static.....20,000psi, Liquid  
.....15,000psi, Gas

Dynamic.....15,000psi, Liquid  
.....5,000psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	no
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes, if Temp <400°F
Steam	no



### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A.....85 ± 5 pts  
ASTM D2240

Tensile Strength, min.....2,300 psi  
ASTM D412

Elongation, min.....125%  
ASTM D412

100% Modulus, min.....1,000 psi  
ASTM D412

Specific Gravity.....---  
ASTM D792 Method A

Compression Set, ASTM D395 Method B  
22 hours @ 400°F, max.....35%

#### 3.2 Critical Transition Temperatures

TR-10, max.....0°F  
Temperature Retraction  
ASTM D1329

Tg.....°F  
Glass Transition Temperature  
ASTM D4065, D4092, D2231

#### 3.3 Air Aged: 70 Hours @ 350°F, ASTM D573

Hardness, Shore A.....90 ± 5 pts  
Tensile Strength, min.....1,840 psi  
Elongation, max.....120%  
100% Modulus, max.....1,200 psi

#### 3.4 Oil Aged: 70 Hours @ 350°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....80 ± 5 pts  
Tensile Strength, min.....1,950 psi  
Elongation, max.....150%  
100% Modulus, max.....1,100 psi

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****HYDROGENATED NITRILE, HIGH STRENGTH, HNBR**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1086578	20-Mar-00	Janoff, Dwight	Parrish, John	RELEASED

Summary: This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 SCOPE

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-005 modified with proprietary friction reduction additives meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,	
Test Fluid Class.....	HH
API 6A, Table 302.3,	
Material Class.....	AA to HH
API 6A, Table 302.2 and Table G1	
Temperature Class.....	S to X
Nominal Temperature Rating.....	0 to 350 <sup>0</sup> F

#### 2.1.2 Pressure Limits:

Static.....	20,000 psi, liquid
	15,000 psi, gas
Dynamic.....	15,000 psi, liquid
	10,000 psi, gas

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes, limited

## 3.0 MATERIAL PROPERTIES

### 3.1 Mechanical Properties

Hardness, Shore A.....	85 ± 5 pts
ASTM D2240	
Tensile Strength, min. ....	3,200 psi
ASTM D412	
Elongation, min.....	130%
ASTM D412	
100% Modulus, min.....	1,950 psi
ASTM D412	
Specific Gravity.....	1.24 ± .05
ASTM D792 Method A	
Compression Set, ASTM D395 Method B	
22 hours @ 350 <sup>0</sup> F, max.....	25%

3.2 Critical Transition Temperatures

TR-10, max.....14 °F (-10°C)  
Temperature Retraction  
ASTM D1329

Tg.....16 to -4 °F (-9 to -20°C)  
Glass Transition Temperature  
ASTM D4065, D4092, D2231

3.3 Air Aged: 70 Hours @ 350°F, ASTM D573

Hardness, Shore A.....90 ± 5 pts  
Tensile Strength, min.....1,400 psi  
Elongation, min.....40%  
50% Modulus, max.....2,200 psi

3.4 Oil Aged: 70 Hours @ 350°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....75 ± 5 pts  
Tensile Strength, min.....2,000 psi  
Elongation, max.....150%  
100% Modulus, min.....1,100 psi

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****HNBR, 90 DUROMETER COMPOUND, LOW FRICTION**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1086578	13-Feb-96	Maligas, Manuel	Long, Kevin	RELEASED

Summary: This specification is for a hydrogenated butadiene and acrylonitrile rubber (HNBR) compound which has been molded, cured, and finished to meet all of the requirements of this specification. The base compound is E50159 that has been modified with an FMC proprietary additive package to reduce friction.

## 1.0 MATERIAL

This specification is for a hydrogenated butadiene and acrylonitrile rubber (HNBR) compound which has been molded, cured, and finished to meet all of the requirements of this specification. The base compound is E50159 that has been modified with an FMC proprietary additive package to reduce friction. FMC proprietary compound M1-031 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class..... HH

API 6A, Table 302.3,  
Material Class..... AA to HH

API 6A, Table 302.2 and Table G1  
Temperature Class..... S to X

Nominal Temperature Rating..... 0 to 350<sup>0</sup>F

#### 2.1.2 Pressure Limits:

Static..... 20,000 psi, liquid  
15,000 psi, gas

Dynamic..... 15,000 psi, liquid  
10,000 psi, gas

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes, limited

## 3.0 MATERIAL PROPERTIES

### 3.1 Mechanical Properties

Hardness, Shore A.....	85 ± 5 pts
ASTM D2240	
Tensile Strength, min.....	3,200 psi
ASTM D412	
Elongation, min.....	130%
ASTM D412	
100% Modulus, min.....	1,950 psi
ASTM D412	
Specific Gravity.....	1.24 ± .05
ASTM D792 Method A	
Compression Set, ASTM D395 Method B	
22 hours @ 350 <sup>0</sup> F, max.....	25%



3.2 Critical Transition Temperatures

TR-10, max.....14<sup>0</sup>F (-10<sup>0</sup>C)  
Temperature Retraction  
ASTM D1329

Tg.....16 to -4<sup>0</sup>F (-9 to -20<sup>0</sup>C)  
Glass Transition Temperature  
ASTM D4065, D4092, D2231

3.3 Air Aged: 70 Hours @ 350<sup>0</sup>F, ASTM D573

Hardness, Shore A.....90 ± 5 pts  
Tensile Strength, min.....1,400 psi  
Elongation, min.....40%  
50% Modulus, max.....2,200 psi

3.4 Oil Aged: 70 Hours @ 350<sup>0</sup>F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....75 ± 5 pts  
Tensile Strength, min.....2,000 psi  
Elongation, max.....150%  
100% Modulus, min.....1,100 psi

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****HYDROGENATED NITRILE, -20 TO 250 F, 75 DUROMETER (NON-NORSOK COMPLIANT VERSION OF E50187)**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1086818	19-Aug-03	Albor, Gabriel	Janoff, Dwight	RELEASED

## Summary:

This specification E50007, is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-006 meets this specification. However, parts made using this specification will not be NORSOK M-710 compliant.

## 1.0 SCOPE

This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-006 meets this specification. Parts made using this specification will not be NORSOK M-710 compliant.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1 Test Fluid Class .....	HH
API 6A, Table 302.3 Material Class.....	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class .....	P to U
Nominal Temperature Rating .....	-20 to 250°F

Note: This does not necessarily take into consideration the results of API Spec. 6A, Appendix F Testing or Life Estimation Testing of Seals.

#### 2.1.2 Pressure Limits:

Static .....	20,000 psi, liquid/15,000 psi, gas
Dynamic.....	15,000 psi, liquid/10,000 psi, gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes
Steam .....	Yes, limited
O <sub>2</sub> , Oxygen .....	No

### 3.0 MECHANICAL AND PHYSICAL PROPERTIES

Specific Gravity, ..... ASTM D 792, Method A	1.21 +/- .05
Hardness, Shore A, ..... ASTM D 2240	75 +/- 5 pts.
Tensile Strength, min. .... ASTM D 412	2,700 psi
Elongation, min. .... ASTM D 412	250%
100% Modulus, min..... ASTM D 412	600 psi
Compression Set, max. .... ASTM D 395, Method B, 212° F for 168 hours in N <sub>2</sub> gas	20%
Glass Transition Temperature ..... ASTM D 4065, D 4092, & D 2231 DMA temperature sweep, -112 to 392°F, 11 Hz, 2% strain, G'' peak to tan delta peak	-45 to 0°F
Tear Resistance..... ASTM D624, Die B, Method A Analysis, .02 in. deep nick	200 lb/in

### 4.0 APPENDIX – REFERENCE ONLY

Air Aged: 70 Hours @ 257°F, ASTM D 573	
Hardness, Shore A .....	80+/- 5 pts
Tensile Strength, min. ....	2,300 psi
Elongation, min. ....	175%
100% Modulus, max. ....	1,000 psi
Oil Aged: 70 Hours @ 257°F, ASTM No. 3 Oil, ASTM D 471	
Hardness, Shore A .....	65 +/- 5 pts
Tensile Strength, min. ....	2,300 psi
Elongation, max. ....	450%
100% Modulus, min.....	510 psi
TR-10, max. ....	14°F
Temperature Retraction, ASTM D 1329	

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****HYDROGENATED NITRILE, -20 TO 250 F, 90 DUROMETER (NON-NORSOK COMPLIANT VERSION OF E50189)**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1086818	19-Aug-03	Albor, Gabriel	Janoff, Dwight	RELEASED

**Summary:**

This specification E50009 is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-008 meets this specification. However, parts made using this specification will not be NORSOK M-710 compliant.

## 1.0 SCOPE

This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-008 meets this specification. Parts made using this specification will not be NORSOK M-710 compliant.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class .....	P to U
Nominal Temperature Rating .....	-20 to 250°F
(Note: This does not necessarily take into consideration the results of API Spec. 6A, Appendix F Testing or Life Estimation Testing of Seals.	

#### 2.1.2 Pressure Limits:

Static .....	20,000 psi, liquid / 15,000 psi, gas
Dynamic.....	15,000 psi, liquid / 10,000 psi, gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes
Steam .....	Yes, limited
O <sub>2</sub> , Oxygen .....	No

### 3.0 MECHANICAL AND PHYSICAL PROPERTIES

Specific Gravity .....	1.28 +/- .05
ASTM D 792, Method A	
Hardness, Shore A .....	90 +/- 5 pts.
ASTM D 2240	
Tensile Strength, min. ....	2,500 psi
ASTM D 412	
Elongation, min .....	100%
ASTM D 412	
100% Modulus, min. ....	1500 psi
ASTM D 412	
Compression Set, max. ....	20%
ASTM D 395, Method B, 212°F for 168 hours in N <sub>2</sub> gas	
Glass Transition Temperature.....	-45 to 0°F
ASTM D 4065, D 4092, & D 2231	
DMA temperature sweep, -112 to 392°F, 11 Hz, 2% strain, G'' peak to tan delta peak	
Tear Resistance .....	200 lbf/in
ASTM D624, Die B, Method A Analysis, .02 in. deep nick	

### 4.0 APPENDIX – REFERENCE ONLY

Air Aged: 70 Hours @ 257°F, ASTM D 573	
Hardness, Shore A .....	90 +/- 5 pts
Tensile Strength, min. ....	2,100 psi
Elongation, min. ....	100%
100% Modulus, max. ....	2,000 psi
Oil Aged: 70 Hours @ 257°F, ASTM No. 3 Oil, ASTM D 471	
Hardness, Shore A .....	80 +/- 5 pts
Tensile Strength, min. ....	2,100 psi
Elongation, max. ....	260%
100% Modulus, min.....	1200 psi
TR-10, max. ....	14°F
Temperature Retraction, ASTM D 1329	

\*\*\* END OF DOCUMENT \*\*\*

**HNBR, HYDROGENATED NITRILE, FIBER FILLED, -75 TO 350 DEG F,  
90 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
E	1111068	01-AUG-2006	Whitsitt, Elizabeth	Strickler, Mike	RELEASED

## Summary:

This specification is for a compound based on a hydrogenated copolymer of butadiene and acrylonitrile (HNBR), which has been molded, cured and finished to meet all of the requirements of this specification.



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## 1.0 Scope

This specification is for a compound based on a butadiene and acrylonitrile copolymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-002 meets this specification.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits

API 6A, Appendix F, Table F114.1, Test Fluid Class	HH
API 6A, Table 302.3, Material Class	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class	K to X
Temperature Rating	-75 to 350 °F (-59 to 177 °C)

#### 2.1.2 Pressure Limits

Static	20,000 psi, Liquid/15,000 psi, Gas
Dynamic	15,000 psi, Liquid/10,000 psi, Gas

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes, limited

## 3.0 Material Properties

### 3.1 Mechanical and Physical Properties

Hardness, Shore A ASTM D2240	94 ± 5 pts
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Tensile Strength, min ASTM D412	2,040 psi
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Elongation, min ASTM D412	30%
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Specific Gravity ASTM D792 Method A	1.36 ± 0.05
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Compression Set, ASTM D395, Method B 22 hours @ 350 °F, max	30%
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### 3.2 Critical Transition Temperature

-- FOR REFERENCE ONLY

Tg Glass Transition Temperature ASTM D4065, D4092, D2231	-20 to -30 °F (-29 to -34 °C)
--	-------------------------------

### 3.3 Mechanical and Physical Properties after Aging

#### 3.3.1 Air Aged

70 Hours @ 250 °F, ASTM D573 -- FOR REFERENCE ONLY

Hardness, Shore A	90 ± 5 pts
Tensile Strength, min	1,800 psi
Elongation, max	60%
100% Modulus, max	2,300 psi

#### 3.3.2 Oil Aged

70 Hours @ 250 °F, ASTM No. 3 Oil, ASTM D471-- FOR REFERENCE ONLY

Hardness, Shore A	80 ± 5 pts
Tensile Strength, min	1,800 psi
Elongation, max	60%
100% Modulus, max	2,200 psi

\*\*\* END OF DOCUMENT \*\*\*

**HNBR WITH MODIFIED MODULUS, 90 DUROMETER FOR HIGH  
SHEAR APPLICATIONS**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1111068	01-AUG-2006	Whitsitt, Elizabeth	Strickler, Mike	RELEASED

## Summary:

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile copolymer (HNBR), which has been molded, cured and finished to meet all of the requirements of this specification.

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## 1.0 Scope

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile copolymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-003 meets this specification.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits

API 6A, Appendix F, Table F114.1, Test Fluid Class	HH
API 6A, Table 302.3, Material Class	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class	P to X
Temperature Rating	.-20 to 350°F (-29 to 177 °C)

#### 2.1.2 Pressure Limits

Static	20,000 psi, Liquid/15,000 psi, Gas
Dynamic	15,000 psi, Liquid/10,000 psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes, limited

### 3.0 Material Properties

#### 3.1 Mechanical and Physical Properties

Hardness, Shore A ASTM D2240	88 ± 5 pts
Tensile Strength, min ASTM D412	2,800 psi
Elongation, min ASTM D412	100%
100% Modulus, min ASTM D412	2,300 psi
Specific Gravity ASTM D792 Method A	1.29 ± 0.03 g/mL
Compression Set, ASTM D395 Method B 22 hours @ 350 °F, max	30%

#### 3.2 Critical Transition Temperatures

TR-10, max Temperature Retraction ASTM D1329	0 °F (-18 °C)
Tg Glass Transition Temperature ASTM D4065, D4092, D2231	14 to -4 °F (-10 to -20 °C)

#### 3.3 Mechanical and Physical Properties after Aging

##### 3.3.1 Air Aged

70 Hours @ 250°F, ASTM D573

Hardness, Shore A	90 ± 5 pts
Tensile Strength, min	3,100 psi
Elongation, max	180%

100% Modulus, max	2,810 psi
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**3.3.2 Oil Aged**

70 Hours @ 250°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A	80 ± 5 pts
Tensile Strength, min	2,260 psi
Elongation, max	180%
100% Modulus, max	2,150 psi

**\*\*\* END OF DOCUMENT \*\*\***



**COMMERCIAL HNBR, 70 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
H	1144932	01-MAY-2009	Wolff, Geoff	Coles, Michael	RELEASED

## Summary:

This specification is for commercially available HNBR based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for commercially available HNBR based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

NOTE: FMC specification E50187 (FMC proprietary compound) is an acceptable substitute for the commercial grade material described in this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 Temperature and Material Classification

Test Fluid Class (API, Table F114.1).....	HH
Material Class (API, Table 302.3).....	AA to HH
Temperature Ratings (API 6A, Table 2).....	P to U
Nominal Temperature Rating *.....	-20 to 250 °F

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water.....	yes
Hydrocarbons.....	yes
CH <sub>4</sub> , Methane.....	yes
N <sub>2</sub> , Nitrogen Gas.....	yes
CO <sub>2</sub> , Carbon Dioxide.....	yes
H <sub>2</sub> S, Hydrogen Sulfide.....	yes
Amines.....	yes
Chlorides.....	yes
HCl, Hydrochloric Acid.....	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	yes, cold
O <sub>2</sub> , Oxygen.....	no
Steam.....	no

### 3.0 FORMULATION REQUIREMENTS

Approved compounds shall include the following chemistry in formulation:

- ML (1+4) @ 100 °C of raw polymer > 70 MU
- Low to mid ACN polymer
- Oil content < 15 phr
- Peroxide cured

Formulations shall be revision controlled.

### 4.0 MATERIAL PROPERTIES

#### 4.1 Mechanical Properties

Hardness, Shore A .....	70 ± 5 pts
ASTM D2240	
Tensile Strength, min .....	2,800 psi (19.3 MPa)
ASTM D412	
Elongation, min. ....	250%
ASTM D412	
100% Modulus, min. ....	850 psi (5.9 MPa)
ASTM D412	
Specific Gravity .....	1.18 ± .06
ASTM D792 Method A	
Compression Set, ASTM D395 Method B 22 hours @ 350°F, max. ....	25 %

#### 4.2 Critical Transition Temperatures

TR-10 .....	14 °F (-10 °C)
Temperature Retraction ASTM D1329	
Tg .....	N/A
Glass Transition Temperature ASTM D4065, D4092, D2231	

### 4.3 Air Aged: 70 Hours @ 257°F, ASTM D573

Hardness, Shore A .....	70 ± 15 pts
Tensile Strength, min.....	2,400 psi (16.5 MPa)
Elongation, min. ....	175%
100% Modulus, max. ....	N/A

### 4.4 Oil Aged: 70 Hours @ 257°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A .....	70 ± 10 pts
Tensile Strength, min.....	2,400 psi (16.5 MPa)
Elongation, max. ....	330%
100% Modulus, min. ....	N/A

## 5.0 APPROVED COMPOUNDS

Table 1 shows the list of approved commercial compounds. Approval of additional compounds shall be done through CTG Materials Engineering using [SPC10027536](#).

**Table 1: Approved E50037 Compounds**

Vendor	Compound	Revision Level	Approved Applications	Qualification Document
Parker	N1173-70		O-Rings	
JDH Rubber Products	HNBR 8015-70		O-Rings	<a href="#">RPT10002588</a>
			L-Packing	
			Dovetail Packing	
Utex Industries	UTEX 8817		O-Rings	<a href="#">RPT10026587</a>
			C-22/29 Packing	
			TC-1A/1W/60 Packing	
			L / Dovetail Packing	

**COMMERCIAL HNBR, -20 TO 250 DEG F, 85 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
F	1100998	11-JUL-2005	Jones, Warren	Parrish, John	RELEASED

## Summary:

This specification is for commercially available HNBR based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

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## 1.0 MATERIAL

This specification is for a commercially available HNBR based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 Temperature and Pressure Compatibility

#### 2.1.1 Temperature Limits:

Test Fluid Class (API, Table F114.1).....	HH
Material Class (API, Table 302.3).....	AA to HH
Temperature Class (API, Table 302.2).....	P to U
Nominal Temperature Rating *.....	-20 to 250°F

\* Depending on the application, may not meet API 6A, Appendix F, low temperature requirements for 0°F & -20°F.

#### 2.1.2 Pressure Limits: \*\*

Static.....	Yes
Dynamic.....	Yes

\*\* Pressure containing capability is dependent upon the specific seal design. Do not use this material for critical wellhead sealing applications.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water.....	yes
Hydrocarbons.....	yes
CH <sub>4</sub> , Methane.....	yes
N <sub>2</sub> , Nitrogen Gas.....	yes
CO <sub>2</sub> , Carbon Dioxide.....	yes
H <sub>2</sub> S, Hydrogen Sulfide.....	yes
Amines.....	yes
Chlorides.....	yes
HCl, Hydrochloric Acid.....	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	yes, cold
O <sub>2</sub> , Oxygen.....	no
Steam.....	no

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A..... ASTM D2240	85 ± 5 pts
Tensile Strength, min..... ASTM D412	2,400 psi
Elongation, min..... ASTM D412	170%
100% Modulus, min..... ASTM D412	1,250 psi
Specific Gravity..... ASTM D792 Method A	1.23 ± .05
Compression Set, ASTM D395 Method B 70 hours @ 212°F, max.....	30%

#### 3.2 Critical Transition Temperatures

TR-10..... Temperature Retraction ASTM D1329	-4°F (-20°C)
Tg..... Glass Transition Temperature ASTM D4065, D4092, D2231	N/A

#### 3.3 Oil Aged: 70 Hours @ 250°F, ASTM No. 3 Oil, ASTM D471

Hardness Change, Shore A.....	+5 to -10 pts
Volume Change.....	0 to +20%

### 4.0 APPROVED COMPOUNDS

The following compounds are approved:

For O-Rings, L-Packing and Dovetail Packing only; JDH Rubber Products, Singapore & Bangkok, Thailand, HNBR 8015 - 80 durometer version. This material is rated from 0 to 250°F only. Test results are documented in report RPT10002588.

Seal Jet/Eco Seal compound #SJHNBR11018 or ECORUBBER-H.

Other compounds are approved if they meet the requirements in this specification.



**COMMERCIAL HNBR, 90 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
G	1144932	01-MAY-2009	Wolff, Geoff	Coles, Michael	RELEASED

## Summary:

This specification is for commercially available HNBR based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for commercially available HNBR based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

NOTE: FMC specification E50189 (FMC proprietary compound) is an acceptable substitute for the commercial grade material described in this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 Temperature and Material Classification

Test Fluid Class (API, Table F114.1).....	HH		
Material Class (API, Table 302.3).....	AA	to	HH
Temperature Class (API, Table 302.2).....	P	to	U
Nominal Temperature Rating *.....	-20	to	250°F

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	yes
Hydrocarbons.....	yes
CH <sub>4</sub> , Methane.....	yes
N <sub>2</sub> , Nitrogen Gas .....	yes
CO <sub>2</sub> , Carbon Dioxide.....	yes
H <sub>2</sub> S, Hydrogen Sulfide.....	yes
Amines.....	yes
Chlorides.....	yes
HCl, Hydrochloric Acid.....	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	yes, cold
O <sub>2</sub> , Oxygen.....	no
Steam.....	no

### 3.0 FORMULATION REQUIREMENTS

Approved compounds shall include the following chemistry in formulation:

- ML (1+4) @ 100 °C of raw polymer > 70 MU
- Low to mid ACN polymer
- Oil content < 15 phr
- Peroxide cured

Formulations shall be revision controlled.

### 4.0 MATERIAL PROPERTIES

#### 4.1 Mechanical Properties

Hardness, Shore A .....	90 ± 5 pts
ASTM D2240	
Tensile Strength, min. ....	3,000 psi (20.7 MPa)
ASTM D412	
Elongation, min. ....	85%
ASTM D412	
50% Modulus, min. ....	1,500 psi (10.3 MPa)
ASTM D412	
Specific Gravity .....	1.30 ± .05
ASTM D792 Method A	
Compression Set, ASTM D395 Method B	
22 hours @ 350°F, max. ....	25%

#### 4.2 Critical Transition Temperatures

TR-10, max.....	14°F (-10°C)
ASTM D1329	
Tg .....	N/A
ASTM D4065, D4092, D2231	

#### 4.3 Air Aged: 70 Hours @ 257°F, ASTM D573

Hardness, Shore A .....	90 ± 15 pts
Tensile Strength, min. ....	2,500 psi (17.2 MPa)

Elongation, min. .... 50%  
50% Modulus, max. .... N/A

#### 4.4 Oil Aged: 70 Hours @ 257°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A ..... 90 ± 10 pts  
Tensile Strength, min. .... 2,500 psi (17.2 MPa)  
Elongation, max. .... 130%  
100% Modulus, min. .... N/A

## 5.0 APPROVED COMPOUNDS

Table 1 shows the list of approved commercial compounds. Approval of additional compounds shall be done through CTG Materials Engineering using [SPC10027536](#).

**Table 1: Approved E50039 Compounds**

Vendor	Compound	Revision Level	Approved Applications	Qualification Document
Precision Associates	55904		O-Rings	
JDH Rubber Products	HNBR 8015-90		O-Rings	<a href="#">RPT10002588</a>
			L-Packing	
			Dovetail Packing	
Parker Hannifin	N4007A90		O-Rings	<a href="#">RPT10030418</a>
			C-22/29 Packing	
			TC-1A/1W/60 Packing	
			L / Dovetail Packing	

**ENGINEERING SPECIFICATION****HYDROGENATED NITRILE, 0 TO 350 DEG F, 80 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1086578	15-DEC-93	MALIGAS	HAEBERLE	RELEASED

Summary: This specification is for a compound based on a Hydrogenated Butadiene and Acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for a compound based on a Hydrogenated Butadiene and Acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-028 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class.....AA to HH

API 6A, Table 302.2  
Temperature Class.....S to X

Nominal Temperature Rating.....0 to 350°F

#### 2.1.2 Pressure Limits:

Static.....20,000 psi, Liquid  
.....15,000 psi, Gas

Dynamic.....15,000 psi, Liquid  
.....10,000 psi, Gas

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes, limited

## 3.0 MATERIAL PROPERTIES

### 3.1 Mechanical Properties

Hardness, Shore A.....80 ± 5 pts  
ASTM D2240

Tensile Strength, min.....2,730 psi  
ASTM D412

Elongation, min.....120%  
ASTM D412

100% Modulus, min.....1,760 psi  
ASTM D412

Specific Gravity.....1.24 ± .02  
ASTM D792 Method A

Compression Set, ASTM D395 Method B  
22 hours @ 350°F, max.....25%

### 3.2 Critical Transition Temperatures

TR-10, max.....14°F (-10°C)  
Temperature Retraction  
ASTM D1329

Tg.....-1 to -22°F (-18 to -30°C)  
Glass Transition Temperature  
ASTM D4065, D4092, D2231

## 3.3 Air Aged: 70 Hours @ 250°F, ASTM D573

Hardness, Shore A.....N/A  
Tensile Strength, min.....N/A  
Elongation, max.....N/A  
100% Modulus, max.....N/A

## 3.4 Oil Aged: 70 Hours @ 250°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....N/A  
Tensile Strength, min.....N/A  
Elongation, max.....N/A  
100% Modulus, max.....N/A

\*\*\* END OF DOCUMENT \*\*\*



**ENGINEERING SPECIFICATION****HYDROGENATED NITRILE, 0 TO 350 F, 85 DUROMETER (NON-NORSOK COMPLIANT VERSION OF E50158)**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1086818	19-Aug-03	Albor, Gabriel	Janoff, Dwight	RELEASED

**Summary:**

This specification E50058 is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-027 meets this specification. However, parts made using this specification will not be NORSOK M-710 compliant.

## 1.0 SCOPE

This specification E50058 is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-027 meets this specification. Parts made using this specification will not be NORSOK M-710 compliant.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class .....	S to X
Nominal Temperature Rating .....	0 to 350°F

Note: This does not necessarily take into consideration the results of API Spec. 6A, Appendix F Testing or Life Estimation Testing of Seals.

#### 2.1.2 Pressure Limits:

Static .....	20,000 psi, liquid / 15,000 psi, gas
Dynamic.....	15,000 psi, liquid / 10,000 psi, gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes
Steam .....	Yes, limited
O <sub>2</sub> , Oxygen .....	No

### 3.0 MECHANICAL AND PHYSICAL PROPERTIES

Specific Gravity .....	1.29 +/- .05
ASTM D 792, Method A	
Hardness, Shore A .....	85 +/- 5 pts.
ASTM D 2240	
Tensile Strength, min. ....	2,554 psi
ASTM D 412	
Elongation, min .....	70%
ASTM D 412	
100% Modulus, min. ....	1370 psi
ASTM D 412	
Compression Set, max. ....	15%
ASTM D 395, Method B, 212°F for 168 hours in N <sub>2</sub> gas	
Glass Transition Temperature.....	-25 to 15°F
ASTM D 4065, D 4092, & D 2231	
DMA temperature sweep, -112 to 392°F, 11 Hz, 2% strain, G'' peak to tan delta peak	
Tear Resistance .....	150 lb <sub>f</sub> /in
ASTM D624, Die B, Method A Analysis, .02 in. deep nick	

### 4.0 APPENDIX – REFERENCE ONLY

TR-10, max. ....	14°F
Temperature Retraction, ASTM D 1329	

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****HYDROGENATED NITRILE, 0 TO 350 F, 90 DUROMETER (NON-NORSOK COMPLIANT VERSION OF E50159)**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1086818	19-Aug-03	Albor, Gabriel	Janoff, Dwight	RELEASED

**Summary:**

This specification E50059 is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-005 meets this specification. However, parts made using this specification will not be NORSOK M-710 compliant.

## 1.0 SCOPE

This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-005 meets this specification. Parts made using this specification will not be NORSOK M-710 compliant.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class .....	S to X
Nominal Temperature Rating .....	0 to 350°F

Note: This does not necessarily take into consideration the results of API Spec. 6A, Appendix F Testing or Life Estimation Testing of Seals.

#### 2.1.2 Pressure Limits:

Static .....	20,000 psi, liquid / 15,000 psi, gas
Dynamic.....	15,000 psi, liquid / 10,000 psi, gas

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes
Steam .....	Yes, limited
O <sub>2</sub> , Oxygen .....	No

### 3.0 MECHANICAL AND PHYSICAL PROPERTIES

Specific Gravity .....	1.24 +/- .05
ASTM D 792, Method A	
Hardness, Shore A .....	85 +/- 5 pts.
ASTM D 2240	
Tensile Strength, min. ....	3,200 psi
ASTM D 412	
Elongation, min.....	130%
ASTM D 412	
100% Modulus, min. ....	1800 psi
ASTM D 412	
Compression Set, max. ....	25%
ASTM D 395, Method B, 212°F for 168 hours in N <sub>2</sub> gas	
Glass Transition Temperature.....	-15 to 15°F
ASTM D 4065, D 4092, & D 2231	
DMA temperature sweep, -112 to 392°F,	
11 Hz, 2% strain, G'' peak to tan delta peak	
Tear Resistance .....	150 lb <sub>f</sub> /in
ASTM D624, Die B, Method A Analysis,	
.02 in. deep nick	

### 4.0 APPENDIX – REFERENCE ONLY

Air Aged: 70 Hours @ 350°F, ASTM D 573	
Hardness, Shore A .....	90 +/- 5 pts
Tensile Strength, min. ....	1,400 psi
Elongation, min. ....	40%
100% Modulus, max. ....	2,200 psi
Oil Aged: 70 Hours @ 350°F, ASTM No. 3 Oil, ASTM D 471	
Hardness, Shore A .....	75 +/- 5 pts
Tensile Strength, min. ....	2,000 psi
Elongation, max. ....	150%
100% Modulus, min.....	1,000 psi
Temperature Retraction, ASTM D 1329	
TR-10, max. ....	14°F

\*\*\* END OF DOCUMENT \*\*\*

**HNBR, LOW TEMPERATURE, 90 DUROMETER COMPOUND, LOW FRICTION.**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1111068	01-AUG-2006	Whitsitt, Elizabeth	Strickler, Mike	RELEASED

## Summary:

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile copolymer, which has been molded, cured and finished to meet all of the requirements of this specification.

E50189 MODIFIED WITH FMC PROPRIETARY PACKAGE TO REDUCE FRICTION

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## 1.0 Scope

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. The base compound is [E50189](#) that has been modified with an FMC proprietary additive package to reduce friction. FMC proprietary compound M1-030 meets this specification.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits

API 6A, Appendix F, Table F114.1, Test Fluid Class	HH
API 6A, Table 302.3, Material Class	AA to HH
API 6A, Table 302.2, Temperature Class	P to U
Nominal Temperature Rating	-20 to 250 °F (-29 to 121 °C)

#### 2.1.2 Pressure Limits

Static	20,000 psi, Liquid/15,000 psi, Gas
Dynamic	15,000 psi, Liquid/10,000 psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes, limited

### **3.0 Material Properties**

#### **3.1 Mechanical and Physical Properties**

Hardness, Shore A	87 ± 5 pts
ASTM D2240	
Tensile Strength, min	2,250 psi
ASTM D412	
Elongation, min	150%
ASTM D412	
100% Modulus, min	1,500 psi
ASTM D412	
Specific Gravity	1.31 ± 0.05 g/mL
ASTM D792 Method A	
Compression Set, ASTM D395 Method B	
22 hours @ 350 °F, max	30%

#### **3.2 Critical Transition Temperatures**

TR-10, max	140 °F (-100 °C)
Temperature Retraction	
ASTM D1329	
Tg	-2 to -220 °F (-19 to -300 °C)
Glass Transition Temperature	
ASTM D4065, D4092, D2231	

#### **3.3 Mechanical and Physical Properties after Aging**

##### **3.3.1 Air Aged**

70 Hours @ 257 °F, ASTM D573

Hardness, Shore A	90 ± 5 pts
Tensile Strength, min	2,100 psi
Elongation, min	100%
100% Modulus, max	2,000 psi

**3.3.2 Oil Aged**

70 Hours @ 257 °F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A	80 ± 5 pts
Tensile Strength, min	2,100 psi
Elongation, max	260%
100% Modulus, min	1,200 psi

**\* \* \* END OF DOCUMENT \* \* \***

**ENGINEERING SPECIFICATION****HNBR, HYDROGENATED NITRILE, HIGH TEAR AND TOUGHNESS**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1086578	2-Apr-98	Janoff, Dwight	Parrish, John	RELEASED

Summary: This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer HNBR, which has been molded, cured, and finished to meet all of the requirements of this specification. This material is intended for applications that require high tear, cut, and abrasion resistance. The compound is primarily used for Dowell Schlumberger applications.

