Technical And Material Standards

Section 2

"QUALITY AND RELIABILITY ASSURED".

QUALITY MECHANICAL SEALS

In our industry, 'QUALITY' is the key word. Vulcan fully understands the true meaning and importance of Quality and have long practiced the principle of Total Product and Supply Quality, through a dedication to installing built-in reliability and quality into every aspect of our company. Electronic production, inspection and process control is integral to every area of our production and logistics. The foundation for this Total Quality Philosophy is our focus upon investment in and development of world class manufacturing facilities, electronic processes and our Technical and Material Standards.

RELIABLE PRODUCT

There are many alternative mechanical seal suppliers around the world. At first sight, their product may look similar but often lacks the many vital aspects which go to make a Quality Mechanical Seal. Failures in supply, fitting or operation often result.

The key is surety, safety, reliability and the resultant seal capability, performance and life. We pride ourselves on being The Most Cost Competitive, Lowest Total Cost Provider of Quality Mechanical Seals.

Vulcan welcomes visitors to view all of our production and distribution facilities. To see for yourselves the Total Quality and Customer Satisfaction Policy, which is central to our success.

MECHANICAL SEAL TESTING

Vulcan have designed, specified and installed a unique, tri-parate, static air pressure test rig, into our seal assembly department. This is utilised partly for seal testing purposes but primarily to sample inspect and test seals, from each batch of production assembly. In addition, we offer 100% batch inspection and test, to agreed parameters, as part of our supply to individual customer contracts and specification.

All of the Vulcan mechanical seal stock types shown in this brochure have been extensively tested on our rotary test facilities. The seal performance data produced, more than supports our conservative Suggested Operating Limits for our seals and our technical information, such as the PV charts.

Dynamic Test Results Data Sheets are available for your consideration and use. In addition, Vulcan can conduct individual specific seal testing to your requirements. Our Test Data Sheets routinely illustrate that the maximum operating parameters of our seals are far in excess of our general advice on Suggested Operating Limits. There are however many factors which can affect safe product specification. Hence why we suggest conservative figures but also offer Test Data Sheets and specific testing to support customers, in their own decision, to evaluate a seals suitability for any particular application.

LASER MARKING

Reliable identification of product is useful and can add to seal quality and reliability. Vulcan has invested in, high specification and cost, laser etching machines to mark both elastomer and stainless steel components. We provide this as a service to individual customer contract specification and are increasing it's use throughout our product range.

IN HOUSE PRODUCTION OF QUALITY MATERIALS

Vulcan are the world's most vertically integrated mechanical seal manufacturer. This has naturally followed from our policy and dedication to specifying optimum material standards. Then developing our in-house manufacture of these materials and subsequent components.

As a result, not only is every Vulcan Standard Mechanical Seal solely produced in our own Vulcan factories but also practically all of our component parts and materials. We consider material manufacture and development to be fundamental to the quality, performance, reliability and economy of our mechanical seals

Two recent developments which illustrate Vulcan's continuous commitment to developing our materials capabilities and uses are;

SINTERED SILICON CARBIDE MANUFACTURING

Vulcan have for over a decade manufactured Reaction Bonded Silicon Carbide for use within our seals. In 2004, following agreement with a global manufacturer and supplier of Carbides, Vulcan purchased an entire Sintered Silicon Carbide production plant, as part of a purchase, installation and technology swap and supply agreement.

As is our practice, we then rapidly developed this plant and facility; adding equipment such as new, more efficient furnaces, isostatic presses, over twenty CNC internal and external grinders and a test and electronic inspection facility. We also subsequently opened and developed the in-house expertise and infrastructure to manufacture our own raw material; Sintered Silicon Carbide powder.

Our goals in these developments is not to become a manufacturer and supplier of Silicon Carbide components but to incorporate the optimum quality materials, reliability and cost control into our mechanical seals.

E.C. FOOD INDUSTRY REGULATIONS AND FDA REQUIREMENTS: MATERIALLY COMPLIANT SEALS FROM VULCAN

Vulcan now offer from stock all common food and dairy seals, specified and specifically manufactured to be complaint with F.D.A. and E.C. Food Industry Regulations.

The principle underlying European Community (E.C) Regulation Number 1935/2004 "On Materials and Articles Intended to Come into Contact with Food" is that any material or article intended to come into contact directly or indirectly with food, must be sufficiently inert to preclude substances from being transferred to food, in quantities large enough to endanger human health, or to bring about an unacceptable change in the composition of the food, or a deterioration in its organoleptic properties".

