ERIKS Sealing Technology

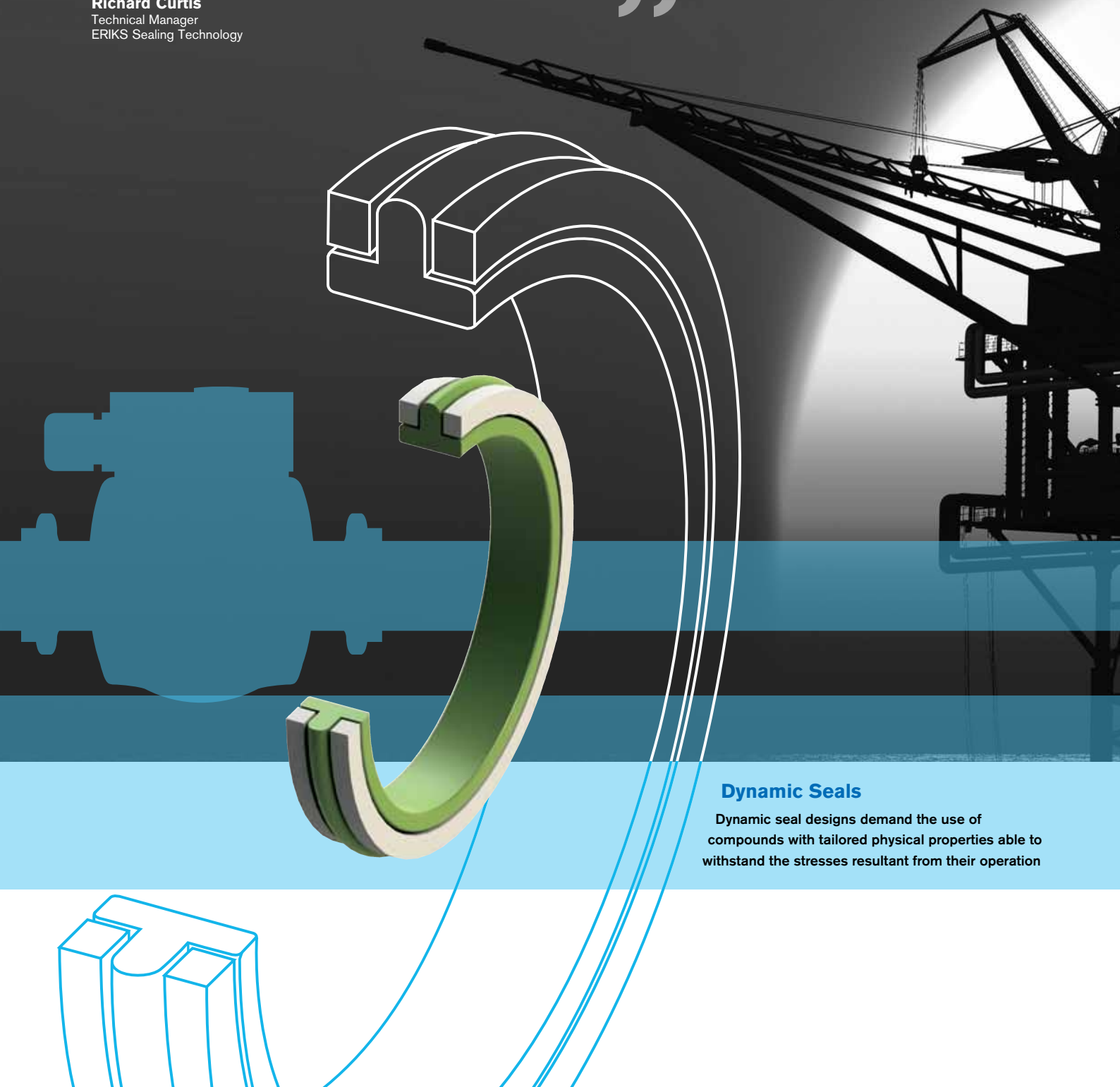
Engineered Polymer Solutions for Oil & Gas Applications

know-how makes the difference

ERIKS

> **Oil and Gas applications present the most extreme conditions in which seals are expected to operate. Mechanical, thermo-chemical and fluid phase conditions must be accommodated to maintain the integrity of the seal in these, often safety critical, uses.**

Richard Curtis
Technical Manager
ERIKS Sealing Technology



Dynamic Seals

Dynamic seal designs demand the use of compounds with tailored physical properties able to withstand the stresses resultant from their operation

Contents

Comprehensive Sealing

With locations and dedicated application engineers based at all of the major global oil and gas industry hubs, ERIKS Sealing Technology is an ideal partner to service your sealing requirements.

Boasting cutting edge technology centres in the UK and USA, ERIKS Sealing Technology operates at the forefront of material science, developing new and tightly controlled, qualified compounds.

Experienced application engineers draw upon in-depth technical knowledge to ensure that the optimal seal is impartially specified for your application; whether this is a standard product from our premium manufacturers, or as a bespoke solution tailored to your needs.

ERIKS design teams work closely with our material scientists to produce accurate materials data upon which our non-linear finite element analyses are based, to minimise design iterations in successfully satisfying your application.

We use the latest 3D CAD to capture design intent, which is verified using our contact and non-contact CMM equipment.

Full traceability of product and batch data per NORSOK M710 requirements is available. We hold ISO 9001:2008 certification across both of the UK sealing core competence centres and throughout our FPAL accredited distribution network, for your peace of mind.

We work closely with premium manufacturers to provide market specific stock profiles and can offer logistical solutions including direct supply, managed inventory, or on-site integrated supply; available via our extensive branch network.

O-rings manufactured from our speciality polymers are also available as components in both our Econ® and other valves via Econosto.

ERIKS' focus on five core activities:

- **Sealing technology**
- **Power transmission, including electromechanical services and condition monitoring**
- **Flow technology**
- **Industrial plastics**
- **Tools and maintenance products**

These products are supported by advanced technical and logistics services that form the link between our know-how and your reliability.

Stock Availability

As Europe's largest stockholder of sealing and associated products, you are assured of the highest levels of availability to keep your operation working.

We hold extensive stocks of O-rings in elastomer compounds suitable for both general purpose and high pressure operation, that may be despatched same-day to meet your requirements.

O-rings are available in AS568, BS1806, BS4518 and ISO 3601, sizes together with Hydraulic Seals, Back-up Rings, Metal Face Seals, Mechanical and Rotary Seals.

Customer specific stock holding is our speciality. This maintains continuity of supply, including specific qualified products that we would not otherwise hold. Our advanced logistics software helps us optimise customer specific stock to maximise availability yet minimise your capital exposure.

Support

- Dedicated office based technical support staff and customer service
- Field based Sealing Technology application engineers and specialists
- Excellent technical support from skilled research and development engineers
- 24-hour call out service available

Global Network - Local to you

Our global network of Service Centres includes 70 UK locations and 25 UK Repair Workshops. This ensures our product and application know how is readily available, to provide support 24/7.

Our local teams have a direct line to all the technical support you may need along with visibility of our own stocks and those of our supply partners.

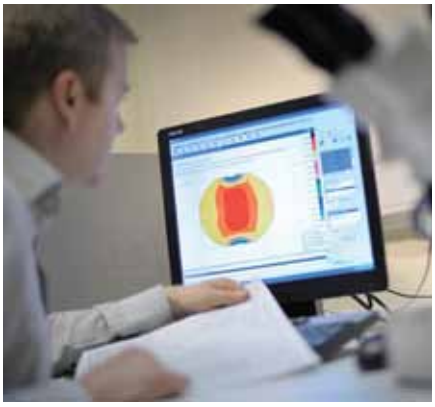
Test and Validation

In an environment dedicated to innovation and free thought, our highly talented design team work with the latest 3D CAD tools to capture design intent with your teams. This technology proves an invaluable tool in communicating and developing conceptual solutions involving co-engineering partnerships, as we can share 3D data in many standard formats including IGES and STEP. Comprehensive change control and configuration management techniques are used to ensure that the design intent is fully embodied into the finished product; with our combined visual and CMM dimensional inspection system being programmed from the original 3D CAD model.

Finite Element Analysis (FEA)

To improve design integrity and efficiency, we use FEA as a mathematical technique to predict: deflection (strain), stress, reaction force and contact pressure. These are based on dimensional information, physical constraints and material properties.

Our Materials Technology Centre can generate temperature specific, validated, hyper-elastic material models, on which to base these analyses. FEA then allows our engineers to rapidly iterate to optimal design solutions, minimising product development time and cost, reducing time to market.



Testing:
In house application capabilities include:

High volume - High pressure gas:
10,000psi gaseous media
Hydro-testing up to pressure class 300
Hydro-testing up to pressure class 2500
Nitrogen Gas (N_2) Test media system –
Ambient temperature gas testing up to pressure class 2500

Low volume – high pressure to 25000psi
Low pressure valve seat and seal testing

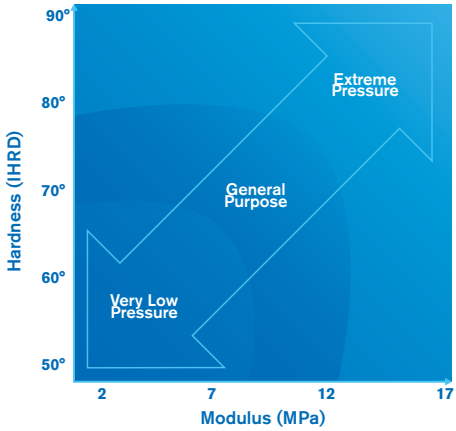
Pressure Guidelines

Sealing of extreme pressure applications typically requires robust high modulus, high hardness materials. On the contrary, elastomers with a reduced hardness and lower modulus are more compliant and complement lower pressure sealing applications.

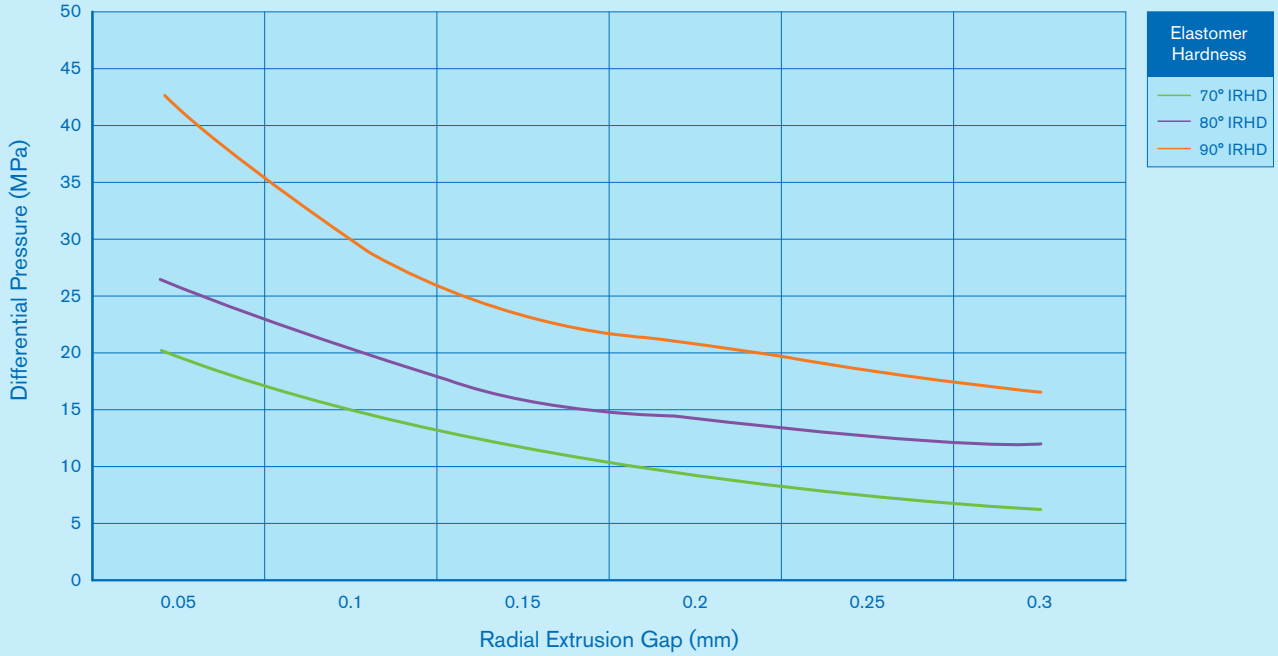
It is normal practice to specify elastomers with a high hardness for high pressure applications. With the vast array of elastomeric compounds and formulations available today, it is possible to utilise materials with a relatively low hardness and relatively high modulus.

Rules to Determine Elastomeric Material Selection

Low hardness and low modulus elastomers complement lower pressure sealing applications. Extreme pressure applications require materials that are robust, with high modulus and high hardness.



O-ring Pressure Capability



Contact ERIKS for assistance in selecting the correct solution for your high pressure application.

At high pressures, above 10MPa, it is typical to use an O-ring in conjunction with either one or two Back-up rings, or to use high performance seal designs such as T-Seals.

Groove Design

Groove Standards

As experts in seal design we recognise that there are a number of international standards used to specify O-Rings into grooves.

AS5857 and AS4716 detail grooves suitable for use with AS568 O-Rings for static and dynamic applications, respectively. All three standards are governed by the US Society of Automotive Engineers and are available from www.sae.org. AS4716 supersedes the popular MIL-G-5514 for dynamic applications.

BS1806 and BS4518 are the British Standards for Imperial and Metric sizes respectively. BS1806 has now been withdrawn and has been replaced by ISO3601, however the recommended groove dimensions differ between the two.

ISO3601 is a comprehensive standard for imperial sizes. However care should be taken when specifying dynamic locations as use of this standard may result in unnecessary machining and AS4716 should be considered in its place.

Groove Design Considerations

Compression (Squeeze) – Compression is applied to an O-ring, which creates an initial seal. As differential pressure increases this is transmitted by the visco-elastic material, with the normal force increasing with pressure, maintaining the seal. There is no single correct initial percentage compression, as this will vary by application. Typically nominal compression levels are:
Face seals - 25%
Static piston / rod seals – 15%
(Lower at large cross section, higher at small cross section, governed by installation force)
Dynamic piston / rod seals – 12%

Increased squeeze may be used to increase high pressure performance; standard grooves should be used per the above except for pressures above 4000psi or where RGD (see below) will be seen. For advice on groove optimisation for such applications please contact our technical department.

Groove fill (Gland Occupancy)

To ensure pressure energisation of the seal for high pressure operation the O-ring should not reach 100% gland occupancy. Typical nominal occupancy levels would be 75% and with the standards taking account of differential rates of thermal expansion, chemical swell and tolerance stack-up.

Stretch

O-rings are typically stretched into piston grooves to overcome tolerance stack-up and ensure correct assembly. Rod applications typically interfere on the outside diameter, although stretch may be applied this is always in a constrained state.

Design for Rapid Gas Decompression (Explosive Decompression)

The adverse effects of rapid gas decompression may be mitigated through both correct compound selection and appropriate mechanical design. To allow dissolved gasses to rapidly permeate out from the seal, smaller cross section O-rings should be used. Use of 200 series, 3.53mm cross section, O-rings is typical. High groove fill and decreased squeeze may be used to minimise principal stresses generated during Rapid Gas Decompression (RGD) and hence increase resistance. For advice on groove optimisation for such applications please contact our technical department.

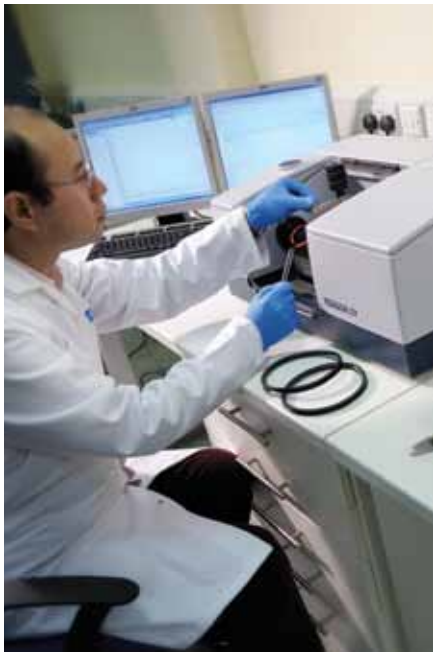
Material Technology Centre

ERIKS Material Technology Centre is a testimony to our commitment to the highest level of product quality and customer satisfaction possible.

Situated in Warrington, in the UK, this facility benefits from continuous investment in technology and people and is one of the major factors in ERIKS Sealing Technology's success. The Material Technology Centre's principal activities are to ensure our high quality standards are maintained and to develop new compounds or technical solutions for your applications.

Capabilities:

- Hardness (°IRHD/Shore A)
- Compression-set
- Mechanical property testing
- Chemical and heat ageing
- Ozone resistance
- Material composition
- Dimensional measurements
- Surface defects
- Material properties at temperatures from –70°C to 300°C
- Wet bench analysis
- Extraction testing
- Failure analysis
- Hyper elastic material characterisation
- Immersion testing

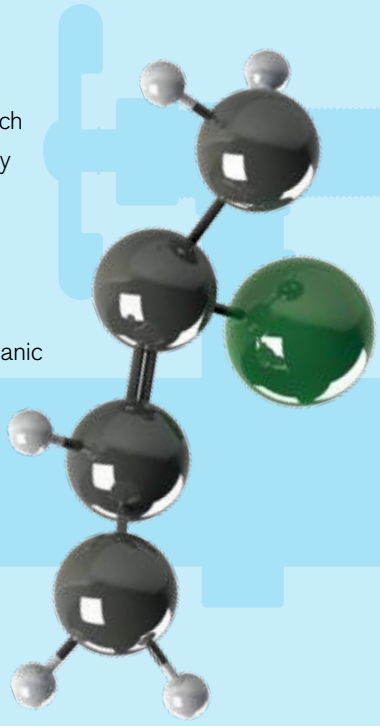


Fourier Transform Infra-red Spectroscopy (FTIR)

Molecules have specific frequencies at which they naturally rotate or vibrate.
By exposing a material sample to a spectrum of infra-red frequencies the equipment can identify which molecules are present by detecting which frequencies are absorbed. This technique is used to identify the base polymers material type in quality control and to identify thermo-chemical decomposition.

Thermo-Gravimetric Analysis (TGA)

TGA is used to identify weight loss of a compound either isothermally over time or over a ramped temperature range. The relative composition of compounds can be identified, to quantify polymer, organic and inorganic filler contents and types.



Differential Scanning Calorimetry (DSC)

DSC analysis measures changes in enthalpy (exothermic or endothermic energy changes) over time, or, with changes in temperature. DSC analysis can be used as a quality tool (residual cure), an analytical tool (failure analysis), or in development of new materials (glass transition, oxidation etc).

With modulated DSC (MDSC), the samples are subjected to a non-linear heating/cooling regime (i.e. sinusoidal). This non-linear temperature profile allows the measurement of heat-capacity effects simultaneously with the kinetic effect, as well as increasing the sensitivity of the system. With the MDSC, overlapping events can also be separated, i.e. measurement of the Tg and molecular relaxation.