## 1.0 MATERIAL

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer HNBR, which has been molded, cured, and finished to meet all of the requirements of this specification. This material is intended for applications that require high tear, cut, and abrasion resistance. The compound is primarily used for Dowell Schlumberger applications. FMC proprietary compound M1-008 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	HH
API 6A, Table 302.3, Material Class.....	AA to HH
API 6A, Table 302.2 Temperature Class.....	P to U
Nominal Temperature Rating.....	-20 to 250 <sup>0</sup> F

#### 2.1.2 Pressure Limits:

Static.....	20,000 psi, Liquid
.....	15,000 psi, Gas
Dynamic.....	15,000 psi, Liquid
.....	10,000 psi, Gas

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes, limited

## 3.0 MATERIAL PROPERTIES

### 3.1 Mechanical Properties

Hardness, Shore A.....	85± 5 pts
ASTM D2240	
Tensile Strength, min.....	2,900 psi
ASTM D412	
Elongation, min.....	200%
ASTM D412	
100% Modulus, min.....	970 psi
ASTM D412	
Specific Gravity.....	1.23 ± .05
ASTM D792 Method A	
Compression Set, ASTM D395 Method B	
22 hours @ 350 <sup>0</sup> F, max.....	50%

### 3.2 Critical Transition Temperatures

TR-10, max.....	14 <sup>0</sup> F (-10 <sup>0</sup> C)
Temperature Retraction	
ASTM D1329	
Tg.....	-2 to -22 <sup>0</sup> F (-19 to -30 <sup>0</sup> C)
Glass Transition Temperature	
ASTM D4065, D4092, D2231	

### 3.3 Air Aged: 70 Hours @ 257<sup>0</sup>F, ASTM D573

Hardness, Shore A.....	90 ± 5 pts
Tensile Strength, min.....	2,100 psi
Elongation, min.....	100%
100% Modulus, max.....	2,000 psi

### 3.4 Oil Aged: 70 Hours @ 257<sup>0</sup>F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....	80 ± 5 pts
Tensile Strength, min.....	2,100 psi
Elongation, max.....	260%
100% Modulus, min.....	1,200 psi

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****PTFE REINFORCED WITH GLASS, NICKEL AND MOLY, -75 TO 500  
DEG F**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1086578	5-Aug-96	Crawford, Neil	Vicic, John	RELEASED

Summary: This material is polytetrafluoroethylene (PTFE) reinforced with 15%  $\pm$  1% by weight fiberglass fiber and 10%  $\pm$  1% by weight nickel chrome and 2%  $\pm$  1% by weight molybdenum disulfide.



## 1.0 MATERIAL

This material is polytetrafluoroethylene (PTFE) reinforced with 15%  $\pm$  1% by weight fiberglass fiber and 10%  $\pm$  1% by weight nickel chrome and 2%  $\pm$  1% by weight molybdenum disulfide.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1	
Test Fluid Class.....	HH
API 6A, Table 302.3	
Material Class.....	AA to HH
API 6A, Table 302.2 & Table G1	
Temperature Class.....	K to X
Temperature Rating.....	-75 to 500°F

### 2.2 Chemical Compatibility:

H <sub>2</sub> O, Water .....	yes
Hydrocarbons .....	yes
CH <sub>4</sub> , Methane .....	yes
N <sub>2</sub> , Nitrogen Gas .....	yes
CO <sub>2</sub> , Carbon Dioxide .....	yes
H <sub>2</sub> S, Hydrogen Sulfide .....	yes
Amines .....	yes
Chlorides .....	yes
HCl, Hydrochloric Acid .....	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	yes
O <sub>2</sub> , Oxygen .....	yes
Steam .....	yes

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

##### 3.1.1 API and Temperature Limits:

Hardness, Shore D..... (ASTM D-785)	68 ± 5 pts
Tensile Strength, Min..... (ASTM D-1708)	3,000 psi
Tensile Elongation, Min..... (ASTM D-4894)	200%
Specific Gravity..... (ASTM D-792 Method A)	2.42 ± .05

\*\*\* End of Document \*\*\*

**ENGINEERING SPECIFICATION****HNBR ELECTRICAL CONNECTOR COMPOUND**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1086578	2-Apr-98	Janoff, Dwight	Parrish, John	RELEASED

Summary: This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer HNBR, which has been molded, cured, and finished to meet all of the requirements of this specification. The compound is a special electrical grade compound used in electrical connectors for ESP systems.

THIS IS A SPECIAL ELECTRICAL GRADE HNBR USED FOR ELECTRICAL CONNECTORS IN ESP SYSTEMS.

## 1.0 MATERIAL

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer HNBR, which has been molded, cured, and finished to meet all of the requirements of this specification. The compound is a special electrical grade compound used in electrical connectors for ESP systems. FMC proprietary compound M1-110 meets the requirements of this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	HH
API 6A, Table 302.3, Material Class.....	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class.....	L to U
Nominal Temperature Rating.....	-50 <sup>0</sup> F to 250 <sup>0</sup> F

#### 2.1.2 Pressure Limits:

Static.....	20,000 psi, Liquid
.....	15,000 psi, Gas
Dynamic.....	15,000 psi, Liquid
.....	10,000 psi, Gas

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes, limited

## 3.0 MATERIAL PROPERTIES

### 3.1 Mechanical Properties

Hardness, Shore A.....	80± 5 pts
ASTM D2240	
Tensile Strength, min.....	1500
ASTM D412	
Elongation, min.....	150%
ASTM D412	
100% Modulus, min.....	1200
ASTM D412	

\*\*\* End of Document \*\*\*

**HNBR, FOR SERVICE IN MTBE AND AROMATIC FLUIDS, 90  
DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1115701	08-JAN-2007	Wolff, Geoff	Whitsitt, Elizabeth	RELEASED

**Summary:**

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile copolymer (HNBR), which has been molded, cured and finished to meet all of the requirements of this specification. The compound is a special grade compound used in seals for use in MTBE (a gasoline additive), MTBE/gasoline, aromatic fluids and hydrocarbons.

THE COMPOUND IS USED FOR SEALS FOR MLA, NALS AND FCD.

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## 1.0 Scope

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. The compound is a special grade compound used in seals for use in MTBE, MTBE/gasoline, aromatic fluids and hydrocarbons. FMC proprietary compound M1-101 meets the requirements of this specification.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits

API 6A, Appendix F, Table F114.1, Test Fluid Class	HH
API 6A, Table 302.3, Material Class	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class	P to U
Nominal Temperature Rating	-20 to 250 °F (-29 to 121 °C)

#### 2.1.2 Pressure Limits

Static	20,000 psi, Liquid/15,000 psi, Gas
Dynamic	15,000 psi, Liquid/10,000 psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes, limited
MTBE	yes
Aromatics	yes



### 3.0 Material Properties

#### 3.1 Mechanical and Physical Properties

Hardness, Shore A ASTM D2240	89 ± 5 pts
Tensile Strength, min ASTM D412	2700 psi
Elongation, min ASTM D412	90%
100% Modulus, min ASTM D412	2000 psi
Specific Gravity	1.34 ± 0.03 g/mL
Compression set, max ASTM D 395, 22Hrs @ 350 °F	35%

**\*\*\* END OF DOCUMENT \*\*\***

**ENGINEERING SPECIFICATION****HYDROGENATED NITRILE, -20 TO 250 DEG F, 75 DUROMETER,  
WITH LOW FRICTION ADDITIVE**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1086578	4-Jan-01	Janoff, Dwight	Parrish, John	RELEASED

Summary: This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. The base compound is E50187 that has been modified with an FMC proprietary additive package to reduce friction.

## 1.0 MATERIAL

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. The base compound is E50187 that has been modified with an FMC proprietary additive package to reduce friction. FMC proprietary compound M1-135 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class.....AA to HH

API 6A, Table 302.2  
Temperature Class.....P to U

Nominal Temperature Rating.....-20 to 250<sup>0</sup>F

#### 2.1.2 Pressure Limits:

Static.....20,000 psi, Liquid  
.....15,000 psi, Gas

Dynamic.....15,000 psi, Liquid  
.....10,000 psi, Gas

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes, limited

## 3.0 MATERIAL PROPERTIES

### 3.1 Mechanical Properties

Hardness, Shore A.....	75 ± 5 pts
ASTM D2240	
Tensile Strength, min.....	2,700 psi
ASTM D412	
Elongation, min.....	250%
ASTM D412	
100% Modulus, min.....	600 psi
ASTM D412	
Specific Gravity.....	1.21 ± .05
ASTM D792 Method A	
Compression Set, ASTM D395 Method B	
22 hours @ 350 <sup>0</sup> F, max.....	25%

### 3.2 Critical Transition Temperatures

TR-10, max.....14<sup>0</sup>F (-10<sup>0</sup>C)  
Temperature Retraction  
ASTM D1329

Tg.....-1 to -22 <sup>0</sup>F (-18 to -30<sup>0</sup>C)  
Glass Transition Temperature  
ASTM D4065, D4092, D2231

### 3.3 Air Aged: 70 Hours @ 257<sup>0</sup>F, ASTM D573

Hardness, Shore A.....80 ± 5 pts  
Tensile Strength, min.....2,300 psi  
Elongation, min.....175%  
100% Modulus, max.....1,000 psi

### 3.4 Oil Aged: 70 Hours @ 257<sup>0</sup>F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....65 ± 5 pts  
Tensile Strength, min.....2,300 psi  
Elongation, max.....450%  
100% Modulus, min.....510 psi

\*\*\* End of Document \*\*\*

**HNBR, HYDROGENATED NITRILE, 0 TO 350 DEG F, 75 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
G	1111070	01-AUG-2006	Whitsitt, Elizabeth	Strickler, Mike	RELEASED

## Summary:

This specification is for a compound based on a hydrogenated copolymer of butadiene and acrylonitrile (HNBR), which has been molded, cured and finished to meet all of the requirements of this specification.

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## 1.0 Scope

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-004 meets this specification.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class	HH
API 6A, Table 302.3, Material Class	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class	S to X
Nominal Temperature Rating	0 to 350 °F (-18 to 177 °C)

#### 2.1.2 Pressure Limits:

Static	20,000 psi, Liquid/15,000 psi, Gas
Dynamic	15,000 psi, Liquid/10,000 psi, Gas

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes, limited

## 3.0 Material Properties

### 3.1 Mechanical and Physical Properties

Hardness, Shore A	73 ± 5 pts
ASTM D2240	



Tensile Strength, min ASTM D412	2,800 psi
Elongation, min ASTM D412	170%
100% Modulus, min ASTM D412	750 psi
Specific Gravity ASTM D792 Method A	1.19 ± 0.05 g/mL

Compression Set, ASTM D395 Method B 22 hours @ 350 °F, max	20%
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### **3.2 Critical Transition Temperatures**

TR-10, max Temperature Retraction ASTM D1329	14 °F (-10 °C)
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Tg Glass Transition Temperature ASTM D4065, D4092, D2231	16 to -2 °F (-9 to 19 °C)
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### **3.3 Mechanical and Physical Properties after Aging**

#### **3.3.1 Hot Air Aged**

70 Hours @ 350 °F, ASTM D573

Hardness, Shore A	80 ± 5 pts
Tensile Strength, min	2,000 psi
Elongation, min	50%
100% Modulus, max	1,900 psi

#### **3.3.2 Hot Oil Aged**

70 Hours @ 350 °F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A	65 ± 5 pts
Tensile Strength, min	2,000 psi
Elongation, max	450%
100% Modulus, min	630 psi

**\*\*\* END OF DOCUMENT \*\*\***

**HNBR, HYDROGENATED NITRILE, 85 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
H	1155994	09-MAR-2010	Parrish, John	Jones, Warren	RELEASED

## Summary:

This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile copolymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 Scope

This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile copolymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-027 meets this specification.

## 2.0 Service Compatibility

### 2.1 Temperature and Material Classification

API 6A, Table F.2, Test Fluid Class ..... HH  
API 6A, Table 3, Material Class ..... AA to HH  
API 6A, Table 2 & G.2, Temperature Class..... S to X  
Nominal Temperature Rating\* ..... 0 to 350 °F (-18 to 177 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H<sub>2</sub>O, Water ..... Yes  
Hydrocarbons ..... Yes  
CH<sub>4</sub>, Methane ..... Yes  
N<sub>2</sub>, Nitrogen Gas..... Yes  
CO<sub>2</sub>, Carbon Dioxide ..... Yes  
H<sub>2</sub>S, Hydrogen Sulfide ..... Yes  
Amines..... Yes  
Chlorides ..... Yes  
HCl, Hydrochloric Acid ..... Yes, cold  
H<sub>2</sub>SO<sub>4</sub>, Sulfuric Acid ..... Yes, cold  
H<sub>2</sub>CO<sub>3</sub>, Carbonic Acid ..... Yes  
Steam ..... Yes, limited  
O<sub>2</sub>, Oxygen ..... No

### 3.0 Material Properties

#### 3.1 Mechanical and Physical Properties

Specific Gravity ..... 1.29 ± 0.05  
ASTM D 792, Method A

Hardness, Shore A ..... 85 ± 5 pts.  
ASTM D 2240

Tensile Strength, min. .... 2,554 psi (17.61 MPa)  
ASTM D 412

Elongation, min. .... 70 %  
ASTM D 412

100% Modulus, min. .... 1,370 psi (9.45 MPa)  
ASTM D 412

Compression Set, max. .... 15 %  
ASTM D 395, Method B,  
350 °F (177 °C) for 22 hours

#### 3.2 Critical Transition Temperatures

Glass Transition Temperature ..... -25 to 15 °F (-31.7 to -9.4 °C)  
ASTM D 4065, D 4092 & D 2231  
DMA temperature sweep, 11 Hz, 2% strain,  
G" peak to tan delta peak

TR-10, max. (for reference only) ..... 14 °F (-10 °C)  
Temperature Retraction, ASTM D 1329

**HNBR, HYDROGENATED NITRILE, 90 DUROMETER, NORSOK  
COMPLIANT**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
M	1160455	01-JUL-2010	Wolff, Geoff	Jones, Warren	RELEASED

## Summary:

This specification is for an elastomeric compound based on a hydrogenated butadiene and acrylonitrile copolymer (HNBR), which has been molded, cured and finished to meet all of the requirements of this specification.

Compound is compliant with the requirements of NORSOK M-710 rev. 2 dated May, 2001 for Annex B RGD damage resistance and Annex A chemical aging resistance.

## 1.0 Scope

This specification is for an elastomeric compound based on a hydrogenated butadiene and acrylonitrile copolymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-005 meets this specification.

Compound is compliant with the requirements of NORSOK M-710 rev. 2 dated May, 2001 for Annex B RGD damage resistance and Annex A chemical aging resistance. [RPT100006300](#) and [RPT10017976](#) document acceptable RGD damage resistance with an S-Seal and [RPT10013070](#) documents life estimation results from chemical aging tests. Material property test results are documented in [RPT10034510](#).

## 2.0 Service Compatibility

### 2.1 Temperature and Material Classification

API 6A, Table F.2, Test Fluid Class .....	HH
API 6A, Table 3, Material Class .....	AA to HH
API 6A, Tables 2 & G.2, Temperature Class .....	S to X
Nominal Temperature Rating* .....	0 to 350 °F (-18 to 177 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons .....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas .....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines .....	Yes
Chlorides .....	Yes
HCl, Hydrochloric Acid .....	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	Yes
Steam .....	Yes, limited
O <sub>2</sub> , Oxygen .....	No

### 3.0 Material Properties

#### 3.1 Mechanical and Physical Properties

Specific Gravity ..... 1.25 ± 0.05  
ASTM D 792, Method A

Hardness, Shore A ..... 89 ± 5 pts.  
ASTM D 2240

Tensile Strength, min. .... 3,000 psi (20.7 MPa)  
ASTM D 412

Elongation, min. .... 100 %  
ASTM D 412

100 % Modulus, min. .... 1,700 psi (11.7 MPa)  
ASTM D 412

Compression Set, max. .... 25 %  
ASTM D 395, Method B,  
212 °F (100 °C) for 168 hours in N<sub>2</sub> gas

Tear Resistance, min. .... 150 lbf/in (26.3 kN/m)  
ASTM D 624, Die B, Method A Analysis,  
0.02 in. (.51 mm) deep nick

#### 3.2 Critical Transition Temperatures

Glass Transition Temperature..... -15 to 15 °F (-26 to -9 °C)  
ASTM D 4065, D 4092, & D 2231  
DMA temperature sweep, 11 Hz, 2 % strain,  
G' peak to tan delta peak

TR-10, max. (reference only) ..... 14 °F (-10 °C)  
Temperature Retraction, ASTM D 1329



### **3.3 Mechanical and Physical Properties after Aging**

#### **3.3.1 Hot Air Aged (for reference only)**

70 Hours @ 350 °F (177 °C), ASTM D 573

Hardness, Shore A .....	90 ± 5 pts
Tensile Strength, min. ....	1,400 psi (9.65 MPa)
Elongation, min. ....	40 %
100 % Modulus, max. ....	2,200 psi (15.2 MPa)

#### **3.3.2 Hot Oil Aged (for reference only)**

70 Hours @ 350 °F (177 °C),, ASTM No. 3 Oil, ASTM D 471

Hardness, Shore A .....	75 ± 5 pts
Tensile Strength, min. ....	2,000 psi (13.8 MPa)
Elongation, max. ....	150 %
100 % Modulus, min. ....	1,100 psi (7.58 MPa)

### **4.0 Approved Vendors, Facilities & Materials**

Compounder: Excel Polymers Corporation at plant on Highway 353 South in  
Jonesborough, TN, U.S.A.

Molder: FMC Non-Metallic Cell in plant at 1777 Gears Rd., Houston, TX,  
U.S.A.

All approval inquiries are to be directed to the CTG Materials Engineering.

**HNBR, HYDROGENATED NITRILE, 75 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
J	1155994	09-MAR-2010	Parrish, John	Jones, Warren	RELEASED

## Summary:

This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile copolymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 Scope

This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile copolymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-006 meets this specification.

## 2.0 Service Compatibility

### 2.1 Temperature and Material Classification

API 6A, Table F.2, Test Fluid Class ..... HH  
API 6A, Table 3, Material Class ..... AA to HH  
API 6A, Table 2 & G.2, Temperature Class..... P to U  
Nominal Temperature Rating\* ..... -20 to 250 °F (-29 to 121 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons .....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides .....	Yes
HCl, Hydrochloric Acid .....	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	Yes
Steam .....	Yes, limited
O <sub>2</sub> , Oxygen .....	No

### 3.0 Material Properties

#### 3.1 Mechanical and Physical Properties

Specific Gravity ..... 1.21 ± 0.05  
ASTM D 792, Method A

Hardness, Shore A ..... 75 ± 5 pts.  
ASTM D 2240

Tensile Strength, min. .... 2,700 psi (18.62 MPa)  
ASTM D 412

Elongation, min. .... 250 %  
ASTM D 412

100% Modulus, min. .... 600 psi (4.14 MPa)  
ASTM D 412

Compression Set, max. .... 20 %  
ASTM D 395, Method B, 350 °F (177 °C) for  
22 hours in air

#### 3.2 Critical Transition Temperatures

Glass Transition Temperature..... -45 to 0 °F (-43 to -18 °C)  
ASTM D 4065, D 4092, & D 2231  
DMA temperature sweep, 11 Hz, 2% strain,  
G' peak to tan delta peak

TR-10, max. (reference only) ..... 14 °F (-10 °C)  
Temperature Retraction, ASTM D 1329

#### 3.3 Mechanical and Physical Properties After Aging

##### 3.3.1 Hot Air Aged (for reference only)

70 Hours @ 257 °F (125 °C), ASTM D 573

Hardness, Shore A ..... 80 ± 5 pts  
Tensile Strength, min. .... 2,300 psi (15.86 MPa)  
Elongation, min. .... 175 %  
100% Modulus, max. .... 1,000 psi (6.89 MPa)

### 3.3.2 Hot Oil Aged (for reference only)

70 Hours @ 257 °F (125 °C), IRM 903 Oil, ASTM D 471

Hardness, Shore A .....	65 ± 5 pts
Tensile Strength, min. ....	2300 psi (15.86 MPa)
Elongation, max. ....	450 %
100% Modulus, min. ....	510 psi (3.52 MPa)

**HNBR, HYDROGENATED NITRILE, -20 TO 250 DEG F, 85  
DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
G	1111070	01-AUG-2006	Whitsitt, Elizabeth	Strickler, Mike	RELEASED

## Summary:

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile copolymer (HNBR), which has been molded, cured and finished to meet all of the requirements of this specification.

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## 1.0 Scope

This specification is for a compound based on a hydrogenated butadiene and acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-007 meets this specification.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits

API 6A, Appendix F, Table F114.1, Test Fluid Class	HH
API 6A, Table 302.3, Material Class	AA to HH
API 6A, Table 302.2, Temperature Class	P to U
Nominal Temperature Rating	-20 to 250°F (-29 to 121 °C)

Note: These temperatures do not necessarily reflect the results of Life Estimation Testing or API 6A, Appendix F, Pressure & Temperature Cycle Testing with specific seal designs.

#### 2.1.2 Pressure Limits

Static	20,000 psi, liquid/15,000 psi, gas
Dynamic	15,000 psi, liquid/10,000 psi, gas

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbon	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>4</sub> CO <sub>3</sub> , Carbonic Acid	yes, cold
O <sub>2</sub> , Oxygen	no
Steam	yes, limited



### 3.0 Material Properties

#### 3.1 Mechanical and Physical Properties

Hardness, Shore A, ASTM D 2240	84 ± 5 pts
Tensile Strength, ASTM D 412, min.	2,200 psi
Elongation, ASTM D 412, min.	110%
100% Modulus, ASTM D 412, min.	800 psi
Specific Gravity, ASTM D 792 Method A	1.26 ± 0.03 g/mL
Compression Set, ASTM D 395 Method B, 22 hours @ 350 °F, max.	30%

**Note: Slabs and buttons molded for mechanical property testing are to be molded at 350 °F for 15 minutes and then post-cured at 400 °F for 2 hours.**

#### 3.2 Critical Transition Temperatures

TR-10, Temperature Retraction, ASTM D 1329, max.	14 °F (-10 °C)
Tg, Glass Transition Temperature, ASTM D 4065, D 4092, D 2231	0 to -22 °F (-18 to -30 °C)

### 3.3 Mechanical and Physical Properties after Aging

#### 3.3.1 Air Aged

70 Hours @ 250 °F, ASTM D 573

Hardness, Shore A	85 ± 5 pts
Tensile Strength, min.	2,200 psi
Elongation, max.	220%
100% Modulus max.	1,340 psi

#### 3.3.2 Oil Aged

70 Hours @ 250 °F, ASTM No. 3 Oil, ASTM D 471

Hardness, Shore A	75 ± 5 pts
Tensile Strength, min.	2,540 psi

Elongation, max.	260%
100% Modulus, max.	960 psi

**\*\*\*END OF DOCUMENT\*\*\***

**HNBR, LOW TEMP SERVICE, 90 DUROMETER, NORSOK  
COMPLIANT**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
J	1160455	01-JUL-2010	Wolff, Geoff	Jones, Warren	RELEASED

## Summary:

This specification is for an elastomeric compound based on a hydrogenated butadiene and acrylonitrile copolymer (HNBR), which has been molded, cured and finished to meet all of the requirements of this specification.

Compound is compliant with the requirements of NORSOK M-710 rev. 2 dated May, 2001 for Annex A chemical aging resistance only (not for Annex B RGD damage resistance).

## 1.0 Scope

This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile copolymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-008 meets this specification.

Compound is compliant with the requirements of NORSOK M-710 rev. 2 dated May, 2001 for Annex A chemical aging resistance only (not for Annex B RGD damage resistance). [RPT10013070](#) documents life estimation results from chemical aging tests. Material property test results are documented in [RPT10034510](#).

## 2.0 Service Compatibility

### 2.1 Temperature and Material Classification

API 6A, Table F.2, Test Fluid Class .....	HH
API 6A, Table 3, Material Class .....	AA to HH
API 6A, Table 2 & G.2 Temperature Class .....	P to U
Nominal Temperature Rating .....	-20 to 250 °F (-29 to 121 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons .....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines .....	Yes
Chlorides .....	Yes
HCl, Hydrochloric Acid .....	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	Yes
Steam .....	Yes, limited
O <sub>2</sub> , Oxygen .....	No

### 3.0 Material Properties

#### 3.1 Mechanical and Physical Properties

Specific Gravity ..... 1.29 +/- 0.05  
ASTM D 792, Method A

Hardness, Shore A ..... 89 +/- 5 pts.  
ASTM D 2240

Tensile Strength, min. .... 2,500 psi (17.2 MPa)  
ASTM D 412

Elongation, min. .... 85 %  
ASTM D 412

100 % Modulus, min. .... 1,500 psi (10.3 MPa)  
ASTM D 412

Compression Set, max. .... 20 %  
ASTM D 395, Method B,  
212 °F (100 °C) for 168 hours in N2 gas

Tear Resistance, min. .... 200 lbf/in (35.0 kN/m)  
ASTM D 624, Die B, Method A Analysis,  
.02 in. (.51 mm) deep nick

#### 3.2 Critical Transition Temperatures

Glass Transition Temperature..... -45 to 0 °F (-43 to -18 °C)  
ASTM D 4065, D 4092, & D 2231  
DMA temperature sweep, 11 Hz, 2 % strain,  
G" peak to tan delta peak

TR-10, max. (reference only) ..... 14 °F (-10 °C)  
Temperature Retraction, ASTM D 1329

### 3.3 Mechanical and Physical Properties after Aging

#### 3.3.1 Hot Air Aged (for reference only)

70 Hours @ 257 °F (125 °C), ASTM D 573

Hardness, Shore A .....	90 +/- 5 pts
Tensile Strength, min. ....	2,100 psi (14.5 MPa)
Elongation, min. ....	100 %
100 % Modulus, max. ....	2,000 psi (13.8 MPa)

#### 3.3.2 Hot Oil Aged (for reference only)

70 Hours @ 257 °F (125 °C), ASTM No. 3 Oil, ASTM D 471

Hardness, Shore A .....	80 +/- 5 pts
Tensile Strength, min. ....	2,100 psi (14.5 MPa)
Elongation, max. ....	260 %
100 % Modulus, min. ....	1,200 psi (8.3 MPa)

### 4.0 Approved Vendors, Facilities, and Materials

Compounder: Excel Polymers Corporation at plant on Highway 353 South in  
Jonesborough, TN, U.S.A.

Molder: FMC Non-Metallic Cell in plant at 1777 Gears Rd., Houston, TX,  
U.S.A.

All approval inquiries are to be directed to CTG Materials Engineering.

**OBSOLETE AND REPLACED BY E50123 - HYDROGENATED  
NITRILE(F/NALS), -20 TO 250 DEG F, 90 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1115703	08-JAN-2007	Wolff, Geoff	Whitsitt, Elizabeth	RELEASED

Summary: This specification is for a compound based on a butadiene and an acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for a compound based on a butadiene and an acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-101 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

2.1.1 API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class.....DD to HH

API 6A, Table 302.2 and Table G1  
Temperature Class.....P to U

Temperature Rating.....-20 to 250°F

#### 2.1.2 Pressure Limits:

Static..... 20,000psi, Liquid  
..... 15,000psi, Gas

Dynamic..... 15,000psi, Liquid  
..... 10,000psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	no
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	no
Amines	unknown



< 25%	Chlorides	yes
	HCl, Hydrochloric Acid	yes, if < 37%
	H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, if
	H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	unknown
	O <sub>2</sub> , Oxygen	yes
	Steam	yes

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A.....90 ± 5 pts  
ASTM D2240

Tensile Strength, min.....2,360psi  
ASTM D412

Elongation, min.....160%  
ASTM D412

100% Modulus, min.....1,800psi  
ASTM D412

Specific Gravity.....1.26 ± .02  
ASTM D792 Method A

Compression Set, ASTM D395 Method B  
22 hrs @ 350°F, max.....35%

#### 3.2 Critical Transition Temperatures

TR-10, max.....-10°F  
Temperature Retraction  
ASTM D1329

29.8°F Tg.....-19.2 to -

Glass transition Temperature  
ASTM D4065, D4092, D2231

3.3 Air Aged: 70 Hours @ 250°F ASTM D573

Hardness, Shore A.....	90 ±5 PTS
Tensile Strength, min.....	1,880psi
Elongation, max.....	200%
100% Modulus, max.....	2,200psi

3.4 Oil Aged: 70 Hours @ 250°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....	80 ±5 PTS
Tensile Strength, min.....	1,880psi
Elongation, max.....	200%
100% Modulus, max.....	2,200psi

**\*\*\* END OF DOCUMENT \*\*\***

**HYDROGENATED NITRILE RUBBER, HIGH TEMPERATURE  
FORMULATION, 85 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1114553	07-DEC-2006	Whitsitt, Elizabeth	Strickler, Mike	RELEASED

Summary: This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification.

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## 1.0 Scope

This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-136 meets this specification.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits

API 6A, Appendix F, Table F114.1, Test Fluid	HH
API 6A, Table 302.3, Material Class	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class	S to X
Nominal Temperature Rating	0 to 350 °F (-18 to 177 °C)

#### 2.1.2 Pressure Limits

Static	20,000 psi, liquid/15,000 psi, gas
Dynamic	15,000 psi, liquid/10,000 psi, gas

(Note: This does not necessarily take into consideration the results of API Spec. 6A, Appendix F Testing or Life Estimation Testing of Seals.)

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	Yes
Hydrocarbons	Yes
CH <sub>4</sub> , Methane	Yes
N <sub>2</sub> , Nitrogen Gas	Yes
CO <sub>2</sub> , Carbon Dioxide	Yes
H <sub>2</sub> S, Hydrogen Sulfide	Yes
Amines	Yes
Chlorides	Yes
HCl, Hydrochloric Acid	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	Yes
Steam	Yes, limited
O <sub>2</sub> , Oxygen	No

### 3.0 Material Properties

#### 3.1 Mechanical and Physical Properties

Specific Gravity 1.24 ± 0.05  
ASTM D 792, Method A

Hardness, Shore A 85 ± 5 pts.  
ASTM D 2240

Tensile Strength, min. 2,400 psi  
ASTM D 412

Elongation, min. 220 %  
ASTM D 412

100% Modulus, min. 800 psi  
ASTM D 412

Compression Set, max 25%  
ASTM D 395, Method B, 350 °F  
for 22 hours

Tear Resistance, min. 150 lb/in  
ASTM D 624, Die B, Method A Analysis,  
0.02 in. deep nick

#### 3.2 Critical Transition Temperatures

Glass Transition Temperature -15 to 15 °F (-26 to -9 °C)  
ASTM D 4065, D 4092, & D 2231  
DMA temperature sweep, -112 to 392°F,  
11 Hz, 2% strain, G'' peak to tan delta peak

TR-10, max 14 °F  
Temperature Retraction, ASTM D 1329

#### 3.3 Mechanical and Physical Properties After Aging

##### 3.3.1 Hot Air Aged

70 Hours @ 350 °F, ASTM D 573

Hardness, Shore A	90 ± 5 pts
Tensile Strength, min.	1,400 psi
Elongation, min.	40 %
100% Modulus, max.	2,200 psi

### **3.3.2 Hot Oil Aged**

70 Hours @ 350 °F, IRM 903 Oil, ASTM D 471

Hardness, Shore A	75 ± 5 pts
Tensile Strength, min.	2,000 psi
Elongation, max.	150 %
100% Modulus, min.	1,100 psi

## **4.0 Approved Vendors, Facilities and Materials**

Compounder: Excel Corporation in Burton, Ohio, USA

Molder: FMC Non-Metallic Cell at plant at 1777 Gears Rd., Houston, TX, U.S.A.

Compounded by uncured raw material **p/n P172133**

**\* \* \* END OF DOCUMENT \* \* \***

**HYDROGENATED NITRILE RUBBER, HIGH TEMPERATURE  
FORMULATION, 85 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1114553	07-DEC-2006	Whitsitt, Elizabeth	Strickler, Mike	RELEASED

Summary: This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification.



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## 1.0 Scope

This specification is for an elastomer compound based on a hydrogenated butadiene and acrylonitrile polymer (HNBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-137 meets this specification.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid	HH
API 6A, Table 302.3, Material Class	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class	S to X
Nominal Temperature Rating	0 to 350 °F (-18 to 177 °C)

#### 2.1.2 Pressure Limits:

Static	20,000 psi, liquid/15,000 psi, gas
Dynamic	15,000 psi, liquid/10,000 psi, gas

(Note: This does not necessarily take into consideration the results of API Spec. 6A, Appendix F Testing or Life Estimation Testing of Seals.)

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	Yes
Hydrocarbons	Yes
CH <sub>4</sub> , Methane	Yes
N <sub>2</sub> , Nitrogen Gas	Yes
CO <sub>2</sub> , Carbon Dioxide	Yes
H <sub>2</sub> S, Hydrogen Sulfide	Yes
Amines	Yes
Chlorides	Yes
HCL, Hydrochloric Acid	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	Yes
Steam	Yes, limited
O <sub>2</sub> , Oxygen	No

### **3.0 Material Properties**

#### **3.1 Mechanical and Physical Properties**

Specific Gravity 1.24 ± 0.05  
ASTM D 792, Method A

Hardness, Shore A 85 ± 5 pts.  
ASTM D 2240, Max. reading

Tensile Strength, min. 3,200 psi  
ASTM D 412

Elongation, min. 100 %  
ASTM D 412

100% Modulus, min. 2000 psi  
ASTM D 412

Compression Set, max. 25 %  
ASTM D 395, Method B, 350 °F for 22 hours

Tear Resistance, min. 150 lb<sub>f</sub>/in  
ASTM D 624, Die B, Method A Analysis,  
0.02 in. deep nick

#### **3.2 Critical Transition Temperatures**

Glass Transition Temperature -15 to 15 °F (- 26 to -9 °C)  
ASTM D 4065, D 4092, & D 2231  
DMA temperature sweep, -112 to 392°F,  
11 Hz, 2% strain, G'' peak to tan delta peak

TR-10, max. 14 °F  
Temperature Retraction, ASTM D 1329

#### **3.3 Mechanical and Physical Properties After Aging**

##### **3.3.1 Hot Air Aged**

70 Hours @ 350 °F, ASTM D 573

Hardness, Shore A	90 ± 5 pts
Tensile Strength, min.	1,400 psi
Elongation, min.	40 %
100% Modulus, max.	2,200 psi

### **3.3.2 Hot Oil Aged**

70 Hours @ 350 °F, IRM 903 Oil, ASTM D 471

Hardness, Shore A	75 ± 5 pts
Tensile Strength, min.	2,000 psi
Elongation, max.	150 %
100% Modulus, min.	100 psi

## **4.0 Approved Vendors, Facilities and Materials**

Compounder: Excel Corporation, Burton, OH

Molder: FMC Non-Metallic Cell at plant at 1777 Gears Rd., Houston, TX, U.S.A.

Compounded by uncured raw material p/n **P175622**

**\* \* \* END OF DOCUMENT \* \* \***

**ENGINEERING SPECIFICATION****HNBR, COMMERCIAL, 90 DUROMETER, FOR KONGSBERG**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1093175	29-JUN-2004	Janoff, Dwight	Parrish, John	RELEASED

## Summary:

## HNBR, 90 Durometer, For Critical Applications in Controls

This specification is for commercial o-rings and other seals for critical service subsea control applications, based on a 90 durometer hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for commercial o-rings and other seals for critical service subsea control applications, based on a 90 durometer hydrogenated butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 2.0 APPROVED COMPOUNDS

The following compounds are approved for O-rings that reference this E spec:

Skega Compound 63 90 093  
Busak+Shamban H 9T40  
Parker N3512-90

New compounds may be approved using per FMC SPC-0000023654. Contact FMC Materials Engineering to evaluate new compounds for this specification.

Before referencing this E spec, the design engineer must verify that it is suitable for the application.

## 3.0 MATERIAL PROPERTIES

The data below (except data marked “for reference only”) may be used for quality control of received parts.

### 3.1 Mechanical Properties

	<u><i>Value</i></u>	<u><i>Method</i></u>
Hardness	82 to 95 °IRH -or- 85 to 95 Shore A	ISO 48 or DIN 53519  DIN 53505 or ASTM D2240
Tensile Strength	min. 2470 psi (17 MPa)	ISO 37 or DIN 53504 or ASTM D412
Elongation	min. 100 %	ISO 37 or DIN 53504 or ASTM D412
Specific Gravity (FOR REFERENCE ONLY)	1.2 – 1.3	ISO 2781 or DIN 53479 or ASTM D792 Method A
Compression Set (FOR REFERENCE ONLY)	max. 55%	70 hours @ 300 °F (150 °C) ISO 815 or ASTM D395 Method B

### 3.2 Critical Transition Temperature (FOR REFERENCE ONLY)

TR-10	1 °F (-17 °C)	ASTM D1329
Temperature Retraction		

### 3.3 Oil Aged (FOR REFERENCE ONLY)

Volume Change	0 to +30 %	70 Hours @ 212°F (100°C)
		ASTM No. 1 Oil
		ISO 1817

## 4.0 SERVICE COMPATIBILITY

### 4.1 Temperature and Pressure Compatibility

#### 4.1.1 Temperature Limits:

Test Fluid Class (API, Table F114.1) .....HH

Material Class (API, Table 302.3) .....AA to HH

Nominal Temperature Rating \* .....-4 to 250°F (-20 TO 121 °C)

\* Actual service temperature range is dependent upon application

#### 4.1.2 Pressure Limits:

Pressure limits are dependent upon seal design and application.

### 4.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	yes
Hydrocarbons .....	yes
CH <sub>4</sub> , Methane .....	yes
N <sub>2</sub> , Nitrogen Gas .....	yes
CO <sub>2</sub> , Carbon Dioxide .....	yes
H <sub>2</sub> S, Hydrogen Sulfide .....	yes
Amines .....	yes
Chlorides .....	yes
HCl, Hydrochloric Acid .....	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	yes, cold
O <sub>2</sub> , Oxygen .....	no
Steam .....	no

\*\*\*END OF DOCUMENT \*\*\*

**FCD USE ONLY - WEATHER RESISTANT NITRILE FOR  
COMMERCIAL AND CUSTOM MOLDED SEALING ELEMENTS**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
F	5026751	18-MAY-2011	Douglas, Don	Soltau, James	RELEASED

Summary: This specification covers the requirements for 80 Durometer nitrile elastomer (NBR) compound.



## **1.0 SCOPE**

- 1.1 This specification covers the requirements for 80 Durometer nitrile elastomer (NBR) compound. This compound is good in the temperature range of -20°F to 250°F for O-Rings, seals, and related applications.

## **2.0 ASSOCIATED SPECIFICATIONS**

- 2.1 ASTM D395, D412, D-2240

## **3.0 PHYSICAL & MECHANICAL PROPERTIES**

- 3.1 Hardness, Durometer, Shore A (ASTM D-2240).....80±5 points
- 3.2 Tensile strength, min (ASTM D-412).....1560 psi
- 3.3 Elongation, min (ASTM D-412).....125%
- 3.4 Compression set, max (ASTM D-395 Method B).....27%

## **4.0 APPROVED COMPOUNDS**

- 4.1 National O-Ring Compound #C97-80
- 4.2 Minnesota Rubber Compound #446A
- 4.3 Indian Rubber Compound #8011
- 4.4 OSI Barlow-Hunt Compound #100-32
- 4.5 LGB Compound CMF104
- 4.6 UTEX Compound 10058

\* \* \* End of Document \* \* \*

**NBR, 70 DUROMETER, EXPANDER O-RING FOR POLYPAK AND PIP  
SEAL ASSEMBLIES**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1112730	20-SEP-2006	Jones, Warren	Strickler, Mike	RELEASED

## Summary:

This specification is for an acrylonitrile butadiene elastomer (NBR or Nitrile) compound which has been molded and cured to meet the requirements of this specification.

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## 1.0 Scope

This specification is for an acrylonitrile butadiene elastomer (NBR or Nitrile) compound which has been molded and cured to meet the requirements of this specification. This compound is compression molded and peroxide cured. Extruded material is NOT acceptable. Parker compounds N1070-70 and N0951-70 meet the requirements of this specification. This compound is for use as the O-Ring Expander (or Energizer) in PolyPak™ and PIP™ Seal assemblies. Any other application must be reviewed by the FMC Energy Systems Core Technology Group.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature

API 6A, Appendix F, Table F114.1, Test Fluid Class	AA
API 6A, Table 302.3, Material Class	AA
Temperature Rating *	-20 to 250°F

\*This temperature range does not necessarily reflect the results of API 6A testing or life estimation testing.

### 2.2 Chemical Compatibility

This compound is for use in water/glycol based and oil based hydraulic fluids. It is also compatible with sea water. Any other service must be reviewed by the Core Technology Group in the FMCTI Energy Production Systems business unit.

## 3.0 Material Properties

### 3.1 Mechanical Properties

Hardness, Shore A ASTM D2240	70 ± 5 pts
Tensile Strength, min. ASTM D412	700 psi
Elongation, min. ASTM D412	150%
100% Modulus, min. ASTM D412	600 psi (Reference only)
Specific Gravity ASTM D792 Method A	1.15 ± .05

Compression Set, ASTM D395 Method B      25%  
70 hours @ 212°F, max

### **3.2 Critical Transition Temperatures**

Tg, Glass Transition Temperature      -25 to -30°C  
ASTM D4065, D4092, D2231

### **4.0 Vulcanized Splices**

This material is used to fabricate compression molded cord which is then used to fabricate O-Rings using vulcanized splices. Two splices per finished O-Ring are permitted. The assembled O-Ring, including the splices, must meet the requirements of this specification.

**\* \* \* End of Document \* \* \***

**NBR, 70 DURO, GENERAL SERVICE, COMMERCIAL**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
K	1190844	06-JUL-2012	Wolff, Geoff	Turbeville, Elliott	RELEASED

## Summary:

This specification is for a commercial compound based on a copolymer of acrylonitrile and butadiene, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 Scope

This specification is for a commercial compound based on a copolymer of acrylonitrile and butadiene, which has been molded, cured, and finished to meet the requirements of this specification. FMC proprietary compound M1-009 meets this specification. Other supplier compounds are also acceptable if they meet the requirements of this specification.

## 2.0 Service Compatibility

### 2.1 Temperature and Material Classification

API 6A, Table F.2, Test Fluid Class .....CC  
API 6A, Table 3, Material Class .....AA to CC  
API 6A, Tables 2 & G.2, Temperature Class .....P to U  
Nominal Temperature Rating\* .....-20 to 250 °F (-29 to 121 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H<sub>2</sub>O, Water .....yes  
Hydrocarbons .....yes  
CH<sub>4</sub>, Methane .....yes  
N<sub>2</sub>, Nitrogen Gas .....yes  
CO<sub>2</sub>, Carbon Dioxide .....yes  
H<sub>2</sub>S, Hydrogen Sulfide .....yes  
Amines .....yes  
Chlorides .....yes  
HCl, Hydrochloric Acidyes, .....cold  
H<sub>2</sub>SO<sub>4</sub>, Sulfuric Acidyes, .....cold  
H<sub>2</sub>CO<sub>3</sub>, Carbonic Acidyes, .....cold  
O<sub>2</sub>, Oxygen .....no  
Steam .....no

### 3.0 Material Properties

#### 3.1 Mechanical and Physical

Hardness, Shore A..... 70 ± 5 pts  
ASTM D2240

Tensile Strength, min..... 2,100 psi (14.5 MPa)  
ASTM D412

Elongation, min..... 150 %  
ASTM D412

100% Modulus, min..... 375 psi (2.59 MPa)  
ASTM D412

Specific Gravity..... 1.15 ± 0.10  
ASTM D792 Method A

Compression Set, ASTM D395 Method B  
22 hours @ 300 °F (149 °C), max..... 30 %

#### 3.2 Critical Transition Temperatures

TR-10, max..... 5 °F (-15 °C)  
Temperature Retraction, ASTM D1329

#### 3.3 Hot Oil Aged

70 Hours @ 250 °F (121 °C), IRM 903 Oil, ASTM D471

Hardness, Shore A..... 70 ± 10 pts  
Tensile Strength, min..... 2,200 psi (15.2 MPa)  
Elongation, min..... 160 %  
100% Modulus..... 750 ± 450 psi (5.17 ± 3.10 MPa)



**NBR, NITRILE RUBBER, GENERAL SERVICE, -20 TO 250 DEG F, 80  
DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
F	1147909	17-JUL-2009	Jones, Warren	Parrish, John	RELEASED

## Summary:

This specification is for a compound based on a butadiene and acrylonitrile copolymer (NBR), which has been molded, cured and finished to meet all of the requirements of this specification.

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## 1.0 Scope

This specification is for a compound based on a butadiene and an acrylonitrile copolymer (NBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-011 meets this specification.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class	CC
API 6A, Table 302.3, Material Class	AA to CC
API 6A, Table 302.2, Temperature Class	P to U
Temperature Rating	-20 to 250 °F (-29 to 121 °C)

#### 2.1.2 Pressure Limits:

Static	20,000 psi, liquid / 10,000 psi, gas
Dynamic	10,000 psi, liquid / 5,000 psi, gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes, cold
O <sub>2</sub> , Oxygen	no
Steam	no

### 3.0 Material Properties

#### 3.1 Physical and Mechanical Properties

Hardness, Shore A ASTM D2240	78 ± 5 pts
Tensile Strength, min. ASTM D412	2,490 psi
Elongation, min ASTM D412	170%
100% Modulus, min. ASTM D412	940 psi
Specific Gravity ASTM D792 Method A	1.21 ± 0.02 g/mL
Compression Set, ASTM D395 Method B 22 hours @ 300 °F, max.	25%

#### 3.2 Critical Transition Temperatures

TR-10, max Temperature Retraction, ASTM D1329	-20 °F (-29 °C)
Tg Glass Transition Temperature ASTM D4065, D4092, D2231	-18 to -52 °F (-28 to -47 °C)

#### 3.3 Physical and Mechanical Properties after Aging

##### 3.3.1 Air Aged

70 Hours @ 250 °F, ASTM D573

Hardness, Shore A	90 ± 5 pts
Tensile Strength, min.	1,640 psi
Elongation, max.	150%
100% Modulus, max.	1,730 psi

**3.3.2 Oil Aged**

70 Hours @ 250°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A	70 ± 5 pts
Tensile Strength, min.	1,950 psi
Elongation, max.	200%
100% Modulus, max.	1,000 psi

**\* \* \* END OF DOCUMENT \* \* \***

**ENGINEERING SPECIFICATION****NITRILE RUBBER, GENERAL SERVICE, -20 TO 250 DEG F, 90  
DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
H	1086578	16-DEC-85	DC	RKS	RELEASED

Summary: This specification is for a compound based on a Butadiene and an Acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for a compound based on a Butadiene and an Acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-012 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	CC
API 6A, Table 302.3, Material Class .....	AA to CC
API 6A, Table 302.2 Temperature Class .....	S to U
Temperature Rating .....	-20 to 250°F

#### 2.1.2 Pressure Limits:

Static .....	20,000 psi, Liquid 10,000 psi, Gas
Dynamic .....	10,000 psi, Liquid 5,000 psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	yes
Hydrocarbons .....	yes
CH <sub>4</sub> , Methane .....	yes
N <sub>2</sub> , Nitrogen Gas .....	yes
CO <sub>2</sub> , Carbon Dioxide .....	yes
H <sub>2</sub> S, Hydrogen Sulfide .....	yes
Amines .....	yes
Chlorides .....	yes
HCl, Hydrochloric Acid .....	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	yes, cold
O <sub>2</sub> , Oxygen .....	no
Steam .....	no

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A .....	90 ± 5 pts
ASTM D2240	
Tensile Strength, min. ....	2,100 psi
ASTM D412	
Elongation, min. ....	125%
ASTM D412	
100% Modulus, min. ....	1,725 psi
ASTM D412	
Specific Gravity .....	---
ASTM D792 Method A	
Compression Set, ASTM D395 Method B	
22 hours @ 300°F, max. ....	27%

#### 3.2 Critical Transition Temperatures

TR-10, max. ....	1°F (-17°C)
Temperature Retraction	
ASTM D1329	
Tg .....	---
Glass Transition Temperature	
ASTM D4065, D4092, D2231	

#### 3.3 Air Aged: 70 Hours @ 250°F, ASTM D573

Hardness, Shore A .....	95 ± 5 pts
Tensile Strength, min. ....	1,680 psi
Elongation, max. ....	110%
100% Modulus, max. ....	2,070 psi

#### 3.4 Oil Aged: 70 Hours @ 250°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A .....	80 ± 5 pts
Tensile Strength, min. ....	1,780 psi
Elongation, max. ....	150%
100% Modulus, max. ....	2,000 psi



#### **4.0 APPROVED COMPOUNDS**

The following compounds are approved:

For O-rings only - Parker N1059-90 (peroxide cured NBR)

For O-ring related backup rings only – Parker N300-90 or N1444-90 (sulfur cured NBR)

Other compounds are approved if they meet the requirements in this specification.

**\*\*\* END OF DOCUMENT \*\*\***

**ENGINEERING SPECIFICATION**

**OBSOLETE AND REPLACED BY E50127 - NITRILE RUBBER, SEMI-  
LOW TEMP SVC, -50 TO +250 DEG F, 70 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
G	1086578	10-AUG-84	MALIGAS	SCHOEN	RELEASED

Summary: **OBSOLETE & REPLACED BY E50127**

**\*\*\* OBSOLETE & REPLACED BY E50127 \*\*\***

**MATERIAL:**

This elastomer is a semi-low temperature nitrile rubber compound. Nitrile is a copolymer of butadiene with acrylonitrile.

**CURE SYSTEM:**

Sulfur

**SERVICE COMPATIBILITY:**

Recommended for *API Service Class	A, B, C
Recommended for *API Temp Class	M
Temperature Class	-50°F to +250°F
Wellhead (Static) Pressure Limitations	20,000 PSI, liquid, 10,000 PSI, gas
Valve (Dynamic) Pressure Limitations	10,000 PSI, liquid, 5000 PSI, gas
H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes, up to 5 ppm
Amines	yes
Chlorides	yes, below 2000 ppm
HCL, Hydrochloric Acid	no, hot or cold at <37%
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	no
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes, if T <200°F
Steam	no

\*Proposed

**MECHANICAL PROPERTIES:**

Hardness, Shore A	70 +5 points ASTM D-2240
Tensile Strength, Ult.,	1500 psi Min. ASTM D-412
Elongation, min.	160%
Compression Set, max.	35%, 250°F for 70 hrs., ASTM D-395B
100% Modulus of Elasticity	650 PSI, ASTM D-412
TR-10, max. ASTM D-1329	-58°F

**PROPERTY CHANGES:**

Air Aging, ASTM D-395B	70 hrs @ 257°F
Hardness Change	+14 pts
Tensile Change	+315 PSI or -20%
Elongation Change, % max.	+20%
Compression Set Change, % max.	+20%
Modulus Change	+130 PSI or +10%

Fluid Immersion, 5ppm H <sub>2</sub> S	72 hrs @ 250°F
Hardness Change	+14 pts
Tensile Change	+315 psi or -20%
Elongation Change, % max.	+20%
Compression Set Change, % max.	+20%
Modulus Change	+130 PSI or +10%
TR-10 Change	+12°F

Fluid Immersion, 100% CO <sub>2</sub>	72 hrs @ 250°F
Hardness Change	+14 pts
Tensile Change, % max.	+315 psi or +20%
Elongation Change, % max.	+20%
Compression Set Change, % max.	+20%
Modulus Change	+130 PSI or +10%
TR-10 Change	+12°F

Fluid Immersion, ASTM #3 Oil	72 hrs @ 250°F
Hardness Change	-12 pts
Tensile Change, % max.	+20%
Elongation Change, % max.	-30%
Volume Change % max.	+20%

**REFERENCES:** ASTM D-2240, D-412, D-395B, D-1329

\*\*\* END OF DOCUMENT \*\*\*

**FCD USE ONLY - SPECIFICATION FOR 90 DUROMETER NITRILE  
COMPOUND FOR GENERAL SERVICE**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	5010941	10-Feb-98	Long, Robert	Taeuber, Ralph	RELEASED

Summary: This specification covers the requirements for 90 Durometer nitrile elastomer (NBR) compound.

## 1.0 SCOPE

This specification covers the requirements for 90 Durometer nitrile elastomer (NBR) compound. This compound is good in the temperature range of 0°F to 250°F for O-Rings, seals, and other specified parts.

## 2.0 MATERIAL

Nitrile rubber (copolymer of butadiene with acrylonitrile)  
Cure system: Sulfur cure - Peroxide cure

## 3.0 PHYSICAL & MECHANICAL PROPERTIES

- 3.1 Original properties of the compound shall conform to the following requirements:

Hardness, Durometer, Shore A (ASTM D-2240) .....	90 ± 5 pts
Tensile strength, min (ASTM D-412) .....	2100 psi
Elongation, min (ASTM D-412) .....	125%
Compression set, max (ASTM D-395 Method B) .....	27%
Modulus at 100% elongation .....	1725 psi
Temperature of Retraction, TR-10 (ASTM D1329)...	+1°F max

- 3.2 Property Change After Heat Aging, 70 hrs at 200°C (392°F) shall meet the following:

Hardness Change .....	± 18 pts
Tensile Change .....	± 420 psi
Elongation Change .....	± 20% max

\* \* \* End of Document \* \* \*

**FCD USE ONLY - SPECIFICATION FOR 90 DUROMETER NITRILE OR  
BUNA N(NBR) O RINGS**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	5020420	03-JUN-2008	Soltau, James	Douglas, Don	RELEASED

Summary: This specification covers the requirements for 90 Durometer Nitrile or Buna-n (NBR) O Rings.

## 1.0 SCOPE

This specification covers the requirements for 90 Durometer Nitrile or Buna-n (NBR) O Rings. O Rings manufactured per ASTM D2000 M3CH914-A25 B34 E016 E036 satisfy this specification.

## 2.0 APPLICABLE SPECIFICATIONS

- 2.1 ASTM D2000
- 2.2 ASTM D865
- 2.3 ASTM D395
- 2.4 ASTM D471
- 2.5 ASTM D2240
- 2.6 ASTM D412

## 3.0 MATERIAL PROPERTIES

- 3.1 Original Properties
  - Hardness, Shore A (ASTM D2240) .....  $90 \pm 5$  points
  - Tensile Strength, min (ASTM D412)..... 2031 psi (14 MPa)
  - Ultimate Elongation, min (ASTM D412).... 100%
- 3.2 Heat Resistance (ASTM D865) -70 hours at 125°C (257°F)
  - Change in hardness..... 0 to +15 points
  - Change in tensile strength, max ..... -25%
  - Change in ultimate elongation, max..... -50%
- 3.3 Compression Set (ASTM D395) -22 hours at 100°C (212°F)
  - Method B, max..... 25%
- 3.4 Fluid Resistance (ASTM D471, No. 1 Oil) -70 hours at 150°C (302°F)
  - Change in hardness..... 0 to +10 points
  - Change in tensile strength, max ..... -20%
  - Change in ultimate elongation, max..... -40%
  - Change in volume..... -15 to +5%
- 3.5 Fluid Resistance (ASTM D471, No. 3 Oil) -70 hours at 150°C (302°F)
  - Change in hardness, max.....  $\pm 10$  points
  - Change in tensile strength, max ..... -35%
  - Change in ultimate elongation, max..... -35%
  - Change in volume..... 0 to +25%



#### 4.0 APPROVED COMPOUNDS

- 4.1 PARKER #N552-90
- 4.2 NATIONAL #C90-90
- 4.3 Indian Industries N90

**\* \* \* End of Document \* \* \***

**NITRILE RUBBER, LOW TEMP SERVICE, COMMERCIAL GRADE, 75  
DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
K	1144932	01-MAY-2009	Wolff, Geoff	Coles, Michael	RELEASED

## Summary:

This specification is for a compound based on a nitrile butadiene elastomer (NBR) designed for low temperature, H<sub>2</sub>S, and amine corrosion inhibitor service. Low levels of acrylonitrile (ACN) in the base polymer (typically 20% or below) improve its H<sub>2</sub>S resistance and allow the material to meet low temperature applications.

THIS SPECIFICATION IS FOR A LOW TEMPERATURE NBR RUBBER WITH LOW ACN. MAIN USE IS FOR WELLHEAD EQUIPMENT FOR ARCTIC OR RUSSIAN APPLICATIONS.

NOTE: FOR HIGH H<sub>2</sub>S, HH SERVICE, OR LONGEST LIFE, E50197 SHOULD BE USED.

## 1.0 MATERIAL

This specification is for a compound based on a nitrile butadiene elastomer (NBR) designed for low temperature, H<sub>2</sub>S, and amine corrosion inhibitor service. The nominal temperature range of this compound is -75°F (-60°C) to 250°F (121°C) when used in proper designs.

NOTE: FMC specification E50197 (FMC proprietary compound) is an acceptable substitute for the commercial grade material described in this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 Temperature and Material Classification

Test Fluid Class (API, Table F114.1)	HH		
Material Class (API, Table 302.3)	AA	to	HH
Temperature Class (API, Table 302.2)	K	to	U
Nominal Temperature Rating *	-75	to	250°F

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
HC, Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCL, Hydrochloric Acid	yes, cold at 37%
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	no
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	no

### 3.0 FORMULATION REQUIREMENTS

Approved compounds shall include the following chemistry in formulation:

- ML (1+4) @ 100 °C of raw polymer > 70 MU
- Low ACN polymer
- Oil content < 15 phr
- Peroxide cured

Formulations shall be revision controlled.

### 4.0 MATERIAL PROPERTIES

#### 4.1 Mechanical Properties

Hardness, Shore A..... ASTM D2240	75 +/-5 pts
Tensile Strength, min..... ASTM D412	1700 psi (11.7 MPa)
Elongation, min..... ASTM D412	140%
100% Modulus, min..... ASTM D412	500 psi (3.5 MPa)
Compression Set, ASTM D395 Method B 22 hrs. @ 300°F, max.....	30%

#### 4.2 Critical Transition Temperatures

TR-10, max..... ASTM D1329	-50°F (-46°C)
Tg..... ASTM D4065, D4092, D2231	N/A

#### 4.3 Air Aged: ASTM D573, 70 hrs @ 250°F (121°C)

Hardness, Shore A max.....	90
Tensile Strength, min.....	1200 psi (8.3 MPa)
Elongation, min.....	90 %

#### 4.4 Oil Aged: ASTM D471, ASTM #3 Oil, 70 hrs @ 250°F (121°C)

Hardness, Shore A min.....	60
Tensile Strength, min.....	1200 psi (8.3 MPa)
Elongation, % Change.....	+/-40
Volume, % Change, max.....	+40

## 5.0 APPROVED COMPOUNDS

Table 1 shows the list of approved commercial compounds. Approval of additional compounds shall be done through CTG Materials Engineering using [SPC10027536](#).

**Table 1: Approved E50127 Compounds**

Vendor	Compound	Revision Level	Approved Applications	Qualification Document
Parker	N0756-75		O-Rings	<a href="#">RPT100012798</a>

**ENGINEERING SPECIFICATION****SPECIFICATION FOR 90 DUROMETER LOW TEMPERATURE  
NITRILE O RINGS**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1086578	27-May-99	Janoff, Dwight	Taeuber, Ralph	RELEASED

Summary: This specification covers the requirements for 90 Durometer Low Temperature Nitrile O Rings used in Fluid Control components.

## 1.0 SCOPE

This specification covers the requirements for 90 Durometer Low Temperature Nitrile O Rings used in Fluid Control components. Low temperature nitrile o-rings manufactured per ASTM D2000 M4CH910-A25 B14 EF31 E015 E035 F16 satisfy this specification. Note: the compound must be good for the following temperature range: -53°C(-65°F) to 107°C(225°F).

## 2.0 APPLICABLE SPECIFICATIONS

- 2.1 ASTM D2000
- 2.2 ASTM D412
- 2.3 ASTM D2240
- 2.4 ASTM D865
- 2.5 ASTM D395
- 2.6 ASTM D471
- 2.7 ASTM D2137

## 3.0 MATERIAL PROPERTIES

- 3.1 Original Properties
  - Hardness, Shore A (ASTM D2240) .....  $90 \pm 5$  points
  - Tensile Strength, min (ASTM D412) ..... 1450 psi (10 MPa)
  - Ultimate Elongation, min (ASTM D412)..... 100%
  - Temperature Range..... -53°C(-65°F) to 107°C(225°F)
- 3.2 Heat Resistance(ASTM D865) -70 hours at 125°C (257°F)
  - Change in hardness..... 0 to +15 points
  - Change in tensile strength, max ..... -25%
  - Change in ultimate elongation, max ..... -50%
- 3.3 Compression Set (ASTM D395) -22 hours at 100°C (212°F)
  - Method B, max ..... 25%
- 3.4 Fluid Resistance (ASTM D471,Ref Fuel C) -70 hours at 23°C (73°F)
  - Change in hardness..... 0 to -30 points
  - Change in tensile strength, max ..... -60%
  - Change in ultimate elongation, max ..... -60%
  - Change in volume ..... 0 to +50%
- 3.5 Fluid Resistance (ASTM D471, No. 1 Oil) -70 hours at 125°C (257°F)
  - Change in hardness ..... 0 to +10 points
  - Change in tensile strength, max ..... -20%
  - Change in ultimate elongation, max ..... -35%
  - Change in volume ..... -15 to +5%

- 3.6 Fluid Resistance (ASTM D471, No. 3 Oil) -70 hours at 125°C (257°F)
- |  |            |
|--|------------|
| Change in hardness .....                 | ±10 points |
| Change in tensile strength, max .....    | -15%       |
| Change in ultimate elongation, max ..... | -30%       |
| Change in volume .....                   | -0 to +25% |
- 3.7 Must pass Low-temperature brittleness, per ASTM D2137 Method A, 9.3.2, nonbrittle after 3 minutes at -35°C (-31°F).

#### **4.0 APPROVED COMPOUNDS**

- 4.1 PARKER #N507-90  
4.2 NATIONAL #D06-90

\*\*\* End of Document \*\*\*



**FCD USE ONLY - SPECIFICATION FOR 90 DUROMETER PEROXIDE  
CURED NITRILE O-RINGS**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	5010941	27-May-99	Janoff, Dwight	Taeuber, Ralph	RELEASED

Summary: This specification covers the requirements for 90 Durometer Peroxide Cured Nitrile O-Rings used in Fluid Control components.

## 1.0 SCOPE

This specification covers the requirements for 90 Durometer Peroxide Cured Nitrile O-Rings used in Fluid Control components. Peroxide cured nitrile o-rings manufactured per ASTM D2000 M4CH910-A25 B14 EF31 E015 E035 F16 satisfy this specification. Note: the compound must be good for the following temperature range: -29°C(-20°F) to 135° C(275° F).