Elastomers

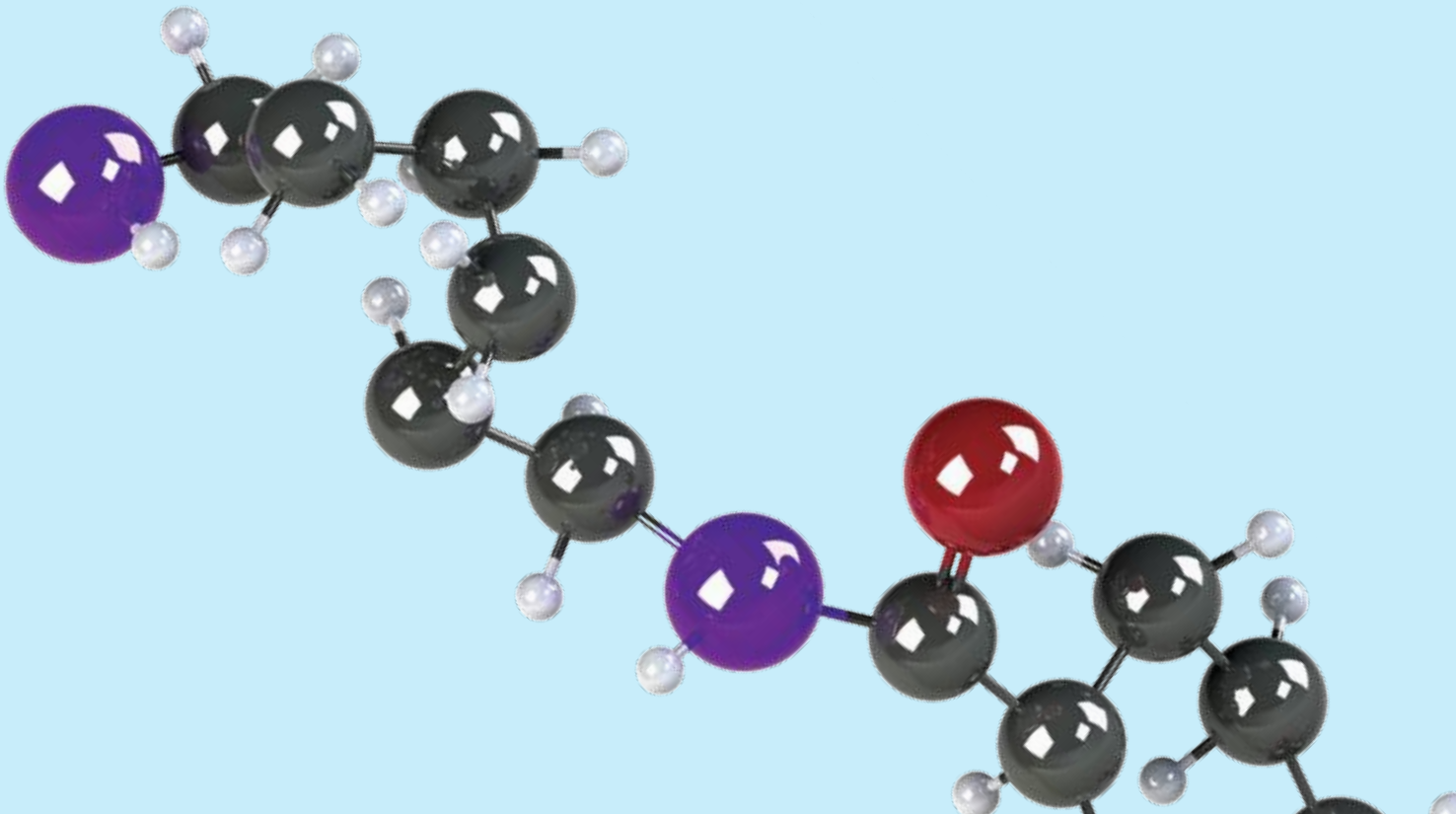
Elastomeric materials are described as having non linear, viscoelastic behaviour, this means that they exhibit elastic recovery, time dependant behaviour and the relationship between load and deflection is not linear.

Elastomers used in sealing are often described as compounds, meaning that they are a mixture of ingredients manufactured under specific conditions. A compound typically comprises:

- **Polymer backbone -** A long chain of molecules made up of one or more monomeric units, this governs basic thermal, chemical and physical properties of a compound. ISO and ASTM classifications define families of elastomer such as NBR, FKM etc.
- **Cross-link -** Polymer chains are tied together by cross links, short chains of molecules eg sulphur, to prevent chain slippage and create elastic behaviour. Different cross link systems will fundamentally change thermo-chemical or physical properties.
- **Fillers -** Organic or inorganic solid particles with specific shapes and chemistries that tailor physical properties such as tensile strength, hardness, elongation at break, modulus and compression-set.
- **Other ingredients** used to achieve specific manufacturing, application or cost requirements.

A typical HNBR 85 Shore A compound may have 20 ingredients and may contain only 30% polymer by weight.

Therefore it is important not just to specify the family of polymer backbone and hardness, but to specify an individual compound/grade in order to achieve consistent performance.



Nitrile (NBR)

Nitrile rubber, often referred to as Buna-N or NBR is the most commonly used elastomer in the sealing industry. It is a copolymer of two monomers: acrylonitrile (ACN) and butadiene. The properties of this elastomer are ruled by the ACN content, which is broken down into three general classifications:

High Nitrile:	**>45% ACN**
Medium Nitrile:	**30 – 45% ACN**
Low Nitrile:	**<30% ACN**

The higher the ACN content, the better the resistance to hydrocarbon-based fluids. With lower ACN content, the material offers better flexibility at low temperatures. Medium nitrile is, therefore, the most widely specified due to its good overall balance in most applications. Typically, nitrile rubber can be compounded to work over a temperature range of -35°C to 120°C and is superior to most other elastomers in regard to compression set, tear and abrasion resistance. Nitrile rubbers possess excellent resistance to oil-based fluids, greases, water and air.

Hydrogenated Nitrile (HNBR)

The properties of hydrogenated nitrile rubber (HNBR) are dependent upon the acrylonitrile content and degree of hydrogenation of the butadiene copolymer. They have better oil and chemical resistance than nitrile rubber, and can withstand higher temperatures. HNBR has excellent resistance to hot water, steam and ozone. Mechanical properties (e.g. tensile and tear strength, elongation, abrasion resistance, compression set etc.) are also excellent and compounds display strong dynamic behaviour at elevated temperatures.

HNBR can either be cured with sulphur or with peroxide, depending on which properties are the most important. Typical applications include O-rings and dynamic seals, and products where high tensile strength or abrasion resistance are needed, e.g. mud motors, rotary steerable tools, MWD/LWD etc. Limitations include poor electrical properties, poor flame resistance and swelling with aromatic oils.

Fluorocarbon Rubber (FKM, Viton®)

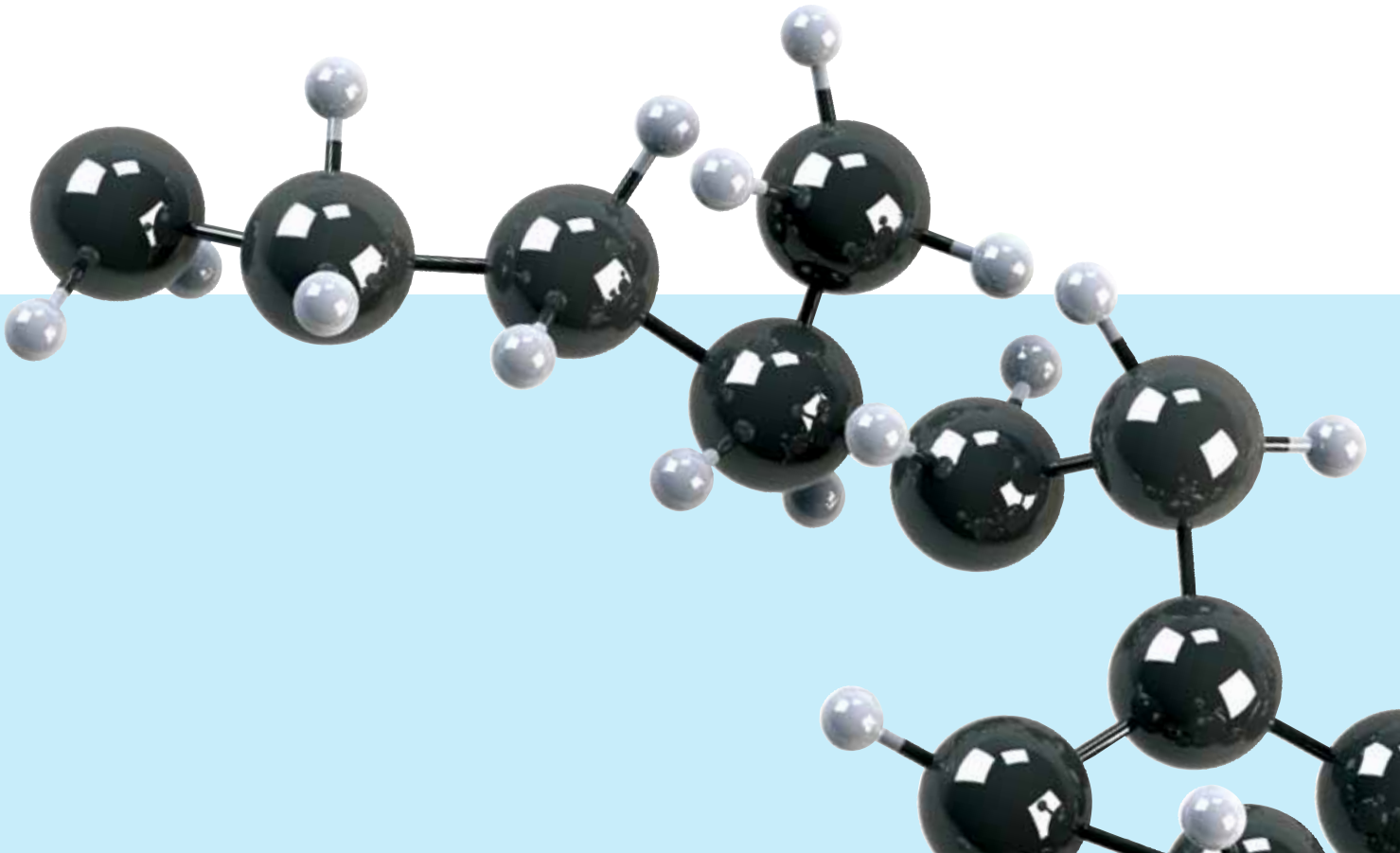
FKMs (sometimes known as FPMs in Europe) are frequently used to resist extreme temperatures and harsh chemicals. The strong carbon-fluorine bonds that make up the polymer structure provide high thermo-chemical resistance, giving excellent ageing characteristics shown by low compression set at elevated temperatures.

FKMs offer excellent resistance to mineral oils and greases, aliphatic, aromatic and some chlorinated hydrocarbons, fuels, silicone oils and greases. However FKMs show poor resistance to ethers, ketones, esters and amines.

FKMs are available as a copolymer (two monomers), terpolymer (three monomers) or as a tetrapolymer (four monomers). Each type determines both fluorine content and chemical structure which in turn significantly impact the chemical resistance and temperature performance of the polymer.

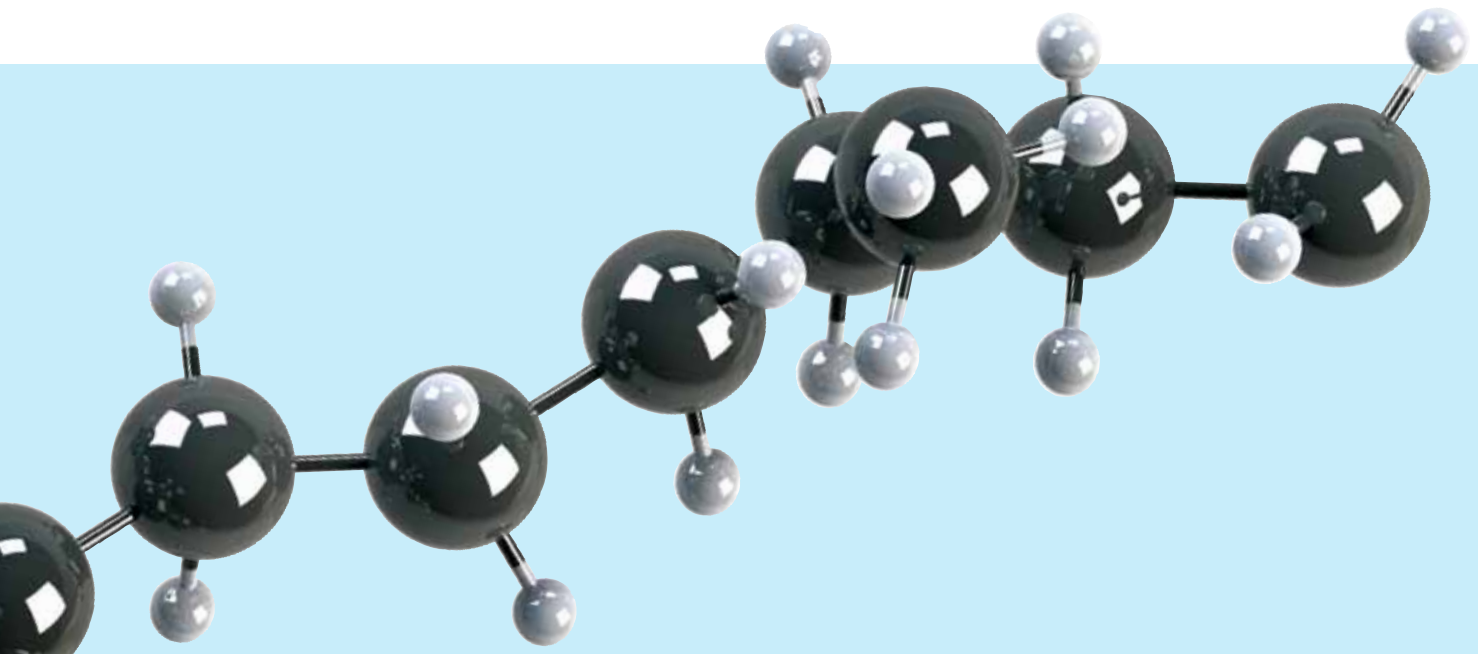
Also related to the chemical resistance of the different types of fluoroelastomer is the cure system utilised. Bisphenol cure systems are common with the copolymer family; this system is a condensation reaction, which can be reversed when exposed to steam, hot water etc. Reversion occurs typically above 150°C, however when specifying into application, terpolymers should be used above 120°C as unsaturated steam will super-heat when pressurised. Terpolymers or tetrapolymers are most commonly cured using peroxide based systems, which offer significant improvements in steam and water resistance. Such cure systems can also offer benefits for hydrogen sulfide (H_2S) exposure.

More recent innovations include the development of FKM materials for use in low temperature applications, where, with a glass transition of -40°C, it is possible to use FKMs down to -51°C in service. ERIKS 514322 brings true low temperature capabilities to chemically demanding and high temperature applications.

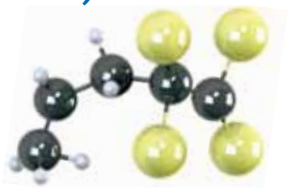


Types of Fluorocarbon Rubber

ASTM D1418 Designation	Common Name	Typical Cure System	Typical Fluorine Content	Description
Type 1	Viton® A	Bisphenol or amine	66%	General purpose with excellent mechanical properties
Type 2	Viton® B, F or GF	Bisphenol, amine or peroxide	66 - 70%	Improved fluid and oil/solvent resistance, including improved fuel resistance. Peroxide cured materials offer improvements in coolant and water resistance
Type 3	Viton® GLT	Peroxide	64 - 67%	Improved low temperature resistance but reduced chemical resistance
Type 4	Aflas®	Peroxide	55%	Excellent resistance to lubricating oils, corrosion inhibitors and coolants.
Type 5	Viton® ETP	Peroxide	67%	Speciality grade, excellent chemical resistance, including increased resistance to amines and fuel additives.
Ultra-low temp	Ultra-low temp	Peroxide	66%	Speciality polymers are available that further extend the low temperature performance of FKMs.



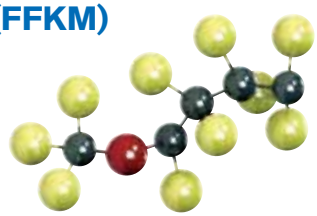
Aflas® (FEPM)



The most common forms of Aflas® (100 or 150 series) are categorized within ASTM D 1418-01 as FEPM. These grades are alternating copolymers of tetrafluoroethylene and propylene, with a fluorine content of ~54%. Such chemical structures offer excellent heat resistance, exceptional chemical resistance (significantly to alkalis and amines), along with high electrical resistivity.

Aflas® compounds are resistant to a wide range of chemicals such as acids, alkalis and steam, offering superior resistance to strong bases in comparison with FKM. A common weakness of Aflas® compounds however is low temperature performance, in aromatic oils and offers only limited resistance to mineral oils.

Perfluoroelastomers (FFKM)



Perfluoroelastomers (FFKM) have a fully fluorinated polymer backbone resulting in a fluorine content >71%. As the material is free from carbon-hydrogen bonds in the polymer chain, the FFKM materials offer the ultimate thermo-chemical resistance.

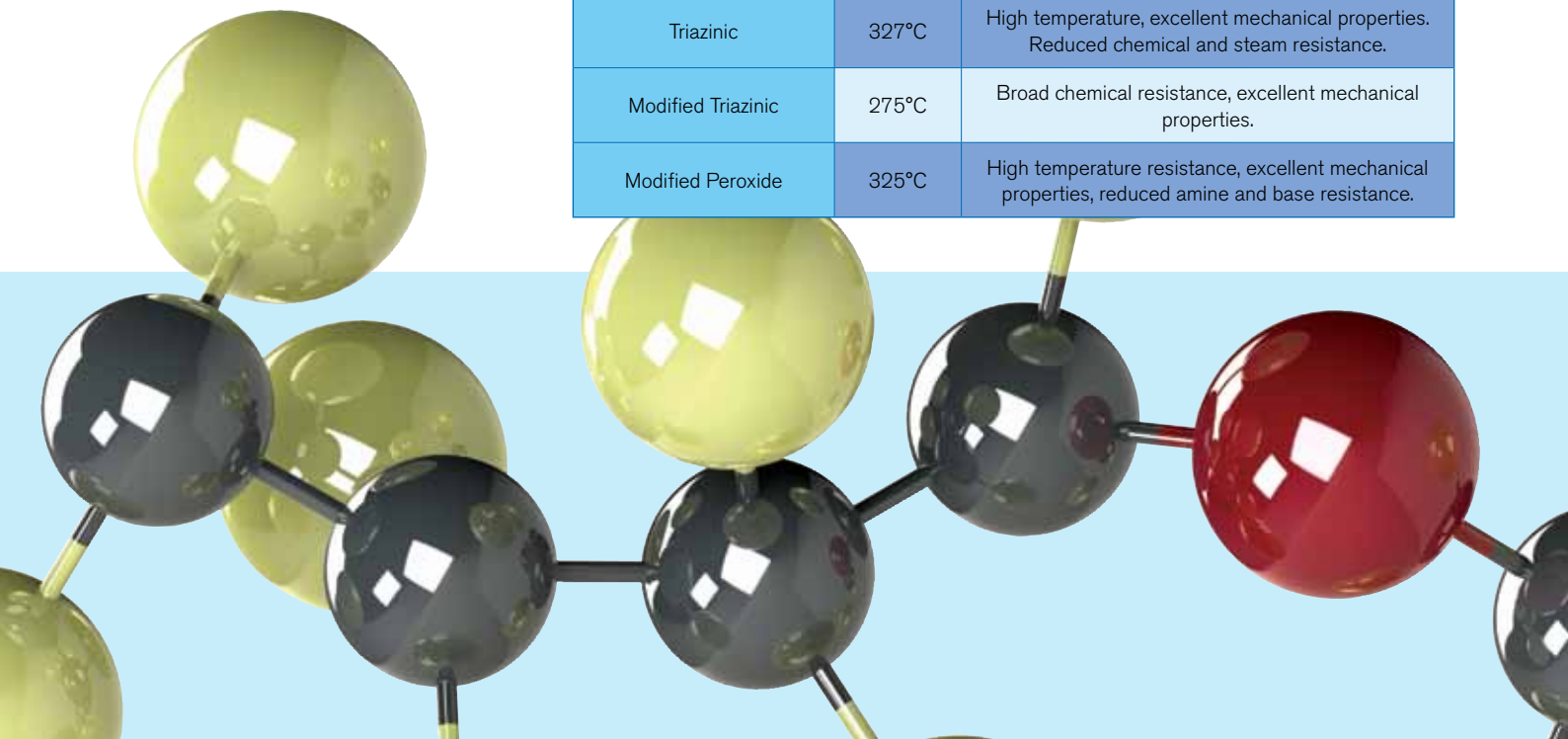
This is demonstrated by the good long-term, high-temperature, compression-set resistance. Chemical resistance is second to none, with good performance in a broad variety of harsh environments: hot amines, steam, solvents, hydrocarbons etc.