## 2.0 APPLICABLE SPECIFICATIONS

- 2.1 ASTM D2000
- 2.2 ASTM D412
- 2.3 ASTM D2240
- 2.4 ASTM D865
- 2.5 ASTM D395
- 2.6 ASTM D471
- 2.7 ASTM D2137

## 3.0 MATERIAL PROPERTIES

- 3.1 Original Properties
  - Hardness, Shore A (ASTM D2240).....90 ± 5 points
  - Tensile Strength, min (ASTM D412) ..... 1450 psi (10 MPa)
  - Ultimate Elongation, min (ASTM D412) ... 100%
  - Temperature Range.....-29°C(-20°F) to 135°C (275°F)
- 3.2 Heat Resistance(ASTM D865) - 70 hours at 125° C (257°F)
  - Change in hardness.....0 to +15 points
  - Change in tensile strength, max .....-25%
  - Change in ultimate elongation, max.....-50%
- 3.3 Compression Set (ASTM D395) - 22 hours at 100°C (212°F)
  - Method B, max.....25%
- 3.4 Fluid Resistance (ASTM D471,Ref Fuel C) - 70 hours at 23° C (73° F)
  - Change in hardness.....0 to -30 points
  - Change in tensile strength, max .....-60%
  - Change in ultimate elongation, max.....-60%
  - Change in volume.....0 to +50%
- 3.5 Fluid Resistance (ASTM D471, No. 1 Oil) - 70 hours at 125°C (257°F)

Change in hardness.....0 to +10 points

Change in tensile strength, max .....-20%

Change in ultimate elongation, max.....-35%

Change in volume.....-15 to +5%

3.6 Fluid Resistance (ASTM D471, No. 3 Oil) - 70 hours at 125° C (257°F)

Change in hardness.....±10 points

Change in tensile strength, max .....-15%

Change in ultimate elongation, max.....-30%

Change in volume.....-0 to +25%

3.7 Must pass Low-temperature brittleness, per ASTM D2137 Method A, 9.3.2, nonbrittle after 3 minutes at -35° C (-31°F).

## 4.0 APPROVED COMPOUNDS

### 4.1 NATIONAL #C67-90

\* \* \* End of Document \* \* \*

**ENGINEERING SPECIFICATION**

**OBSOLETE AND REPLACED BY E50107 - NITRILE RUBBER,  
GENERAL SERVICE, -20 TO 250 DEG F, 70 DUROMETER, PEROXIDE  
CURED**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1086578	10-AUG-84	HAEBERLE	FONTENOT	RELEASED

Summary: OBSOLETE AND REPLACED BY E50107

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****NITRILE RUBBER, GENERAL SERVICE, -50 TO 250 DEG F, 90  
DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
F	1086578	15-AUG-86	MALIGAS	BM	RELEASED

Summary: Nitrile Rubber is a copolymer of Butadiene with Acrylonitrile

## 1.0 MATERIAL

Nitrile Rubber is a copolymer of Butadiene with Acrylonitrile.  
-50°F to +250°F

## 2.0 CURE SYSTEM

Peroxide Cure

## 3.0 SERVICE COMPATIBILITY

Recommended for *API Temp Class.....	L - U
Temperature Range.....	-50°F to +250°F
Wellhead (Static) Pressure Limitations.....	20,000 PSI, Liquid
.....	10,000 PSI, Gas
Valve (Dynamic) Pressure Limitations.....	10,000 PSI, Liquid
.....	5,000 PSI, Gas
H <sub>2</sub> O, Water	Yes
Hydrocarbons	Yes
CH <sub>4</sub> , Methane	Yes
N <sub>2</sub> , Nitrogen Gas	Yes
CO <sub>2</sub> , Carbon Dioxide	Yes
H <sub>2</sub> S, Hydrogen Sulfide	Yes, Up to 5 ppm
Amines	Yes
Chlorides	Yes, Below 20,000 ppm
HCl, Hydrochloric Acid	No, Hot or Cold at <37%
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	No
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	Yes
O <sub>2</sub> , Oxygen	Yes, If T <200°F
Steam	No

## 4.0 MECHANICAL PROPERTIES

Hardness, Shore A	90 +5 Points
ASTM D-2240	
Tensile Strength, Ult.,	2,000 PSI
Min. ASTM D-412	
Elongation, Min.	100%
Compression Set, Max	25%
ASTM D-395B	70 Hrs @250°F
Brittleness,	-50°F
Low Temperatures, Pass	
ASTM D-7846B	

**5.0 PROPERTY CHANGES**

Air Aging, ASTM D-395B	70 hrs @ 250°F
Hardness Change	+18 Pts, Max
Tensile Change	-420 PSI, Max
Elongation Change, % Max	-20%
Modulus Change	+345 PSI
Fluid Immersion, 5 ppm H <sub>2</sub> S	72 Hrs @ 250°F
Hardness Change	+18 Pts, Max
Tensile Change	-420 PSI, Max
Elongation Change, % Max	-20%
Modulus Change	+345 PSI, Max
TR-10 Change	+5°F + 5°F Max
Fluid Immersion, 100% CO <sub>2</sub>	72 Hrs @ 250°F
Hardness Change	18 Pts, Max
Tensile Change	-420 PSI, Max
Elongation Change, % Max	-20%
Modulus Change	+345 PSI, Max
TR-10 Change	+50°F, Max
Fluid Immersion, ASTM #3 Oil	72 Hrs @ 250°F
Hardness Change	-10 Pts, Max
Tensile Change	-15%, Max
Elongation Change, % Max	-30%
Volume Change % Max	0 to +25%

**REFERENCES:** ASTM D-2240, D-412, D-395B, D-1329, D-746B

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION**

**OBSOLETE AND REPLACED BY E50197 - NITRILE RUBBER, SEMI-  
LOW TEMPERATURE SVC, -50 TO 180 DEG F, 70 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1086578	09-JUN-88	MALIGAS	HAEBERLE	RELEASED

Summary: OBSOLETE AND SUPERSEDED BY E50197.



**ENGINEERING SPECIFICATION**

**OBSOLETE AND REPLACED BY E50199 - NITRILE RUBBER, SEMI-  
LOW TEMPERATURE SVC, -50 TO 180 DEG F, 90 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1086578	09-JUN-88	MALIGAS	HAEBERLE	RELEASED

Summary: OBSOLETE AND REPLACED BY E50199

**NBR, LOW TEMP SERVICE, -50 TO 250 DEG F, 75 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
J	1111070	01-AUG-2006	Whitsitt, Elizabeth	Strickler, Mike	RELEASED

## Summary:

This specification is for a compound based on a butadiene and acrylonitrile copolymer (NBR), which has been molded, cured and finished to meet all of the requirements of this specification.

USE FOR EXTREME LOW TEMPERATURE, HIGH H<sub>2</sub>S, HH SERVICE, FOR LONGEST LIFE

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## 1.0 Scope

This specification is for a compound based on a butadiene and an acrylonitrile copolymer (NBR), which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-013 meets this specification.

## 2.0 Service Compatibility

### 2.1 API 6A, Temperature, and Pressure Compatibility

(Note: This does not necessarily take into consideration the results of API Spec. 6A, Appendix F Testing or Life Estimation Testing of Seals.)

#### 2.1.1 API and Temperature Limits

API 6A, Appendix F, Table F114.1, Test Fluid Class	HH
API 6A, Table 302.3, Material Class	AA to HH
API 6A, Table 302.2, Temperature Class	L to U
Nominal Temperature Rating	-50 to 250 °F (-46 to 121 °C)

#### 2.1.2 Pressure Limits

Static	20,000 psi Liquid/10,000 psi Gas
Dynamic	10,000 psi Liquid/5,000 psi Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes, cold
O <sub>2</sub> , Oxygen	no
Steam	no

### 3.0 Material Properties

#### 3.1 Mechanical and Physical Properties

Hardness, Shore A ASTM D2240	74 ± 5 pts
Tensile Strength, min ASTM D412	1990 psi
Elongation, min ASTM D412	150%
100% Modulus, min ASTM D412	540 psi
Specific Gravity ASTM D792 Method A	1.18 ± 0.03 g/mL
Compression Set, ASTM D395 Method B 22 hours @ 300 °F, max	30%

#### 3.2 Critical Transition Temperatures

TR-10, max Temperature Retraction ASTM D1329	-72 °F (-58 °C)
Tg, Glass Transition Temperature ASTM D4065, D4092, D2231	-38 to -58 °F (-39 to -50 °C)

#### 3.3 Mechanical and Physical Properties after Aging

##### 3.3.1 Air Aged

70 Hours @ 250 °F, ASTM D573

Hardness, Shore A	80 ± 5 pts
Tensile Strength, min	1,700 psi
Elongation, min	125%
100% Modulus, max	1,300 psi

##### 3.3.2 Oil Aged

70 Hours @ 250 °F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A	65 ± 5 pts
Tensile Strength, min	860 psi

Elongation, max  
100% Modulus, min

125%  
580 psi

## 4.0 Approved Compounds

The following compound is approved per Test Report [RPT100012798](#).  
For O-Rings only - Parker O-Ring Division N0756-75

Other compounds are approved if they meet the requirements in this specification.

**\*\*\* END OF DOCUMENT \*\*\***

**NBR, LOW TEMP SERVICE, -50 TO 250 DEG F, 80 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1105141	11-JAN-2006	Jones, Warren	Parrish, John	RELEASED

## Summary:

This specification is for a compound based on a Butadiene and an Acrylonitrile co-polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

USE FOR EXTREME LOW TEMPERATURE, HIGH H<sub>2</sub>S, HH SERVICE, FOR LONGEST LIFE.

## 1.0 MATERIAL

This specification is for a compound based on a Butadiene and an Acrylonitrile co-polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-014 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

(Note: This does not necessarily take into consideration the results of API Spec. 6A, Appendix F Testing or Life Estimation Testing of Seals.)

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class...	HH
API 6A, Table 302.3, Material Class.....	AA to HH
API 6A, Table 302.2, Temperature Class.....	L to U
Temperature Rating.....	-50 to 250°F (-46 to 121°C)

#### 2.1.2 Pressure Limits:

Static.....	20,000 psi Liquid & 10,000 psi Gas
Dynamic.....	10,000 psi Liquid & 5,000 psi Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes, cold
O <sub>2</sub> , Oxygen	no
Steam	no



### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A..... ASTM D2240	80 ± 5 pts
Tensile Strength, min..... ASTM D412	1,890 psi
Elongation, min..... ASTM D412	95%
100% Modulus, min..... ASTM D412	860 psi
Specific Gravity..... ASTM D792 Method A	1.22 ± .02
Compression Set, ASTM D395 Method B 22 hours @ 300°F, max.....	25%

#### 3.2 Critical Transition Temperatures

TR-10, max..... Temperature Retraction ASTM D1329	-58°F (-50°C)
Tg..... Glass Transition Temperature ASTM D4065, D4092, D2231	n/a

#### 3.3 Air Aged: 70 Hours @ 250°F, ASTM D573

Hardness, Shore A.....	85 ± 5 pts
Tensile Strength, min.....	1,500 psi
Elongation, max.....	120%
100% Modulus, max.....	1,000 psi

#### 3.4 Oil Aged: 70 Hours @ 250°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....	70 ± 5 pts
Tensile Strength, min.....	1,500 psi
Elongation, max.....	80%
100% Modulus, max.....	1,000 psi

\*\*\* END OF DOCUMENT \*\*\*

**NBR, 90 DURO, LOW TEMP SERVICE, PROPRIETARY**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
F	1184673	16-FEB-2012	Wolff, Geoff	Turbeville, Elliott	RELEASED

## Summary:

This specification is for a FMC proprietary compound based on a copolymer of butadiene and acrylonitrile, which has been molded, cured, and finished to meet all of the requirements of this specification.

USE FOR EXTREME LOW TEMPERATURE, HIGH H<sub>2</sub>S, HH SERVICE, FOR LONGEST LIFE.

## 1.0 SCOPE

This specification is for a FMC proprietary compound based on a copolymer of butadiene and acrylonitrile, which has been molded, cured, and finished to meet all of the requirements of this specification. Only FMC proprietary compound M1-015 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 Temperature and Material Classification

API 6A, Table F.2, Test Fluid Class.....	HH
API 6A, Table 3, Material Class.....	AA to HH
API 6A, Tables 2 & G.2, Temperature Class.....	L to U
Nominal Temperature Rating *.....	-50 to 250 °F (-46 to 121 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	yes
Hydrocarbons.....	yes
CH <sub>4</sub> , Methane.....	yes
CO <sub>2</sub> , Carbon Dioxide.....	yes
H <sub>2</sub> S, Hydrogen Sulfide.....	yes
Amines.....	yes
Chlorides.....	yes
HCl, Hydrochloric Acid.....	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	yes, cold
O <sub>2</sub> , Oxygen.....	no
Steam.....	no

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical and Physical Properties

Hardness, Shore A.....	87 ± 5 pts
ASTM D2240	
Tensile Strength, min.....	1,700 psi (11.7 MPa)
ASTM D412	
Elongation, min.....	80 %
ASTM D412	
50 % Modulus, min.....	600 psi (4.14 MPa)
ASTM D412	
Specific Gravity.....	1.25 ± 0.03
ASTM D792 Method A	
Compression Set, ASTM D395 Method B 22 hours @ 300 °F (149 °C), max.....	35 %

#### 3.2 Critical Transition Temperatures

Glass Transition Temperature ASTM D4065, D4092 & D5992 Torsional, forced vibration DMA, temp. sweep 11 Hz, 2 % strain (max.), 30 sec. soak G" peak to tan δ peak.....	-75 to -58 °F (-60 to -50 °C)
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#### 3.3 Mechanical and Physical Properties after Aging

##### 3.3.1 Air Aged

70 Hours @ 250 °F (121 °C), ASTM D573

Hardness, Shore A.....	95 ± 5 pts
Tensile Strength, min.....	1,200 psi (8.27 MPa)
Elongation, max.....	200 %
100 % Modulus, max.....	750 psi (5.17 MPa)

**3.3.2 Oil Aged**

70 Hours @ 250 °F (121 °C), ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....	80 ± 5 pts
Tensile Strength, min.....	1,200 psi (8.27 MPa)
Elongation, max.....	150 %
100 % Modulus, max.....	750 psi (5.17 MPa)

**NBR, EXTRUDED CORD STOCK FOR O-RINGS, NON-CRITICAL APPLICATIONS, -20 TO 225 DEG F, 70 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1120623	16-AUG-2007	Jones, Warren	Parrish, John	RELEASED

## Summary:

This specification is for a compound based on a butadiene - acrylonitrile copolymer (NBR), which has been manufactured to meet all of the requirements of this specification. This is a commercial material extruded as cord stock to be spliced/vulcanized into O-Rings. **This material is for non-critical applications only! See Scope in body of specification.**

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## 1.0 SCOPE

This specification is for a compound based on a butadiene - acrylonitrile copolymer (NBR), which has been manufactured to meet all of the requirements of this specification. This is a commercial material extruded as cord stock to be spliced/vulcanized into O-Rings. **This material is for non-critical applications only!**

### 1.1 Examples of Non-Critical Applications

- Test seals for liquid media (no limit on pressure) – these are only required to seal early in the equipment's life cycle with no or minimal elevated temperature exposure.
- Low pressure (<100 psi) contaminant excluder seals
- Retention rings (such as to retain a shaft in a bore)
- Controlled-load shear rings

### 1.2 Limitations

- Surface imperfections and material disruption associated with the splice.
- Reduction in material properties inherent in extruded material compared to compression or injected molded material. The former includes process aides in the compound to facilitate the extrusion process and is cured without the benefit of pressure. The former limits the life of the material at elevated temperature and the latter contributes to poorer compression set resistance.
- Larger tolerances on cross section diameter compared to that achievable with compression or injection molding.

### 1.3 Advantages

The motivation for using extruded cord stock in the manufacture of an O-Ring is to avoid the lead time and/or cost associated with manufacturing a mold. This implies that the O-Ring is not one of the AS568 (or other common O-Ring standard) standard sizes which are easily and quickly sourced from commercial suppliers and manufactured using a compression or injected molded process.



## **2.0 MATERIAL PROPERTIES**

Hardness, Shore A ..... 70 ± 5 pts  
ASTM D2240

Tensile Strength, min ..... 1,800 psi (12.4 MPa)  
ASTM D412

Elongation, min. .... 250 %  
ASTM D412

Compression Set, 22 hours @ 212 °F, max. .... 30 %  
ASTM D395, Method B

## **3.0 APPROVED COMPOUND**

The following compound is approved:

Gulf Coast Seal, Inc. compound BN70.

Other compounds are approved if they meet the requirements of this specification.

**NBR, EXTRUDED CORD STOCK FOR O-RINGS, NON-CRITICAL APPLICATIONS, -20 TO 225 DEG F, 90 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1120623	16-AUG-2007	Jones, Warren	Parrish, John	RELEASED

## Summary:

This specification is for a compound based on a butadiene - acrylonitrile copolymer (NBR), which has been manufactured to meet all of the requirements of this specification. This is a commercial material extruded as cord stock to be spliced/vulcanized into O-Rings. **This material is for non-critical applications only! See Scope in body of specification.**

## Table of Contents

Section	Title	Page
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<b>2.0</b>	<b>MATERIAL PROPERTIES.....</b>	<b>4</b>
<b>3.0</b>	<b>APPROVED COMPOUNDS .....</b>	<b>4</b>

## 1.0 SCOPE

This specification is for a compound based on a butadiene - acrylonitrile copolymer (NBR), which has been manufactured to meet all of the requirements of this specification. This is a commercial material extruded as cord stock to be spliced/vulcanized into O-Rings. **This material is for non-critical applications only!**

### 1.1 Examples of Non-Critical Applications

- Test seals for liquid media (no limit on pressure) – these are only required to seal early in the equipment's life cycle with no or minimal elevated temperature exposure.
- Low pressure (<100 psi) contaminant excluder seals
- Retention rings (such as to retain a shaft in a bore)
- Controlled-load shear rings

### 1.2 Limitations

- Surface imperfections and material disruption associated with the splice.
- Reduction in material properties inherent in extruded material compared to compression or injected molded material. The former includes process aides in the compound to facilitate the extrusion process and is cured without the benefit of pressure. The former limits the life of the material at elevated temperature and the latter contributes to poorer compression set resistance.
- Larger tolerances on cross section diameter compared to that achievable with compression or injection molding.

### 1.3 Advantages

The motivation for using extruded cord stock in the manufacture of an O-Ring is to avoid the lead time and/or cost associated with manufacturing a mold. This implies that the O-Ring is not one of the AS568 (or other common O-Ring standard) standard sizes which are easily and quickly sourced from commercial suppliers and manufactured using a compression or injected molded process.

## 2.0 MATERIAL PROPERTIES

Hardness, Shore A .....90 ± 5 pts  
ASTM D2240

Tensile Strength, min.....2,500 psi (17.2 MPa)  
ASTM D412

Elongation, min.....100 %  
ASTM D412

Compression Set, 22 hours @ 212 °F, max.....30 %  
ASTM D395, Method B

## 3.0 APPROVED COMPOUNDS

This is a commodity compound. Those materials that meet the requirements of this specification may be used.

**NBR, COMMERCIAL, 70 DUROMETER, LOW TEMPERATURE, FOR  
KONGSBERG ONLY**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1169723	28-FEB-2011	Wolff, Geoff	Coles, Michael	RELEASED

## Summary:

## NBR, 70 Durometer, For Critical Applications in Controls

This specification is for commercial o-rings and other seals based on a butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. This specification applies to o-rings used in critical applications in controls products.

## 1.0 Material

This specification is for commercial o-rings based on a butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 2.0 Approved Compounds

The following compounds are approved:

Vendor	Compound	Qualification Document
Trelleborg Sealing Solutions	Skega Compound 63 70 001	
	Busak+Shamban N 762A	
Parker Hannifin	N0674-70	
ERIKS	36624	<a href="#">RPT60059222</a>
Freudenberg	455100	<a href="#">RPT60069438</a>

New compounds may be approved using [SPC-0000023654](#). Contact FMC Materials Engineering to evaluate new compounds for this specification.

Before referencing this E spec, the design engineer must verify that it is suitable for the application.

## 3.0 Service Compatibility

### 3.1 Temperature and Material Classification

API 6A, Table F.2, Test Fluid Class.....HH  
API 6A, Table 3, Material Class.....AA to HH  
Nominal Temperature Rating\*.....-26 to 150 °F (-32 to 65 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 3.2 Chemical Compatibility

H <sub>2</sub> O, Water.....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane.....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide.....	Yes
H <sub>2</sub> S, Hydrogen Sulfide.....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes, cold
O <sub>2</sub> , Oxygen.....	No
Steam.....	No

### 4.0 Material Properties

The data below (except data marked “reference only”) may be used for quality control of received parts.

#### 4.1 Mechanical Properties

Hardness,	
ISO 48 or DIN 53519.....	62 – 75 ° IRH
DIN53505 or ASTM D2240.....	65 – 75 Shore A
Tensile Strength, min. ....	2030 psi (14.0 MPa)
ISO 37, DIN 53504, or ASTM D412	
Elongation, min. ....	300 %
ISO 37, DIN 53504, or ASTM D412	
Specific Gravity (reference only).....	1.2 – 1.3
ISO 2781, DIN 53479, or ASTM D792, Method A	
Compression Set, max. (reference only).....	25 %
ISO 815 or ASTM D395, Method B	
212 °F (100 °C) for 24 hours	

#### 4.2 Critical Transition Temperatures

TR-10, max. (reference only).....	-13 °F (-25 °C)
ASTM D1329	



### 4.3 Hot Oil Aged (reference only)

Volume Change..... -6 % to 0 %  
ISO 1817, ASTM No. 1 Oil  
212 °F (100 °C) for 70 hours

**NBR, COMMERCIAL, 90 DUROMETER, FOR KONGSBERG ONLY**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1169723	28-FEB-2011	Wolff, Geoff	Coles, Michael	RELEASED

## Summary:

NBR, 90 Durometer, For Critical Applications in Controls.

This specification is for commercial o-rings and other seals for critical service subsea control applications, based on a 90 durometer butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 Material

This specification is for commercial o-rings and other seals for critical service subsea control applications, based on a 90 durometer butadiene and acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 2.0 Approved Compounds

The following compounds are approved for O-rings that reference this E-spec:

Vendor	Compound	Qualification Document
Trelleborg Sealing Solutions	Skega Compound 63 90 097	
	Busak+Shabmban N 9T40	
Parker Hannifin	N0552-90	
	N3599-90	
ERIKS	47702	<a href="#">RPT60059222</a>
Freudenberg	455102	<a href="#">RPT60069438</a>

New compounds may be approved using [SPC-0000023654](#). Contact FMC Materials Engineering to evaluate new compounds for this specification.

Before referencing this E spec, the design engineer must verify that it is suitable for the application.

## 3.0 Service Compatibility

### 3.1 Temperature and Material Classification

API 6A, Table F.2, Test Fluid Class.....HH  
API 6A, Table 3, Material Class.....AA to HH  
Nominal Temperature Rating\*.....-4 to 150 °F (-20 to 65 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 3.2 Chemical Compatibility

H <sub>2</sub> O, Water.....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane.....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide.....	Yes
H <sub>2</sub> S, Hydrogen Sulfide.....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	Yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes, cold
O <sub>2</sub> , Oxygen.....	No
Steam.....	No

### 4.0 Material Properties

The data below (except data marked "reference only") may be used for quality control of received parts.

#### 4.1 Mechanical Properties

Hardness,	
ISO 48 or DIN 53519.....	82 – 95 ° IRH
DIN53505 or ASTM D2240.....	85 – 95 Shore A
Tensile Strength, min. ....	2030 psi (14.0 MPa)
ISO 37, DIN 53504, or ASTM D412	
Elongation, min. ....	125 %
ISO 37, DIN 53504, or ASTM D412	
Specific Gravity (reference only).....	1.25 – 1.40
ISO 2781, DIN 53479, or ASTM D792, Method A	
Compression Set, max. (reference only).....	25 %
ISO 815 or ASTM D395, Method B	
212 °F (100 °C) for 24 hours	

#### 4.2 Critical Transition Temperatures

TR-10, max. (reference only).....	-4 °F (-20 °C)
ASTM D1329	

### 4.3 Hot Oil Aged (reference only)

Volume Change..... -10 % to 5 %  
ISO 1817, ASTM No. 1 Oil  
212 °F (100 °C) for 70 hours

**ENGINEERING SPECIFICATION****NITRILE RUBBER, FABRIC REINFORCED, -20 TO 250 DEG F**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1086578	01-NOV-85	MALIGAS	DC	RELEASED

Summary: This specification outlines Nitrile rubber, which is a copolymer of Butadiene with Acrylonitrile.

## 1.0 MATERIAL

This specification outlines Nitrile rubber, which is a copolymer of Butadiene with Acrylonitrile. The fabric reinforcement shall be a fabric made of 12 oz. hose duck. Seal configurations include vee rings.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....CC

API 6A, Table 302.3,  
Material Class.....AA to CC

API 6A, Table 302.2  
Temperature Class.....P to U

Temperature Rating.....-20 to 250°F

#### 2.1.2 Pressure Limits:

Static.....20,000 psi, liquid  
.....10,000 psi, gas

Dynamic.....10,000 psi, liquid  
.....5,000 psi, gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	no
Chlorides	yes, cold
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	no

### **3.0 MATERIAL PROPERTIES**

Not defined by standard tests at this time.

NOTE:       Packing is to be constructed by the Laminated Horizontal Bias (LHB) Method. Minimum pull strength between layers is to be 25 lbs/inch.

\*\*\* END OF DOCUMENT \*\*\*



**FEPM (AFLAS-TM), 75 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
E	1142112	16-FEB-2009	Jones, Warren	Whitsitt, Elizabeth	RELEASED

Summary: This specification is for a compound based on a Tetrafluoroethylene and a Propylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for a compound based on a Tetrafluoroethylene and a Propylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-020 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class .....HH

API 6A, Table 302.3,  
Material Class .....AA to HH

API 6A, Table 302.2 and Table G1  
Temperature Class .....---

Nominal Temperature Rating .....40 to 400 °F

#### 2.1.2 Pressure Limits

Static .....20,000 psi liquid / 15,000 psi gas

Dynamic.....15,000 psi liquid / 10,000 psi gas

### 2.2 Chemical Compatibility

H<sub>2</sub>O, Water .....yes  
Hydrocarbons .....yes  
CH<sub>4</sub>, Methane .....yes  
N<sub>2</sub>, Nitrogen Gas.....yes  
CO<sub>2</sub>, Carbon Dioxide .....yes  
H<sub>2</sub>S, Hydrogen Sulfide .....yes  
Amines.....yes  
Chlorides .....yes  
HCL, Hydrochloric Acid.....yes  
H<sub>2</sub>SO<sub>4</sub>, Sulfuric Acid.....yes  
H<sub>2</sub>CO<sub>3</sub>, Carbonic Acid .....yes  
O<sub>2</sub>, Oxygen .....no  
Steam .....yes

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness Shore A ..... 75 ± 5 pts  
ASTM D-2240

Tensile Strength, min ..... 2,200 psi  
ASTM D-412

Elongation, min ..... 125 %  
ASTM D-412

100% Modulus of Elasticity ..... 1,200 psi  
ASTM D-412

Specific Gravity ..... 1.59 ± .05  
ASTM D-792, Method A

Compression Set, max ..... 30 %  
ASTM D-395, Method B, 22 hours @ 400 °F

#### 3.2 Critical Transition Temperatures

TR-10, max ..... 50 °F (100 °C)  
Temperature Retraction

Glass Transition Temperature ..... N/A  
ASTM D-1329, ASTM D-4065, D-4092, D-2231

#### 3.3 Air Aged: 70 Hours @ 400 °F, ASTM D-573

Hardness, Shore A ..... 80 ± 5 pts  
Tensile Strength, min. .... 2,600 psi  
Elongation, min. .... 100 %  
100% Modulus, max. .... 2,100 psi

#### 3.4 Oil Aged: 70 Hours @ 400 °F, ASTM No. 3 Oil, ASTM D-471

Hardness, Shore A ..... 65 ± 5 pts  
Tensile Strength, min. .... 1,650 psi  
Elongation, min. .... 315 %  
100% Modulus, min. .... 480 psi

\*\*\* END OF DOCUMENT \*\*\*

**AFLAS(TM) 100H, 40 TO 400 DEG F, 80 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
G	1086578	09-OCT-85	MALIGAS	SCHOEN	RELEASED

Summary: This specification is for a compound based on a Tetrafluoroethylene and a Propylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL:

This specification is for a compound based on a Tetrafluoroethylene and a Propylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-021 meets this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class.....AA to HH

API 6A, Table 302.2 and Table G1  
Temperature Class.....---

Nominal Temperature Rating.....40 to 400<sup>0</sup>F

#### 2.1.2 Pressure Limits:

Static.....	20,000psi, Liquid
.....	15,000psi, Gas
Dynamic.....	15,000psi, Liquid
.....	10,000psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes

Chlorides	yes	
HCL, Hydrochloric Acid	yes	
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid		yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes	
O <sub>2</sub> , Oxygen	no	
Steam	yes	

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness Shore A.....80 ± 5 pts  
ASTM D-2240

Tensile Strength, min.....2,090psi  
ASTM D-412

Elongation, min.....200%  
ASTM D-412

100% Modulus, min.....760psi  
ASTM D412

Specific Gravity.....1.60 ± .05  
ASTM D792 Method A

Compression Set, ASTM D395 Method B  
22 hours @ 400<sup>0</sup>F, max.....30%

#### 3.2 Critical Transition Temperatures

TR-10, max.....50<sup>0</sup>F (10<sup>0</sup>C)  
Temperature Retraction  
ASTM D-1329

Tg.....N/A  
Glass Transition Temperature  
ASTM D4065, D4092, D2231

3.3 Air Aged: 70 Hours @ 400<sup>0</sup>F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A..... 85 ± 5 pts  
Tensile Strength, min..... 2,500psi  
Elongation, min..... 160%  
100% Modulus, max..... 1,350psi

3.4 Oil Aged: 70 Hours @ 400<sup>0</sup>F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....70 ± 5 pts  
Tensile Strength, min.....1,560 psi  
Elongation, max.....500%  
100% Modulus, min.....300 psi

**\*\*\* END OF DOCUMENT \*\*\***

**ENGINEERING SPECIFICATION****AFLAS(TM) 100H, 40 TO 400 DEG F, 90 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
E	1086578	27-AUG-84	MALIGAS	SCHOEN	RELEASED

Summary: This specification is for a compound based on a Tetrafluoroethylene and a Propylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

MAY BE USED IN CO2 < 5000 PSI



## 1.0 MATERIAL:

This specification is for a compound based on a Tetrafluoroethylene and a Propylene polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. FMC proprietary compound M1-022 meets this specification.

## 2.0 SERVICE COMPATIBILITY:

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	HH
API 6A, Table 302.3, Material Class.....	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class.....	---
Temperature Rating.....	40 to 400 <sup>0</sup> F

#### 2.1.2 Pressure Limits:

Static.....	20,000psi, Liquid
.....	15,000psi, Gas
Dynamic.....	15,000psi, Liquid
.....	10,000psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCL, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A.....90 ± 5 points  
ASTM D-2240

Tensile Strength,min.....2,350psi  
ASTM D-412

Elongation, min.....120%  
ASTM D412

100% Modulus, min.....1,550psi  
ASTM D412

Specific Gravity.....1.60 ± .05  
ASTM D792 Method A

Compression Set,ASTM D395 Method B  
22 hours @ 400<sup>0</sup>F, max..... 30%

#### 3.2 Critical Transition Temperatures

TR-10, max.....50<sup>0</sup>F (10<sup>0</sup>C)  
Temperature Retraction  
ASTM D1329

Tg.....34 to 52<sup>0</sup>F (1 to 11<sup>0</sup>C)  
Glass Transition Temperature  
ASTM D4065, D4092, D2231

#### 3.3 Air Aged: 70 Hours @ 400<sup>0</sup>F, ASTM D573

Hardness Shore A.....95 ± 5 pts  
Tensile Strength, min.....2,800psi  
Elongation, min.....100%  
100% Modulus,max.....2,700psi

#### 3.4 Oil Aged: 70 Hours @ 400<sup>0</sup>F, ASTM No. 3 Oil, ASTM D471

Hardness Shore A.....80 ± 5 pts  
Tensile Strength, min.....1,800psi  
Elongation, max.....300%  
100% Modulus, min.....650psi

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****AFLAS(TM) 100H, 10 TO 400 DEG F, 95 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1086578	27-AUG-84	MALIGAS	RB	RELEASED

Summary: This specification is for a compound based on a tetrafluoroethylene and a propylene polymer that has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for a compound based on a tetrafluoroethylene and a propylene polymer that has been molded, cured, and finished to meet all of the requirements of this specification. An example of this material is Seals Eastern compound 7182A.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	HH
API 6A, Table 302.3, Material Class.....	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class.....	S to X
Temperature Rating.....	10 to 400°F

#### 2.1.2 Pressure Limits:

Static.....	Not recommended
Dynamic.....	15,000psi, Liquid
.....	15,000psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes
Steam	yes

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A.....	95 ± 5 pts
ASTM D2240	
Tensile Strength, min.....	2,900psi
ASTM D412	
Elongation, min.....	110%
ASTM D412	
100% Modulus, min. ....	2,780psi
ASTM D412	
Specific Gravity.....	---
ASTM D792 Method A	
Compression Set, ASTM D395 Method B	
22 hours @ 400°F, max. ....	27%

#### 3.2 Critical Transition Temperatures

TR-10, max. ....	10°F (50°C)
Temperature Retraction	
ASTM D1329	
Tg.....	---
Glass Transition Temperature	
ASTM D4065, D4092, D2231	

#### 3.3 Air Aged: 70 Hours @ 482°F, ASTM D573

Hardness, Shore A .....	5 ± 5 pts
Tensile Strength, min.....	2,700psi
Elongation, max.....	130%
100% Modulus, max.....	3,100psi

#### 3.4 Oil Aged: 72 Hours @ 350°F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....	75 ± 12 pts
Tensile Strength, min.....	2,700psi
Elongation, max.....	150%
100% Modulus, max.....	3,200psi

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION**

**OBSOLETE AND REPLACED BY E54219 - AFLAS FOR ELASTOMER  
SPRING ENERGIZED LIP TYPE SEALS**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1086578	01-AUG-85	HAEBERLE	STODDARD	RELEASED

Summary: OBSOLETE AND SUPERSEDED BY E54219

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION**

<b>TFE/P, STEAM SERVICE, 10 TO 550 DEG F, 95 DUROMETER</b>
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Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1086578	23-Mar-95	Crawford, Neil	Maligas, Manuel	RELEASED

Summary: This specification is for a compound based on a tetrafluoroethylene and a propylene polymer that has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for a compound based on a tetrafluoroethylene and a propylene polymer that has been molded, cured, and finished to meet all of the requirements of this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	HH
API 6A, Table 302.3 Material Class.....	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class.....	R
Nominal Temperature Rating.....	10 to 550 °F

#### 2.1.2 Pressure Limits:

Static.....	20,000psi, Liquid
.....	15,000psi, Gas
Dynamic.....	15,000psi, Liquid
.....	15,000psi, Gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes



### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore A..... ASTM D2240	95 + 5 pts
Tensile Strength, min..... ASTM D412	1,842psi
Elongation, min..... ASTM D412	78%
100% Modulus, min..... ASTM D412	1,692psi
Specific Gravity..... ASTM D792 Method A	N/A
Compression Set, ASTM D395 Method B 22 hours @ 400 <sup>0</sup> F, max.....	30%

#### 3.2 Critical Transition Temperatures

TR-10, max..... Temperature Retraction ASTM D1329	50 <sup>0</sup> F (10 <sup>0</sup> C)
Tg..... Glass Transition Temperature ASTM D4065, D4092, D2231	50 <sup>0</sup> F (10 <sup>0</sup> C)

#### 3.3 Air Aged: 70 Hours @ 482<sup>0</sup>F, ASTM D573

Hardness, Shore A.....	N/A
Tensile Strength, min.....	N/A
Elongation, max.....	N/A
100% Modulus, max.....	N/A

#### 3.4 Oil Aged: 72 Hours @ 350<sup>0</sup>F, ASTM No. 3 Oil, ASTM D471

Hardness, Shore A.....	N/A
Tensile Strength, min.....	N/A
Elongation, max.....	N/A
100% Modulus, max.....	N/A

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****AFLAS(TM) 100H, FABRIC REINFORCED, 10 TO 400 DEG F**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1086578	22-JUL-85	HAEBERLE	STODDARD	RELEASED

Summary: This specification outlines a copolymer of tetrafluoroethylene and propylene.

## 1.0 MATERIAL

This specification outlines a copolymer of tetrafluoroethylene and propylene. The rubber portion of the material must be a compound of AFLAS ® 100H base rubber gum. The fabric reinforcement shall be a fabric made of glass, Kevlar ®, or Nomex ®. Seal configurations include vee rings for stem packing.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	HH
API 6A, Table 302.3, Material Class.....	AA to HH
API 6A, Table 302.2 AND TABLE G1 Temperature Class.....	S to X
Temperature Rating.....	10 to 400°F

#### 2.1.2 Pressure Limits:

Static.....	20,000 psi, liquid
.....	15,000 psi, gas
Dynamic.....	15,000 psi, liquid
.....	10,000 psi, gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes

Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	no
Steam	yes

### 3.0 MATERIAL PROPERTIES

Not defined by standard tests at this time.

NOTE: Packing is to be constructed by the Laminated Horizontal Bias (LHB) Method. Minimum pull strength between layers is to be 25 lbs/inch.

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****CARBOXYLATED NITRILE U-CUP TYPE SEAL W/ NITRILE FILLER  
ELEMENT, -20 TO 250 DEG F**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
F	1086578	26-JUL-85	MALIGAS	HAEBERLE	RELEASED

Summary: This specification is for a compound based on a Butadiene and an Acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification.

## 1.0 MATERIAL

This specification is for a compound based on a Butadiene and an Acrylonitrile polymer, which has been molded, cured, and finished to meet all of the requirements of this specification. Parker's Nitroxile N4263A90 is an acceptable material.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....CC

API 6A, Table 302.3,  
Material Class.....AA to CC

API 6A, Table 302.2  
Temperature Class.....P to U

Nominal Temperature Rating.....-20 to 250°F

#### 2.1.2 Pressure Limits:

Static.....20,000 psi ,liquid  
.....10,000 psi ,gas

Dynamic.....10,000 psi ,liquid  
.....5,000 psi ,gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes, cold
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes, cold
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes, cold
O <sub>2</sub> , Oxygen	no
Steam	no

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

	<b>Filler Element</b>	<b>Polypaks, O-Ring and U-Cup</b>
Hardness, Shore A ASTM D2240	70 ± 5 pts	90 ± 5 pts
Tensile Strength, min. ASTM D412	2,000 psi	3,555 psi
Elongation, min. ASTM D412	250%	100%
100% Modulus, min. ASTM D412	510 psi	3,515 psi
Specific Gravity ASTM D792 Method A	N/A	1.28 ± .05
Compression Set, max ASTM D395 Method B	25%	15%

#### 3.2 Critical Transition Temperatures

TR-10, max. Temperature Retraction ASTM D1329	-15°F (-26°C)	2°F(-17°C)
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#### 3.3 Air Aged: ASTM D573

Hardness	70 ± 14 pts	90 ± 5 pts
Tensile Strength, min	1,600 psi	3,100 psi
Elongation, max	250%	150%
100% Modulus, max	620 psi	N/A

#### 3.4 Oil Aged: ASTM D471 ASTM No. 3 Oil

Hardness, Shore A	65 ± 5 pts	85 ± 5 pts
Tensile Strength, min	1,800 psi	3,200 psi
Elongation, max	250%	150%
100% Modulus, max	N/A	N/A

\*\*\* END OF DOCUMENT \*\*\*

**ACETAL POLYMER, UNFILLED**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
F	1177333	23-AUG-2011	Jones, Warren	Coles, Michael	RELEASED

## Summary:

This material is an extruded, unfilled, low porosity, acetal polymer. Examples are Dupont Delrin® 150 acetal homopolymer and Quadrant EPP Acetron® GP acetal copolymer.



## 1.0 MATERIAL

This material is an extruded, unfilled, low porosity, acetal polymer (POM – Polyoxymethylene). Examples are Dupont Delrin® 150 acetal homopolymer (generally porosity limited to diameters up to 3" [76.2mm]) and Quadrant EPP Acetron® GP acetal copolymer. A common configuration is a choke indicator drum.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

Test Fluid Class (API 6A, Table F.2), ..... CC  
Material Class (API 6A, Table 3), ..... AA to CC  
Nominal Temperature Rating (API 6A, Table 2) .. P to T (-20 to 180 °F [-29 to 82 °C])

#### 2.1.2 Pressure Limits:

Pressure limitations..... 15,000 psi (103.4 MPa)

### 2.2 Chemical Compatibility

Chemical	Rating
----------	--------

H <sub>2</sub> O, Water .....	A
Hydrocarbons .....	A
CH <sub>4</sub> , Methane .....	A
N <sub>2</sub> , Nitrogen Gas.....	A
CO <sub>2</sub> , Carbon Dioxide .....	A
H <sub>2</sub> S, Hydrogen Sulfide .....	C
Amines.....	D
Chlorides .....	B
HCl, Hydrochloric Acid .....	C
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	D
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	B
O <sub>2</sub> , Oxygen .....	D
Steam .....	D

A – Excellent      B - Good      C – Poor      D - Do not use

### 3.0 MATERIAL PROPERTIES

#### 3.1 Required

Specific Gravity, ASTM D792, Method A..... 1.42 ± .05

Tensile Strength, ASTM D638, min..... 9,500 psi (65.5 MPa)

Tensile Elongation, ASTM D638, min..... 30%

Impact Strength (Izod notched) min.  
ASTM D256, Type A..... 1.0 ft-lb/in

#### 3.2 Reference Only

Hardness, ASTM D785, Rockwell R ..... 120 ± 5 pt

Flexural Modulus, ASTM D790 ..... 400,000 to 450,000 psi  
(2758 to 3103 MPa)

Compressive Strength, min.  
ASTM D695, 1% deformation ..... 5,200 psi (35.9 MPa) or  
ASTM D695, 10% deformation ..... 15,000 psi (103.4 MPa)

Heat Deflection Temp, min.  
ASTM D256, at 264 psi..... 207 °F (97 °C)

**\* \* \* End of Document \* \* \***

**ACETAL POLYMER, 20 PERCENT PTFE, -20 TO 250 DEG F**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1114044	02-NOV-2006	Coles, Michael	Strickler, Mike	RELEASED

Summary: This material is a thermoplastic acetal polymer with 20% PTFE-filled. Examples are Dupont Delrin® AF Blend or 570 acetal homopolymer.

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## MATERIAL

This material is a thermoplastic acetal polymer (POM –Polyoxymethylene) with 20% PTFE filler. Examples are Dupont Delrin® AF Blend or 570 acetal homopolymer.

### 1.0 SERVICE COMPATIBILITY

#### 1.1 API 6A, Temperature, and Pressure Compatibiliy

##### 1.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F.2, Test Fluid Class	CC
API 6A, Table 3, Material Class	AA to CC
API 6A, Table 2, Temperature Class	P to T
Temperature Rating	-20 to 180°F

##### 1.1.2 Pressure Limits:

Pressure limitations	15,000psi
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#### 1.2 Chemical Compatibility

<u>Chemical</u>	<u>Rating</u>
H <sub>2</sub> O, Water	A
Hydrocarbons	A
CH <sub>4</sub> , Methane	A
N <sub>2</sub> , Nitrogen Gas	A
CO <sub>2</sub> , Carbon Dioxide	A
H <sub>2</sub> S, Hydrogen Sulfide	C
Amines	D
Chlorides	B

HCl, Hydrochloric Acid	C		
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	D		
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	B		
O <sub>2</sub> , Oxygen	D		
Steam	D		
A – Excellent	B- Good	C – Poor	D-Do not use

## 2.0 MATERIAL PROPERTIES

Hardness, Rockwell R ASTM D785	118 ± 5 pts (reference)
Tensile Strength, min ASTM D638	8,000psi
Flexural Modulus ASTM D790	440,000-725,000psi (reference)
Tensile Elongation, min ASTM D638	15%
Impact Strength (Izod notched) min ASTM D256 Type A (73°F/23°C)	0.7 ft-lb/in
Specific Gravity ASTM D792 Method A (73°F/23°C)	1.54 ± .05
Compression Strength, min ASTM D695 1% Deformation 10% Deformation	(reference) 4,500psi or 15,000psi
Heat Deflection Temp, min at 264 psi ASTM D256	244°F (118°C) (reference)

**\* \* \* End of Document \* \* \***

**ENGINEERING SPECIFICATION****GEOLAST HARD HEEL COMPOUND, 55 SHORE D**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1087515	13-Jan-03	Janoff, Dwight	Parrish, John	RELEASED

Summary: This specification is for a 55 durometer Shore D thermoplastic elastomer with excellent performance in seal applications in water or hydrocarbon based hydraulic fluids.

## 1.0 MATERIAL

This specification is for a 55 durometer Shore D thermoplastic elastomer with excellent performance in seal applications in water or hydrocarbon based hydraulic fluids. This compound should only be used for seals that require a "hard heel" for pressure and extrusion resistance. This compound is designed for use as a "hard heel" material in combination with the 45 Shore D thermoplastic elastomer specified by E50105. Any other application should be reviewed by CTG Engineering. The trade name for the base material is Geolast® and Parker Seal compound Z4732D56 is an example of a specific compound that meets the requirements of this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	AA
API 6A, Table 302.3, Material Class.....	AA
API 6A, Table 302.2 Temperature Class.....	P to U
Temperature Rating* -20 to 250°F	

\* This temperature range does not necessarily reflect the results of API 6A testing or life estimation testing.

#### 2.1.2 Pressure Limits:

Pressure limitation.....	N/A
--------------------------	-----

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water.....	yes
Hydrocarbons.....	yes
CH <sub>4</sub> , Methane yes	
N <sub>2</sub> , Nitrogen Gas.....	yes
CO <sub>2</sub> , Carbon Dioxide.....	no
H <sub>2</sub> S, Hydrogen Sulfide.....	no
Amines.....	no
Chlorides.....	yes
HCl, Hydrochloric Acid.....	no



H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	no
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	no
O <sub>2</sub> , Oxygen.....	no
Steam.....	no

### 3.0 MATERIAL PROPERTIES

The required properties are listed below. Physical and mechanical properties shall be obtained from a fan-gated plaque 2 mm thick. Properties obtained from slabs molded using other methods, or from a molded Polypak seal may be slightly different from those listed below.

#### 3.1 Original Properties

Hardness, Shore D, 5 Sec.....	55 ± 5 pts.
ASTM D2240	
Tensile Strength, min.....	2400 psi
ASTM D412	
Elongation, min.....	300 %
ASTM D412	
100 % Modulus.....	1750 psi, min
ASTM D412	
300 % Modulus.....	1950 psi, min
ASTM D412	
Specific Gravity.....	0.96 ± 0.03
ASTM D792 Method A	

\*\*\* End of Document \*\*\*

**TPE, THERMOPLASTIC ELASTOMER, GEOLAST (TM), 45  
DUROMETER SHORE D**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
F	1111074	09-AUG-2006	Jones, Warren	Strickler, Mike	RELEASED

**Summary:**

This specification is for a 45 durometer Shore D thermoplastic elastomer with excellent performance in seal applications in water or hydrocarbon based hydraulic fluids. These applications require an elastomer with a combination of high toughness and hardness for good extrusion resistance.

THIS IS A HIGH HARDNESS AND TOUGHNESS ELASTOMER FOR EXTRUSION RESISTANT SEALS WITH MAXIMUM ENVIRONMENTAL RESISTANCE IN WATER AND HYDROCARBON BASED HYDRAULIC FLUIDS.

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## 1.0 MATERIAL

This specification is for a 45 durometer Shore D thermoplastic elastomer with excellent performance in seal applications in water or hydrocarbon based hydraulic fluids. These applications require an elastomer with a combination of high toughness and hardness for good extrusion resistance. The trade name for the base material is Geolast® and Parker EPS compound Z4754D45 (W4754D45) is an example of a specific compound that meets the requirements of this specification.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A Temperature and Pressure Compatibility\*

This temperature range does not necessarily reflect the results of API 6A, Annex F Testing or Life Estimation Testing.

#### 2.1.1 API and Temperature Limits

API 6A, Appendix F, Table F114.1, Test Fluid Class	AA
API 6A, Table 302.3 Material Class	AA
API 6A, Table 302.2 Temperature Class	N/A
Temperature Rating	30 to 180°F*

#### 2.1.2 Pressure Limits

Pressure limitation	N/A
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### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	no
H <sub>2</sub> S, Hydrogen Sulfide	no
Amines	no
Chlorides	yes
HCl, Hydrochloric Acid	no
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	no
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	no
O <sub>2</sub> , Oxygen	no
Steam	no

### 3.0 MATERIAL PROPERTIES

The required properties are listed below. The melt viscosity properties (LCR and Melt Flow Index) shall be obtained from the pellets of the raw material. The other physical and mechanical properties shall be obtained from a fan-gated plaque 2 mm thick. Properties obtained from slabs molded using other methods, or from a molded PolyPak Seal may be slightly different from those listed below.

On molded seals, a hardness of 42 to 52 pts. Shore D is acceptable.

#### 3.1 Original Properties

Hardness, Shore D, 5 sec. ASTM D2240	45 ± 3 pts.
Tensile Strength, min. ASTM D412	1700 psi
Elongation, min. ASTM D412	250 %
100 % Modulus ASTM D412	1550 ± 350 psi
Specific Gravity ASTM D792 Method A	0.99 ± 0.03
Laboratory Capillary Rheometer (LCR at 1200/sec) TPE-2000, min.	120 Pa-sec
Melt Flow Index (Reference Only) D1238, 190°C, 5 kg	0.6 to 1.1 g/10 minutes
Compression Set, 22 Hours @ 212°F, max. ASTM D395, Method B	65%

#### 3.2 Aged in Air: 70 Hours @ 212°F (REFERENCE ONLY)

Hardness Change Shore D, max.	± 5 pts.
Tensile Strength, min.	1600 psi
Elongation, min.	200 %
100 % Modulus, min.	1200 psi
200 % Modulus, min.	1450 psi

### **3.3 Aged in Marston Bentley HW 525: 70 Hours @ 212°F (REFERENCE ONLY)**

Hardness Change Shore D, max.	± 5 pts.
Tensile Strength, min.	1500 psi
Elongation, min.	250 %
100 % Modulus, min.	1100 psi
200 % Modulus, min.	1500 psi
Volume Change	0 to + 10 %

### **3.4 Aged in Castrol Brayco Micronic 864: 70 Hours @ 212°F (REFERENCE ONLY)**

Hardness Change Shore D, max.	± 5 pts.
Tensile Strength, min.	1500 psi
Elongation, min.	250 %
100 % Modulus, min.	1100 psi
200 % Modulus, min.	1350 psi
Volume Change	0 to + 10 %

## **4.0 SEAL LIFE QUALIFICATION**

Seals fabricated from a new compound or a new process must exhibit a minimum 25 year life at 200°F when tested in either Marston Bentley HW525 or Castrol Brayco Micronic 864 hydraulic fluids. The material will be tested in the form of a PolyPak Seal in the FMC seal life estimation test. At least three data points will be collected. FMC Core Technology Group should be contacted for seal configurations and test procedures.

## **5.0 MOLDING PARAMETERS**

Molding procedures shall be performed so as to avoid seal canting, minimize void size and number, and promote knit line fusion.

1. A surfactant, 1/4 % hydrocerol (dispersion, 40 % active) shall be used in the molding operation to promote a fine dispersion of internal voids. This is in contrast to the coarse dispersion of voids that are formed without the use of surfactant.
2. A baseline hold time in the mold for each particular seal mold shall be established that minimizes canting of the seal and promotes knit line strength.
3. Once the base line hold time is established for a particular seal, the actual seal hold time shall not exceed 1.5 times the baseline for any molded seal.

**\*\*\* END OF DOCUMENT \*\*\***

**ENGINEERING SPECIFICATION**

**NYLON, HEAT STABILIZED, -20 TO 200 DEG F**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1086578	23-JUN-86	MALIGAS	HAEBERLE	RELEASED

Summary: This material is a heat stabilized nylon of medium viscosity.

## 1.0 MATERIAL

This material is a heat stabilized nylon of medium viscosity.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....N/A

API 6A, Table 302.3,  
Material Class.....N/A

API 6A, Table 302.2 and Table G1  
Temperature Class.....P to T

Temperature Rating.....-20 to 200°F

#### 2.1.2 Pressure Limits:

Pressure limitation.....15,000 psi

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	no
Amines	unknown
Chlorides	yes
HCl, Hydrochloric Acid	no
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	unknown
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	unknown
O <sub>2</sub> , Oxygen	unknown
Steam	no



### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Rockwell R.....115 ± 5 pts  
ASTM D785

Tensile Strength, min.....10,000 psi  
ASTM D638

Elongation, min.....10%  
ASTM D638

Tensile Modulus, min.....400,000 psi  
ASTM D638

Specific Gravity.....1.15 ± .05  
ASTM D792 Method A

Compression Strength, min.....10,000 psi  
10% Deflection  
ASTM D695

Heat Deflection Temp.....200°F  
@ 264 psi  
ASTM D648

\*\*\* END OF DOCUMENT \*\*\*

**PEEK, UNFILLED GRADE, NORSOK COMPLIANT**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
P	1157013	17-AUG-2010	Wolff, Geoff	Jones, Warren	RELEASED

## Summary:

This specification is for PEEK with no fillers. PEEK is the common name for Polyetheretherketone, a high performance, aromatic and polyether thermoplastic.

The following have been designated as critical and require NORSOK M-710 compliance:

PI Seals (Anti-Extrusion Rings)

HTHP Metal Spring Energized U-Cup Seals (Anti-Extrusion Rings)

UV Stem Packings (Top Adaptors & T-Rings)

Face Metal Spring Energized U-Cup Seals in Gate Valves (Jackets)

They are compliant when their components are produced to this specification using the approved materials. Parts other than these calling for this specification do not require compliance.

## 1.0 Scope

PEEK is the common name for Polyetheretherketone, a high performance, aromatic and polyether thermoplastic. This specification is for PEEK with no fillers.

The following have been designated as critical and require Norsok M-710 compliance:

- PI Seals (Anti-Extrusion Rings)
- HTHP Metal Spring Energized U-Cup Seals (Anti-Extrusion Rings)
- UV Stem Packings (Top Adaptors & T-Rings)
- Face Metal Spring Energized U-Cup Seals in Gate Valves (Jackets)

They are compliant when their components are produced to this specification using the approved materials. Parts other than these calling for this specification do not require compliance.



**Approved vendors, plants and materials depend on whether component is part of a critical seal requiring Norsok M-710 Compliance. See Section 5.0 for explanation.**

### NOTE

## 2.0 Service Compatibility

### 2.1 API 6A Limits

API 6A, Table F.2, Test Fluid Class .....	HH
API 6A, Table 3, Material Class .....	AA to HH
API 6A, Table 2 & Table G.1, Temperature Class .....	K to X
Nominal Temperature Rating* .....	75 to 350 °F (-60 to 177 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons .....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides .....	Yes
HCl, Hydrochloric Acid .....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	Yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	Yes
Steam .....	Yes

## 3.0 Mold System

Billets shall be molded using an injection or extrusion process and virgin raw material having no heat or pressure history. This is to be followed by post annealing at a maximum temperature of 450 °F (232 °C). Compression molding is not permitted. Exceptions to this requirement are possible only when specific authorization is provided by the Materials Engineering.

## 4.0 Material Properties

### 4.1 Mechanical & Physical Properties

Specific Gravity ..... 1.30 +/- .05  
ASTM D 792, Method A  
(Report for each batch)

Hardness ..... 89 +/- 6 pts.  
ASTM D 2240, Shore D, maximum reading  
(Report for each batch)

Tensile Strength, min. .... 13,000 psi (89.6 MPa)  
ASTM D 638, Type 1 injection molded specimen  
(Report for each batch)

Elongation, min. .... 30 %  
ASTM D 638, Type 1 injection molded specimen  
(Report for each batch)

Compressive Strength, min. .... 15,000 psi (103.4 MPa)  
ASTM D 695, longitudinal direction of billet

Glass Transition Temperature, onset ..... 257 to 311 °F (125 to 155 °C)  
Differential Scanning Calorimeter

### 4.2 Material Testing & Reporting Requirements

Select properties in Section 4.0 are to be reported for each production batch. They are designated "(Report for each batch)". A minimum of 3 samples is required for each property. Reports shall include results, plus specification limits and are to be kept on file by the vendor for a minimum of five years.

## 5.0 Vendors, Plants & Materials

### 5.1 Approved Raw Material

Victrex 450G is the only approved raw material for the injection molding or extrusion processes. If a black color is specified, Victrex 450G903 Black is the only approved raw material.

## 5.2 Approved Vendors For Components in Critical Seals Requiring NORSOK M-710 Compliance

Of the seal types utilizing this material, PI Seals, UV Stem Packings, HTHP Metal Spring Energized (MSE) U-Cup Seals and Face Metal Spring Energized (MSE) U-Cup Seals have been designated as critical. NORSOK M-710 compliance is therefore required of the components in these seal assemblies. See Table 1 for approved vendors and plants. Material from these vendors has been determined to be NORSOK M-710 compliant with FMC's specification. All other components in seal types and other parts utilizing this material do not require NORSOK M-710 compliance.

Table 1: Approved Vendors F/ Components in Critical Seals Requiring NORSOK M-710 Compliance

Seal Name	Component in Seal	Approved Vendor(s)	Material Designation	Plant(s)
PI Seal	Anti-Extrusion Ring	AccuSeal, a Division of Utex Industries	AccuSeal AC-144	4330 Brittmoore Road, Houston, TX, U.S.A.
HTHP MSE U-Cup Seal			Utex 50320	605 Utex Drive, Weimar, TX, U.S.A.
Face MSE U-Cup Seal	Jacket	FAST – Houston CDI Seals	Arylex 745	8103 Rankin Road, Humble, TX, U.S.A.
		Gulf Coast Seal	P2000 (GCS designation for Arylex 745)	9119 Monroe Road, Houston, TX, U.S.A. (Billets are produced at 8103 Rankin Road, Humble, TX, U.S.A.)
UV Stem Packing	Top Adaptor	Saint Gobain Performance Plastics	Fluoroloy A35	7301 Orangewood Avenue, Garden Grove, CA, U.S.A
	T-Ring			Heiveldekens 22, Kontich, Belgium

Note: One-time material property test results are documented in Test Report [RPT10034510](#).



### NOTE

The identification of a vendor in Table 1 as approved for a given part must be consistent with the requirements on a part or assembly DBI. In other words, if a part or assembly DBI specifically identifies a vendor or vendors as being approved exclusive of others, the DBI takes precedence.

## 5.3 Possible Vendors For Components in Non-Critical Seals & Other Parts Not Requiring NORSOK M-710 Compliance

Components in non-critical seal types and other parts utilizing this material do not require NORSOK M-710 compliance. See above section for seals identified as critical. Other vendors and their material designations may be used if their molding, heat treatment and material property specifications meet the requirements of this specification.

**PEEK, 25 PERCENT GLASS FILLED GRADE**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
J	1155994	09-MAR-2010	Parrish, John	Jones, Warren	RELEASED

Summary: PEEK is the common name for Polyetheretherketone, a high performance aromatic polyether thermoplastic.

## 1.0 SCOPE

PEEK is the common name for Polyetheretherketone, a high performance aromatic polyether thermoplastic. This specification is for PEEK filled with 25%  $\pm$  1% by weight glass filler. Seal configurations include: back up rings, lantern rings, adapter rings, and junk rings.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class ..... HH

API 6A, Table 302.3,  
Material Class .....AA to HH

API 6A, Table 302.2 and Table G1  
Temperature Class .....K to X

Temperature Rating.....-100 to 600°F

#### 2.1.2 Pressure Limits:

Pressure limitations .....35,000 psi

Note: This does not necessarily take into consideration the results of API specification 6A, Appendix F, Testing or Life Estimation Testing of Seals.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes



CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes
Steam	yes

### 3.0 MOLD SYSTEM

Billets shall be molded using an injection or extrusion process and virgin raw material having no heat or pressure history. Compression molding is not permitted. Exceptions to this requirement are possible only when specific authorization is provided by the CTG Materials Technology Group. Finished parts may subsequently be machined from the billet.

### 4.0 MATERIAL PROPERTIES

#### 4.1 Mechanical Properties

Hardness, Shore D .....90 ± 5 pts  
ASTM D2240  
**(Report for each batch)**

Tensile Strength, min. ....20,300 psi  
ASTM D638  
**(Report for each batch)**

Elongation, min. ....1.0 %  
ASTM D638  
**(Report for each batch)**

Impact Strength .....1.6 ft-lb/in  
ASTM D256  
**(Report for each batch)**

Specific Gravity .....1.60 ± .05  
ASTM D792 Method A  
**(Report for each batch)**

Compressive Strength, min. ....32,000 psi

ASTM D695  
(Report for each batch)**5.0 POST MOLD ANNEALING (REQUIRED OF ALL PARTS)**

- 5.1 All heat treatment shall be performed in a furnace that has been calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not to furnace temperature.
- 5.2 Billet or raw stock shall be heated to between 380 and 400°F at a rate of 50°F per hour and held for 4 to 4 1/2 hours. Then slow cooled to 140°F at a rate of 50°F per hour. Then air cooled from 140°F to room temperature.

**6.0 HEAT TREATMENT (ONLY REQUIRED OF TOP ADAPTER RING IN UV STEM PACKING)**

- 6.1 This special heat treatment is specified as a means of improving material toughness. It accomplishes this by imparting higher residual compressive stresses and lower crystallinity at the external surfaces because they experience faster cooling rates. It is only required for the Top Adapter Ring in a UV Stem Packing Assembly but it may be specified for other parts by referencing it on the individual part DBI.
- 6.2 All heat treatment shall be performed in a furnace that has been calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not furnace temperature.
- 6.3 **After** performing the post mold annealing, the following heat treatment shall be performed. Billet or raw stock shall be heated to between 600 and 625°F at a rate of 165°F per hour and held for 1 to 1 1/2 hours and then **water quenched**. Rough machine the billet or raw stock to within .080 inches of the basic finished dimensions before performing this heat treatment.
- 6.4 Parts other than Top Adaptor Rings may also be heat treated as above for convenience, for example, if the same billet is being used. The .080 inches stock requirement is not a requirement for these other parts.
- 6.5 Stress Relieve: In the event that stress relieving is required after heat treatment, do not stress relieve at temperatures greater than 350°F.

- 6.6 Alternative processes may be accepted. Alternative heat treatments must be reviewed and approved by the CTG Materials Technology Group.
- 6.7 The vendor will keep the furnace records on file for a minimum period of 5 years. These records are to be traceable from the labels on the individual part or the subassembly part packages.

## **7.0 COMPRESSION TEST FOR BRITTLE FRACTURE RESISTANCE**

- 7.1 This special test is specified as a means of verifying proper molding practices, post mold annealing and heat treatment. It is only required for the Top Adapter Ring in a UV Stem Packing Assembly but it may be specified for other parts by referencing it on the individual part DBI.
- 7.2 For every batch of material the vendor must supply test coupons and perform the test on a minimum of three pieces. The test coupon will have the same ID and OD as the finished Top Adaptor Ring and be processed identically (same billet and same heat treating/machining process). Thickness of the test coupon should be 0.500  $\pm$  .010 inches. The ends should be flat and substantially square with the OD and ID.
- 7.3 The acceptance criteria for each piece is no longitudinal cracks or splits after compression of the test coupon a minimum of 35% between two plates. A schematic of this is shown in Figure 1. Bulging at the OD or ID is acceptable as is wrinkling of the surfaces, shear along 45° planes and small pieces separating from the corners.
- 7.4 The vendor is required to keep the load-deflection curves on file for a minimum period for 5 years. The curves are to be traceable from the labels on the individual part or the subassembly part packages.
- 7.5 If the material fails the compression test as described above in 5.2, all of the components manufactured from that batch will be rejected.

## **8.0 REPORTING REQUIREMENTS**

Select properties in Section 4.0 are to be reported for each production batch. They are designated "(Report for each batch)". A minimum of 3 samples is required for each property. Reports shall included results, plus specification limits

and are to be kept on file by the vendor for a minimum of five years. Each batch of material (individual parts or in subassemblies) shall be supplied with a certificate of conformance (COC) and include traceability as a minimum from the package label.

For Top Adapter Rings, the COC shall also certify that the material has been properly heat treated per section 6.0

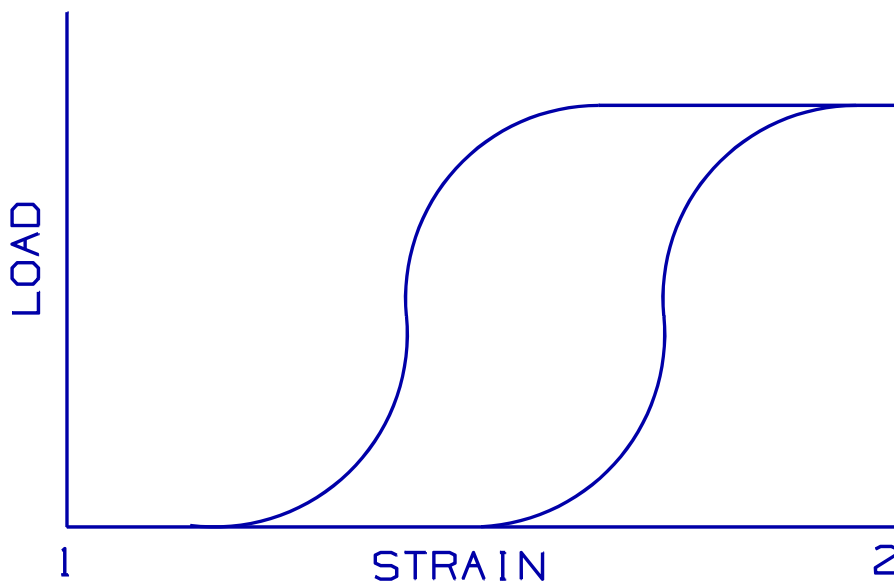
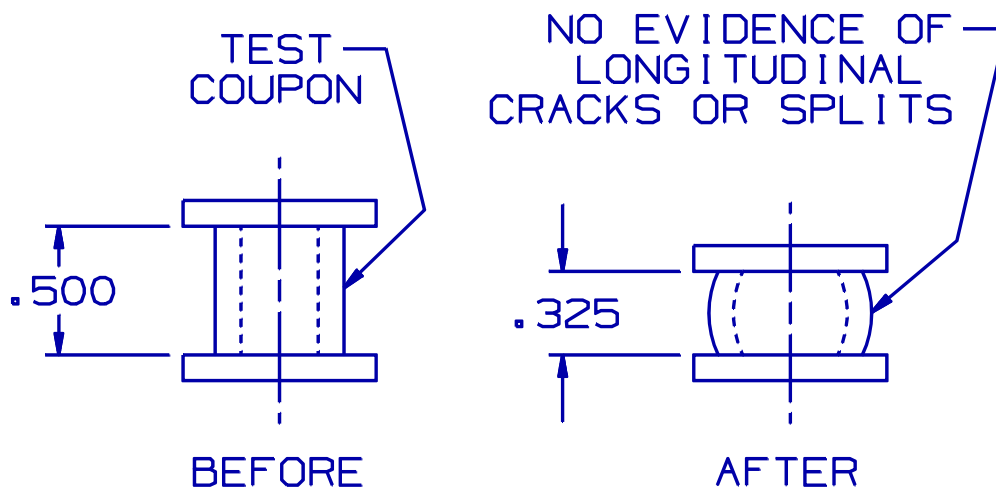


Figure 1  
Schematic of Compression Test

## 9.0 APPENDIX – REFERENCE ONLY

Heat Deflection Temp, min. .... 600°F  
ASTM D 256

Glass Transition Temperature, onset  
Differential Scanning Calorimetry..... 257 to 311°F

**\*\*\* END of DOCUMENT \*\*\***

**PEEK WITH PPS, 25 PERCENT CARBON FILLED GRADE**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
E	1086578	18-FEB-87	MALIGAS	HAEBERLE	RELEASED

Summary: PEEK is the common name for Polyetheretherketone, a high performance, aromatic and polyether thermoplastic. This specification is for PEEK with PPS, filled with 25 +/-1% by weight carbon.