Traditionally, FFKM polymers have offered limited resistance to low temperatures, however, new polymer chemistry now offers FFKM grades capable of sealing at temperatures down to -40°C.

Although all FFKM polymer backbones are fully fluorinated, the cross-linking systems used to join the polymer chains together differ significantly, resulting in varied temperature and chemical resistance.

Types of perfluoroelastomers

Common FFKM Types		
Peroxide	240°C	Broad chemical resistance.
Triazinic	327°C	High temperature, excellent mechanical properties. Reduced chemical and steam resistance.
Modified Triazinic	275°C	Broad chemical resistance, excellent mechanical properties.
Modified Peroxide	325°C	High temperature resistance, excellent mechanical properties, reduced amine and base resistance.



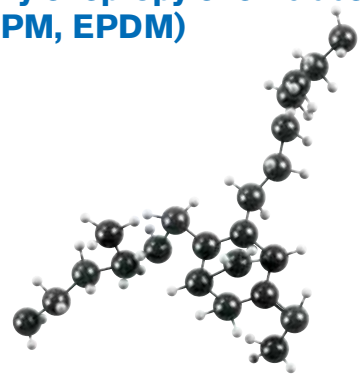
Polychloroprene (CR, Neoprene®)

Neoprene (CR) rubbers are homopolymers of chloroprene (chlorobutadiene), and were among the earliest synthetic rubbers used to produce seals. CR has good ageing characteristics in ozone and weather environments, along with abrasion and flex-cracking resistance.

Most elastomers are either resistant to deterioration from exposure to petroleum based lubricants, or, to oxygen; Neoprene is unusual, in offering a degree of resistance to both. CR also offers resistance to ammonia, silicone oils, water, ozone, alcohols and low-pressure oxygen. This, combined with a broad temperature range and moderate cost, accounts for its desirability in many seal applications. CR is not effective in aromatic and oxygenated solvent environments, and offers only limited resistance to mineral oils.

As CR has a halogen incorporated in its backbone, such grades can offer a degree of inherent flame retardancy.

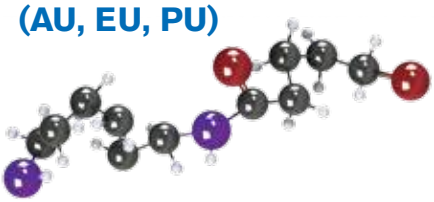
Ethylenepropylene Rubbers (EPM, EPDM)



Ethylenepropylene based rubbers are forms of non-polar synthetic rubbers. EPM (sometimes also known as EP) rubber is based on ethylene and propylene monomers, with no unsaturation (carbon-carbon double bonds) present. EPDM is also based on the same constituent monomers, however as no unsaturation is present in the backbone, it is added as a third monomer, pendent to the main chain. EPDM materials can be cured with either sulfur or peroxide; sulfur offers improved mechanical properties and peroxide enhanced heat stability. EPM rubber can only be cured using free-radicals (peroxide or radiation curing). As the polymer chains of both EPM and EPDM have completely saturated hydrocarbon backbones, excellent ozone resistance and very good resistance to heat and oxidation are achieved.

Being non-polar elastomers, EPM and EPDM offer good performance in polar fluids such as alcohols, hydrogen sulfide (H_2S), super-critical carbon-dioxide, water, steam, ketones etc., but perform badly in non-polar fluids such as hydrocarbon oils, lubricants and greases.

Polyurethane Rubber (AU, EU, PU)



Polyurethane rubber is a polymer formed from a chain of organic units joined by urethane links. Polyurethanes are produced by the addition reaction of a polyisocyanate with a polyalcohol (polyol) in the presence of a catalyst and other additives.

Polyurethane demonstrates excellent resistance to weathering and oxidation. They resist hydrocarbon fuels, hydrogen sulfide (H_2S) and mineral oils, however some grades degrade (hydrolyse) in hot water. Polyurethane rubbers also offer some of the best resistance to abrasion, and are therefore often specified for use in hydraulic, reciprocating or dynamic seals.

Selection of Standard ERIKS Compounds

A range of different ERIKS compounds developed for specific applications

Elastomer	Compound Reference	Colour	Hardness	Temperature	Application
Nitrile, NBR, Buna N	36624	Black	70	–35 to +110°C –31 to +230°F	Standard compound with good compression-set values and medium acrylonitrile content for use with hydraulic oils, vegetable oils, animal fats, acetylene, alcohols, water, air, fuels and many other fluids.
	47702	Black	90	–25 to +110°C –13 to +230°F	Similar to 36624 with higher hardness for higher pressure applications.
Ethylene Propylene, EPDM, EPM	55914	Black	70	–55 to +130°C –67 to +266°F	Standard, sulphur cured EPDM compound with very good compression-set for use with solvents, alcohols, ketones, esters, organic and inorganic acids. Not recommended for animal fats, vegetable or mineral oils.
	55914PC	Black	70	–50 to +150°C –58 to +302°F	High performance peroxide cured EPDM compound with very good compression-set, steam, ozone and weathering resistance.
Hydrogenated Nitrile, HNBR	886510	Black	70	-40 to +1502°C	Low temperature HNBR, offering good hydrocarbon resistance and high temperature performance. Good abrasion resistance.
Fluorocarbon FKM, Viton® A	51414	Black	75	–20 to +200°C –4 to +392°F	General purpose compound with very low compression-set characteristics at high temperatures and chemical resistance to oils, fats, fuels. Suitable for vacuum applications.
	51414G	Green	75	–20 to +200°C –4 to +392°F	General purpose compound with very low compression-set characteristics at high temperatures and chemical resistance to oils, fats, fuels. Suitable for vacuum applications.
	514320	Black	90	–20 to +200°C –4 to +392°F	Similar to 51414 with higher hardness for higher pressure applications.
Viton® GF	514141	Black	75	–10° to +200°C +14°F +392°F	Original Viton® GF-Terpolymer with improved steam and temperature resistance.
Perfluoroelastomer, FFKM	Kalrez® 0090	Black	90	+250°C +482°F	A product developed to provide outstanding resitance to rapid gas decompression (RGD), as well as broad chemical resistance. Kalrez® 0090 also retains high levels of elasticity and recovery even after long-term exposure to temperatures up to 250 degree C
	Kalrez® 6375	Black	75	+275°C +527°F	Outstanding performance in the widest possible range of chemicals and temperatures

Dupont Kalrez® is also available through ERIKS, subject to regional availability.

Physical Properties of ERIKS Compounds

Technical Data	36624	47702	55914	55914PC	886510	51414	51414G	514320	514141	FFKM-75-162	FFKM-75-164
Colour	Black	Black	Black	Black	Black	Black	Green (RAL 6011)	Black	Black	Black	Black
Hardness (ISO 48 Method M) ±5 °IRHD	70	90	70	70	70	75	75	90	75	75 (Shore A)	75 (Shore A)
Specific Gravity	1.25	1.25	1.13	1.12	1.24	1.85	2.07	1.87	1.88	–	–
Minimum operating temperature °C	–30	–30	–50	–55	–40	–20	–20	–20	–10	–	–
TR-10 °C	–22	–22	–40	–45	–33	–16	–16	–16	–16	–	–
Maximum operating temperature °C	120	120	130	150	150	200	200	200	200	275	310
Tensile strength MPa	13	16	10	10	20	13	12	14	19.3	14	13
Elongation %	250	150	250	330	340	170	170	120	328	130	137
Compression-set (ISO 815 method A)											
Test time (hours)	22	22	22	22	22	24	24	24	22	70	70
Test temperature °C	100	100	100	150	150	200	200	200	175	200	200
Result – Slab %	12	13	16	15	12	12	14	14	14	–	–
Result – O-ring 3.53 mm %	20	25	26	25	16	18	19	18	–	14.2	22.9
Heat Ageing (ISO 188)											
Test time (hours)	70	70	70	70	20	70	70	70	70	–	–
Test temperature °C	100	100	100	100	150	200	200	200	250	–	–
Hardness change °IRHD	6	4	14	12	-2	4	5	5	4	–	–

Thermoplastics

Polytetrafluoroethylene (PTFE)

PTFE (polytetrafluoroethylene) is a synthetic, thermoplastic polymer and offers exceptional chemical resistance over a wide range of temperatures, as well as extremely low levels of friction.

PTFE lacks elasticity which prevents its use as an elastomeric-type sealing ring, however, it is commonly used for anti-extrusion as a back-up ring, and for non-stick requirements. Owing to its low friction and excellent chemical resistance, it is also commonly used for applications such as bearings, rotary seals etc.

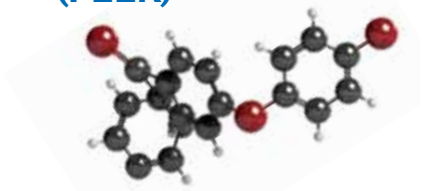
Non-filled ('virgin') grades are stable up to +260°C and quite flexible and resistant to breaking under tensile and compressive stresses. PTFE is also available with fillers added, to enhance its physical characteristics.

Typical fillers include:

- **Glass fillers** for improved deformation and wear
- **Inorganic fillers** (e.g. calcium silicate, wollastonite) are used in a similar manner to glass fillers, with reduced abrasiveness
- **Carbon-filled** for considerable wear and deformation improvement, and increased thermal conductivity
- **Graphite or molybdenum disulphide (MoS_2) filled** to lower the coefficient of friction
- **Polyester filled** for improved high temperature and wear resistance, for applications where running surfaces are non-hardened
- **Polyphenylenesulphide (PPS) filled** for improved extrusion and deformation resistance

Combinations of some of the above are also often used to offer optimal performance in service.

Polyether ether ketone (PEEK)



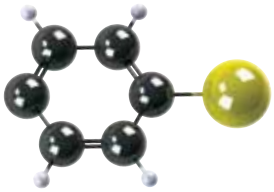
Polyether ether ketone (PEEK) is an organic, semicrystalline, thermoplastic polymer used in demanding engineering applications. PEEK offers excellent mechanical properties, which are maintained at high temperatures. Its resistance to thermal attack and its dimensional stability at high temperatures, along with broad chemical resistance, allows PEEK to be used in applications such as bearings, sealing back-up rings etc.

PEEK is available as non-filled ('virgin') grades, and as various filled grades which modify its physical and mechanical characteristics.

- **Virgin grades** offer high impact resistance as well as a degree of recovery.
- **Glass-filled** PEEK grades have increased compressive strength and shear strength at elevated temperatures.
- **Carbon-filled** grades have enhanced compressive strength, tensile strength and wear-resistance.
- **PTFE-filled** PEEK offers a reduced coefficient of friction.
- **Graphite-filled** PEEK reduces the friction of the materials, improving the 'glide' properties.

Combinations of some of the above are also often used to offer optimal performance in service.

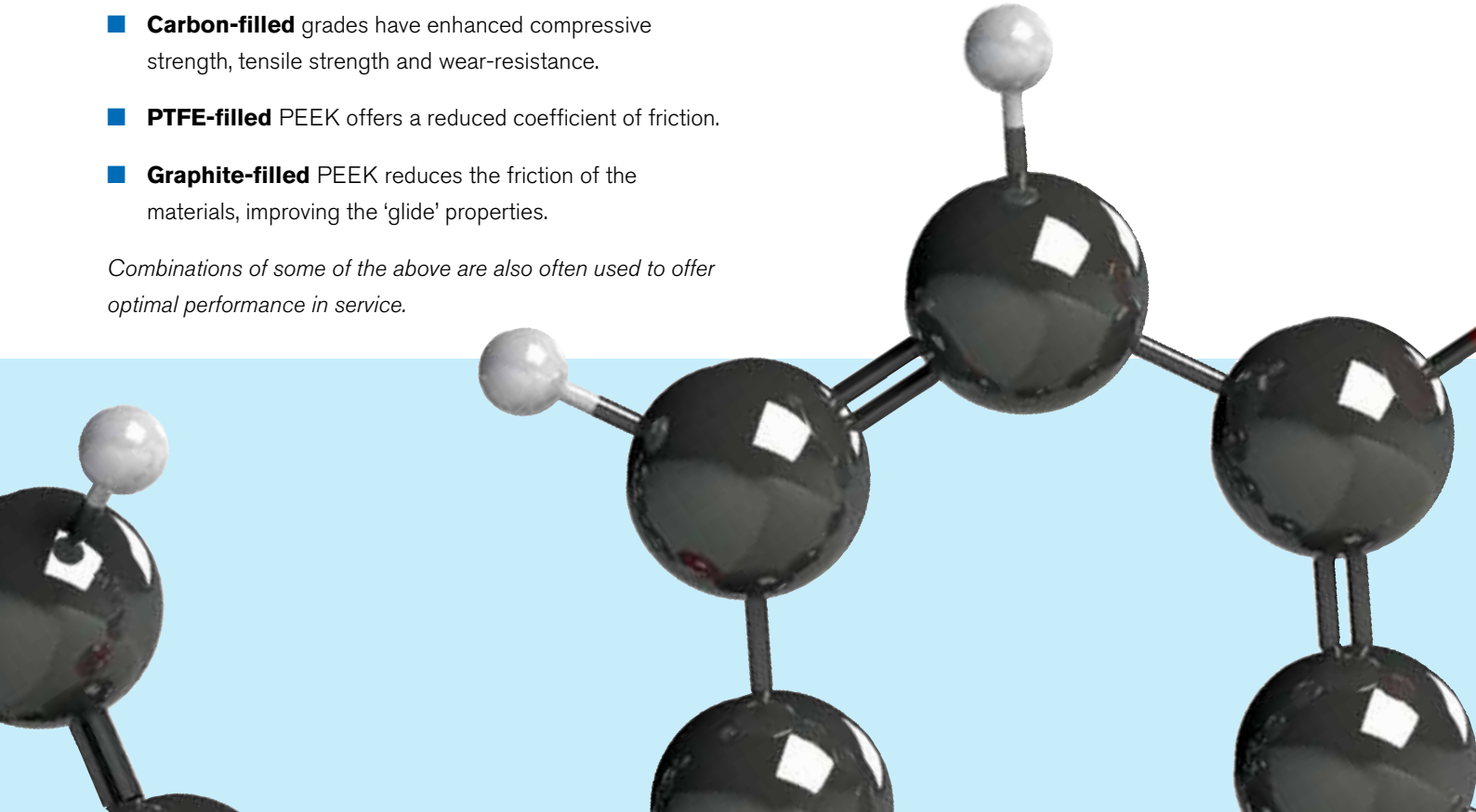
Polyphenylenesulfide (PPS)



Polyphenylenesulfide (PPS) is a high-temperature, semi-crystalline thermoplastic material that offers an excellent combination of thermal, mechanical and chemical resistance. PPS can be moulded, extruded, or machined to precise tolerances and in its pure form is opaque white to light tan in colour. Maximum service temperature is approx. 220°C, and parts can withstand exposure to pressures up to ~70MPa, even at elevated temperatures.

PPS offers good chemical resistance and has been found to not dissolve in any solvent at temperatures below 200°C. Based on such broad chemical resistance, PPS is generally recommended for use in both sweet and sour applications, crude oil, and with amines.

In its pure form it is often described as 'brittle' and hence can be supplied with various fillers to improve its mechanical properties.



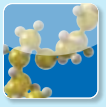
Phenolic Resins

Phenolic resins, also known as phenol formaldehyde resins (PF), are synthetic thermosetting materials created by the reaction of phenols with formaldehyde. These thermosets perform well in most engineering applications such as: hydraulic fluids, oil, glycols, phosphate esters etc.

Phenolic resins demonstrate high dimensional stability and abrasion resistance, and are commonly used in wear-ring applications in sealing, where the resin is reinforced by the addition of a matrix to form a composite.