## 1.0 SCOPE

PEEK is the common name for Polyetheretherketone, a high performance, aromatic and polyether thermoplastic. This specification is for PEEK with PPS, filled with 25 +/-1% by weight carbon. Seal configurations include Back-Up Rings, Lantern Rings, Adapter Rings and Junk Rings.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class.....	K to X
Temperature Rating .....	-100 to 600 °F

#### 2.1.2 Pressure Limits:

Pressure limitations.....	35,000psi
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Note: This does not necessarily take into consideration the results of API Spec. 6A, Appendix F Testing or Life Estimation Testing of Seals.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	yes
Hydrocarbons .....	yes
CH <sub>4</sub> , Methane .....	yes
N <sub>2</sub> , Nitrogen Gas.....	yes

CO <sub>2</sub> , Carbon Dioxide .....	yes
H <sub>2</sub> S, Hydrogen Sulfide .....	yes
Amines .....	yes
Chlorides .....	yes
HCl, Hydrochloric Acid .....	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	yes
O <sub>2</sub> , Oxygen .....	yes
Steam .....	yes

### 3.0 MOLD SYSTEM

Billets shall be molded using an injection or extrusion process and virgin raw material having no heat or pressure history. Compression molding is not permitted. Exceptions to this requirement are possible only when specific authorization is provided by the CTG Materials Technology Group. Finished parts may subsequently be machined from the billet.

### 4.0 MECHANICAL AND PHYSICAL PROPERTIES

Tensile Strength, min.....	30,000 psi
ASTM D 638	
Elongation, min.....	2.0 %
ASTM D 638	
Impact Strength, Notched, min.....	1.0 ft-lb/in
ASTM D 256	
Specific Gravity.....	1.44 +/- .05
ASTM D 792, Method A	
Compressive Strength, min.....	25,000 psi
ASTM D 695	

### 5.0 POST MOLD ANNEALING

5.1 All heat treatment shall be performed in a furnace that has been calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not furnace temperature.



- 5.2 Billet or raw stock shall be heated to between 380 and 400 °F at a rate of 50 °F per hour and held for 4 to 4-1/2 hours. Then slow cooled to 140 °F at a rate of 50 °F per hour. Then air cooled from 140 °F to room temperature.

## 6.0 APPENDIX - REFERENCE ONLY

### 6.1 Mechanical and Physical Properties

Heat Deflection Temperature, min..... 600 °F  
ASTM D 256

Coefficient of Thermal Expansion.....  $.4 \text{ to } .8 \times 10^{-5} \text{ in/in } ^\circ\text{F}^{-1}$   
ASTM D 696

### 6.2 Heat Treatment

- 6.2.1 A special heat treatment may be specified as a means of improving material toughness. It accomplishes this by imparting higher residual compressive stresses and lower crystallinity at the external surfaces because they experience faster cooling rates. **To specify this treatment, it must be referenced on the individual part DBI.**
- 6.2.2 All heat treatment shall be performed in a furnace that has been calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not furnace temperature.
- 6.2.3 **After** performing the post mold annealing, the following heat treatment shall be performed. Billet or raw stock shall be heated to between 600 and 625 °F at a rate of 165 °F per hour and held for 1 to 1-1/2 hours and then **water quenched**. Rough machine the billet or raw stock to within .080 inches of the basic finished dimensions before performing this heat treatment.

6.2.4 Stress Relieve: In the event that stress relieving is required after heat treatment, do not stress relieve at temperatures greater than 350 °F.

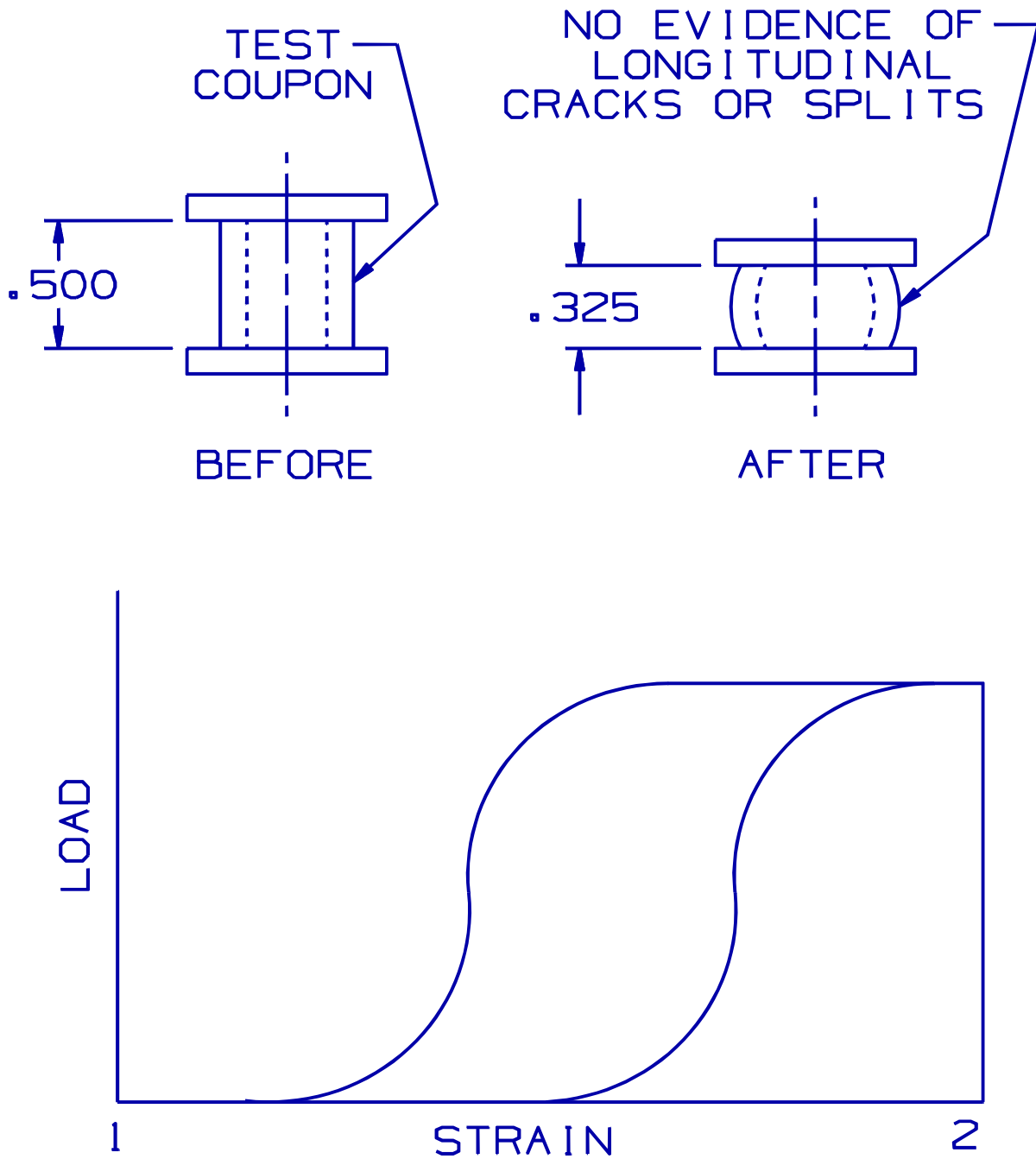
6.2.5 The vendor will keep the furnace records on file for a minimum period of 5 years. These records are to be traceable from the labels on the individual part or the subassembly part packages.

### 6.3 Compression Test for Brittleness

A special compression test may be specified as a means of verifying proper molding practices, post mold annealing and/or heat treatment. It consists of compressing test coupons a percentage of their original height and checking for longitudinal cracking. The vendor would supply the test coupons and perform the testing. **To specify this test, it must be referenced on the individual part DBI.**

An example test coupon is a ring machined from the billet from which the actual parts are machined. The ring should have the same ID and OD as the billet and a .500 +/- .010 inch thickness. The ends should be substantially square with the OD and ID. A desirable acceptance threshold for this geometry is no longitudinal cracks or splits after compression of the test coupon a minimum of 35% between two plates. A schematic of this is shown in Figure 1. Bulging at the OD or ID is acceptable as is wrinkling of the surfaces, shear along 45° planes and small pieces separating from the corners.

This testing may be required on a batch material basis and the vendor should be required to keep the load-deflection curves on file for a minimum period of 5 years. The curves should be traceable from the labels on the individual part or the subassembly part packages.



**Figure 1**  
**Schematic of Compression Test**

**PEEK, 30 PERCENT CARBON FIBER FILLED GRADE, NORSOK  
COMPLIANT**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
L	1165491	02-NOV-2010	Jones, Warren	Coles, Michael	RELEASED

**Summary:**

This specification is for PEEK filled nominally with 30 % carbon fiber. PEEK is the common name for Polyetheretherketone, a high performance, aromatic and polyether thermoplastic.

UV Stem Packings have been designated as critical and their Top Adaptors and T-Rings require NORSOK M-710 compliance. They are compliant when produced to this specification using the approved materials. Parts other than these calling for this specification do not require compliance.

## 1.0 Scope

PEEK is the common name for Polyetheretherketone, a high performance, aromatic and polyether thermoplastic. This specification is for PEEK filled with 30 % nominal weight carbon fiber, as measured by TGA. By definition, this material has a 30 +/-6 % carbon fiber weight range. The crystallinity is to be 26 +/-4 % as determined by DSC.

UV Stem Packings have been designated as critical and their Top Adaptors and T-Rings require NORSOK M-710 compliance. They are compliant when produced to this specification using the approved materials. Parts other than these calling for this specification do not require compliance.



**Approved vendors, plants and materials depend on whether component is part of a critical seal requiring NORSOK M-710 Compliance. See Section 7.0 for explanation.**

### NOTE

## 2.0 Service Compatibility

### 2.1 API 6A Limits

API 6A, Table F.2, Test Fluid Class .....	HH
API 6A, Table 3, Material Class .....	AA to HH
API 6A, Table 2 & Table G.1, Temperature Class .....	K to X
Nominal Temperature Rating* .....	-75 to 350 °F (-60 to 177 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons .....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas .....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines .....	Yes
Chlorides .....	Yes
HCl, Hydrochloric Acid .....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes

H<sub>2</sub>CO<sub>3</sub>, Carbonic Acid ..... Yes  
Steam ..... Yes

### 3.0 Mold System

Billets shall be molded using an injection or extrusion process and virgin raw material having no heat or pressure history. Compression molding is not permitted. Exceptions to this requirement are possible only when specific authorization is provided by the CTG Materials Technology Group.

## 4.0 Material Properties

### 4.1 Mechanical & Physical Properties

Specific Gravity ..... 1.41 +/- .05  
ASTM D 792, Method A  
(Report for each batch)

Hardness ..... 89 +/- 5 pts.  
ASTM D 2240, Shore D, maximum reading  
(Report for each batch)

Tensile Strength, min. .... 30,000 psi (206.8 MPa)  
ASTM D 638, Type 1 injection molded specimen  
(Report for each batch)

Elongation, min. .... 1.0 %  
ASTM D 638, Type 1 injection molded specimen  
(Report for each batch)

Impact Strength, min. .... 1.0 ft-lb/in<sup>2</sup>  
ISO 179, specimen type 1,  
notch A, edgewise blow direction

Compressive Strength, min. .... 25,000 psi (172.4 MPa)  
ASTM D 695 Longitudinal direction of billet

Glass Transition Temperature, onset ..... 257 to 311 °F (125 to 155 °C)  
Differential Scanning Calorimeter

### 4.2 Material Testing & Reporting Requirements

Select properties in Section 4.1 are to be reported for each production batch. They are designated "(Report for each batch)". A minimum of 3 samples is required for each property. Reports shall include results, plus specification limits and are to be kept on file by the vendor for a minimum of five years.

## 5.0 Post Mold Annealing

All heat treatment shall be performed in a furnace that is calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not furnace temperature.

Billet or raw stock shall be heated to between 380 & 400 °F (193 & 204 °C) at a rate of 50 °F per hour and held for 4 to 4-1/2 hours. It shall then be slow-cooled to 140 °F (60 °C) at a rate of 50 °F per hour 28 °C per hour) and then air cooled from 140 °F (60 °C) to room temperature.

## 6.0 Heat Treatment (Only Required of Top Adaptor in UV Stem Packing)

This special heat treatment is specified as a means of improving material toughness. It accomplishes this by imparting higher residual compressive stresses and lower crystallinity at the external surfaces because they experience faster cooling rates. It is only required for the Top Adapter in a UV Stem Packing Assembly but it may be specified for other parts by referencing it on the DBI.

All heat treatment shall be performed in a furnace that has been calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature and not furnace temperature.

The billet or raw stock shall be rough machined to within .080 inches (2.03 mm) of the basic finished dimensions before performing this heat treatment.

After performing the post mold annealing, the following heat treatment shall be performed:

- Billet or raw stock shall be heated to between 600 & 625 °F (316 & 329 °C) at a rate of 165 °F per hour (equivalent to 92 °C per hour), held for 1 to 1-1/2 hours and then water quenched.

Parts other than Top Adapters may also be heat treated as above for convenience, for example, if the same billet is being used. The .080 inches (2.03 mm) stock requirement is not a requirement for these other parts.

Stress Relieve: In the event that stress relieving is required after heat treatment do not stress relieve at temperatures greater than 350 °F (177 °C).

Alternative processes may be accepted. Alternative heat treatments must be reviewed and approved by Materials Engineering.

The vendor will keep the furnace records on file for a minimum period of 5 years. These records are to be traceable from the labels on the individual part or the subassembly part packages.

## 7.0 Vendors, Plants & Materials

### 7.1 Approved Raw Material

Victrex 450CA30 is the only approved raw material for the injection molding or extrusion processes.

### 7.2 Approved Vendors For Components in Critical Seals Requiring Norsok M-710 Compliance

Of the seal types utilizing this material, UV Stem Packings have been designated as critical seals. Norsok M-710 compliance is therefore required of the components in these seal assemblies. See Table 1 for approved vendors and plants. Material from these vendors has been determined to be Norsok M-710 compliant with FMC's specification. All other components in seal types and other parts utilizing this material do not require Norsok M-710 compliance.

Table 1: Approved Vendors F/ Components in Critical Seals Requiring Norsok M-710 Compliance

Seal Name	Component in Seal	Approved Vendor(s)	Material Designation	Plant(s)
UV Stem Packing	Top Adaptor	AccuSeal, a Division of Utex Industries	AccuSeal AC-150	4330 Brittmoore Road, Houston, TX, U.S.A.
			Utex 50325	605 Utex Drive, Weimar, TX, U.S.A.
		FAST – Houston CDI Seals	Arylex 754	8103 Rankin Road, Humble, TX, U.S.A.
	T-Ring	Gulf Coast Seal	P2330 (GCS designation fro Arylex 754)	9119 Monroe Road, Houston, TX, U.S.A. (Billets are produced are 8103 Rankin Road, Humble, TX, U.S.A.)
				7301 Orangewood Avenue, Garden Grove, CA, U.S.A
		Saint Gobain Performance Plastics	Fluoroloy A32	Heiveldekens 22, Kontich, Belgium

Note: One-time material property test results are documented in Test Report [RPT10034510](#).



#### NOTE

The identification of a vendor in Table 1 as approved for a given part must be consistent with the requirements on a part or assembly DBI. In other words, if a part or assembly DBI specifically identifies a vendor or vendors as being approved exclusive of others, the DBI takes precedence.



### 7.3 Possible Vendors For Components in Non-Critical Seals & Other Parts Not Requiring Norsok M-710 Compliance

Components in non-critical seal types and other parts utilizing this material do not require Norsok M-710 compliance. See above section for seals identified as critical. Other vendors and their material designations may be used if their molding, heat treatment and material property specifications meet the requirements of this specification.

## 8.0 Compression Test for Brittleness – Reference Only

A special compression test may be specified as a means of verifying proper molding practices and post mold annealing. It consists of compressing test coupons a percentage of their original height and checking for longitudinal cracking. The vendor would supply the test coupons and perform the testing. This test is not a requirement unless it is specified on the individual part DBI.

An example test coupon is a ring machined from the billet from which the actual parts are machined. The ring should have the same ID and OD as the bullet and a .500 +/- .010 inch thickness. The ends should be substantially square with the OD and ID. A desirable acceptance threshold for this geometry is no longitudinal cracks or splits after compression of the test coupon a minimum of 35% between two plates. A schematic of this is shown in Figure 1. Bulging at the OD or ID is acceptable as is wrinkling of the surfaces, shear along 45° planes and small pieces separating from the corners.

This testing may be required on a batch material basis and the vendor should be required to keep the load-deflection curves on file for a minimum period of 5 years. The curves should be traceable from the labels on the individual part or the subassembly part packages.

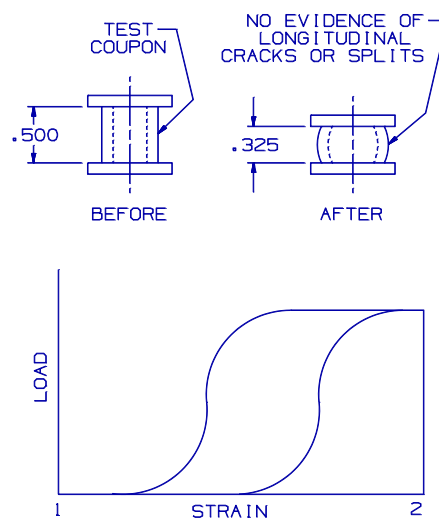


Figure 1: Schematic of Compression Test

**ENGINEERING SPECIFICATION****PEEK, 30 PERCENT CARBON/PTFE LUBRICATED GRADE**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1086578	16-Feb-01	Janoff, Dwight	Parrish, John	RELEASED

Summary: PEEK is the common name for Polyetheretherketone, a high performance, aromatic and polyether thermoplastic.

## 1.0 SCOPE

PEEK is the common name for Polyetheretherketone, a high performance, aromatic and polyether thermoplastic. This specification is for PEEK filled 30% nominally by weight with carbon and PTFE for lubrication. Uses for this material includes Anit-Extrusion Devices and Glide Bushings.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class .....	K to X
Temperature Rating	
5,000 psi or less.....	-100 to 400 °F
10,000 – 15,000 psi.....	-100 to 450 °F
with metal backup.....	-100 to 600 °F

#### 2.1.2 Pressure Limits:

Pressure limitations .....	35,000 psi
----------------------------	------------

Note: This does not necessarily take into consideration the results of API Spec. 6A, Appendix F Testing or Life Estimation Testing of Seals.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water.....	yes
Hydrocarbons .....	yes
CH <sub>4</sub> , Methane.....	yes
N <sub>2</sub> , Nitrogen Gas .....	yes
CO <sub>2</sub> , Carbon Dioxide .....	yes
H <sub>2</sub> S, Hydrogen Sulfide.....	yes
Amines .....	yes
Chlorides .....	yes
HCl, Hydrochloric Acid.....	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	yes

H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	yes
O <sub>2</sub> , Oxygen.....	yes
Steam.....	yes

### 3.0 MOLD SYSTEM

Billets shall be molded using an injection or extrusion process and virgin raw material having no heat or pressure history. Compression molding is not permitted. Exceptions to this requirement are possible only when specific authorization is provided by the CTG Materials Technology Group. Finished parts may subsequently be machined from the billet.

### 4.0 MECHANICAL AND PHYSICAL PROPERTIES

Tensile Strength, min.....	18,125 psi
ASTM D 638	
Elongation, min.....	1.0 %
ASTM D 638	
Impact Strength, Notched, min.....	1.0 ft-lb/in
ASTM D 256	
Specific Gravity.....	1.44 +/- .05
ASTM D 792, Method A	
Compressive Strength, min.....	20,000 psi
ASTM D 695	

### 5.0 POST MOLD ANNEALING

- 5.1 All heat treatment shall be performed in a furnace that has been calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not furnace temperature.
- 5.2 Billet or raw stock shall be heated to between 380 and 400 °F at a rate of 50 °F per hour and held for 4 to 4-1/2 hours. Then slow cooled to 140 °F at a rate of 50 °F per hour. Then air cooled from 140 °F to room temperature.

### 6.0 ACCEPTABLE COMPOUNDS

<u>Manufacturer</u>	<u>Compound</u>
Victrex	PEEK 450 FC30
Greene Tweed	Arlon 1555
CDI	Arylex 781
Parker EPS	W4738

## 7.0 APPENDIX - REFERENCE ONLY

### 7.1 Mechanical and Physical Properties

Heat Deflection Temperature, min..... ASTM D 256	520 °F
Coefficient of Thermal Expansion..... ASTM D 696	1.2 to 1.6 x 10 <sup>-5</sup> in/in °F <sup>-1</sup>

### 7.2 Heat Treatment

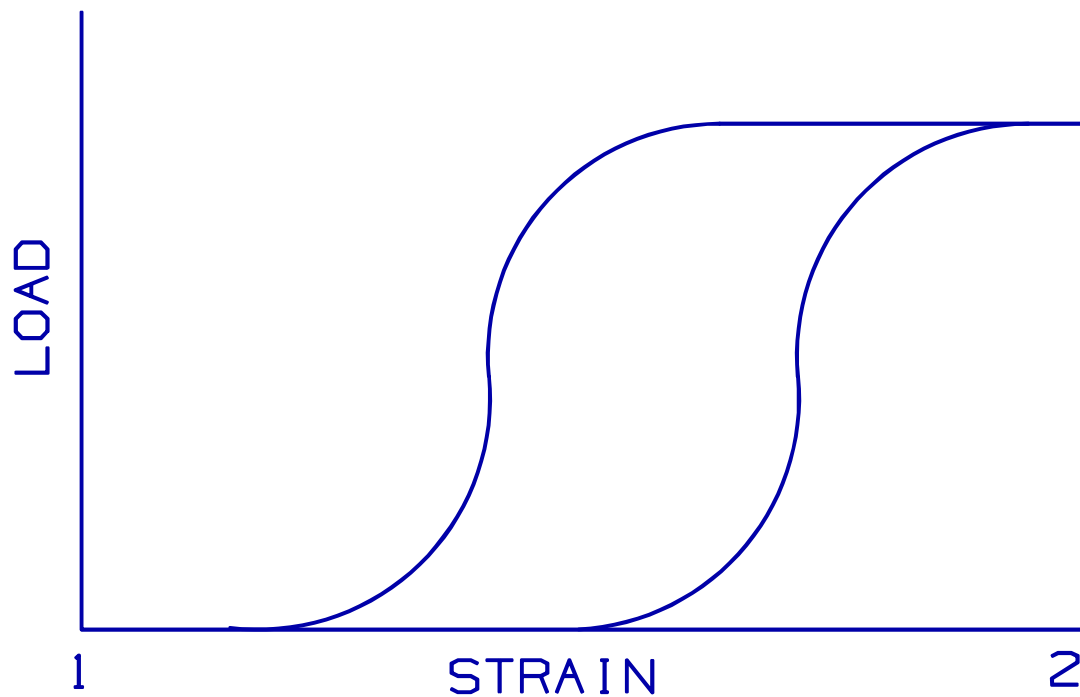
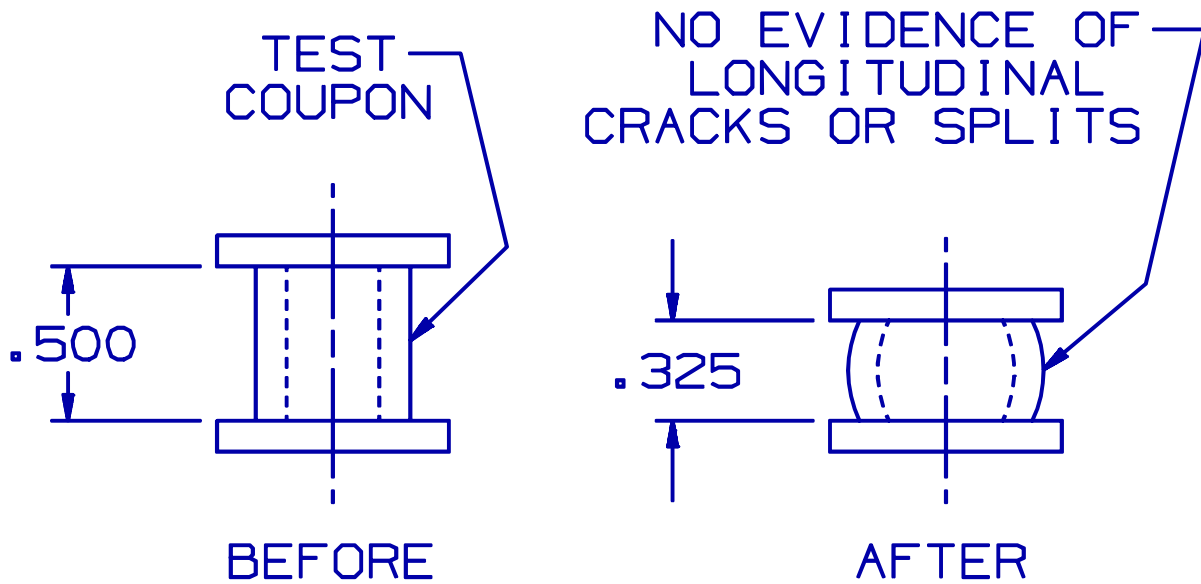
- 7.2.1 A special heat treatment may be specified as a means of improving material toughness. It accomplishes this by imparting higher residual compressive stresses and lower crystallinity at the external surfaces because they experience faster cooling rates. **To specify this treatment, it must be referenced on the individual part DBI.**
- 7.2.2 All heat treatment shall be performed in a furnace that has been calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not furnace temperature.
- 7.2.3 **After** performing the post mold annealing, the following heat treatment shall be performed. Billet or raw stock shall be heated to between 600 and 625 °F at a rate of 165 °F per hour and held for 1 to 1-1/2 hours and then **water quenched**. Rough machine the billet or raw stock to within .080 inches of the basic finished dimensions before performing this heat treatment.
- 7.2.4 Stress Relieve: In the event that stress relieving is required after heat treatment, do not stress relieve at temperatures greater than 350 °F.
- 7.2.5 The vendor will keep the furnace records on file for a minimum period of 5 years. These records are to be traceable from the labels on the individual part or the subassembly part packages.

### 7.3 Compression Test for Brittleness

A special compression test may be specified as a means of verifying proper molding practices, post mold annealing and/or heat treatment. It consists of compressing test coupons a percentage of their original height and checking for longitudinal cracking. The vendor would supply the test coupons and perform the testing. **To specify this test, it must be referenced on the individual part DBI.**

An example test coupon is a ring machined from the billet from which the actual parts are machined. The ring should have the same ID and OD as the billet and a .500 +/- .010 inch thickness. The ends should be substantially square with the OD and ID. A desirable acceptance threshold for this geometry is no longitudinal cracks or splits after compression of the test coupon a minimum of 35% between two plates. A schematic of this is shown in Figure 1. Bulging at the OD or ID is acceptable as is wrinkling of the surfaces, shear along 45° planes and small pieces separating from the corners.

This testing may be required on a batch material basis and the vendor should be required to keep the load-deflection curves on file for a minimum period of 5 years. The curves should be traceable from the labels on the individual part or the subassembly part packages.



**Figure 1**  
**Schematic of Compression Test**

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**PEEK, 30 PERCENT GLASS FIBER FILLED GRADE, NORSOK  
COMPLIANT**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
G	1157013	17-AUG-2010	Wolff, Geoff	Jones, Warren	RELEASED

## Summary:

This specification is for PEEK filled nominally with 30 % glass fiber. PEEK is the common name for Polyetheretherketone, a high performance, aromatic and polyether thermoplastic.

HTHP Metal Spring Energized U-Cup Seals and PI Seals have been designated as critical and their Anti-Extrusion Rings require NORSOK M-710 compliance. They are compliant when produced to this specification using the approved materials. Parts other than these calling for this specification do not require compliance.



## 1.0 Scope

PEEK is the common name for Polyetheretherketone, a high performance, aromatic and polyether thermoplastic. This specification is for PEEK filled 30 % nominally by weight with glass fiber, as measured by TGA.

HTHP Metal Spring Energized U-Cup Seals and PI Seals have been designated as critical and their Anti-Extrusion Rings require Norsok M-710 compliance. They are compliant when produced to this specification using the approved materials. Parts other than these calling for this specification do not require compliance.



### NOTE

**Approved vendors, plants and materials depend on whether component is part of a critical seal requiring Norsok M-710 Compliance. See Section 6.0 for explanation.**

## 2.0 Service Compatibility

### 2.1 API 6A Limits

API 6A, Table F.2, Test Fluid Class ..... HH  
API 6A, Table 3, Material Class ..... AA to HH  
API 6A, Table 2 & Table G.1, Temperature Class ..... K to X  
Nominal Temperature Rating\* ..... 75 to 350 °F (-60 to 177 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H<sub>2</sub>O, Water ..... Yes  
Hydrocarbons ..... Yes  
CH<sub>4</sub>, Methane ..... Yes  
N<sub>2</sub>, Nitrogen Gas ..... Yes  
CO<sub>2</sub>, Carbon Dioxide ..... Yes  
H<sub>2</sub>S, Hydrogen Sulfide ..... Yes  
Amines ..... Yes  
Chlorides ..... Yes  
HCl, Hydrochloric Acid ..... Yes  
H<sub>2</sub>SO<sub>4</sub>, Sulfuric Acid ..... Yes  
H<sub>2</sub>CO<sub>3</sub>, Carbonic Acid ..... Yes  
Steam ..... Yes

### 3.0 Mold System

Billets shall be molded using an injection or extrusion process and virgin raw material having no heat or pressure history. Compression molding is not permitted. Exceptions to this requirement are possible only when specific authorization is provided by the Materials Engineering.

## 4.0 Material Properties

### 4.1 Mechanical & Physical Properties

Specific Gravity ..... 1.49 +/- .05  
ASTM D 792, Method A  
(Report for each batch)

Hardness ..... 91 +/- 5 points  
ASTM D 2240, Shore D, maximum reading  
(Report for each batch)

Tensile Strength, min. .... 20,000 psi (137.9 MPa)  
ASTM D 638, Type 1 injection molded specimen  
(Report for each batch)

Elongation, min. .... 1.0 %  
ASTM D 638, Type 1 injection molded specimen  
(Report for each batch)

Compressive Strength, min. .... 25,000 psi (172.4 MPa)  
ASTM D 695, Longitudinal direction of billet

Glass Transition Temperature, onset ..... 257 to 311 °F (125 to 155 °C)  
Differential Scanning Calorimeter

### 4.2 Material Testing & Reporting Requirements

Select properties in Section 4.1 are to be reported for each production batch. They are designated "(Report for each batch)". A minimum of 3 samples is required for each property. Reports shall include results, plus specification limits and are to be kept on file by the vendor for a minimum of five years.

## 5.0 Post Mold Annealing

All heat treatment shall be performed in a furnace that is calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not furnace temperature.

Billet or raw stock shall be heated to between 380 & 400 °F (193 & 204 °C) at a rate of 50 °F per hour and held for 4 to 4-1/2 hours. It shall then be slow-cooled to 140 °F

(60 °C) at a rate of 50 °F per hour (28 °C per hour) and then air cooled from 140 °F (60 °C) to room temperature.

## 6.0 Vendors, Plants & Materials

### 6.1 Approved Raw Material

Victrex 450GL30 is the only approved raw material for the injection molding or extrusion processes.

### 6.2 Approved Vendors For Components in Critical Seals Requiring NORSOK M-710 Compliance

Of the seal types utilizing this material, HTHP MSE U-Cup Seals and PI Seals have been designated as critical seals. NORSOK M-710 compliance is therefore required of the components in these seal assemblies. See Table 1 for approved vendors and plants. Material from these vendors has been determined to be NORSOK M-710 compliant with FMC's specification. All other components in seal types and other parts utilizing this material do not require NORSOK M-710 compliance.