Standard ERIKS Thermoplastic Grades

Material Reference	Description	Application
E400	Virgin Polytetrafluoroethylene (PTFE)	Static, Low duty cycles
E451U	Glass reinforced PTFE	Dynamic / static duty, hardened running surfaces
E471	Graphite reinforced PTFE	Dynamic, Medium duty cycles
E462	Carbon / Graphite reinforced PTFE	Dynamic, Medium duty cycles
E491	Polyester reinforced PTFE	Dynamic/static, Medium to high duty cycles, minimum 45 HRc runnning surface
E282Z	Carbon / Graphite/ PPS reinforced PTFE	Dynamic /static, high duty cycles, Hardened metal running surfaces
E210	Virgin Polyphenylene sulphide (PPS)	Anti-extrusion rings Machined wear rings Structural components V-rings
V1	PEEK 450 Virgin 0	Back-up Rings
V2	PEEK 450 CA30 Carbon filled	Dynamic Anti-extrusion elements / bearings
V3	PEEK 450 GL30 Glass filled	Bearings
V4	PEEK 450 FC30 Lubricated	Bearings



Material information can also be found on our Chemical Compatibility tool:
http://oring-groove-wizard.eriks.co.uk/chemicalcompatibility.aspx

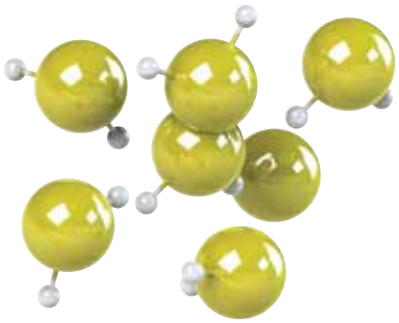
Common Chemical Compatibilities of Materials

CHEMICAL COMPATIBILITY	EPDM	CR	NBR	HNBR	FKM (A)	FKM (GF)	FKM (low temp)	FEPM	FFKM	PU (AU or EU)	Phenolics	Nylon	PPS	PEEK	Polyimide	PTFE
Acetic acid	1	4	2	2	3	2	2	3	1	4	2	3	1	1	1	1
Acetone	1	4	4	4	4	4	4	4	1	4	2	1	1	1	3	1
Acid - carboxylic; strong	1	4	2	2	3	2	2	3	1	4	2	3	1	1	1	1
Acid - carboxylic; weak	1	3	2	2	2	1	1	2	1	3	2	3	1	1	1	1
Acid - mineral; strong	1	4	3	3	3	2	2	2	1	4	1	3	2	1	3	1
Acid - mineral; weak	1	3	3	3	3	1	1	1	1	3	1	3	2	1	3	1
Alcohols (not methanol)	1	1	1	1	1	1	1	1	1	4	2	1	1	1	1	1
Aliphatic hydrocarbons	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Alkalis	1	2	2	1	3	3	3	1	1	3	2	1	2	1	2	1
Alkanes	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Amines	1	3	3	2	4	4	4	1	1	3	3	1	2	1	2	1
Aromatic hydrocarbons	4	4	4	4	2	1	1	3	1	3	2	2	2	1	1	1
Base oil	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Biocide - conc.	2	2	3	3	3	3	3	2	1	1	1	3	1	1	1	1
Biocide - dilute	1	1	1	1	2	2	2	1	1	1	1	2	1	1	1	1
Brine - alkaline - NaOH / KOH	1	1	1	1	2	2	2	1	1	1	1	2	1	1	1	1
Brine - HD - Na/Ca bromide	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Brine - HD - Zn bromide	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Brine - LD - Ca/Na chloride	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Brines	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Calcium bromide	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Carbon dioxide - supercritical	2	3	3	3	3	3	3	2	2	2	1	1	1	1	1	1
Carbon dioxide, CO_2	2	2	1	1	2	2	2	2	1	1	1	1	1	1	1	1
Cement	1	2	2	1	2	1	1	1	1	3	1	1	1	1	1	1
Corrosion inhibitor - amine	1	3	3	2	4	4	4	1	1	3	3	1	2	1	2	1
Corrosion inhibitor - K_2CO_3	1	2	2	1	3	3	3	1	1	3	2	1	2	1	2	1
Corrosion inhibitors	1	3	2	1	3	3	3	1	1	2	2	1	1	1	1	1
Crude oil, sour <2000ppm H_2S	4	2	3	1	2	1	1	1	1	2	1	1	1	1	1	1
Crude oil, sour 2000ppm-5% H_2S	4	2	3	2	3	1	1	1	1	2	1	2	1	1	1	1
Crude oil, sour 5% to 40% H_2S	4	3	4	4	4	2	2	1	1	3	1	3	1	1	1	1
Crude oil, sweet	4	2	1	1	1	1	1	1	1	2	2	1	1	1	1	1
De-emulsifier (mud)	4	2	2	1	1	1	1	1	1	2	1	1	1	1	1	1
Defoamers	3	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Dielectric fluid	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Dimethyl disulfide (DMDS)	4	2	1	1	1	1	1	1	1	1	1	1	2	1	1	1
Dissolvers	1	3	3	3	3	1	1	1	1	3	1	3	2	1	3	1
Drilling mud	1	2	3	2	2	2	2	1	1	2	1	1	1	1	1	1
Drilling mud (diesel oil)	4	2	2	1	2	1	2	2	1	2	1	2	1	1	1	1
Drilling mud (ester)	1	2	2	1	3	3	3	2	1	3	1	1	1	1	1	1
Drilling mud (mineral oil)	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Drilling mud (silicate)	1	1	2	1	2	2	2	1	1	1	1	1	1	1	1	1
Emulsifiers	3	2	2	1	1	1	1	1	1	2	1	1	1	1	1	1
Fire fighting media	1	1	4	4	1	1	1	2	1	2	1	1	1	1	1	1
Fluorinated grease	1	1	1	1	2	3	2	2	2	1	1	1	1	1	1	2
Foaming agents	2	2	2	2	1	1	1	2	1	2	1	1	1	1	1	1
Formation water - acid	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Formation water - chloride	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Formic acid	1	4	2	2	3	2	2	3	1	4	2	3	1	1	1	1
Glycols	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Gravel packer fluid (oil based)	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Gravel packer fluid (water based)	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Hydraulic fluid - fire resistant	1	2	2	1	3	3	3	2	1	3	1	1	1	1	1	1
Hydraulic fluid - HFD-R	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hydraulic fluid - HFD-S	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hydraulic fluid - HFD-U	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CHEMICAL COMPATIBILITY	EPDM	CR	NBR	HNBR	FKM (A)	FKM (GF)	FKM (low temp)	FEPM	FFKM	PU (AU or EU)	Phenolics	Nylon	PPS	PEEK	Polyimide	PTFE
Hydraulic fluid - mineral oil	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hydraulic fluid - oil/water emulsion (HFB)	3	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Hydraulic fluid - phosphate ester	1	2	2	1	3	3	3	2	1	3	1	1	1	1	1	1
Hydraulic fluid - water free	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Hydraulic fluid - water/oil emulsion (HFA)	3	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Hydrochloric acid	1	3	3	3	3	1	1	1	1	3	1	3	2	1	3	1
Hydrofluoric acid	4	4	4	4	3	1	1	1	1	4	3	4	2	1	2	1
Hydrogen sulphide (H_2S) - dry	2	2	1	1	3	3	3	1	1	3	1	3	1	1	1	1
Hydrogen sulphide (H_2S) - wet	2	2	4	4	3	3	3	1	1	3	1	3	1	1	1	1
Hydraulic fluid - water/glycol (HFC)	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Liquified petroleum gas (LPG)	4	2	1	1	1	1	1	2	1	3	1	2	1	1	1	1
Lithium complex grease	4	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
Lost circulation treatment fluid	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Lubricant - synthetic	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Mercaptans	1	2	2	1	3	3	3	1	1	2	1	1	1	1	1	1
Methane	4	2	1	1	1	1	1	1	1	3	1	1	1	1	1	1
Methanol	1	1	1	1	3	1	2	1	1	3	1	2	1	1	1	1
Methanol with hydrocarbons	3	1	1	1	3	1	2	1	1	3	1	2	1	1	1	1
Methanol with water	1	1	1	1	3	1	2	1	1	3	1	2	1	1	1	1
Methylethylketone (MEK)	1	4	4	4	4	4	4	4	1	4	1	1	2	1	1	1
Mineral oil / lubricants	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Mud - oil based	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Mud - synthetic oil based	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Mud - water based	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Natural gas	4	2	1	1	1	1	1	1	1	3	1	1	1	1	1	1
Polyalkylene glycol	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Poly-a-olefin oil	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Polyethylene glycol	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Polyol fire resistant ester oil	1	2	2	1	3	3	3	2	1	3	1	1	1	1	1	1
Polypropylene glycol	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Potassium carbonate	1	2	2	1	3	3	3	1	1	3	2	1	2	1	2	1
Salt water	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Scale inhibitors	1	3	3	3	3	1	1	1	1	3	1	3	2	1	3	1
Sea water	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Slurries	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Solvent - aromatic	4	4	4	4	1	1	1	2	1	4	1	2	2	1	1	1
Solvent - halogenated	1	3	1	1	3	3	3	2	2	4	1	1	1	1	3	1
Steam 100-150°C	1	3	3	2	2	1	1	1	1	4	1	4	1	1	2	1
Steam 150-200°C	3	4	4	4	4	1	1	1	1	4	2	4	2	1	3	1
Steam >200°C	4	4	4	4	4	4	4	3	2	4	3	4	3	1	4	1
Strong acids	1	4	2	2	3	2	2	3	1	4	2	3	1	1	1	1
Synthetic biodegradable ester	1	2	2	1	3	3	3	2	1	3	1	1	1	1	1	1
Synthetic grease	4	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Thinners	4	4	4	4	1	1	1	2	1	4	1	2	2	1	1	1
Toluene	4	4	4	4	1	1	1	2	1	4	1	2	2	1	1	1
Trichloromethane	4	4	4	4	1	1	1	4	1	4	2	4	1	1	4	1
Viscosifiers	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Water - general	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Water - produced	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Water - treated	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1
Wax dissolvers	4	4	4	4	1	1	1	2	1	4	1	2	2	1	1	1
Weathering / UV	1	1	2	1	1	1	1	1	1	2	1	1	1	1	1	1
Well cleaning fluids	1	1	2	1	3	1	2	1	1	3	1	2	1	1	1	1
Xylene	4	4	2	1	2	1	1	4	1	4	1	1	1	1	1	1
Zinc bromide	1	1	2	1	1	1	1	1	1	3	1	2	1	1	1	1

KEY: 1 = Excellent 3 = Poor
2 = Good 4 = Not recommended

Sour and Sweet Gas/Oil



"Sour" gas or oil is an often-used term for hydrocarbons containing hydrogen sulphide (H_2S). Those that do not contain significant amounts of hydrogen sulphide are called "sweet". Hydrogen sulphide has a "dipole" which is created from the bond angle of the hydrogen atoms, and is therefore best described as a "Lewis Base" (i.e. an electron donor or nucleophile). Therefore, H_2S causes problems with elastomer seals in two different ways: physical swelling of components and chemical degradation (nucleophilic attack). With regards to explosive decompression, H_2S has little effect other than to weaken some elastomers through chemical degradation, thus reducing a materials ability to withstand rapid gas decompression.

For such sour environments, the selection of the material is therefore key. Traditionally, FKMs were thought to offer poor performance in sour environments, however, more recent studies have brought this into question. Therefore, in terms of material selection for sour applications, the following can be adopted: FKM copolymers (<0.2% H_2S); FKM terpolymers (up to 64% H_2S); Aflas® (up to 30% H_2S); HNBR (up to 5% H_2S depending on ACN content of the elastomer); FFKM (generally resistant). The effects of corrosion inhibitors should also be accounted for, as it is often the case that where H_2S is present, such chemicals are also found. Corrosion inhibitors can take a number of different forms (e.g. amine, potassium carbonate based), however not all materials perform well in such conditions (i.e. FKM grades in amines).

Rapid Gas Decompression / Explosive Decompression

Rapid Gas Decompression (RGD) occurs when elastomers are subject to prolonged exposure to high pressure gases which are subsequently depressurized. Whilst exposed, gas permeates and dissolves into the elastomer, once the pressure is released, the dissolved gas drops out of solution and must escape. If the gas pressure is reduced quickly, the dissolved gas coalesces to form pockets. This gas cannot escape fast enough, it increases in volume, and causes the rubber to blister or rupture.

This effect is compounded by increased temperatures, pressures or decompression rate. Different gas / elastomer combinations will also have different results, with some elastomers being more permeable to particular gases. Carbon dioxide can be particularly difficult, especially in the supercritical phase, as it works as a very powerful solvent to most elastomers.

Components with small cross-sections are less liable to such damage, as the gas can escape more efficiently than with larger sections.

*O-ring and hardware dimensional details are available at:
http://oring-groove-wizard.eriks.co.uk/DiameterGrooves.aspx

ED Standard Test Conditions

	Norsok M710 Annex B	NACE TM 0297-2002 Effects of High-Temperature, High-Pressure Carbon Dioxide Decompression in Elastomeric Materials	NACE TM0192-2003 Evaluating Elastomeric Materials in Carbon Dioxide Decompression Environments	TOTAL GS EP PVV 142	Shell DODEP 02.01B.03.02
Test aim:	General decompression resistance of elastomer materials	Exposure of seals to high CO_2 environments	Exposure of seals to high CO_2 environments	Evaluation ED resistance of seals for use in valves	Evaluation ED resistance of seals for use in valves
Sample size	BS-325 O-ring	AS-325 O-ring; 37.47 x 5.33mm	AS-325 O-ring; 37.47 x 5.33mm	113.67mm ID with either 5.33mm or 6.99mm cross-sections	BS1806-329
Arrangement	Flange / face seal	Free or constrained (optional)	Free	Flange / face seal	Flange / face seal
Compression	20%	Optional	Not applicable	13.5%	14.0%
Groove-fill	Mounted between parallel plates	Optional	Not applicable	73%	Open or 83%
No. of test samples	3 minimum	6	3	5 (3 for ED testing, 1 for mechanical testing, 1 reference)	Not specified
Gas(es)	3 % CO_2, 97 % CH_4 or 10 % CO_2, 90 % CH_4 or 100 % CO_2	100% CO_2	100% CO_2	80/20 CH_4/CO_2	CO_2, CH_4, North Sea Hydrocarbon gas. (min. 5% CO_2)
Temperature	100, 150 or 200°C	50, 100, 120, 150, 170, 230°C	Room temperature (20-30°C)	75°C	100°C
Pressure	15, 20 or 30 MPa	7, 17, 28, 38 MPa	5.2 MPa	19 +/-2 MPa	13.8 MPa minimum
Initial soak time	72 hours	24 hours	24 hours	78 hours	72 hours
Cycle soak times	23 hours	Not applicable	Not applicable	48 hours	72 hours
Decompression rate	2-4 MPa/min	7 MPa/min	<1minute	19 to 0.1 MPa in 90 secs; linear	Instantaneous
Dwell at ambient	1hour	None	None	1 hour	1 hour
No. of cycles	10	Minimum of 1	1	Initial soak followed by 4 cycles	20
Sample removal	Removed after 24 hours at ambient pressure	As soon as possible at ambient pressure	As soon as possible at ambient pressure	Removed from test vessel within 3 hours	Not specified
Examination	Internal and external	Internal and external	Internal and external	External	Internal and external
Other	Photographic evidence required at x10 magnification	Samples removed as soon as possible after depressuring. Dimensions and mechanical properties are measured.	Samples removed as soon as possible after depressuring. Dimensions and mechanical properties are measured.	Dimensional checks, weight change, density, hardness and tensile strength before and after testing required. Photographic evidence required at x10 and x20 mag.	Dimensions, hardness and mechanical properties measured

Explosive Decompression Test Ratings

NOROSK M710 Rating:

- No internal cracks, holes or blisters of any size (0)
- Less than 4 internal cracks, each shorter than 50% of cross section with total crack length less than the cross section (1)
- Less than 6 internal cracks, each shorter than 50% of the cross section, with a total crack length of less than 2.5 times the cross section (2)
- Less than 9 internal cracks of which max. 2 cracks can have a length between 50% and 80 % of the cross section (3)
- More than 8 internal cracks or one or more cracks longer than 80 % of the cross section (4)
- Crack(s) going through cross section or complete separation of the seal into fragments (5)

Seals with rating 4 or 5 are not acceptable.

Explosive Decompression Resistant Grades

Polymer Type	Compound reference	Colour	Hardness (IRHD)	Temperature Range	Select for…							Material Designator
					Sour Gas		RGD / ED					
					Norsok M710 Annex A	NACE TM0187	Norsok M710 Annex B	NACE TM0297	TOTAL GS EP PVV 142	Shell DODEP 02.01B.03.02	Other	
HNBR	866516	Black	90	-35 to +160°C	✔		✔				✔	HNBR
FKM (B)	514530	Black	90	-27 to +230°C			✔	✔	✔	✔		FPM
FKM (GLT)	514531	Black	90	-40 to +220°C			✔	✔	✔	✔		FPM
FKM (ultra-low temp)	514532	Black	90	-50 to +225°C							✔	FPM
FEPM (Aflas®)	223504	Black	90	-20 to +200°C			✔					FEPM
FFKM	FFKM-90-248	Black	90	-40 to +270°C							✔	FFKM

Materials For TOTAL GS EP PVV 142

Polymer Type	Compound reference	Colour	Hardness (IRHD)	Temperature Range	Material Designator
HNBR (med)	866523	Black	90	-25 to +180°C	HNBR
FKM (B)	514533	Black	90	-27 to +230°C	FPM
FKM (GF)	514534	Black	91	-10 to +200°C	FPM
FKM (GLT)	514535	Black	92	-40 to +220°C	FPM

Drilling – Evaluation

Abrasive drilling muds and mechanically hostile conditions, demand the use of rugged elastomer compounds, specifically developed to maximise their ability to withstand the conditions seen by the drill string.

Applications	Requirements	Seal Profiles	Sealing Materials
■ Rock bit seals	■ High pressure	■ O-Rings	■ NBR
■ Fluid sampling (sampling cylinders)	■ High temperature	■ T-Seals	■ HNBR
■ Core analysis	■ Chemical resistance	■ Pressure compensated tubes	■ FKM
■ Control systems & rotary steerable tools	■ Low temperature [1]	■ Metal face seals	■ FKM -F
■ Mud motors	■ Rapid gas decompression [1]		■ FFKM
	■ Abrasion resistance		■ Aflas®
	■ Drilling fluid resistance		
	[1] = Sampling cylinders only		

Down-hole Completion and Production

The varied applications seen down-hole require a plethora of tailored sealing solutions, each requiring in-depth understanding of the application details to ensure reliable operation.

Thermal expansions and hardware deflection must be accounted for when designing down-hole seals.

Applications	Requirements	Seal Profiles	Sealing Materials
■ Safetly valves	■ High pressure	■ O-Rings	■ NBR
■ Blow out preventors (BOP)	■ High temperature	■ T-Seals	■ HNBR
■ Flow divertors	■ Chemical resistance	■ Hydraulic seals	■ FKM
■ Perforation guns	■ Rapid gas decompression	■ V-Packings	■ FKM -F
■ Enchanced oil recovery - Excitation - Fracking - Electrical Submersible		■ S-Seals	■ FFKM
■ Artificial Lift		■ SE-Seals	■ Aflas®
		■ BOP rubber metal bonded blocks	

Wireline and Fishing Services

Intervention techniques may be necessary in diverse conditions to meet the needs of the specific wells or tasks. Tailored sealing solutions are often required to optimise tool performance to a specific role.