Table 1: Approved Vendors For Components in Critical Seals Requiring NORSOK M-710 Compliance

Seal Name	Component in Seal	Approved Vendor(s)	Material Designation	Plant(s)
HTHP MSE U-Cup Seal	Anti-Extrusion Ring	AccuSeal, a Division of Utex Industries	AccuSeal AC-158	4330 Brittmoore Road, Houston, TX, U.S.A.
			Utex 50323	605 Utex Drive, Weimar, TX, U.S.A.
		FAST - Houston CDI Seals	Arylex 747	8103 Rankin Road, Humble, TX, U.S.A.
PI Seal		Gulf Coast Seal	P2025 (GCS designation for Arylex 747)	9119 Monroe Road, Houston, TX, U.S.A. (Billets are produced at 8103 Rankin Road, Humble, TX, U.S.A.)
		Saint Gobain Performance Plastics	Fluoroloy A37	7301 Orangewood Avenue, Garden Grove, CA, U.S.A
				Heiveldekens 22, Kontich, Belgium

Note: One-time material property test results are documented in Test Report [RPT10034510](#).



#### NOTE

The identification of a vendor in Table 1 as approved for a given part must be consistent with the requirements on a part or assembly DBI. In other words, if a part or assembly DBI specifically identifies a vendor or vendors as being approved exclusive of others, the DBI takes precedence.

### **6.3 Possible Vendors For Components in Non-Critical Seals & Other Parts Not Requiring NORSOK M-710 Compliance**

Components in non-critical seal types and other parts utilizing this material do not require NORSOK M-710 compliance. See above section for seals identified as critical. Other vendors and their material designations may be used if their molding, heat treatment and material property specifications meet the requirements of this specification.

**ENGINEERING SPECIFICATION****PEEK, UNFILLED GRADE (NON-NORSOK COMPLIANT VERSION OF E55001)**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1086818	19-Aug-03	Albor, Gabriel	Janoff, Dwight	RELEASED

**Summary:**

PEEK is the common name for Polyetheretherketone, a high performance, aromatic, and polyether thermoplastic. This specification E55008 is for PEEK with no fillers. Seal configurations include anti-extrusion, lantern, adapter, and junk rings. However, parts made using this specification will not be NORSOK M-710 compliant.

## 1.0 SCOPE

PEEK is the common name for Polyetheretherketone, a high performance, aromatic, and polyether thermoplastic. This specification is for PEEK with no fillers. Seal configurations include anti-extrusion, lantern, adapter, and junk rings. Parts made using this specification will not be NORSOK M-710 compliant.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class .....	K to X
Continuous Use Temperature Rating..... UL 746B	500°F

#### 2.1.2 Pressure Limits:

Pressure Limitations .....	25,000 psi
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Note: This does not necessarily take into consideration the results of API Spec. 6A, Appendix F Testing or Life Estimation Testing of Seals.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes
Steam .....	Yes

### 3.0 MOLD SYSTEM

Billets shall be molded using an injection or extrusion process and virgin raw material having no heat or pressure history. This is to be followed by post annealing at a maximum temperature of 450° F. Compression molding is not permitted. Exceptions to this requirement are possible only when specific authorization is provided by the CTG Materials Technology Group. Finished parts may subsequently be machined from the billet.

### 4.0 MECHANICAL AND PHYSICAL PROPERTIES

Softening Point .....	>572° F
ASTM D 1525, Rate A	
Specific Gravity .....	1.30 +/- .05
ASTM D 792, Method A	
Hardness, Shore D .....	89 +/- 6 pts.
ASTM D 2240	
Tensile Strength, min. ....	13,000 psi
ASTM D 638, longitudinal direction of billet	
Elongation, min .....	30%
ASTM D 638, longitudinal direction of billet	
Compressive Strength, min. ....	15,000 psi
ASTM D 695, longitudinal direction of billet	
Glass Transition Temperature.....	257 to 311° F
Differential Scanning Calorimeter	

### 5.0 APPROVED VENDORS AND MATERIALS

Saint Gobain (Furon) .....	Fluoroloy 55, 85, or 99 per MSD 1042
Greene Tweed.....	Arlon 1000
Parker.....	W4685
CDI .....	Arylex 745
Victrex .....	450G

Other vendor material designations are also approved if their molding, heat treatment, and material property specifications meet the requirements of this specification.

### 6.0 APPENDIX A – REFERENCE ONLY

#### 6.1 Mechanical and Physical Properties

Coefficient of Thermal Expansion.....	<T <sub>g</sub> , 2.6 x 10 <sup>-5</sup> in/in °F <sup>-1</sup>
ASTM D 696	>T <sub>g</sub> , 6.0 x 10 <sup>-5</sup> in/in °F <sup>-1</sup>
Thermal Conductivity .....	1.73 BTU-in/hr-ft <sup>2</sup> - °F
ASTM C 177	

Melting Point, Peak of Endotherm ..... DSC	644 °F
Volume Resistivity ..... ASTM D 257	$4.9 \times 10^{16} \text{ } \Omega\text{-cm}$
Coefficient of Friction ..... ICI	.34

## 6.2 Compression Test for Brittleness

A special compression test may be specified as a means of verifying proper molding practices and post mold annealing. It consists of compressing test coupons a percentage of their original height and checking for longitudinal cracking. The vendor would supply the test coupons and perform the testing. **To specify this test, it must be referenced on the individual part DBI.**

An example test coupon is a ring machined from the billet from which the actual parts are machined. The ring should have the same ID and OD as the billet and a .500 +/- .010 inch thickness. The ends should be substantially square with the OD and ID. A desirable acceptance threshold for this geometry is no longitudinal cracks or splits after compression of the test coupon a minimum of 35% between two plates. A schematic of this is shown in Figure 1. Bulging at the OD or ID is acceptable as is wrinkling of the surfaces, shear along 45° planes and small pieces separating from the corners.

This testing may be required on a batch material basis and the vendor should be required to keep the load-deflection curves on file for a minimum period of 5 years. The curves should be traceable from the labels on the individual part or the subassembly part packages.

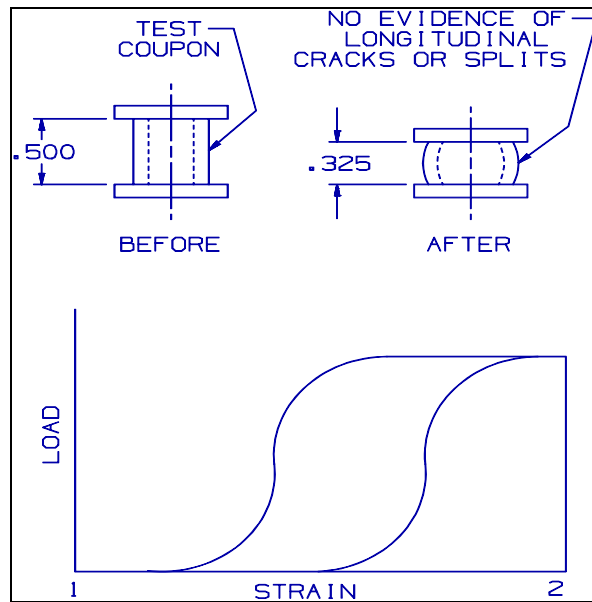


Figure 1: Schematic of Compression Test

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**ENGINEERING SPECIFICATION****PEEK, 30 PERCENT CARBON FIBER FILLED GRADE (NON-NORSOK  
COMPLIANT VERSION OF E55004)**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1086818	19-Aug-03	Albor, Gabriel	Janoff, Dwight	RELEASED

**Summary:**

PEEK is the common name for Polyetheretherketone, a high performance, aromatic, and polyether thermoplastic. This specification is for PEEK, filled with 30% nominal weight carbon fiber, as measured by TGA. The product should be defined as 30 +/- 6% of the actual value. The crystallinity is to be 26 +/- 4% determined by DSC. Parts made using this specification will not be NORSOK M-710 compliant.

## 1.0 SCOPE

PEEK is the common name for Polyetheretherketone, a high performance, aromatic, and polyether thermoplastic. This specification is for PEEK, filled with 30% nominal weight carbon fiber, as measured by TGA. The product should be defined as 30 +/- 6% of the actual value. The crystallinity is to be 26 +/- 4% determined by DSC. Parts made using this specification will not be NORSOK M-710 compliant.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class .....	K to X
Temperature Rating	
5,000 psi or less .....	-100 to 400° F
10,000 – 15,000 psi.....	-100 to 450° F
When used with a metal backup .....	-100 to 600° F

#### 2.1.2 Pressure Limits:

Pressure Limitations .....	35,000 psi
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Note: This does not necessarily take into consideration the results of API Specification 6A, Appendix F, testing or Life Estimation Testing of Seals.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes
Steam .....	Yes

Oxygen..... Yes

### 3.0 MOLD SYSTEM

Billets shall be molded using an injection or extrusion process and virgin raw material having no heat or pressure history. Compression molding is not permitted. Exceptions to this requirement are possible only when specific authorization is provided by the CTG Materials Technology Group. Finished parts may subsequently be machined from the billet.

### 4.0 MECHANICAL AND PHYSICAL PROPERTIES

Softening Point .....	>572° F
ASTM D 1525, Rate A	
Specific Gravity .....	1.41 +/- .05
ASTM D 792, Method A	
Hardness, Shore D .....	89 +/- 5 pts.
ASTM D 2240	
Tensile Strength, min. ....	30,000 psi
ASTM D 638, longitudinal direction of billet	
Elongation, min .....	1.0%
ASTM D 638, longitudinal direction of billet	
Impact Strength, min .....	1.0 ft-lb/in
ISO 179, specimen type 1, Notch A with .08 in. depth, edgewise blow direction	
Compressive Strength, min. ....	25,000 psi
ASTM D 695, longitudinal direction of billet	
Glass Transition Temperature, onset .....	257 to 311° F
Differential Scanning Calorimeter	

### 5.0 POST MOLD ANNEALING (REQUIRED OF ALL PARTS)

1. All heat treatment shall be performed in a furnace that has been calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not furnace temperature.
2. Billet or raw stock shall be heated to between 380 and 400° F at a rate of 50° F per hour and held for 4 to 4-1/2 hours. Then, slow cooled to 140° F at a rate of 50° F per hour. Then air cooled from 140° F to room temperature.

## 6.0 HEAT TREATMENT (ONLY REQUIRED OF TOP ADAPTER RING IN UV STEM PACKING)

1. This special heat treatment is specified as a means of improving material toughness. It accomplishes this by imparting higher residual compressive stresses and lower crystallinity at the external surfaces because they experience faster cooling rates. It is only required for the Top Adapter Ring in a UV Stem Packing Assembly but it may be specified for other parts by referencing it on the individual part DBI.
2. All heat treatment shall be performed in a furnace that has been calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not furnace temperature.
3. **After** performing the post mold annealing, the following heat treatment shall be performed. Billet or raw stock shall be heated to between 600 and 625 °F at a rate of 165 °F per hour and held for 1 to 1-1/2 hours and then **water quenched**. Rough machine the billet or raw stock to within .080 inches of the basic finished dimensions before performing this heat treatment.
4. Parts other than Top Adapter Rings may also be heat treated as above for convenience, for example, if the same billet is being used. The .080 inches stock requirement is not a requirement for these other parts.
5. Stress Relieve: In the event that stress relieving is required after heat treatment, do not stress relieve at temperatures greater than 350 °F.
6. Alternative processes may be accepted. Alternative heat treatments must be reviewed and approved by the CTG Materials Technology Group.
7. The vendor will keep the furnace records on file for a minimum period of 5 years. These records are to be traceable from the labels on the individual part or the subassembly part packages.

## 7.0 COMPRESSION TEST FOR BRITTLE FRACTURE RESISTANCE (ONLY REQUIRED OF TOP ADAPTOR RING IN UV STEM PACKING)

1. This special test is specified as a means of verifying proper molding practices, post mold annealing, and heat treatment. It is only required for the Top Adapter Ring in a UV Stem Packing Assembly but it may be specified for other parts by referencing it on the individual part DBI.
2. For every batch of material, the vendor must supply test coupons and perform the test on a minimum of three pieces. The test coupons will have the same ID and OD as the finished Top Adapter Ring, and be processed identically (same billet and same heat treating/machining process). Thickness of the test coupon should be 0.500 +.010 inches. The ends should be flat and substantially square with the OD and ID.
3. The acceptance criteria for each piece is no longitudinal cracks or splits after compression of the test coupon a minimum of 25% between two plates. A schematic of this is shown

in Figure 1. Bulging at the OD or ID is acceptable as is wrinkling of the surfaces, shear along 45° planes and small pieces separating from the corners.

4. The vendor is required to keep the load-deflection curves on file for a minimum period of 5 years. The curves are to be traceable from the labels on the individual part or the subassembly part packages.
5. If the material fails the compression test as described above in 5.2, all of the components manufactured from that batch will be rejected.

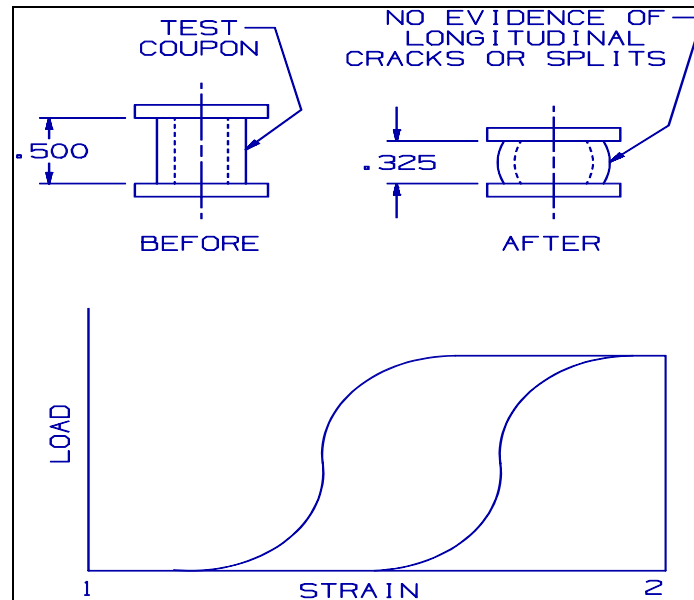


Figure 1: Schematic of Compression Test

## 8.0 APPROVED VENDORS, AND MATERIALS

Saint Gobain (Furon) .....	Fluoroloy E1 per MSD 1067
Greene Tweed.....	Arlon 11260
CDI .....	Arylex 754
Victrex .....	450CA30

Other vendor material designations are also approved if their molding, heat treatment, and material property specifications meet the requirements of this specification.

## 9.0 APPENDIX – REFERENCE ONLY

### 9.1 Mechanical and Physical Properties

Heat Deflection Temperature, min. ....	600° F
ASTM D 256	

Coefficient of Thermal Expansion.....  $.4 - .8 \times 10^{-5} \text{ in/in } ^\circ\text{F}^{-1}$   
ASTM D 696

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****PEEK, 30 PERCENT GLASS FIBER FILLED GRADE (NON-NORSOK  
COMPLIANT VERSION OF E55007)**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1086818	19-Aug-03	Albor, Gabriel	Janoff, Dwight	RELEASED

## Summary:

PEEK is the common name for Polyetheretherketone, a high performance, aromatic, and polyether thermoplastic. This specification is for PEEK, filled 30% nominally by weight with glass fiber, as measured by TGA. Parts made using this specification will not be NORSOK M-710 compliant.

## 1.0 SCOPE

PEEK is the common name for Polyetheretherketone, a high performance, aromatic, and polyether thermoplastic. This specification is for PEEK, filled 30% nominally by weight with glass fiber, as measured by TGA. Parts made using this specification will not be Norsok M-710 compliant.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class .....	K to X
Temperature Rating	
5,000 psi or less .....	-100 to 400° F
10,000 – 15,000 psi.....	-100 to 450° F
When used with a metal backup .....	-100 to 600° F

#### 2.1.2 Pressure Limits:

Pressure Limitations .....	35,000 psi
----------------------------	------------

Note: This does not necessarily take into consideration the results of API Specification 6A, Appendix F, testing or Life Estimation Testing of Seals.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes
Steam .....	Yes



Oxygen..... Yes

### 3.0 MOLD SYSTEM

Billets shall be molded using an injection or extrusion process and virgin raw material having no heat or pressure history. Compression molding is not permitted. Exceptions to this requirement are possible only when specific authorization is provided by the CTG Materials Technology Group. Finished parts may subsequently be machined from the billet.

### 4.0 MECHANICAL AND PHYSICAL PROPERTIES

Softening Point .....	>572° F
ASTM D 1525, Rate A	
Specific Gravity .....	1.49 +/- .05
ASTM D 792, Method A	
Hardness, Shore D .....	91 +/- 5 pts.
ASTM D 2240	
Tensile Strength, min. ....	20,000 psi
ASTM D 638, longitudinal direction of billet	
Elongation, min .....	1.0%
ASTM D 638, longitudinal direction of billet	
Compressive Strength, min. ....	25,000 psi
ASTM D 695, longitudinal direction of billet	
Glass Transition Temperature, onset .....	257 to 311° F
Differential Scanning Calorimeter	

### 5.0 POST MOLD ANNEALING (REQUIRED OF ALL PARTS)

1. All heat treatment shall be performed in a furnace that has been calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not furnace temperature.
2. Billet or raw stock shall be heated to between 380 and 400° F at a rate of 50° F per hour and held for 4 to 4-1/2 hours. Then, slow cooled to 140° F at a rate of 50° F per hour. Then air cooled from 140° F to room temperature.

### 6.0 APPROVED VENDORS, AND MATERIALS

Saint Gobain (Furon) .....	Fluoroloy 47 per MSD 1042
Greene Tweed.....	Arlon 1160
CDI .....	Arylex 747
Victrex .....	450GL30

Other vendor material designations are also approved if their molding, heat treatment, and material property specifications meet the requirements of this specification.

## 7.0 APPENDIX – REFERENCE ONLY

### 7.1 Heat treatment

1. A special heat treatment may be specified as a means of improving material toughness. It accomplishes this by imparting higher residual compressive stresses and lower crystallinity at the external surfaces because they experience faster cooling rates. To specify this treatment, it must be referenced on the individual part DBI.
2. All heat treatment shall be performed in a furnace that has been calibrated on an annual basis to an appropriate NIST standard. Temperature refers to part temperature, and not furnace temperature.
3. After performing the post mold annealing, the following heat treatment shall be performed. Billet or raw stock shall be heated to between 600 and 625° F at a rate of 165° F per hour and held for 1 to 1-1/2 hours and then water quenched. Rough machine the billet or raw stock to within .080 inches of the basic finished dimensions before performing this heat treatment.
4. Stress Relieve: In the event that stress relieving is required after heat treatment, do not stress relieve at temperatures greater than 350° F.
5. The vendor will keep the furnace records on file for a minimum period of 5 years. These records are to be traceable from the labels on the individual part or the subassembly part packages.

### 7.2 Compression Test for Brittleness

1. A special compression test may be specified as a means of verifying proper molding practices, post mold annealing, and/or heat treatment. It consists of compressing test coupons a percentage of their original height and checking for longitudinal cracking. The vendor would supply the test coupons and perform the testing. **To specify this test, it must be referenced on the individual part DBI.**
2. An example test coupon is a ring machined from the billet from which the actual parts are machined. The ring should have the same ID and OD as the billet and a .500 +/- .010 inch thickness. The ends should be substantially square with the OD and ID. A desirable acceptance threshold for this geometry is no longitudinal cracks or splits after compression of the test coupon a minimum of 25% between two plates. A schematic of this is shown in Figure 1. Bulging at the OD or ID is acceptable as is wrinkling of the surfaces, shear along 45° planes and small pieces separating from the corners.
3. This testing may be required on a batch material basis and the vendor should be required to keep the load-deflection curves on file for a minimum period of 5 years. The curves should be traceable from the labels on the individual part or the subassembly part packages.

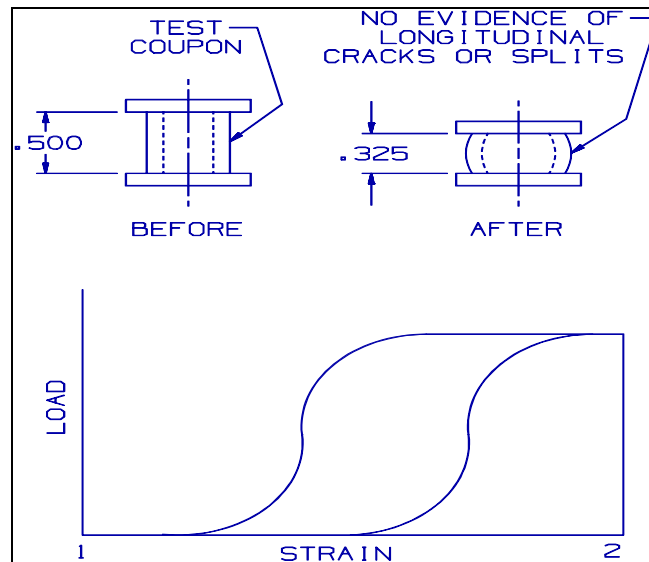


Figure 1: Schematic of Compression Test

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**ENGINEERING SPECIFICATION**

<b>POLYURETHANE, -65 TO 200 DEG F, 90 DUROMETER SHORE A</b>
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Rev	ECN No.	Date	Reviewed By	Approved By	Status
E	1086578	24-SEP-85	DC	KEK	RELEASED

Summary: This specification covers a polyester based polyurethane commonly used to injection mold Polypack.

CLEAN.

## 1.0 MATERIAL

This specification covers a polyester based polyurethane commonly used to injection mold Polypack, PIP and Wiper Seals. Parker EPS compound P4615A90 designated “Molythane” meets the requirements of this specification. This compound no longer includes Molybdenum Disulfide as an internal ingredient.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	AA
API 6A, Table 302.3, Material Class.....	AA
API 6A, Table 302.2 Temperature Class.....	L to T
Temperature Rating.....	-65 to 200°F

#### 2.1.2 Pressure Limits:

Pressure limitation.....	N/A
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### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	yes, limited
Hydrocarbons .....	yes
CH <sub>4</sub> , Methane .....	yes
N <sub>2</sub> , Nitrogen Gas .....	no
CO <sub>2</sub> , Carbon Dioxide .....	no
H <sub>2</sub> S, Hydrogen Sulfide .....	no
Amines .....	no
Chlorides .....	yes
HCl, Hydrochloric Acid .....	no
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	no
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	no
O <sub>2</sub> , Oxygen .....	no
Steam .....	no

### **3.0 MATERIAL PROPERTIES**

#### **3.1 Mechanical Properties**

Hardness, Shore A.....90 ± 5 pts  
ASTM D2240

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****POLYESTER ELASTOMER, -65 TO 275 DEG F, 53 DUROMETER  
SHORE D**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1086578	24-SEP-85	DC	KEK	RELEASED

Summary: This specification covers a polyester elastomer made from Parker seal compound Z4651D53.

## 1.0 MATERIAL

This specification covers a polyester elastomer made from Parker seal compound Z4651D53.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....AA

API 6A, Table 302.3,  
Material Class.....AA

API 6A, Table 302.2  
Temperature Class.....L to U

Temperature Rating.....-65 to 275°F

#### 2.1.2 Pressure Limits:

Pressure limitation.....N/A

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes, limited
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes, limited
H <sub>2</sub> S, Hydrogen Sulfide	yes, limited
Amines	no
Chlorides	yes
HCl, Hydrochloric Acid	no
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	no
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	no
O <sub>2</sub> , Oxygen	no
Steam	no



### **3.0 MATERIAL PROPERTIES**

#### **3.1 Mechanical Properties**

Hardness, Shore A.....53 ± 5 pts  
ASTM D2240

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****POLYESTER ELASTOMER, U-CUP TYPE SEAL W/NITRILE FILLER  
ELEMENT, -65 TO 275 DEG F**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
C	1086578	20-FEB-86	MALIGAS	EMM	RELEASED

Summary: This specification covers a polyester elastomer made from Parker seal compound Z4651. Nitrile rubber is a copolymer of Butadiene with Acrylonitrile.

MAY BE USED ONLY IN PRESSURES < 5000 PSI.

## 1.0 MATERIAL

This specification covers a polyester elastomer made from Parker seal compound Z4651. Nitrile rubber is a copolymer of Butadiene with Acrylonitrile. Seal configurations include U-cup type seals with elastomer filler elements.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....AA

API 6A, Table 302.3,  
Material Class.....AA

API 6A, Table 302.2  
Temperature Class.....L to U

Temperature Rating.....-65 to 275°F

#### 2.1.2 Pressure Limits:

Static.....5,000 psi, liquid  
.....5,000 psi, gas

Dynamic.....5,000 psi, liquid  
.....5,000 psi, gas

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes, limited
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes, limited
H <sub>2</sub> S, Hydrogen Sulfide	yes, limited
Amines	no
Chlorides	yes
HCl, Hydrochloric Acid	no
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	no
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	no
O <sub>2</sub> , Oxygen	no
Steam	no

**3.0 MATERIAL PROPERTIES****3.1 Mechanical Properties**

	<b>Filler Element</b>	<b>U-Cup</b>
Hardness ASTM D2240	70 ± 5 pts Shore A	55 ± 5 pts Shore D
Tensile Strength, min. ASTM D412	2,000 psi	5,820 psi
Elongation, min. ASTM D412	250%	810%
100% Modulus, min. ASTM D412	510 psi	2495 psi
Specific Gravity ASTM D792 Method A	N/A	N/A
Compression Set, max. ASTM D395 Method B	25%	44%

**3.2 Critical Transition Temperatures**

TR-10, max. Temperature Retraction ASTM D1329	-15°F (-26°C)	-94°F(-71°C)
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**3.3 Air Aged: ASTM D573**

Hardness	70 ± 14 pts	50 ± 5 pts
Tensile Strength, min.	1600 psi	5587 psi
Elongation, max.	250%	842%
100% Modulus, max.	620 psi	N/A

**3.4 Oil Aged: ASTM D471  
ASTM No. 3 Oil**

Hardness, Shore A	65 ± 5 pts	55 ± 5 pts
Tensile Strength, min.	1800 psi	5529 psi
Elongation, max.	250%	810%
100% Modulus, max.	N/A	N/A

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****HYTREL, 5555HS, POLYESTER ELASTOMER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1090790	23-Feb-04	Janoff, Dwight	Parrish, John	RELEASED

**Summary:**

This specification covers a polyester elastomer, Hytrel 5555HS, manufactured by DuPont.

## 1.0 MATERIAL

This specification covers a polyester elastomer Hytrel 5555HS manufactured by DuPont.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	AA
API 6A, Table 302.3, Material Class.....	AA
API 6A, Table 302.2 Temperature Class.....	L to U
Temperature Rating.....	-75 to 250 °F

#### 2.1.2 Pressure Limits:

Pressure limitation.....	N/A
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### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes, limited
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes, limited
H <sub>2</sub> S, Hydrogen Sulfide	yes, limited
Amines	no
Chlorides	yes
HCl, Hydrochloric Acid	no
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	no
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	no
O <sub>2</sub> , Oxygen	no
Steam	no

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical and Physical Properties

Hardness, Shore D..... ASTM D2240	50 to 55
Stress at Break, min ..... ASTM D412	5,000 psi (34 Mpa)
Strain at Break, min ..... ASTM D412	450 %
Specific Gravity ..... ASTM D792 or equivalent	1.15 to 1.2

\*\*\* End of Document\*\*\*

**ENGINEERING SPECIFICATION****GLASS FILLED FORTRON POLYPHENYLENE SULFIDE BASED  
PLASTIC**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	1086578	19-Feb-98	Janoff, Dwight	Wong, Henry	RELEASED

Summary: This specification covers high strength, increased impact strength polyphenylene sulfide (PPS). This compound is reinforced with 40%  $\pm$  1% by weight glass and 3%  $\pm$  1% by weight PTFE. . This material is available under the trade name of Fortron.



## 1.0 MATERIAL

This specification covers high strength, increased impact strength polyphenylene sulfide (PPS). This compound is reinforced with 40%  $\pm$  1% by weight glass and 3%  $\pm$  1% by weight PTFE. Seal configurations include: back up rings, lantern rings, and adapter rings. This material is available under the trade name of Fortron.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	HH
API 6A, Table 302.3, Material Class.....	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class.....	K to X
Temperature Rating.....	-100 to 400°F

#### 2.1.2 Pressure Limits:

Pressure limitations.....	12,000 psi
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### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes
Steam	yes

**3.0 MATERIAL PROPERTIES****3.1 Mechanical Properties**

Hardness, Shore D..... ASTM D2240	90 ± 5 pts
Tensile Strength, min. .... ASTM D638	25,000 psi
Elongation, min..... ASTM D638	3%
Impact Strength..... ASTM D256	2.0 ft-lb/in
Specific Gravity..... ASTM D792 Method A	1.64 ± .05
Compression Strength, min. .... ASTM D695	30,000 psi
Heat Deflection Temp, min..... ASTM D256	510°F (266°C)

\*\*\* End of Document \*\*\*

**GLASS FILLED PPS, -100 TO 400 DEG F, 90 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
G	1173355	24-MAY-2011	Wolff, Geoff	Coles, Michael	RELEASED

## Summary:

This specification covers polyphenylene sulfide (PPS). This compound is reinforced with 40 %  $\pm$  1 % by weight glass and 3 %  $\pm$  1 % by weight PTFE. Seal configurations include: back up rings, lantern rings, and adapter rings.

MAY ONLY BE USED IN PRESSURES < 12000 PSI.

## 1.0 Scope

This specification covers polyphenylene sulfide (PPS). This compound is reinforced with 40 %  $\pm$  1 % by weight glass and 3 %  $\pm$  1 % by weight PTFE. Seal configurations include: back up rings, lantern rings, and adapter rings.

## 2.0 API 6A Limits

API 6A, Table F.2, Test Fluid Class ..... HH  
API 6A, Table 3, Material Class ..... AA to HH  
API 6A, Table 2 & Table G.1, Temperature Class ..... K to X  
Nominal Temperature Rating\* ..... -100 to 400 °F(-73 to 204 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

## 2.1 Chemical Compatibility

H<sub>2</sub>O, Water ..... Yes  
Hydrocarbons ..... Yes  
CH<sub>4</sub>, Methane ..... Yes  
N<sub>2</sub>, Nitrogen Gas ..... Yes  
CO<sub>2</sub>, Carbon Dioxide ..... Yes  
H<sub>2</sub>S, Hydrogen Sulfide ..... Yes  
Amines ..... Yes  
Chlorides ..... Yes  
HCl, Hydrochloric Acid ..... Yes  
H<sub>2</sub>SO<sub>4</sub>, Sulfuric Acid ..... Yes  
H<sub>2</sub>CO<sub>3</sub>, Carbonic Acid ..... Yes  
O<sub>2</sub>, Oxygen ..... Yes  
Steam ..... Yes

### 3.0 Material Properties

Hardness.....90 ± 5 pts  
ASTM D2240, Shore D, max. reading

Tensile Strength, min.....15,000 psi (103 MPa)  
ASTM D638

Elongation, min.....1.2 %  
ASTM D638

Impact Strength, min.....1.0 ft-lb/in  
ASTM D256

Specific Gravity.....1.69 ± 0.05  
ASTM D792, Method A

Compression Strength, min.....24,300 psi (168 MPa)  
ASTM D695

Heat Deflection Temp, min.....490 °F (254 °C)  
ASTM D648

**PTFE, 10 PERCENT CARBON/GRAPHITE FILLED GRADE, NORSOK  
COMPLIANT**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
I	1157013	17-AUG-2010	Wolff, Geoff	Jones, Warren	RELEASED

## Summary:

This specification is for PTFE filled nominally with 10 % carbon and graphite. PTFE is the common name for polytetrafluoroethylene.

HTHP Metal Spring Energized U-Cup Seals have been designated as critical and their Jackets require NORSOK M-710 compliance. They are compliant when produced to this specification using the approved materials. Parts other than these calling for this specification do not require compliance.

## 1.0 Scope

PTFE is the common name for polytetrafluoroethylene. This specification is for PTFE blended with 10 +/-2 % by weight carbon and graphite. Parts are made from a billet that has been compression or isostatically molded and then sintered.

HTHP Metal Spring Energized U-Cup Seals have been designated as critical and their Jackets require NORSOK M-710 compliance. They are compliant when produced to this specification using the approved vendors and materials. Parts other than these calling for this specification do not require compliance.