Applications	Requirements	Seal Profiles	Sealing Materials
■ Wireline	■ High pressure	■ O-Rings	■ NBR
■ Fishing tools	■ High temperature	■ Energised lip seals	■ HNBR
	■ Chemical resistance	■ Cap seals	■ FKM
	■ Rapid gas decompression		■ FKM -F
	■ Abrasion[1]		■ FFKM
	[1] = Fishing tools only		■ Aflas®

Sub-Sea

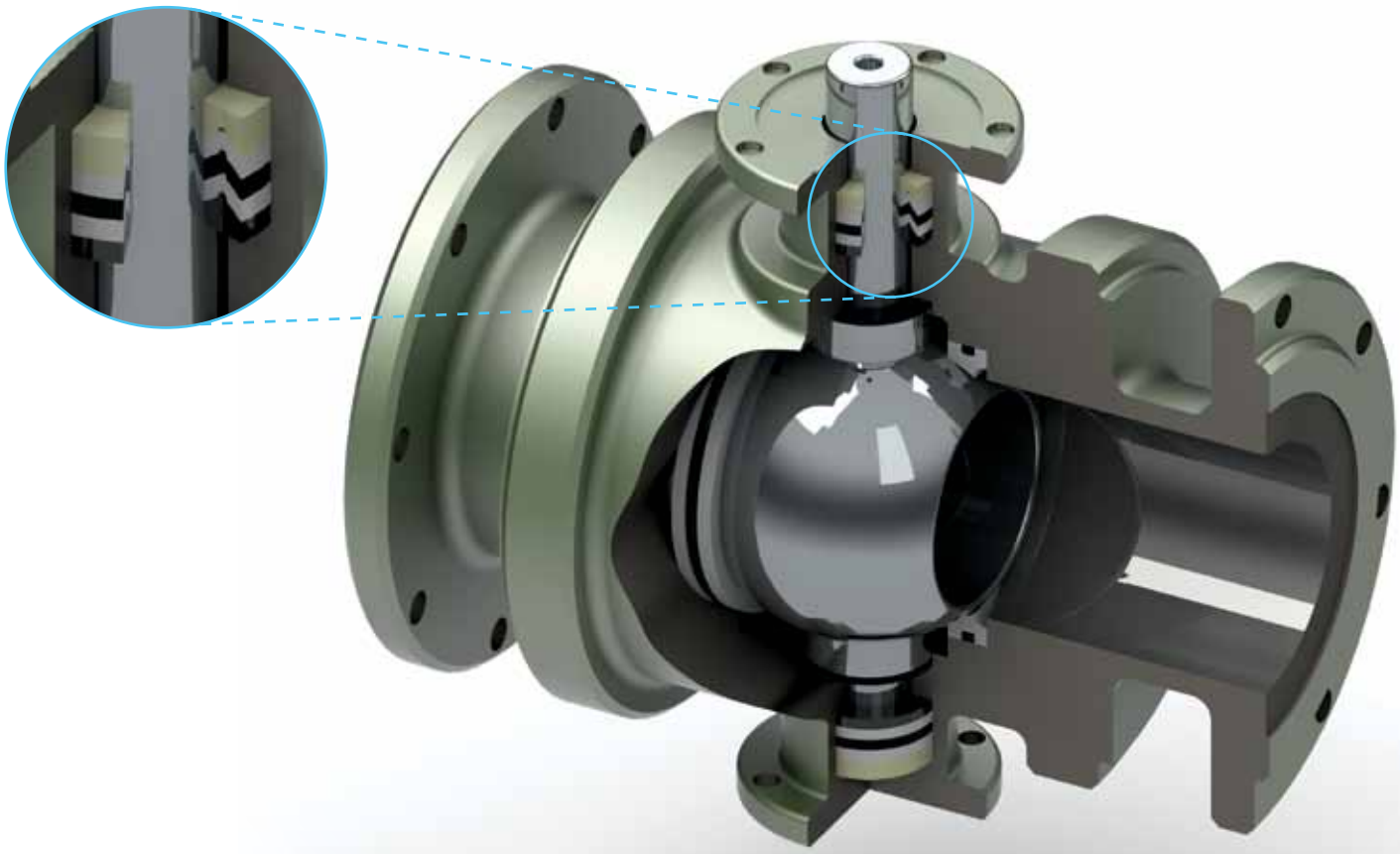
Once above the safety valve the likelihood of Rapid Gas Decompression significantly increases. The use of elastomers resistant to damage from RGD is therefore typical in flow applications. The differential pressures applied to submerged hydraulic sealing arrangements, may demand pressure venting to be added.

Applications	Requirements	Seal Profiles	Sealing Materials
■ Christmas trees	■ High pressure	■ O-Rings	■ NBR
■ Wellhead	■ High temperature	■ Energised lip seals	■ HNBR
■ Hydraulics	■ Chemical resistance	■ Cap seals	■ FKM
■ Valves	■ Rapid gas decompression		■ FKM -F
■ Risers			■ FFKM
■ Remote operated vehicles (ROV)			■ Aflas®

Top-Side

Larger diameter applications typically have broader tolerances and higher extrusion gaps. Seal selection and design must accommodate such requirements whilst creating a reliable, safe seal.

Applications	Requirements	Seal Profiles	Sealing Materials
■ Pipeline	■ Chemical resistance	■ O-Rings	■ NBR
■ Closure seals	■ Rapid gas decompression	■ Lip seals	■ HNBR
■ Pumps	■ Large diameter	■ Spring reinforced lip seals	■ FKM
■ Compressors	■ Large extrusion gaps	■ Back-up rings	■ FKM -F
■ Wellhead	■ Rough surfaces		■ FFKM
■ Hydraulics			■ Aflas®
■ Valves			



O-ring

Product Overview

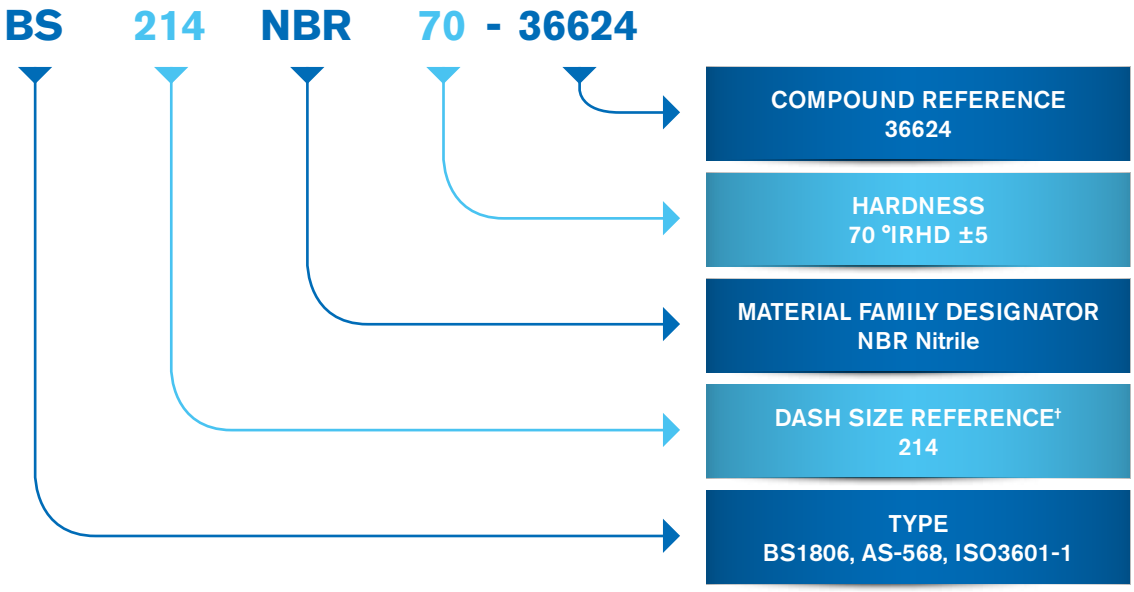
The most common type of static seal is the flexible elastomer O-ring. O-rings provide an affordable seal that in most cases are simple to install and subject to correct material selection, give acceptable life between maintenance checks.

Available in a variety of materials to suit every sealing application, fully moulded O-rings are manufactured to several international size standards, including BS1806, BS4518, AS568 and ISO 3601. Alternatively non-standard custom sizes, up to 2.5m (8ft) diameter can be produced to specific requirements.

O-ring Standard Compounds

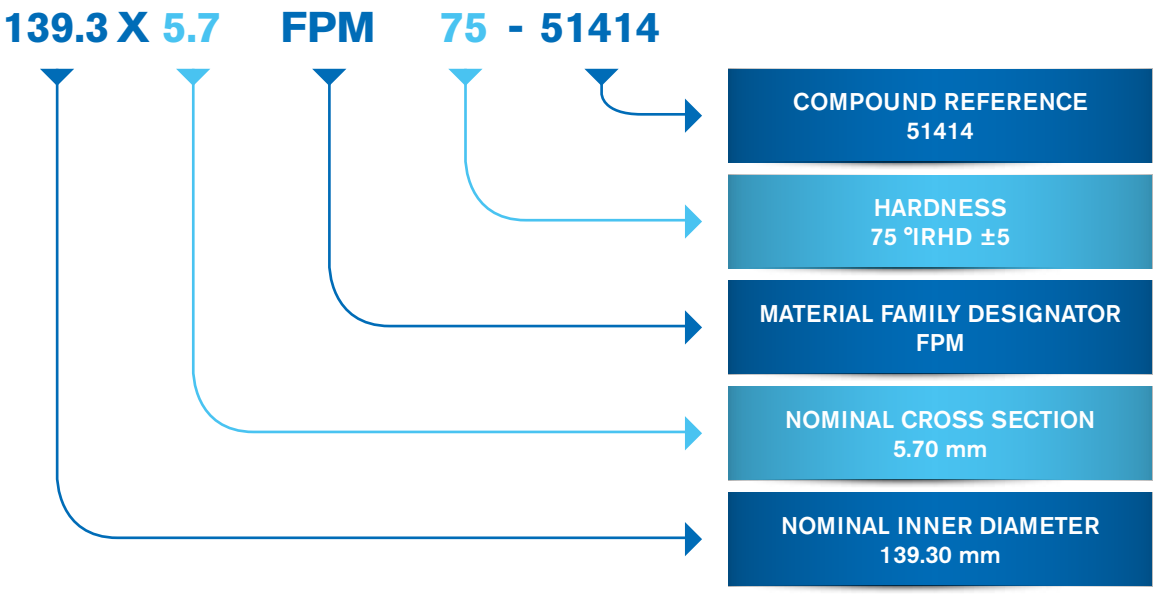
Polymer Type	Compound reference	Colour	Hardness (IRHD)	Temperature Range	Select for..	Material Designator
NBR (low)	366519	Black	70	-40 to +120°C	Top-side and low temperature applications	NBR
NBR (med)	36624	Black	70	-30 to +120°C	General purpose all round grade	NBR
NBR (med)	47702	Black	90	-30 to +120°C	High pressure applications	NBR
HNBR (low)	886510	Black	70	-40 to +150°C	Low temperature	HNBR
HNBR (low)	886512	Black	85	-40 to +150°C	High pressure, low temperature	HNBR
HNBR (med)	886516	Black	90	-30 to +150°C	RGD compliant	HNBR
EPDM	55914 PC	Black	70	-55 to +150°C	Water based applications, geothermal	EP
EPDM	559519	Black	90	-55 to +150°C	High pressure	EP
FKM (A)	51414	Black	75	-20 to +200°C	General purpose all round grade	FPM
FKM (A)	514309	Black	90	-20 to +200°C	High pressure	FPM
FKM (A)	514204	Black	90	-20 to +200°C	RGD compliant	FPM
FKM (GF)	514141	Black	75	-10 to +200°C	High chemical resistance	FPM
FKM (GF)	514522	Black	90	-10 to +200°C	RGD compliant, high chemical resistance	FPM
FKM (GLT)	514523	Black	75	-40 to +200°C	Low temperature	FPM
FKM (GLT)	514525	Black	90	-40 to +200°C	RGD compliant, low temperature	FPM
FKM (ultra-low temp)	514322	Black	70	-51 to +20°C	Ultra Low temperature	FPM
FFKM	FFKM-75-162	Black	75	-15 to +275°C	General purpose all round grade	FFKM
FFKM HT	FFKM-75-164	Black	75	-15 to +310°C	High temperature	FFKM
FEPM	223301	Black	80	-15 to +230°C	General purpose all round grade	FEPM
FEPM	223503	Black	90	-15 to +230°C	RGD compliant	FEPM

Imperial O-rings



†O-rings are supplied to ISO3601-1 class B tolerances unless otherwise specified.

Metric O-rings



†O-rings are supplied to ISO3601-1 class B tolerances unless otherwise specified.

Use this QR code to access data sheets for specific approvals available at http://oring-groove-wizard.eriks.co.uk

Vulc-O-ring

Product overview

ERIKS has developed a very successful method of producing O-rings from extruded cord to a very high technical standard.

The main benefits of Vulc-O-rings are:

- Moulds are not required resulting in cost savings
- No upper diameter restrictions such as moulding
- No flash lines are present
- Can be used in standard housings
- Short lead times

Metric Vulc-O-rings

1999.35 x 5.7 FPM 75 514206 - VULC

- **COMPOUND REFERENCE** 514206
- **HARDNESS** 75 °IRHD
- **MATERIAL FAMILY DESIGNATOR** FPM
- **NOMINAL CROSS SECTION** 5.70 mm
- **NOMINAL INNER DIAMETER** 1999.35 mm

Vulc-O-ring Materials

Elastomer	Compound Reference	Colour	Hardness °IRHD	Material Family Designator
Nitrile (NBR)	366185	Black	75	NBR
Fluorocarbon (FKM) A Type	514206	Black	75	FPM
Fluorocarbon (FKM) GF Type	514141	Black	75	FPM
Ethylene Propylene Diene Monomer	559303	Black	75	EPDM

Back-up Rings (Anti-extrusion Ring)

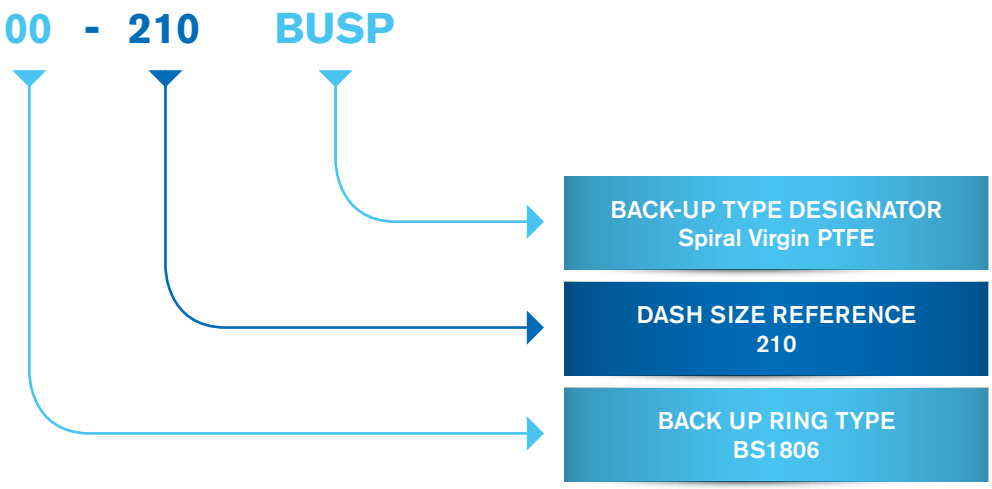
Product overview

Back-up rings are used to extend the operating pressure of an O-ring. Either one or two back-up rings are co-located within a groove of increased width, on the low-pressure side of the seal. When pressure is applied to the sealing system the back-up ring is axially compressed, increasing its radial width to close the extrusion gap. The high shear strength of the back-up ring material is then able to contain the elevated pressures.

Unlike elastomers, which see visco-elastic extrusion, thermoplastic back-up ring materials fail if the maximum shear stress is greater than the shear strength of the material at the operating temperature.

The graphs and instructions on the following pages can be used to select the correct material.

T1



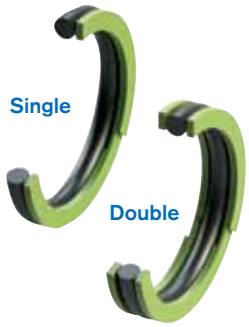
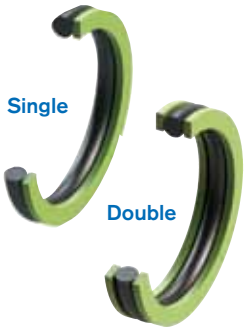
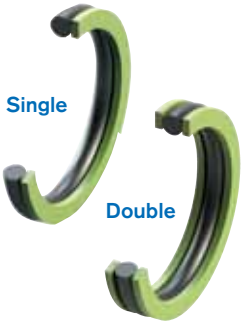
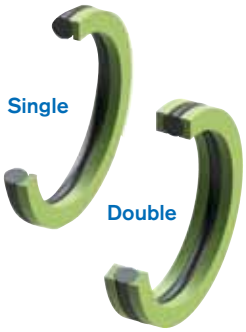
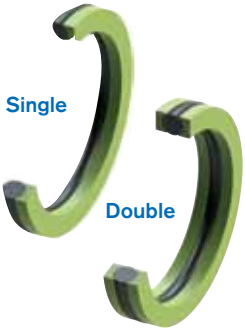
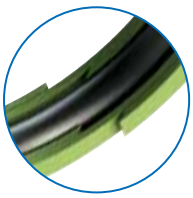
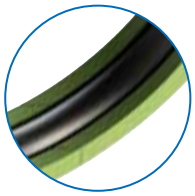
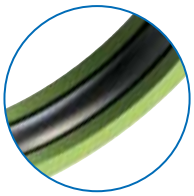
Back-up Type Designator

Designator	Type
BUSP	Spiral Back-up
BUCU	Scarf Cut Back-up
BUEN	Solid Back-up

ISO 3601 Back-up Ring Material

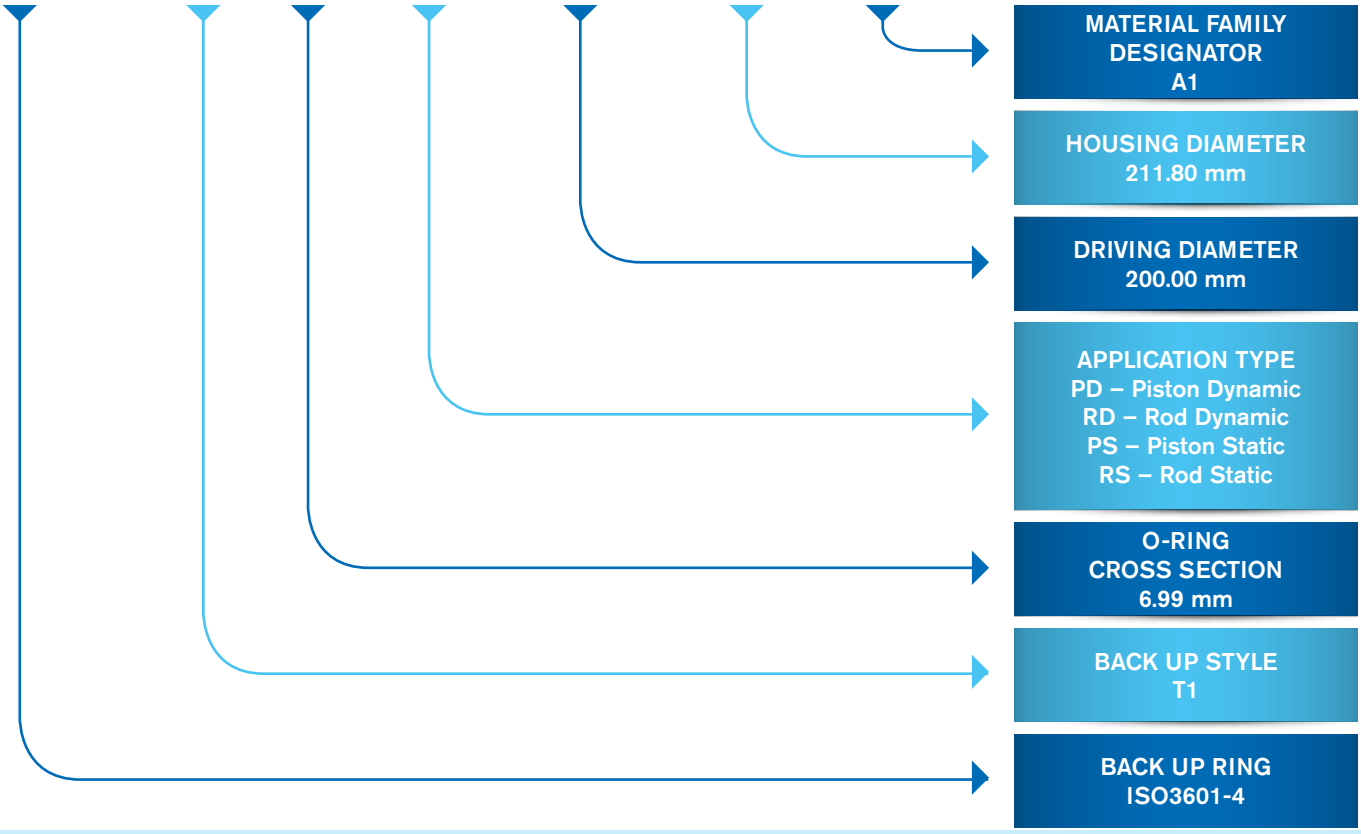
Material Family Designator	Description
A1	Virgin Polytetrafluoroethylene (PTFE)
V1	Virgin PEEK
V3	Glass Filled

Note: Back-up rings are groove specific, the above part numbering format being only suitable for BS1806 grooves. Hardware dimensional details are available at: ***http://oring-groove-wizard.eriks.co.uk/DiameterGrooves.aspx***

T1 Spiral Turn Anti-Extrusion Ring	T2 Scarf Cut Anti-Extrusion Ring	T3 Solid Anti-Extrusion Ring	T4 Scarf Cut Concaved Anti-Extrusion Ring	T5 Solid Concaved Anti-Extrusion Ring
				
 Spiral	 Scarf cut	 Solid	 Scarf cut	 Solid

ISO3601 Back-up Rings

ISO3601-4 - T1 - 699 - PD - 20000 - 21180 - A1



Back-up Ring Material Selection Process

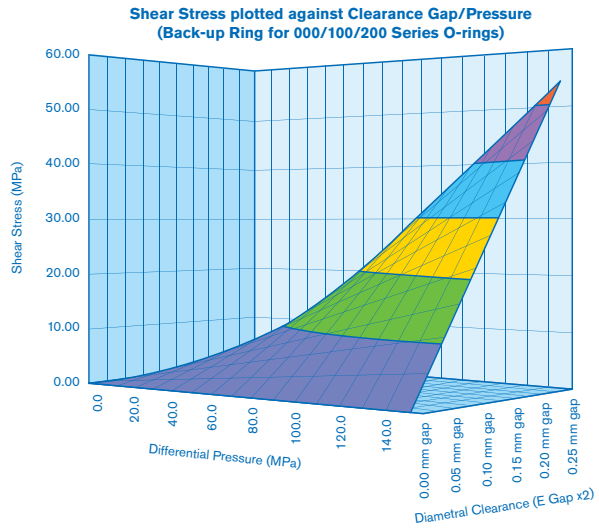
The graphs and instructions on these pages can be used to select the correct material.

Step 1: Select the correct shear stress 3D plot for your O-ring cross- section. Plot the system's maximum diametral clearance and differential pressure then read off the appropriate shear stress.

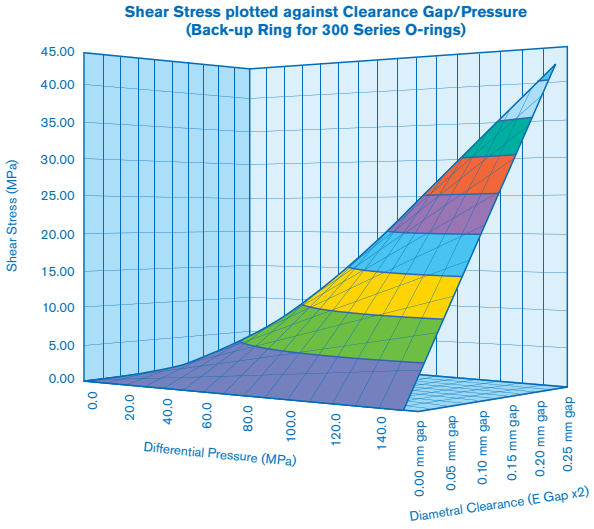
Step 2: Apply an appropriate safety factor to this value (Minimum 2).

Step 3: Select a material from the 'Material Shear Strengths' chart where the Shear Strength of the material is greater than the value calculated at Step 2, at the application operating temperature.

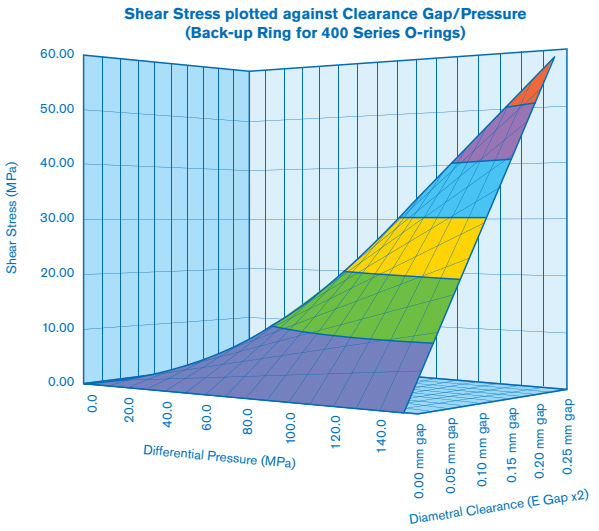
Back-up Ring for 000/100/200 series



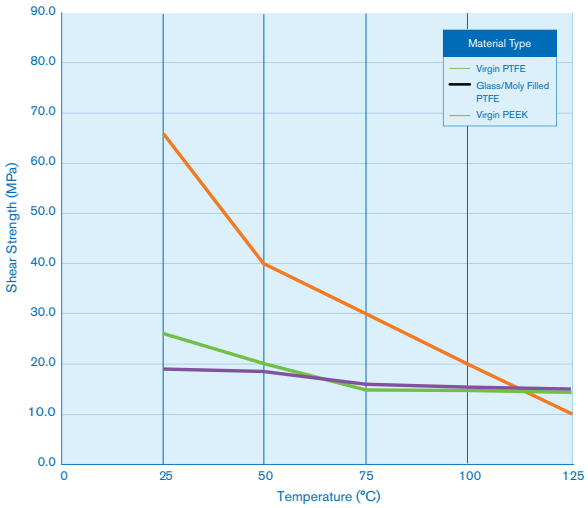
Back-up Ring for 300 series



Back-up Ring for 400 series



Material Shear Strength Vs Temperature



T-Seal

Product Overview

Typically used in reciprocating and high pressure static applications, T-Seals comprise a single T-section elastomeric energiser and two thermoplastic back-up rings. Available in both piston and rod geometries, T-Seals can retro-fit into most standard O-ring grooves designed for widths to accommodate 0, 1 or 2 back-ups.

The shape prevents spiral failure whilst reciprocating. The elastomer component transmits the system pressure under the low pressure back-up ring, forcing it into position, closing the extrusion gap. As an elastomeric contact seal, the T-Seal provides highly efficient sealing and can be used in applications where two fluid types need to be separated e.g. gas, oil separation by an accumulator piston seal.

pioneer WESTON

T1P-BSI-214- 0 - C- 36624- E471- PWI

BACK-UP MATERIAL REFERENCE
E471

ELASTOMER ENERGISER COMPOUND REFERENCE
36624

BACK-UP RING STYLE
C=SCARF CUT S = SOLID

Groove width
0 = Zero back-up ring width (Narrow)
1 = Single back-up ring width (Inter)
2 = Double back-up ring width (Wide)

SIZE REFERENCE
214

Groove design standard
BSI = BS1806, ASD = AS4716
ASS = ASS857, ISO = ISO3601
BSM = BS4518

TYPE
T1P = PISTON
T1R = ROD

Elastomeric Energiser Materials

Elastomer	Compound Reference	Colour	Hardness (IRHD)	Temperature Range	Select for..
Nitrile rubber (NBR)	36624	Black	70	-30 to +120°C	General purpose
Fluorocarbon (FKM, A-type)	51414	Black	75	-20 to +200°C	High temperature performance; high speed applications
	51414G	Green	75		
Hydrogenated nitrile, HNBR	886510	Black	70	-40 to +150°C	High temperature, mechanically demanding applications

Back-Up Material Reference Codes

PTFE Reference	Material Composition	Colour	Coefficient of Friction	Temperature Range	Select for..
E400	Virgin PTFE	White	0.05 / 0.08	-240 to +200°C	Static or low duty cycles
E451U	Glass filled PTFE	Cream	0.06 / 0.10	-160 to +290°C	Dynamic or static, medium duty cycles, hardened metal running surfaces
E471	Graphite reinforced PTFE	Black	0.06 / 0.10	-200 to 250°C	Dynamic, medium duty cycles
E462	Carbon and graphite reinforced PTFE	Black	0.08 / 0.12	-200 to 250°C	Dynamic, medium duty cycles
E491	Polyester reinforced PTFE	Beige	0.08 / 0.12	-130 to +290°C	Dynamic or static, medium to high duty cycles, minimum 45 HRc running surface
E282Z	Carbon, graphite and PPS reinforced PTFE	Grey/Black	0.08 / 0.12	-130 to +290°C	Dynamic or static, high duty cycles, hardened metal running surfaces

Use this QR code to access data sheets for specific approvals available at http://oring-groove-wizard.eriks.co.uk

S-Seal

Product Overview

The S-Seal is a compact, moulded elastomeric seal design with two integral metal spring anti-extrusion supports, designed to prevent seal extrusion.

Sized to fit existing O-ring type grooves, they also offer resistance to high pressure and high temperature, without the need for additional anti-extrusion rings.

They are available in both rod and piston seal orientation. Custom sizes for unique sealing applications can be designed on request.

Developed to withstand pressures of 140 MPa and above, S-Seals are particularly suited for demanding oil and gas applications where traditional O-rings may be prone to short service life or failure.

pioneer WESTON

SSR - 125 - 15000 - 55414 - SS

- **SPRING MATERIAL (SS – STAINLESS STEEL)**
- **ELASTOMER COMPOUND REFERENCE 55414**
- **ROD OR BORE DIAMETER 6.000” = 006000†**
- **NOMINAL RADIAL GROOVE CROSS SECTION 0.125” = 125†**
- **SEAL TYPE AND ORIENTATION SSR – ROD SSP - PISTON**

(†Dimension rounded down to 3 decimal places, multiplied by 100)

Energised Lip Seals

Product overview

Pioneer Weston's Energised Lip Seal is a symmetrical seal optimised for heavy duty reciprocating applications with unidirectional pressure.

The Energised Lip Seal comprises a high modulus, highly durable, wear resistant, elastomeric jacket, energised by a low modulus split O-ring.

The jacket provides superior sealing efficiency and abrasion resistance, whilst the O-ring both transmits system pressure to the contact surfaces and ensures energisation of the seal lips under low pressure or low temperature. The elongated square heal minimises seal roll and improves seal stability.

By separating the sealing and energising functions, optimal materials may be selected for each. A typical application would include actuator rod seals.

Imperial (English) Sizes

ELS - AM1 - 125 - 006000 - 343 - PWI

- **ELS** — ENERGISED LIP SEAL TYPE ELS
- **AM1** — JACKET COMPOUND REFERENCE AM1
- **125** — NOMINAL RADIAL GROOVE CROSS SECTION 0.125" = 125†3
- **006000** — NOMINAL SEAL ID 6.000" = 006000†2
- **343** — NOMINAL AXIAL GROOVE WIDTH 0.125" = 125†1

†1 to 3 decimal places multiplied by 1000
†2 (Rod diameter/Piston groove diameter to 3 decimal places) multiplied by 1000
†3 to 3 decimal places multiplied by 1000

Jacket Material	Compound Reference	Energiser Material	Colour	Hardness (IRHD)	Temperature Range	Select for..	Gasket Designator
Aflas® (FEPM)	FE-80-229	FKM 75	Black	80	-10 to +200°C	High temperatures, increased chemical resistance	FE7
Polyurethane (PU)	PU-90-203	NBR 70	Black	90	-40 to +100°C	Hydraulic ram rod seals for high volume manufacture	AM1
Hydrogenated nitrile (HNBR), moulded	H-85-205	HNBR 70	Black	85	-40 to +180°C	Elevated temperatures, high abrasion resistance	HJ1
Hydrogenated nitrile (HNBR), machined	H-85-206	HNBR 70	Black	85	-40 to +180°C	Elevated temperatures, high abrasion resistance; low volume rapid manufacture	HJ2

Single Acting Cap Seal

Product overview

A self-actuating, pressure venting, extrusion resistant seal that combines low breakout and running friction with minimal leakage. The seal is constructed of a premium grade PTFE sealing element and an elastomer energiser.

The Single Acting Cap Seal is a reliable, compact, design with a long service life and is available in both rod and piston type geometries to retro-fit into ISO7425-2. Stick-slip is eliminated even after long periods of inactivity whether in a lubricated or non-lubricated environment, giving low breakout friction.

C** - 15000 - D - 36624 - E471 - PWI

PTFE GRADE CODE
E471 Graphite Filled PTFE

ELASTOMERIC ENERGISER COMPOUND REFERENCE
36624 Nitrile NBR 70 °IRHD

RADIAL SECTION CODE
A = 1.78
B = 2.62
C = 3.53
D = 5.33
E = 6.99

BORE/ROD DIAMETER
150.00 mm

TYPE
SP – Piston Type Single Acting
DP – Piston Type Double Acting
SR – Rod Type Single Acting
DR – Rod Type Double Acting

Standard Radial Sections

Radial Section Code	Standard Bore Diameter (mm)	Piston Groove Diameter (mm)	Rod Groove Diameter (mm)	Groove Width (mm)
A	8 – 16.9	–4.9	+4.9	2.20
B	17 – 26.9	–7.3	+7.3	3.20
C	27 – 59.9	–10.7	+10.7	4.20
D	60 – 199.9	–15.1	+15.1	6.30
E	200 – 255.9	–20.5	+20.5	8.10

Energiser Materials

Elastomer	Compound Reference	Colour	Hardness (IRHD)	Temperature Range	Select for..
Aflas®	223301	Black	80	-10 to +200°C	Good chemical resistance (including amines and alkalis), good high temperature performance
Nitrile rubber (NBR)	36624	Black	70	-30 to +120°C	General purpose
Fluorocarbon (FKM, A-type)	51414	Black	75	-20 to +200°C	High temperature performance; high speed applications; 514141 (Viton® GF type) for improved coolant and fuel resistance
	51414G	Green	75		
Fluorocarbon (FKM, GF-type)	514141	Black	75	-10 to +200°C	
Hydrogenated nitrile (HNBR)	88625	Black	70	-30 to +180°C	Abrasion resistance; high temperatures
Perfluoroelastomer (FFKM)	FFKM-75-162	Black	75	-15 to +275°C	Exceptional chemical resistance and high temperatures
	FFKM-75-164	Black	75	-15 to +310°C	

Material Grades

Material Reference	Description	Colour	Coefficient of Friction	Temperature Range	Select for..
E400	Virgin PTFE	Grey	0.05 / 0.08	-240 to +200°C	Static or low duty cycles
E451U	Glass reinforced PTFE	Grey / Black	0.06 / 0.10	-160 to +290°C	Dynamic or static, medium duty cycles, hardened metal running surfaces
E471	Graphite reinforced PTFE	White	0.06 / 0.10	-200 to +250°C	Dynamic, medium duty cycles
E462	Carbon and graphite reinforced PTFE	Black	0.08 / 0.12	-200 to +250°C	Dynamic, medium duty cycles
E491	Polyester reinforced PTFE	Brown	0.08 / 0.12	-130 to +290°C	Dynamic or static, medium to high duty cycles, minimum 45 HRc running surface
E282Z	Carbon, graphite and PPS reinforced PTFE	Grey	0.08 / 0.12	-130 to +290°C	Dynamic or static, high duty cycles, hardened metal running surfaces

Double Acting Cap Seal

Product overview

A self-actuating, bi-directional, extrusion resistant seal that combines low breakout and running friction with minimal leakage. The seal is constructed of a premium grade PTFE sealing element and an elastomer energiser.

The Double Acting Cap Seal is a reliable, compact design with a long service life and is available in both rod and piston type geometries to retro-fit into ISO7425-2. Stick-slip is eliminated even after long periods of inactivity whether in a lubricated or non-lubricated environment, giving low breakout friction.

pioneer WESTON

C** - 15000 - D - 36624 - E471 - PWI

PTFE GRADE CODE
E471 Graphite Filled PTFE

ELASTOMERIC ENERGISER COMPOUND REFERENCE
36624 Nitrile NBR 70 °IRHD

RADIAL SECTION CODE
A = 1.78
B = 2.62
C = 3.53
D = 5.33
E = 6.99

BORE/ROD DIAMETER
150.00 mm

TYPE
SP – Piston Type Single Acting
DP – Piston Type Double Acting
SR – Rod Type Single Acting
DR – Rod Type Double Acting

Standard Radial Sections

Radial Section Code	Standard Bore Diameter (mm)	Piston Groove Diameter (mm)	Rod Groove Diameter (mm)	Groove Width (mm)
A	8 – 16.9	–4.9	+4.9	2.20
B	17 – 26.9	–7.3	+7.3	3.20
C	27 – 59.9	–10.7	+10.7	4.20
D	60 – 199.9	–15.1	+15.1	6.30
E	200 – 255.9	–20.5	+20.5	8.10

Energiser Materials

Elastomer	Compound Reference	Colour	Hardness (IRHD)	Temperature Range	Select for..
Aflas®	223301	Black	80	-10 to +200°C	Good chemical resistance (including amines and alkalis), good high temperature performance
Nitrile rubber (NBR)	36624	Black	70	-30 to +120°C	General purpose
Fluorocarbon (FKM, A-type)	51414	Black	75	-20 to +200°C	High temperature performance; high speed applications; 514141 (Viton® GF type) for improved coolant and fuel resistance
	51414G	Green	75		
Fluorocarbon (FKM, GF-type)	514141	Black	75	-10 to +200°C	
Hydrogenated nitrile (HNBR)	88625	Black	70	-30 to +180°C	Abrasion resistance; high temperatures
Perfluoroelastomer (FFKM)	FFKM-75-162	Black	75	-15 to +275°C	Exceptional chemical resistance and high temperatures
	FFKM-75-164	Black	75	-15 to +310°C	

Material Grades

Material Reference	Description	Colour	Coefficient of Friction	Temperature Range	Select for..
E400	Virgin PTFE	Grey	0.05 / 0.08	-240 to +200°C	Static or low duty cycles
E451U	Glass reinforced PTFE	Grey / Black	0.06 / 0.10	-160 to +290°C	Dynamic or static, medium duty cycles, hardened metal running surfaces
E471	Graphite reinforced PTFE	White	0.06 / 0.10	-200 to +250°C	Dynamic, medium duty cycles
E462	Carbon and graphite reinforced PTFE	Black	0.08 / 0.12	-200 to +250°C	Dynamic, medium duty cycles
E491	Polyester reinforced PTFE	Brown	0.08 / 0.12	-130 to +290°C	Dynamic or static, medium to high duty cycles, minimum 45 HRc running surface
E282Z	Carbon, graphite and PPS reinforced PTFE	Grey	0.08 / 0.12	-130 to +290°C	Dynamic or static, high duty cycles, hardened metal running surfaces

Capped O-ring

Product Overview

Capped O-rings are a cost-effective solution for providing cap seals for rod and piston seal applications. The seal assembly consists of a cap manufactured from one of ERIKS premier PTFE compounds and an O-ring to act as the seal energiser.