**Approved vendors, plants and materials depend on whether component is part of a critical seal requiring NORSOK M-710 Compliance. See Section 4.0 for explanation.**

### NOTE

## 2.0 Service Compatibility

### 2.1 API 6A Limits

API 6A, Table F.2, Test Fluid Class ..... HH  
API 6A, Table 3, Material Class ..... AA to HH  
API 6A, Table 2 and Table G.1, Temperature Class ..... K to X  
Nominal Temperature Rating\* ..... -75 to 350 °F (-60 to 177 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons .....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides .....	Yes
HCL, Hydrochloric Acid.....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	Yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	Yes
Steam .....	Yes
Oxygen .....	Yes

## 3.0 Material Properties

### 3.1 Mechanical & Physical Properties

Specific Gravity .....	2.13 +/- .05
ASTM D 4745 or D 792, method A (Report for each batch)	
Hardness .....	61 +/- 5 pts.
ASTM D 2240, Shore D, maximum reading (Report for each batch)	
Tensile Strength, min. ....	2,600 psi (17.9 MPa)
ASTM D 4745 or D 1708, Transverse direction of billet (Report for each batch)	
Elongation, min. ....	200 %
ASTM D 4745 or D 1708, Transverse direction of billet (Report for each batch)	
Compressive Strength, min.....	3,000 psi (20.7 MPa)
ASTM D 695, Longitudinal direction of billet	

### 3.2 Material Testing & Reporting Requirements

Select properties in Section 3.1 are to be reported for each production batch. They are designated "(Report for each batch)". A minimum of 3 samples is required for each property. Reports shall include results, plus specification limits and are to be kept on file by the vendor for a minimum of five years.



## 4.0 Vendors, Plants & Materials

### 4.1 Approved Vendors For Components in Critical Seals Requiring Norsok M-710 Compliance

Of the seal types utilizing this material, HTHP Metal Spring Energized (MSE) U-Cup Seals have been designated as critical. Norsok M-710 compliance is therefore required of the components in these seal assemblies. See Table 1 for approved vendors and plants. Material from these vendors has been determined to be Norsok M-710 compliant with FMC's specification. All other components in seal types and other parts utilizing this material do not require Norsok M-710 compliance.

Table 1: Approved Vendors F/ Components in Critical Seals Requiring Norsok M-710 Compliance

Seal Name	Component in Seal	Approved Vendor(s)	Material Designation	Plant(s)
HTHP MSE U-Cup Seal	Jacket	AccuSeal, a Division of Utex Industries	AccuSeal AC-157	4330 Brittmoore Road, Houston, TX, U.S.A.
		Saint Gobain Performance Plastics	Fluoroloy A36	7301 Oranewood Avenue, Garden Grove, CA, U.S.A
				Heiveldekens 22, Kontich, Belgium

Note: One-time material property test results are documented in Test Report [RPT10034510](#).



#### NOTE

The identification of a vendor in Table 1 as approved for a given part must be consistent with the requirements on a part or assembly DBI. In other words, if a part or assembly DBI specifically identifies a vendor or vendors as being approved exclusive of others, the DBI takes precedence.

### 4.2 Possible Vendors For Components in Non-Critical Seals & Other Parts Not Requiring Norsok M-710 Compliance

Components in non-critical seal types and other parts utilizing this material do not require Norsok M-710 compliance. See above section for seals identified as critical. Other vendors and their material designations may be used if their molding, heat treatment and material property specifications meet the requirements of this specification.

**ENGINEERING SPECIFICATION****50 PERCENT NICKLE-CHROME FILLED PTFE**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1086578	12-DEC-84	MALIGAS	STODDARD	RELEASED

Summary: This specification is for a 50%  $\pm$  -1% by weight powder nickel-chrome filled PTFE. Applications include high pressure seals, back-up rings and non-extrusion rings.

## 1.0 MATERIAL

This specification is for a 50%  $\pm$  -1% by weight powder nickel-chrome filled PTFE. Applications include high pressure seals, back-up rings and non-extrusion rings. Material is chemically inert up to 500<sup>0</sup>F, weather resistant, water resistant, and non-flammable. The trade name for this material is GSF code no. 1100.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A Temperature Compatibility

API 6A, Table 302.2 and Table G1  
Temperature Class.....K to X  
Temperature Rating.....-140 to 500<sup>0</sup>F

## 3.0 MATERIAL PROPERTIES

### 3.1 Material Properties

Hardness, Shore D.....68  $\pm$  5 pts  
ASTM D2240  
Tensile Strength, min.....2,300psi  
ASTM D1708  
Elongation, min.....205%  
ASTM D1708  
Flexural Strength, min.....3,600psi  
ASTM D790  
Flexural Modulus, min.....2.9 x 10<sup>5</sup>psi  
ASTM D790  
Specific Gravity.....3.78  
ASTM D792 METHOD A  
Coefficient of Linear Expansion.....4.4  
ASTM D696  
Wear Factor.....5  
Coefficient of Friction  
Static @ 33.33psi, ..... .08  
Dynamic @ 33.33psi, 150 fpm ..... .12

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****PTFE IMPREGNATED FIBER WITH WIRE REINFORCEMENT, -60 TO  
450 DEG F**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
E	1086578	27-AUG-84	MALIGAS	BENEFIELD	RELEASED

Summary: This specification covers fiber impregnated with PTFE and Inconel 600 or 316 SS wire.

## 1.0 MATERIAL

This specification covers fiber impregnated with PTFE and Inconel 600 or 316 SS wire. This material is compression molded or endless die formed into rings. A common application includes the packing material utilized in lockdown screws.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class.....	HH
API 6A, Table 302.3, Material Class.....	AA to HH
API 6A, Table 302.2 and Table G1 Temperature Class.....	L to X
Temperature Rating.....	-60 to 450°F

#### 2.1.2 Pressure Limits:

Pressure limitation.....	30,000 psi
--------------------------	------------

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes
Steam	yes

**3.0 MATERIAL PROPERTIES****3.1 Mechanical Properties**

Specific Gravity.....1.83 ± .05  
ASTM D792 Method A

Fiber Content by Weight.....25% ± 10%

Teflon Content by Weight.....45% ± 5%

Inconel 600 or 316 SS wire.....30% ± 10%  
content by weight (.008" dia.)

\*\*\* END OF DOCUMENT \*\*\*

**PTFE, ASTM D4894 TYPE II, 55 DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1185753	06-MAR-2012	Wolff, Geoff	Turbeville, Elliott	RELEASED

## Summary:

This specification is for unfilled polytetrafluoroethylene consisting of a finely divided resin with average particle size less than 100 µm.

## 1.0 Scope

This specification is for unfilled polytetrafluoroethylene consisting of a finely divided resin with average particle size less than 100 µm. Unfilled PTFE is very resistant to chemical attack, except by alkali metals and elemental fluorine. PTFE will not absorb water and very few materials adhere to it. PTFE has moderate tensile strength, high elongation, and long life in flexural applications. Common application include: Gaskets, seats, non-extrusion rings, V-packings, bearings, wear rings, o-rings, and piston rings.

## 2.0 Service Compatibility

### 2.1 API 6A Limits

API 6A, Table F.2, Test Fluid Class .....	HH
API 6A, Table 3, Material Class .....	AA to HH
API 6A, Table 2 and Table G.1, Temperature Class .....	K to X
Nominal Temperature Rating* .....	-75 to 350 °F (-60 to 177 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons .....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas .....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines .....	Yes
Chlorides .....	Yes
HCL, Hydrochloric Acid .....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	Yes
Steam .....	Yes
Oxygen .....	Yes



## 3.0 Material Properties

### 3.1 Mechanical & Physical Properties

Specific Gravity .....	2.17 ± 0.05
ASTM D 792, Method A	
Hardness .....	55 ± 5 pts.
ASTM D 2240, Shore D, maximum reading	
Tensile Strength, min. ....	3,400 psi (24 MPa)
ASTM D 1708, Transverse direction of billet	
Tensile Elongation, min.....	300 %
ASTM D 1708, Transverse direction of billet	
Compressive Stress at 70 % Strain, min. ....	20 ksi (138 MPa)
ASTM D 695, Longitudinal direction of billet	

### 3.2 Reference Properties

Flexular Modulus .....	97 ksi (670 MPa)
ASTM D 790	
Coefficient of Friction	
Static. ....	0.08
Dynamic.....	0.16

**ENGINEERING SPECIFICATION****FIBERGLASS FILLED(REINFORCED) PTFE, -75 TO 500 DEG F, 60  
DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1086578	13-AUG-84	MALIGAS	STODDARD	RELEASED

Summary: This material is polytetrafluoroethylene (PTFE) reinforced with 25% fiberglass.

## 1.0 MATERIAL

This material is polytetrafluoroethylene (PTFE) reinforced with 25% fiberglass. The glass filling is intended to improve wear resistance but increase abrasion slightly. The trade names for this material are "Glass Filled Teflon ®" or "Reinforced Teflon ®".

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class.....AA to HH

API 6A, Table 302.2 and Table G1  
Temperature Class.....K to X

Temperature Rating.....-75 to 500°F

#### 2.1.2 Pressure Limits:

Pressure limitation.....20,000 psi

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes
Steam	yes

**3.0 MATERIAL PROPERTIES****3.1 Mechanical Properties**

Hardness, Shore D.....62 ± 5 pts  
ASTM D785

Tensile Strength, min.....2,400 psi  
ASTM D1708

Elongation, min.....250%  
ASTM D1708

Flexular Modulus, min.....1.9 x 10<sup>5</sup> psi  
ASTM D790

Specific Gravity.....2.22 ± .05  
ASTM D792 Method A

**Coefficient of Friction**

Static.....0.07

Dynamic.....0.12

\*\*\* END OF DOCUMENT \*\*\*

**PTFE, 15 PERCENT GLASS FIBER AND 5 PERCENT MOLY FILLED  
GRADE, NORSOK COMPLIANT**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
L	1166879	13-DEC-2010	Jones, Warren	Coles, Michael	RELEASED

## Summary:

This specification is for PTFE filled nominally with 15 % glass fiber and 5 % molybdenum disulfide. PTFE is the common name for polytetrafluoroethylene.

The following have been designated as critical and require NORSOK M-710 compliance:

UV Stem Packings (V-Ring & Jacket of Metal Spring Energized U-Cup Seal)

Face Seal Rings in Seat Assemblies of Gate Valves

They are compliant when their components are produced to this specification using the approved materials. Parts other than these calling for this specification do not require compliance.

## 1.0 Scope

PTFE is the common name for polytetrafluoroethylene. This specification is for PTFE reinforced with 15 +/- 1 % by weight glass fiber and 5 +/- 1 % by weight molybdenum disulfide. Parts are made from a billet that has been compression or isostatically molded and then sintered.

The following have been designated as critical and require Norsok M-710 compliance:

- UV Stem Packings (V-Ring & Jacket of Metal Spring Energized U-Cup Seal)
- Face Seal Rings in Seat Assemblies of Gate Valves

They are compliant when their components are produced to this specification using the approved materials. Parts other than these calling for this specification do not require compliance.



**Approved vendors, plants and materials depend on whether component is part of a critical seal requiring Norsok M-710 Compliance. See Section 4.0 for explanation.**

### NOTE

## 2.0 Service Compatibility

### 2.1 API 6A Limits

API 6A, Table F.2, Test Fluid Class ..... HH  
API 6A, Table 3, Material Class ..... AA to HH  
API 6A, Table 2 and Table G.1, Temperature Class ..... K to X  
Nominal Temperature Rating\* ..... -75 to 350 °F (-60 to 177 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons .....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas .....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines .....	Yes
Chlorides .....	Yes
HCL, Hydrochloric Acid .....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	Yes
Steam .....	Yes
Oxygen .....	Yes

## 3.0 Material Properties

### 3.1 Mechanical & Physical Properties

Specific Gravity .....	2.26 +/- .05
ASTM D 4745 or ASTM D 792, Method A (Report for each batch)	
Hardness .....	63 +/- 5 pts.
ASTM D 2240, Shore D, maximum reading (Report for each batch)	
Tensile Strength, min. ....	2,000 psi (13.8 MPa)
ASTM D 4745 or ASTM D 1708, Transverse direction of billet (Report for each batch)	
Tensile Elongation, min. ....	200 %
ASTM D 4745 or ASTM D 1708, Transverse direction of billet (Report for each batch)	
Compressive Strength, min. ....	3,000 psi (20.7 MPa)
ASTM D 695, Longitudinal direction of billet	

### 3.2 Material Testing & Reporting Requirements

Select properties in Section 3.1 are to be reported for each production batch. They are designated "(Report for each batch)". A minimum of 3 samples is required for each property. Reports shall include results, plus specification limits and are to be kept on file by the vendor for a minimum of five years.

## 4.0 Vendors, Plants & Materials

### 4.1 Approved Vendors For Components in Critical Seals Requiring Norsok M-710 Compliance

Of the seal types utilizing this material, UV Stem Packings and Face Seal Rings in the Seat Assemblies of Gate Valves have been designated as critical. Norsok M-710 compliance is therefore required of the components in these seal assemblies. See Table 1 for approved vendors and plants. Material from these vendors has been determined to be Norsok M-710 compliant with FMC's specification. All other components in seal types and other parts utilizing this material do not require Norsok M-710 compliance.

Table 1: Approved Vendors F/ Components in Critical Seals Requiring Norsok M-710 Compliance

Seal Name	Component in Seal	Approved Vendor(s)	Material Designation	Plant(s)
UV Stem Packing Face Seal Ring	V-Ring	AccuSeal, a Division of Utex Industries	AccuSeal AC-130N	4330 Brittmoore Road, Houston, TX, U.S.A.
	MSE U-Cup Seal			
	N/A			
UV Stem Packing Face Seal Ring	V-Ring	FAST – Houston CDI Seals	PTFE 702	8103 Rankin Road, Humble, TX, U.S.A.
	MSE U-Cup Seal			
	N/A			
UV Stem Packing Face Seal Ring	V-Ring	Saint Gobain Performance Plastics	Fluoroloy A33	7301 Orangewood Avenue, Garden Grove, CA, U.S.A
	MSE U-Cup Seal			Heiveldekens 22, Kontich, Belgium
	N/A			

Note: One-time material property test results are documented in Test Report [RPT10034510](#).



#### NOTE

The identification of a vendor in Table 1 as approved for a given part must be consistent with the requirements on a part or assembly DBI. In other words, if a part or assembly DBI specifically identifies a vendor or vendors as being approved exclusive of others, the DBI takes precedence.



## **4.2 Possible Vendors For Components in Non-Critical Seals & Other Parts Not Requiring Norsok M-710 Compliance**

Components in non-critical seal types and other parts utilizing this material do not require Norsok M-710 compliance. See above section for seals identified by FMC as critical. Other vendors and their material designations may be used if their molding, heat treatment and material property specifications meet the requirements of this specification.

**ENGINEERING SPECIFICATION**

**PTFE FILLED WITH 50 PERCENT 316 SS, -75 TO 400 DEG F, 70  
DUROMETER**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
D	1086578	21-NOV-84	MALIGAS	STODDARD	RELEASED

Summary: This material is polytetrafluoroethylene (PTFE) filled with 50%  $\pm$  1% by weight nickel chrome (316 SS).

## 1.0 MATERIAL

This material is polytetrafluoroethylene (PTFE) filled with 50%  $\pm$  1% by weight nickel chrome (316 SS). Parts may be compression molded. Seal configurations include: back up rings, non-extrusion rings, and bearings.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class .....AA to HH

API 6A, Table 302.2 and Table G1  
Temperature Class..... K to X

Temperature Rating.....-75 to 400(F

#### 2.1.2 Pressure Limits:

Pressure limitation..... 25,000 psi

### 2.2 Chemical Compatibility

H2O, Water	yes
Hydrocarbons	yes
CH4, Methane	yes
N2, Nitrogen Gas	yes
CO2, Carbon Dioxide	yes
H2S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes
H2SO4, Sulfuric Acid	yes
H2CO3, Carbonic Acid	yes
O2, Oxygen	yes
Steam	yes

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties

Hardness, Shore D.....70 ± 5 pts  
ASTM D638

Elongation, min.....200%  
ASTM D1708

Mold Direction Tensile, min.....2,000 psi  
ASTM D1457

Cross Direction Tensile, min.....2,500 psi  
ASTM D695

Specific Gravity.....3.75 ± .03  
ASTM D792 Method A

**\*\*\* End of Document \*\*\***

**PTFE, 25 PERCENT CARBON/GRAPHITE FILLED GRADE, NORSOK  
COMPLIANT**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
M	1157013	17-AUG-2010	Wolff, Geoff	Jones, Warren	RELEASED

## Summary:

This specification is for PTFE filled nominally with 25 % carbon and graphite. PTFE is the common name for polytetrafluoroethylene.

UV Stem Packings have been designated as critical and their Backup V-Rings require NORSOK M-710 compliance. They are compliant when produced to this specification using the approved materials. Parts other than these calling for this specification do not require compliance.

## 1.0 Scope

PTFE is the common name for polytetrafluoroethylene. This specification is for PTFE reinforced with 25 +/- 1 % by weight carbon and graphite. Parts are made from a billet that has been compression or isostatically molded and then sintered.

UV Stem Packings have been designated as critical and their Backup V-Rings require NORSOK M-710 compliance. They are compliant when produced to this specification using the approved materials. Parts other than these calling for this specification do not require compliance.



**Approved vendors, plants and materials depend on whether component is part of a critical seal requiring NORSOK M-710 Compliance. See Section 4.0 for explanation.**

### NOTE

## 2.0 Service Compatibility

### 2.1 API 6A Limits

API 6A, Table F.2, Test Fluid Class ..... HH  
API 6A, Table 3, Material Class ..... AA to HH  
API 6A, Table 2 and Table G.1, Temperature Class ..... K to X  
Nominal Temperature Rating\* ..... -75 to 350 °F (-60 to 177 °C)

\* Nominal temperature range is given for reasonable long term material property retention. Actual temperature performance of sealing systems using this material is not defined by rating provided above. Performance is determined by a combination of sealing conditions (applied stresses and chemical exposures), material selection, and seal / gland design. Seal system performance ratings are proven only through pressure, temperature, environmental, and cyclic testing to the appropriate industry protocols.

## 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons .....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides .....	Yes
HCL, Hydrochloric Acid.....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	Yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	Yes
Steam .....	Yes
Oxygen .....	Yes

## 3.0 Material Properties

### 3.1 Mechanical & Physical Properties

Specific Gravity .....	2.06 +/- .08
ASTM D 4745 or ASTM D 792, Method A (Report for each batch)	
Hardness .....	65 +/- 5 pts.
ASTM D 2240, Shore D, maximum reading (Report for each batch)	
Tensile Strength, min. ....	1,700 psi (11.7 MPa)
ASTM D 4745 or D 1708, Transverse direction of billet (Report for each batch)	
Elongation, min. ....	60 %
ASTM D 4745 or D 1708, Transverse direction of billet (Report for each batch)	
Compressive Strength, min. ....	3,000 psi (20.7 MPa)
ASTM D 695, Longitudinal direction of billet	

### 3.2 Material Testing & Reporting Requirements

Select properties in Section 3.1 are to be reported for each production batch. They are designated "(Report for each batch)". A minimum of 3 samples is required for each property. Reports shall include results, plus specification limits and are to be kept on file by the vendor for a minimum of five years.

## 4.0 Vendors, Plants & Materials

### 4.1 Approved Vendors For Components in Critical Seals Requiring Norsok M-710 Compliance

Of the seal types utilizing this material, UV Stem Packings have been designated as critical. Norsok M-710 compliance is therefore required of the components in these seal assemblies. See Table 1 for approved vendors and plants. Material from these vendors has been determined to be Norsok M-710 compliant with FMC's specification. All other components in seal types and other parts utilizing this material do not require Norsok M-710 compliance.

Table 1: Approved Vendors F/ Components in Critical Seals Requiring Norsok M-710 Compliance

Seal Name	Component in Seal	Approved Vendor(s)	Material Designation	Plant(s)
UV Stem Packing	Backup V-Ring	AccuSeal, a Division of Utex Industries	AccuSeal AC-124	4330 Brittmoore Road, Houston, TX, U.S.A.
		FAST – Houston CDI Seals	PTFE 711	8103 Rankin Road, Humble, TX, U.S.A.
		Saint Gobain Performance Plastics	Fluoroloy A34	7301 Orangewood Avenue, Garden Grove, CA, U.S.A
				Heiveldekens 22, Kontich, Belgium

Note: One-time material property test results are documented in Test Report [RPT10034510](#).



#### NOTE

The identification of a vendor in Table 1 as approved for a given part must be consistent with the requirements on a part or assembly DBI. In other words, if a part or assembly DBI specifically identifies a vendor or vendors as being approved exclusive of others, the DBI takes precedence.

### 4.2 Possible Vendors For Components in Non-Critical Seals & Other Parts Not Requiring Norsok M-710 Compliance

Components in non-critical seal types and other parts utilizing this material do not require Norsok M-710 compliance. See above section for seals identified as critical. Other vendors and their material designations may be used if their molding, heat treatment and material property specifications meet the requirements of this specification.



**ENGINEERING SPECIFICATION****15 PERCENT GLASS FIBER AND 5 PERCENT MOLY REINFORCED  
PTFE, -75 TO 350 DEG F (NON-NORSOK COMPLIANT VERSION OF  
E55503)**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1086818	19-Aug-03	Albor, Gabriel	Janoff, Dwight	RELEASED

**Summary:**

PTFE is the common name for polytetrafluoroethylene. This specification is for PTFE reinforced with 15 +/- 1% by weight glass fiber and 5 +/- 1% by weight molybdenum disulfide. Parts may be made by injection or compression molding and then machining. UV Stem Packing V-Rings and Lip Seals as well as Gate Valve Seat Face Seal Rings produced to this specification are compliant with the requirements of NORSOK M-710, Rev 2, and dated May 2001. Products other than UV Stem Packing V-Rings and Lip Seals as well as Gate Valve Seat Face Seal Rings are not necessarily compliant. Parts made using this specification will not be NORSOK M-710 compliant.

## 1.0 SCOPE

PTFE is the common name for polytetrafluoroethylene. This specification is for PTFE reinforced with 15 +/- 1% by weight glass fiber and 5 +/- 1% by weight molybdenum disulfide. Parts may be made by injection or compression molding and then machining. UV Stem Packing V-Rings and Lip Seals as well as Gate Valve Seat Face Seal Rings produced to this specification are compliant with the requirements of NORSOK M-710, Rev 2, dated May 2001. Products other than UV Stem Packing V-Rings and Lip Seals as well as Gate Valve Seat Face Seal Rings are not necessarily compliant. Parts made using this specification will not be NORSOK M-710 compliant.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class .....	K to X
Temperature Rating .....	-75 to 350° F

Note: This does not necessarily take into consideration the results of API 6A, Appendix F, Testing or Life Estimation Testing of Seals.

#### 2.1.2 Pressure Limits:

Pressure Limitations..... 25,000 psi

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide.....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes

H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes
Steam .....	Yes
Oxygen.....	Yes

### 3.0 MECHANICAL AND PHYSICAL PROPERTIES

Softening Point .....	>500° F
ASTM D 1525, Rate A	
Specific Gravity .....	2.26 +/- .05
ASTM D 792, Method A (Report for each batch)	
Hardness .....	63 +/- 5 pts.
ASTM D 2240, Shore D (Report for each batch)	
Tensile Strength, min. ....	2,000 psi
ASTM D 1708, longitudinal direction of billet	
Tensile Elongation, min. ....	200%
ASTM D 1708, longitudinal direction of billet	
Compressive Strength, min. ....	3,000 psi
ASTM D 695, longitudinal direction of billet	

### 4.0 APPROVED VENDORS AND MATERIALS

Saint Gobain (Furon) .....	Fluoroloy 06 per MSD 1007
CDI: .....	PTFE 702

Other vendor material designations are also approved if their material property specifications meet the requirements of this specification.

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****25 PERCENT CARBON/GRAPHITE FILLED PTFE, -75 TO 250 DEG F  
(NON-NORSOK COMPLIANT VERSION OF E55505)**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1086818	19-Aug-03	Albor, Gabriel	Janoff, Dwight	RELEASED

## Summary:

PTFE is the common name for polytetrafluoroethylene. This specification is for PTFE reinforced with 25 +/- 1% by weight carbon/graphite fiber. Parts may be made by injection or compression molding and then machining. UV Stem Packing Backup V-Rings produced to this specification are compliant with the requirements of NORSOK M-710, Rev. 2, and dated May 2001. Products other than UV Stem Packing Backup V-Rings are not necessarily compliant. Parts made using this specification will not be NORSOK M-710 compliant.

## 1.0 SCOPE

PTFE is the common name for polytetrafluoroethylene. This specification is for PTFE reinforced with 25 +/- 1% by weight carbon/graphite fiber. Parts may be made by injection or compression molding and then machining. UV Stem Packing Backup V-Rings produced to this specification are compliant with the requirements of NORSOK M-710, Rev. 2, and dated May 2001. Products other than UV Stem Packing Backup V-Rings are not necessarily compliant. Parts made using this specification will not be NORSOK M-710 compliant.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class .....	K to U
Temperature Rating .....	-75 to 250° F

#### 2.1.2 Pressure Limits:

Pressure Limitations .....	25,000 psi
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Note: This does not necessarily take into consideration the results of API 6A, Appendix F, Testing or Life Estimation Testing of Seals.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide.....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes
Steam .....	Yes
Oxygen.....	Yes

### 3.0 MECHANICAL AND PHYSICAL PROPERTIES

Softening Point .....	>500 °F
ASTM D 1525, Rate A	
Specific Gravity .....	2.08 +/- .05
ASTM D 792, Method	
Hardness .....	65 +/- 5 pts.
ASTM D 2240, Shore D	
Tensile Strength, min.....	1,700 psi
ASTM D 1708, longitudinal direction of billet	
Elongation, min. ....	60%
ASTM D 1708, longitudinal direction of billet	
Compressive Strength, min.....	3,000 psi
ASTM D 695, longitudinal direction of billet	

### 4.0 APPROVED VENDORS AND MATERIALS

Saint Gobain (Furon) .....	Fluoroloy 20 per MSD 1006
CDI: .....	PTFE 711

Other vendor material designations are also approved if their material property specifications meet the requirements of this specification.

### 5.0 APPENDIX – REFERENCE ONLY

Coefficient of Linear Thermal Expansion .....	$7.0 \times 10^{-5} \text{ }^{\circ}\text{F}^{-1}$
78°F to 400°F, ASTM D 696	

\*\*\* END OF DOCUMENT \*\*\*

**ENGINEERING SPECIFICATION****10 PERCENT CARBON/GRAPHITE FILLED PTFE, -75 TO 350 DEG F  
(NON-NORSOK COMPLIANT VERSION OF E50132)**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1086818	19-Aug-03	Albor, Gabriel	Janoff, Dwight	RELEASED

## Summary:

PTFE is the common name for polytetrafluoroethylene. This specification is for PTFE blended with 10 +/- 2% by weight carbon and graphite. Parts may be made from a billet that has been extruded or auto, isostatically, or compression molded and then sintered. However, parts made using this specification will not be NORSOK M-710 compliant.

## 1.0 SCOPE

PTFE is the common name for polytetrafluoroethylene. This specification is for PTFE blended with 10 +/- 2% by weight carbon and graphite. Parts may be made from a billet that has been extruded or auto, isostatically, or compression molded and then sintered. However, parts made using this specification will not be NORSOK M-710 compliant.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class .....	K to X
Temperature Rating .....	-75 to 350° F

#### 2.1.2 Pressure Limits:

Pressure Limitations .....	25,000 psi
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Note: This does not necessarily take into consideration the results of API 6A, Appendix F, Testing or Life Estimation Testing of Seals.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons.....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide.....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides.....	Yes
HCl, Hydrochloric Acid.....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid .....	Yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid.....	Yes
Steam .....	Yes
Oxygen.....	Yes



### 3.0 MECHANICAL AND PHYSICAL PROPERTIES

Softening Point .....	>500 °F
ASTM D 1525, Rate A	
Specific Gravity .....	2.13 +/- .05
ASTM D 792, Method	
Hardness .....	58 +/- 5 pts.
ASTM D 2240, Shore D	
Tensile Strength, min.....	2,600 psi
ASTM D 1708, longitudinal direction of billet	
Elongation, min. ....	200%
ASTM D 1708, longitudinal direction of billet	
Compressive Strength, min.....	3,000 psi
ASTM D 695, longitudinal direction of billet	

### 4.0 APPROVED VENDORS AND MATERIALS

Saint Gobain (Furon) .....	Fluoroloy SL per MSD 1048
CDI: .....	PTFE 734

Other vendor material designations are also approved if their material property specifications meet the requirements of this specification.

\*\*\* END OF DOCUMENT \*\*\*

**PTFE, 5 PERCENT MOLY FILLED GRADE**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	1103521	01-NOV-2005	Jones, Warren	Parrish, John	RELEASED

## Summary:

PTFE is the common name for polytetrafluoroethylene. This specification is for PTFE blended with nominal 5% by weight natural molybdenum disulfide. Parts may be made from a billet that has been extruded or auto, isostatically, or compression molded and then sintered.

## 1.0 SCOPE

PTFE is the common name for polytetrafluoroethylene. This specification is for PTFE blended with nominal 5% by weight natural molybdenum disulfide. Parts may be made from a billet that has been extruded or auto, isostatically, or compression molded and then sintered.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1, Test Fluid Class .....	HH
API 6A, Table 302.3, Material Class .....	AA to HH
API 6A, Table 302.2 and Table G1, Temperature Class .....	K to X
Temperature Rating .....	-75 to 350° F

#### 2.1.2 Pressure Limits:

Pressure Limitations .....	15,000 psi
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Note: The above API pressure and temperature limits do not necessarily take into consideration the results of API 6A, Appendix F, Testing or Life Estimation Testing of Seals.

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water .....	Yes
Hydrocarbons .....	Yes
CH <sub>4</sub> , Methane .....	Yes
N <sub>2</sub> , Nitrogen Gas.....	Yes
CO <sub>2</sub> , Carbon Dioxide .....	Yes
H <sub>2</sub> S, Hydrogen Sulfide .....	Yes
Amines.....	Yes
Chlorides .....	Yes
HCl, Hydrochloric Acid.....	Yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid.....	Yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid .....	Yes
Steam .....	Yes
Oxygen .....	Yes

### 3.0 MECHANICAL AND PHYSICAL PROPERTIES

Specific Gravity .....	2.1 +/- .1
ASTM D 4745 and ASTM D 792, Method A	
Hardness .....	60 +/- 5 pts.
ASTM D 2240, Shore D, maximum reading	
Tensile Strength, min. ....	2,500 psi
ASTM D 4745	
Elongation, min. ....	250%
ASTM D 4745	

**\* \* \* END OF DOCUMENT \* \* \***

**ENGINEERING SPECIFICATION**

**ETFE, GLASS FILLED, -100 TO 400 DEG F**

Rev	ECN No.	Date	Reviewed By	Approved By	Status
E	1086578	27-AUG-84	MALIGAS	STODDARD	RELEASED

Summary: ETFE resins are copolymers of ethylene and tetrafluoroethylene.

ONLY TO BE USED IN PRESSURES < 10000 PSI.

## 1.0 MATERIAL

ETFE resins are copolymers of ethylene and tetrafluoroethylene. This compound is 25%  $\pm$  1% by weight glass reinforced. Seal configurations include: back up rings and anti-extrusion rings.

## 2.0 SERVICE COMPATIBILITY

### 2.1 API 6A, Temperature, and Pressure Compatibility

#### 2.1.1 API and Temperature Limits:

API 6A, Appendix F, Table F114.1,  
Test Fluid Class.....HH

API 6A, Table 302.3,  
Material Class.....HH

API 6A, Table 302.2 and Table G1  
Temperature Class.....K to X

Temperature Rating.....-100 to 400°F

#### 2.1.2 Pressure Limits:

Pressure limitations.....10,000psi

### 2.2 Chemical Compatibility

H <sub>2</sub> O, Water	yes
Hydrocarbons	yes
CH <sub>4</sub> , Methane	yes
N <sub>2</sub> , Nitrogen Gas	yes
CO <sub>2</sub> , Carbon Dioxide	yes
H <sub>2</sub> S, Hydrogen Sulfide	yes
Amines	yes
Chlorides	yes
HCl, Hydrochloric Acid	yes
H <sub>2</sub> SO <sub>4</sub> , Sulfuric Acid	yes
H <sub>2</sub> CO <sub>3</sub> , Carbonic Acid	yes
O <sub>2</sub> , Oxygen	yes
Steam	yes, limited

### 3.0 MATERIAL PROPERTIES

#### 3.1 Mechanical Properties:

Hardness, Shore D.....	70 ± 5 pts
ASTM D638	
Tensile Strength, min. ....	12,000psi
ASTM D638	
Elongation, min.....	8%
ASTM D638	
Impact Strength.....	9.0 ft-lb/in
ASTM D256	
Specific Gravity.....	1.86 ± .05
ASTM D792 Method A	
Compression Strength, min.....	10,000 psi
ASTM D695	
Heat Deflection Temp, min.....	410°F (210°C)
ASTM D256	

\*\*\* End of Document \*\*\*