The design of the capped O-ring protects the elastomer from extrusion and nibbling. The specially profiled cap element acts as the seal's dynamic interface and prevents spiral failure and reduces stick slip, commonly associated with O-ring seals.

Our capped O-rings are designed to retrofit existing O-ring grooves, including AS4716 standard housing dimensions. Both metric and imperial sizes are available and can be tailored to fit housing dimensions provided. Our technical team can also advise on how to optimise O-ring squeeze to minimise seal friction.

pioneer WESTON

COP- 10000 - C - 36624 - E491 - PWI

PTFE GRADE CODE E491	
ELASTOMERIC ENERGISER COMPOUND REFERENCE 36624	
RADIAL SECTION CODE A = 1.78 B = 2.62 C = 3.53 D = 5.33 E = 6.99	
BORE/ROD DIAMETER 150.00 mm	
TYPE COP = Piston COR = Rod	

Energiser Materials

Elastomer	Compound Reference	Colour	Hardness (IRHD)	Temperature Range	Select for..
Aflas®	223301	Black	80	-10 to +200°C	Good chemical resistance (including amines and alkalis), good high temperature performance
Nitrile rubber (NBR)	36624	Black	70	-30 to +120°C	General purpose
Fluorocarbon (FKM, A-type)	51414	Black	75	-20 to +200°C	High temperature performance; high speed applications; 514141 (Viton® GF type) for improved coolant and fuel resistance
	51414G	Green	75		
Fluorocarbon (FKM, GF-type)	514141	Black	75	-10 to +200°C	
Hydrogenated nitrile (HNBR)	88625	Black	70	-30 to +180°C	Abrasion resistance; high temperatures
Perfluoroelastomer (FFKM)	FFKM-75-162	Black	75	-15 to +275°C	Exceptional chemical resistance and high temperatures
	FFKM-75-164	Black	75	-15 to +310°C	

Material Grades

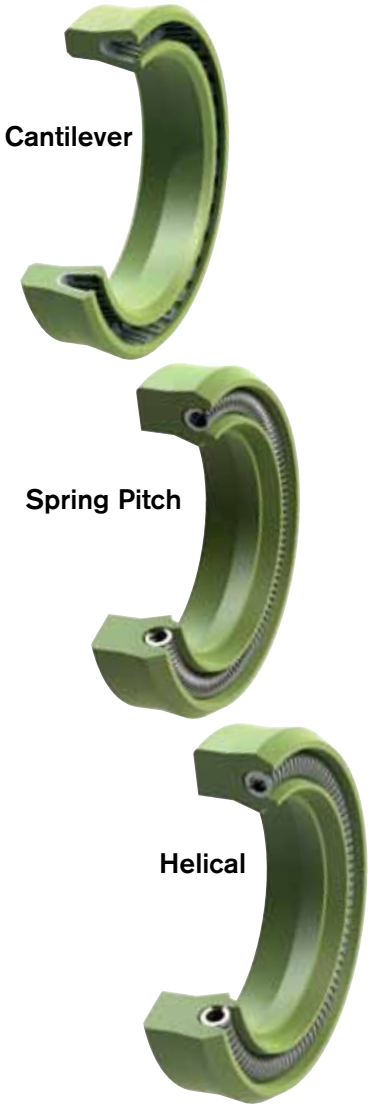
Material Reference	Description	Colour	Coefficient of Friction	Temperature Range	Select for..
E400	Virgin PTFE	Grey	0.05 / 0.08	-240 to +200°C	Static or low duty cycles
E451U	Glass reinforced PTFE	Grey / Black	0.06 / 0.10	-160 to +290°C	Dynamic or static, medium duty cycles, hardened metal running surfaces
E471	Graphite reinforced PTFE	White	0.06 / 0.10	-200 to +250°C	Dynamic, medium duty cycles
E462	Carbon and graphite reinforced PTFE	Black	0.08 / 0.12	-200 to +250°C	Dynamic, medium duty cycles
E491	Polyester reinforced PTFE	Brown	0.08 / 0.12	-130 to +290°C	Dynamic or static, medium to high duty cycles, minimum 45 HRc running surface
E282Z	Carbon, graphite and PPS reinforced PTFE	Grey	0.08 / 0.12	-130 to +290°C	Dynamic or static, high duty cycles, hardened metal running surfaces

Spring Energised Seal

Product overview

The Spring Energised (SE) seal pressure activated seal, with assisted energisation provided by corrosion-resistant metal spring. When the seal is in situ, the spring is under compression and applies force to seal's sealing lips. This creates a tight barrier to prevent gas or fluids from leaking.

The spring also provides resiliency to compensate for seal wear, gland misalignment or eccentricity. While spring force provides adequate force for sealing at low pressure, at high pressure the system pressure augments the spring force to provide an even tighter seal. SE seals are precision machined from PTFE, filled PTFE and other high performance polymers. SE seals work consistently under a wide array of temperatures and pressures. ERIKS offers over 100 jacket materials, 8 spring materials, and 5 spring designs to meet your sealing needs.



Spring Designation

Spring Type	Material Code	Material Description
Cantilever	1	301 Stainless Steel
	6	316 Stainless Steel
	H	Hastelloy® C-276
	E	Elgiloy®
Spiral Pitch	2	302 Stainless Steel
	6	316 Stainless Steel
	H	Hastelloy® C-276
Helical	2	302 Stainless Steel
	H	Hastelloy® C-276

PTFE Grades

Material Reference	Description	Wear Factor (K)	Application
E431	Glass and Molybdenum Disulphide reinforced PTFE	15	Dynamic/Static, Medium duty cycles Hardened metal running surfaces
E471	Graphite reinforced PTFE	10	Dynamic, Medium duty cycles
E462	Carbon/Graphite reinforced PTFE	15	Dynamic, Medium duty cycles
E491	Polyester reinforced PTFE	2	Dynamic / Static, Medium to high duty cycles, Minimum 45 HRc running surface
E282Z	Carbon/Graphite/PPS reinforced PTFE	1	Dynamic / Static, High duty cycles, Hardened metal running surfaces

E - V - 1 - A - 1 - M - 136 - E431

MATERIAL CODE
E431

DASH SIZE REFERENCE
136

SPRING LOAD
L – Light
M – Medium
H – Hard

SPRING MATERIAL
301 Stainless Steel

LIP CONFIGURATION
ROD AND PISTON SEALS:
A – Standard
B – I.D. Scraper
C – O.D. Scraper
D – Double Scraper
FACE SEALS:
A – Standard

SEAL TYPE
ROD AND PISTON SEALS:
1– Standard heel rod seal
2 – Standard heel piston seal
3 – Extended heel rod seal
4 – Extended heel piston seal
FACE SEALS:
5 – Internal face seal
6 – External face seal

SPRING TYPE
V – Cantilever
S – Spiral pitch
H – Helical

PRODUCT LINE
E

Metal Face Seals

Product Overview

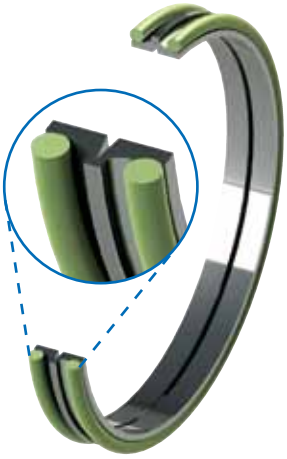
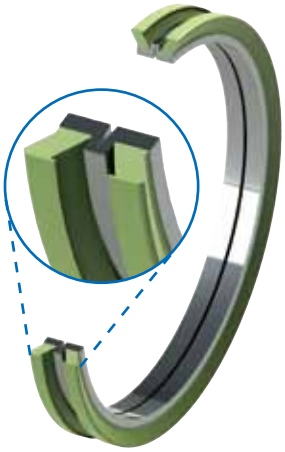
Pioneer Weston's range of metal face seals offer bearing protection and fluid retention on any relatively slow-moving housing assembly. These seals are constructed from two identical, tapered metal rings, loaded using elastomer seals. Such designs excel under extreme environments, where the exclusion of contaminants such as sand, rock, mud and water is imperative, providing a robust efficient solution, with long service life and low maintenance.

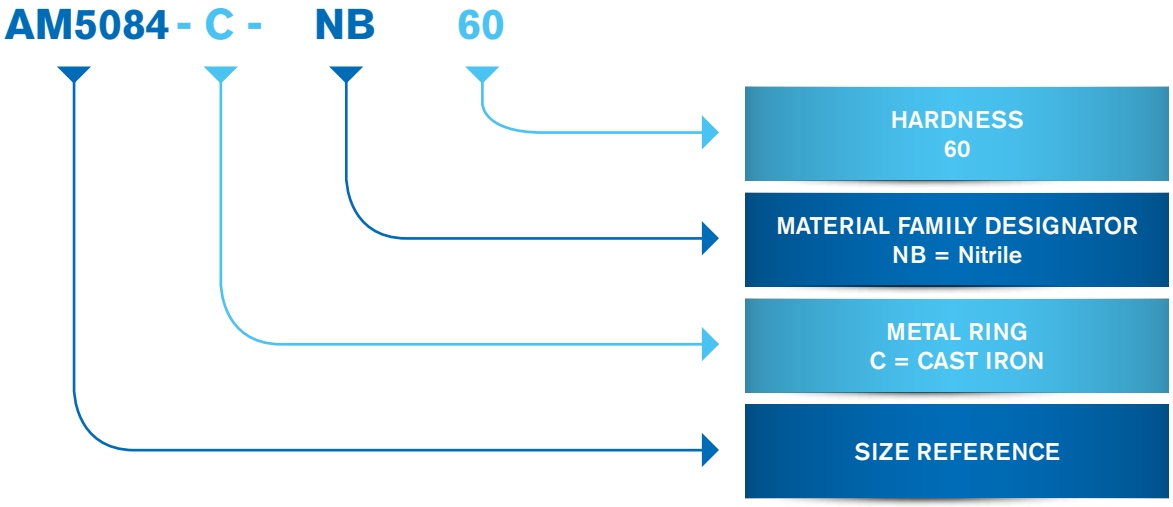
Advantages & Benefits

- Corrosion and abrasion resistant seal rings
- Special seals and load ring materials to match application requirements
- Self-centering to compensate for eccentricity or misalignment
- Cost savings from extended machinery life
- Easy to assemble and minimal maintenance
- Broad operational temperature range from -40°C to 200°C, dependent upon material selections

Pioneer Weston can provide a comprehensive range of sizes that are common in the market place. Non standard sizes are available on request.

Metal Face Seal Profiles

Seal Profile	Profile Features	Advantages and Benefits	Applications
5000 Series 	– Two identical tapered metal rings with precision lapped opposing faces (One rotating and the other stationary). – Elastomer O-rings	– The most common design of a metal face seal, available in a large range of sizes. – O-rings are used as secondary sealing elements providing: static sealing on housing and ID, uniform axial pressure on metal rings, transmits torque to the rotating face. – Tapered surfaces allow lubrication to get to the precision-lapped metal faces via centrifugal action	– Large rigid axles – Rock drill bits – Conveyor equipment (e.g. rollers) – Mixers and grinders – Road-rolling equipment – Cranes – Planetary gear box (speed reducer) – Idler rollers for tracked vehicles – Tunnelling and mining equipment
5500 Series 	– Two identical tapered metal rings with precision lapped opposing faces (One rotating and the other stationary). – Special elastomer washers	– Allows for simpler housing design and construction – Housing is easier to machine, but more housing space is required – Tapered surfaces allow lubrication to get to the precision-lapped metal faces via centrifugal action – Special elastomer seals allows higher pressure capability, whilst maintaining the same functions as an O-ring.	– Specifically used for undercarriage applications for agricultural and construction vehicles, i.e. bulldozers, excavators – Military Vehicles



Selection and Material Specification

Ensuring the correct material composition is paramount. Pioneer Weston can work with the customer to analyse application requirements and recommend the most suitable materials. The main factors in ensuring the correct selection are: size, temperature, speed, pressure, media

Metal Face Seals Reference

Polymer Family	Compound Reference	Colour	Hardness (IRHD)	Temperature Range	Select for..	Material Designator
Nitrile rubber (NBR)	N-60-214	Black	60	-35 to +110°C	General purpose	NB
	N-60-148	Black	60	-60 to +110°C	Low temperature, with a degree of resistance to lubricants	LTNB
Fluorocarbon (FKM, A-type)	V-60-190	Black	60	-20 to +200°C	High temperatures, good lubricant resistance.	FKM
Fluorocarbon (FKM, GLT-type)	V-60-181	Black	60	-40 to +200°C		LTF
Hydrogenated nitrile (HNBR)	H-60-123	Green	60	-40 to +180°C	Abrasion resistance; high temperatures	HN

Metal Ring Designator	Metal Type	Description
F	Forged roller bearing steel	■ General purpose ■ Hardness >58 HRc ■ Circumferential speed ≤ 2.0m/s ■ Pressure ≤ 1.5 bar
C	Cast iron	■ Enhanced corrosion and abrasion resistance ■ Hardness 65-72 HRc ■ Circumferential speed ≤ 3.0m/s ■ Pressure ≤ 2.0 bar
X	Cast alloy	■ Superior corrosion and abrasion resistance ■ Hardness 68-72 HRc ■ Circumferential speed ≤ 4.0m/s ■ Pressure ≤ 2.5 bar

Installation and Maintenance

Installation Method

1. Ensure that the inside of the housing is clean, free of burrs, scratches and dust. The load ring must be correctly fitted on the seal and be free from distortion (see Figure A).

2. Install the seal with load ring in the housing (Figure B). At this time, confirm that the end of the housing (1) will be parallel to the lapped surface of the seal (2). If the seal becomes out of alignment, even partially (Figure C) the seal shall have abnormal wear, the o-ring will become distorted and will eventually fail prematurely.

3. After insertion, make sure that the precision lapped surfaces are absolutely free of foreign matter, then lightly apply lubricant oil to the mating surfaces. Upon completion of the seal installation, reassemble the housings to the correct setting gap (see below) and fill with lubricating oil.

When properly installed, the two mated metal surfaces seal against each other, a thin film of lubrication between these two surfaces minimises wear, and the load rings provide pressure to ensure positive sealing.

Setting gap

The setting gap determines the amount of axial pressure on the sealing faces and the compression applied to the elastomeric rings. Pioneer Weston seals are designed so a setting gap A of 3.0-0.5mm will provide adequate sealing force for the majority of applications. However if the seals are required to work at a continuous high peripheral speed the setting gap should be adjusted in order to prevent an excessive loading of the lubricating oil.

This will reduce surface pressures and can be done by increasing the setting gap. In this case tests should be conducted to find the most suitable setting.

Lubrication

Correct installation will count for very little if the lubrication regime is overlooked or incorrectly administered. The seals will have a far greater operating life when provided with good lubricating and heat dissipating qualities when oil is used as opposed to grease.

Oil

Transmission oils, grade SAE 80 and SAE 90 are recommended. If necessary, lower viscosity lubricants such as engine oil 20W 20 can also be used. In cases where hydraulic fluids / bio-oils are to be used, please contact Pioneer Weston direct for advice. The oil level should be between the axis centre line and 2/3 of the seal diameter. When filled to the correct level, the oil will generally suffice for the lifetime of the seal.

Grease

Although grease can be used as a lubricator it is not recommended due to the fact it will not centrifuge to the wedge gaps in the seal faces during dynamic conditions. If grease is used it will result in higher wear, shorter lifetime and can only run at slower sliding speeds.

The seal should, on no account, be regreased with a grease gun, as the high pressure of the gun can dislodge the o-rings and ultimately destroy them.

Figure A

Correct Incorrect

Figure B

Figure C

Exclusion Devices / Wiper Rings

Product Overview

Exclusion devices also known as Wiper Rings or Scrapers are installed in sealing configurations to exclude foreign particles such as sand, grit, dirt, water, abrasive media, etc. They are normally installed in the piston rod gland housing and wipe the piston rod during retraction. They prevent contamination of the hydraulic fluid, which could otherwise damage valves, seals, wear rings and other components.

ERIKS Sealing Technology offers a comprehensive range of metallic and polymeric Exclusion devices. These configurations include combinations of elastomeric, metallic and PTFE based material Exclusion/Wiper lips, which are configured to the application requirements. ERIKS also provide both single-acting and double-acting wiper ring designs. Vented forms available for subsea applications on request.

WR - MET - 050.00 - 070.00 - 10.00 - GPN

- **GPN** — MATERIAL DESIGNATOR GPN
- **10.00** — GROOVE WIDTH 10.00mm
- **070.00** — GROOVE DIAMETER 70.00mm
- **050.00** — ROD DIAMETER (mm) 50.0mm ROD
- **MET** — WIPER RING STYLE
  MET = Metal / Elastomeric
  MEP = Metal Encased Polyurethane
  ETP = Elastomeric and Thermoplastic Double Acting Wipers
- **WR** — WIPER RING CALL OUT

Metal Scrapers

Metal scrapers consist of a Nitrile (NBR) wiping lip in conjunction with a thin brass scraper lip, encased in a steel shell. The combination is used for arduous environments and is suitable for tar, ice, removing dried or frozen mud and other contaminants from the rod.

Metal Encased Polyurethane Scraper

A Metal Encased Polyurethane scraper can be installed into open grooves. This style of Scraper comprises of a polyurethane (AU) scraper element housed in a metallic casing. The polyurethane scraper element offers highly effective scraping performance and abrasion resistance. This design is commonly used in mobile hydraulic plant and agricultural equipment.

Elastomeric and Thermoplastic Double Acting Wipers

A Double acting wiper has either a sealing and a scraping lip in Nitrile (NBR) or proprietary reinforced PTFE. It is optimised when used with rod seals that have a back pumping capability. The double acting wiper is recommended for light to medium duty and is available in alternative elastomeric/PTFE grades on request.

Material Designator Codes

Material Designator	Description	Temperature Range
BPN	Bronze reinforced PTFE / NBR 70	-30°C to 100°C
BPV	Bronze reinforced PTFE / FKM 70	-20°C to 200°C
GPN	Graphite reinforced PTFE / NBR 70	-30°C to 100°C
GPV	Graphite reinforced PTFE / FKM 70	-20°C to 200°C

Machined Wear Ring / Bearing Strip

Product Overview

The design intent of a Bearing Strip or Wear Ring is to guide the piston and/or rod into a pneumatic or hydraulic cylinder. Any potential side or transverse loads applied to the piston rod will be supported by the Wear Ring, thus preventing contact between the static and sliding parts of the cylinder.

ERIKS Wear Rings are non-metallic and offer advantages over traditional metallic bearings. These benefits include improved load distribution, reduced friction, easy installation and lower abrasion.

Different types of materials are available depending upon the application requirements. PTFE based Wear Rings are for use in low to medium loads, fabric composite Wear Rings are to be used under high load conditions.

ERIKS Wear Rings are precision machined to mate with the customers hardware and are available in a range of sizes, as defined by the below part numbering system.

MWR -P -125.00 - B - 2.15 -14.50- B

- **MATERIAL DESIGNATOR**
  V = Virgin PTFE
  C = Carbon Filled PTFE
  B = Bronze Filled PTFE
  F = Fabric Composite
- **GROOVE WIDTH (mm)**
- **THICKNESS (GROOVE DEPTH)**
- **TYPE OF CUT**
  A = Angled B = Butt
  S = Stepped
- **BORE/ROD DIAMETER**
  5mm TO 999.99mm
- **BEARING ORIENTATION**
  P = PISTON TYPE R = ROD TYPE
- **MWR – MACHINED WEAR RING**
  BT – PRE-CUT BEARING STRIP

Machined Wear Ring Dimensions

PISTON BEARINGS			
Bearing Radial Thickness (mm)	Groove Width (mm) (+0.25/0.00)	Bearing Groove Diameter	Internal Groove Radii
1.00	6.00	Bore Diameter - 2.00/2.05mm	0.25mm Max
1.50	3.20	Bore Diameter - 3.00/3.05mm	
	10.00		
1.55	2.50	Bore Diameter - 3.10/3.15mm	
	4.00		
2.00	9.70	Bore Diameter - 4.00/4.05mm	
	15.00		
2.50	4.20	Bore Diameter - 5.00/5.05mm	
	5.60		
	6.30		
	8.10		
	9.70		
	15.00		
	20.00		
	25.00		
	30.00		
3.00	20.00	Bore Diameter - 6.00/6.05mm	
4.00	9.70	Bore Diameter - 8.00/8.05mm	
	25.00		

ROD BEARINGS			
Bearing Radial Thickness (mm)	Groove Width (mm) (+0.25/0.00)	Bearing Groove Diameter	Internal Groove Radii
1.00	6.00	Rod Diameter - 2.00/2.05mm	0.25mm Max
1.50	3.20	Rod Diameter - 3.00/3.05mm	
	10.00		
1.55	2.50	Rod Diameter - 3.10/3.15mm	
	4.00		
2.00	9.70	Rod Diameter - 4.00/4.05mm	
	15.00		
2.50	4.20	Rod Diameter - 5.00/5.05mm	
	5.60		
	6.30		
	8.10		
	9.70		
	15.00		
	20.00		
	25.00		
	30.00		
3.00	20.00	Rod Diameter - 6.00/6.05mm	
4.00	9.70	Rod Diameter - 8.00/8.05mm	
	25.00		

Bearing Strip

Product Overview

Bearing Strips are skived from material billets and are available in the standard thicknesses and widths. ERIKS Bearing Strip can be supplied in metre lengths.

Length Calculation for Bearing Strip

Once the bearing strip is installed it is important that a 'Gap' is present between each end of the bearing strip. This feature is required to ensure :-

- There is sufficient room to allow for expansion which occurs during increases in temperature.
- The prevention of pressure entrapment.
- To ease installation and aid bearing strip removal.

If you purchase our Bearing Strip by the metre, the length of the strip can be calculated as shown in the box to the right.

For Bearing Strip used in Piston applications:-

$$LB = (\pi \times (B - TH) / 1.01) - C$$

For Bearing Strip used in Rod applications:-

$$LB = (\pi \times (R + TH) / 1.01) - C$$

Where:-

LB	=	Calculated Bearing Strip Length (mm).
B	=	Bore diameter (mm)
R	=	Rod diameter (mm).
TH	=	Bearing Strip thickness (mm)
C	=	Gap constant: 0.8 (1.8 for PTFE based materials above 120°C)

Wear Ring / Machined Bearing Strip Design Guide

Bearing Design Options

Careful consideration needs to be taken when choosing the correct bearing material. Factors influencing the design are load capacity, friction, temperature, service life and running velocity. As a general guide if wear and load bearing is paramount, then Phenolic/fabric composite materials are favoured. If low friction is important, PTFE based materials offer the best option.

Load Capability

To ensure minimal wear and optimum performance it is important to maintain the lowest possible unit load over the bearing. The bearing load can be estimated using the below illustrated calculation.

Influencing factors such as rod/piston deflection, bearing deformation and diametrical tolerancing need to be considered when considering bearing design. Other factors including external loads, geometrical tolerances (eccentricity, concentricity, ovality) and component weight also need to be recognised.

It is good practice to minimise bearing radial cross section as for a given load the thinner the radial cross section, the less the deflection. Lifetime requirements may contradict this.

Our experts can assist you in selecting the optimal configuration for your application if required.

BT - 2.50- 15.00 - B

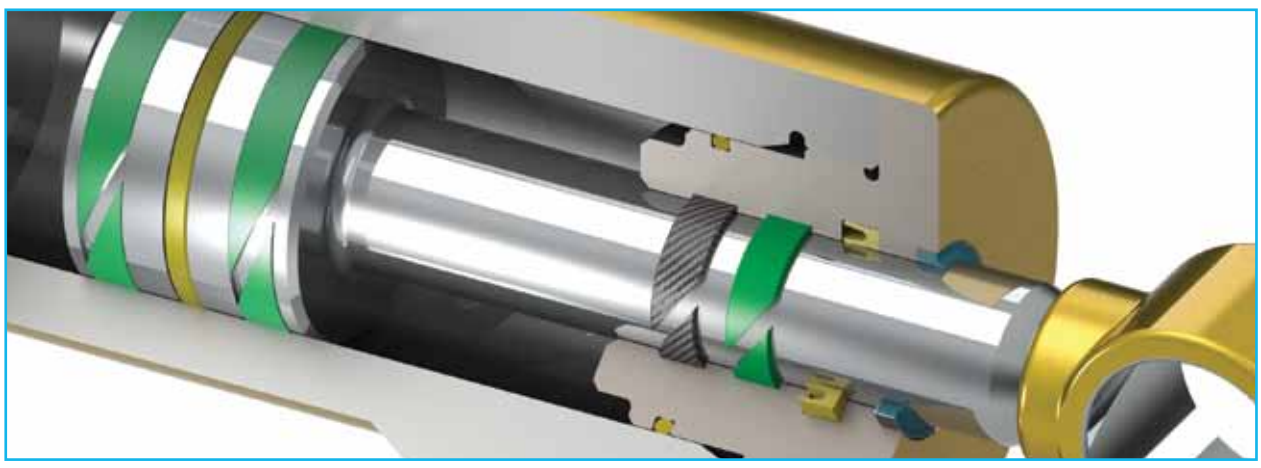
MATERIAL DESIGNATOR
V = Virgin PTFE
C = Carbon filled PTFE
B = Bronze Filled PTFE

GROOVE WIDTH (mm)
2.50
4.00
5.60
9.70
15.00
20.00
25.00

THICKNESS (GROOVE DEPTH)
1.00mm
1.55mm
2.00mm
2.50mm
3.00mm
4.00mm

BT–BEARING STRIP

Note: For small diameters, machined wear rings are recommended to aid installation. Minimum Bearing Strip Diameters: PTFE 8mm, Fabric 60mm.

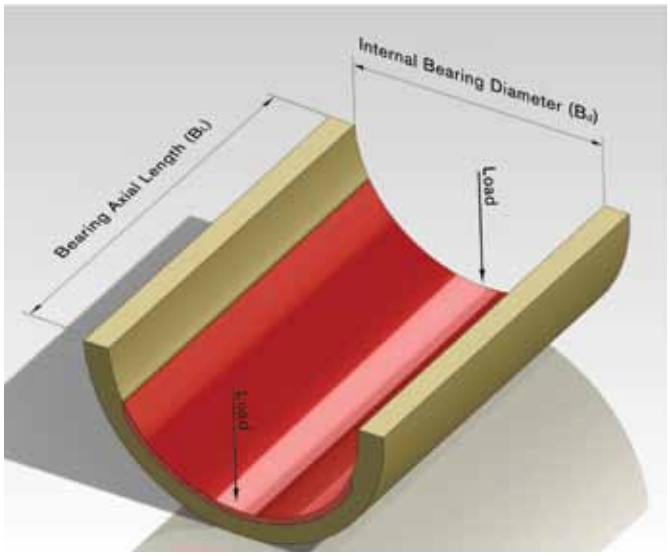


Bearing Calculation

For the Bearing Load Calculation we assume the load distribution is uniform over a project bearing area. The bearing area may be approximated by using the following calculation.

Projected Bearing Area (Bpa) =
Internal Bearing Dia (Bd) X Bearing Axial Length (BL).

e.g.	Internal Bearing Diameter (Bd)	= 50mm
	Bearing Axial Length (BL)	= 25mm
	Projected Bearing Area (Bpa)	= 1,250mm^2

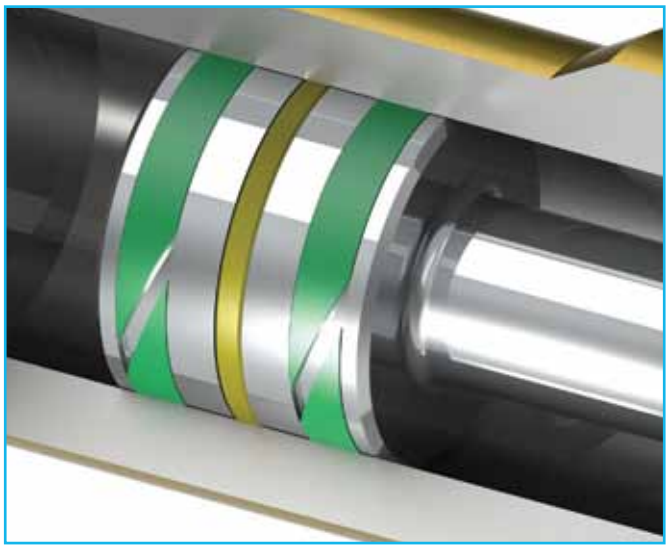


When the Projected Bearing Area (shaded red) has been approximated, the bearing pressure may be found by dividing the Total Force Load by the Projected Bearing Area. This will determine the minimum compressive strength (Cs) of the bearing material to be utilised. If your design requires the incorporation of a safety factor, it is advisable to multiply the Total Force Load (FL) by the desired factor of safety (FOS), e.g. 2. The required bearing compressive strength can be calculated as follows;

$$Cs = \frac{FOS \times FL}{(Bd \times BL)}$$

$$Cs = \frac{(2 \times 3000N)}{(50mm \times 25mm)}$$

$$Cs = \frac{6000}{1250} = 4.8\ MPa$$



Material Selection

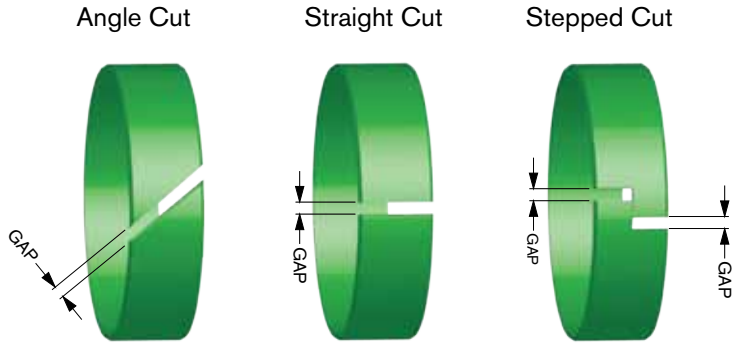
Calculating the required bearing material strength is important in determining the correct material to use. Listed below are additional criteria that need to be considered;

- Is the application rotary, reciprocating or static?
- What surface speed will the bearing see?
- Is lubrication present?
- What are the temperature extremes?
- What is the shaft/bore material, hardness and surface finish?
- Does the bearing have exposure to abrasive, erosive and chemically aggressive media?

The below table defines the properties of the standard materials available.

Material	Compressive Strength (Max)	Max Surface Speed	Mating Surface	Size Availability	General Uses
Bronze filled PTFE	15 MPa at 25°C 12 MPa at 80°C 8 MPa at 120°C	15.0 m/s	Steel Hard Chrome, Steel Hardened	Rings 8mm to 2600mm	Light load, Lubricated environment
Carbon filled PTFE	12 MPa at 25°C 9 MPa at 80°C 5 MPa at 120°C		Stainless Steel, Hard Anodised Aluminium	Up to 4600mm in Strip form	Light duty, can run dry
Phenolic (Fabric composite)	300 MPa at 25°C (Static) 50 MPa at 60°C (Dynamic)	1.0 m/s	Steel Hard Chrome, Steel Hardened	10mm to 1500mm (Rod Dia)	Heavy load, lubricated environment

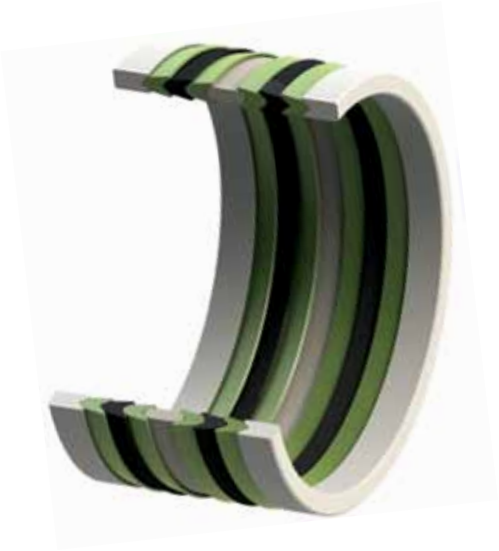
Type of Cut



Angled cuts are recommended for use in reciprocating applications. Straight cuts are for rotary applications. Stepped cuts are used in special applications, e.g. for flow restriction.

Machined Wear Rings are application specific. Based upon application data, the appropriate dimensions and hardware tolerances will be calculated by our technical team for the entire sealing system.

V-packing



If seal redundancy is required, the multi-lip V-packing assembly is the seal of choice. Configurations of PTFE, Thermoplastic and Elastomer can be combined to provide sealing solutions across a broad range of parameters.

V-packing assemblies are available in both uni-directional and bi-directional designs. A typical uni-directional V-packing assembly consists of a header (primary) seal, V-rings (secondary seals) and an end adaptor. The number of V-rings can be tailored to meet the specific redundancy needs. To aid installation V-packing seal assemblies need to be installed in open glands.

High differential pressures can be tolerated, as the multi-lip redundancy can offer a suitable solution for low fugitive emission requirements. Each sealing lip is mechanically energised by the prior sealing element and provides support, thus increasing the seal assembly resistance to extrusion.

The practice of multi-lip redundancy optimises sealing integrity across the complete seal assembly and maximises sealing efficiency for ultimate leakage control. ERIKS V-packing assemblies are tailored to meet specific application environments. Please contact ERIKS UK with your application details or for further information.

Lip seals for use in Pipeline Closures

Pipeline closures offer a unique set of challenges to seals making very specific sealing solutions necessary:

Application conditions:

- 150, 300, 600, 900, 1200, 1500 ASA pressure ratings
- Wide operating temperature ranges starting from -46°C
- Diverse fluid media
- Over-compression of the seal during door closure
- Very high clearance gaps
- Low closure force requirements
- Low pressure sealing requirements
- Fast activation required to accommodate pressure fluctuations
- Pressure trapping in groove
- Large diameters
- Uneven clearance gaps due to effects of gravity on heavy horizontally opening doors
- Rapid Gas Decompression resistance

Specially designed lip seals with or without reinforcing elements may be used to meet this challenging combination of application requirements. Careful design optimisation using Finite Element Analysis is often critical to success.

Rubber Moulded and Extruded Products

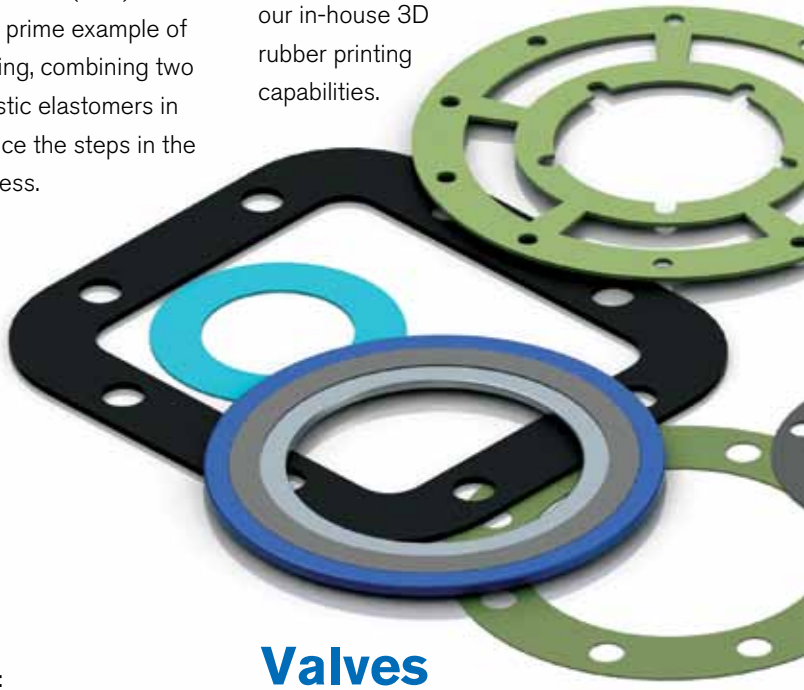
Rubber Mouldings

The moulding of rubber and elastomeric compounds is accomplished by forcing the material into a shape using heat and pressure. Rubber and elastomers can be moulded by compression, transfer and injection methods. The volume of parts and type of compound required will determine the moulding method used. Our engineers participate with you to develop innovative solutions for your production.

Extruded Rubber Profiles/ Inflatables

Our comprehensive product range incorporates not only rubber, but also Thermo Plastic Elastomer (TPE). Our TPE solutions are a prime example of our innovative thinking, combining two or three thermo plastic elastomers in one product to reduce the steps in the manufacturing process.

Our in-house CAD/CAM capability also enables us to quickly design and accurately manufacture innovative solutions to meet new applications and operating conditions utilising our in-house 3D rubber printing capabilities.



Gaskets

ERIKS' product knowledge ensures you always get the right gasket for the job. Our gasket installation kits for example, have the seals and gaskets logically packed for ease of assembly, to save you time.

We design, manufacture and supply a wide range of essential sealing and insulation components to many industries where equipment failure is not an option. Products include cut gaskets, packings, sheet jointing materials, moulded seals and shaped thermal insulation components, all vital to a modern industrial society.

By closely working with leading material manufacturers we offer a range of quality products at cost-effective prices. Cut gaskets and sheet jointing available from every imaginable sealing material including specialised materials

In addition we offer:

- **Spiral Wound Gaskets**
- **Gland Packings**
- **Ring Type Joints**
- **Extrusions**
- **Rubber Mouldings Rubber Proof Woven Cloths**
- **Dry and Coated Woven Cloths**
- **Boiler House Products**
- **Thermal Insulation Fabrications**
- **Multi-ply Expansion Joints and Strip**
- **Boiler Combustion Chamber Insulation**
- **Boiler/Cooker Case Insulation**

Valves

Econosto offer a wide range of oil & gas valves from stock held locally both at Aberdeen and Leicester.
These may be supplied with API 6D and API 6A approvals for wellhead and Christmas tree equipment.

From stock:
Forged steel gate
Globe and check valves
Ball valves
Trunnion-mounted ball valves

Upon request:
Tandem trunnion ball valves
Floating ball valves
Bypass valves with high temperature and cryogenic options

ERIKS Sealing Technology

ERIKS Sealing Technology offers a comprehensive range of high performance sealing products, supported by a world-class technical and logistical service to deliver the right seal on time to your critical applications.

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know-how makes the difference

ERIKS