Understanding the implications of these regulations is increasingly leading to food industry manufacturers stipulating that all materials, including mechanical seals, that come into contact with food should be made from F.D.A. compliant materials, which comply with the above E.C. Regulations (as required in Paragraph 8) and have full traceability of said materials (Paragraph 18).

In order to comply with these regulations where specified and as an integral part of Vulcan's standard policy to only offer superior designs and materials, we have made available from stock, all of our market leading range of food industry seals, specified to be manufactured from certified compliant materials to meet U.S. and European Food Industry Regulations.

These materials are specified to comply firstly with Part 177 of Title 21 of the Food and Drug Administration Regulations for safe use as articles or components of articles for producing, manufacturing, processing, preparing, treating, packing, transporting or holding food, in accordance with FDA Regulation 21. CFR.177.1550. and 177.2600.

Secondly, The Sub Group Mechanical Seals of the European Hygienic Engineering & Design Group (EHEDG), Specification of August 2002, stipulates requirements for component materials of mechanical seals, which come into contact with food. The materials, production and surface finish of Vulcan's Food Industry Compliant Seals have been carefully specified to meet all of the EHEDG recommendations and criteria. Full details are available upon request.

This range of Vulcan seals offer superior performance, reliability and life. They are specified to be compliant to the existing known regulations applicable in Europe and North America.

In order to specify or purchase these seals, merely add the prefix Y - to the existing stock code (replacing the W – prefix if you are already specifying the same). All common types are available ex-stock.

We can provide Vulcan's Certificates of Compliance, to the above Vulcan Specifications, upon request.

Note;

Please note that constantly developing legislation and Vulcan practices, may negate the advice given in this brochure. All of the information supplied within is given in good faith and in Vulcan's best judgment and is meant for guidance purposes only. We make no warranty that any Vulcan part will perform satisfactorily in a given application and would strongly recommends an independent evaluation prior to acceptance. Vulcan reserves the right to amend all statements, dimensions and technical data without prior notice.

VULCAN ELASTOMERS

In order to ensure absolute cost and quality control, all standard secondary seal materials are manufactured in-house by Vulcan (except for 'O'-Rings). We compound and manufacture the final elastomer and then mould our components, from moulds produced in our machine shops.
The Vulcan factories' moulding section utilises modern moulding machinery and techniques to produce any and all elastomeric components required for our seals, or as specials to customer needs.
Vulcan thus, uniquely in the mechanical seal industry, produce all our standard elastomer components, through final compounding of elastomer material, vulcanisation, oven curing, production of moulds, moulding, final curing and automatic flash removal.

NITRILE RUBBER; VULCAN GRADE VN19 SPECIFICATION

Raw material = BAYER Compound XL34.19

MATERIAL ANALYSIS

Nitrile	100.0
Calcium Carbonate	10.0
Steric Acid	1.0
Paraffins	1.0
Retarder	1.5
Zinc Oxide	5.0
Sulphur	1.8
H.A. Carbon Black	50.0
Re-inf. Carbon Black	20.0
Plasticiser 88	5.0
Plasticiser FH	5.0
Brimstone	1.8
Accelerant CZ	1.2
Accelerant MS	0.4
Accelerant MB	0.6

PROPERTIES

Original

Specific Gravity	ASTM D1817	1.28
Hardness: Shore A	ASTM D2240	70
Tensile Strength (Mpa)	ASTM D412	18.0
Elongation at Break (%)	ASTM D412	415.0

Heat Ageing in hot air at 100°C for 70hr (ASTM D573)

Tensile Strength (Mpa)	19.3
Elongation at Break (%)	250.0
Weight loss grams (%)	negligible

Fluid Immersion in ASTM3 oil at 100°C for 70hr (ASTM D472)

Tensile Strength (Mpa)	19.8
Elongation at Break (%)	315.0
Weight increasing ratio (%)	4.8
Volume increasing ratio (%)	2.9

E.P RUBBER; VULCAN GRADE VEP.MAR.4045 SPECIFICATION

MATERIAL ANALYSIS

EPDM	100.0
Zinc Oxide	5.0
Steric Acid	1.5
Naphthene Oil	8.0
H.A. Carbon Black	32.0
S.F. Carbon Black	18.0
Curing Agent	4.5
MBTS Vulcanising accelerant	0.6
TMTD Vulcanising accelerant	1.0
C. Oil	10.0
P. Oil	10.0

PROPERTIES

Original

Specific Gravity	ASTM D1817	1.42
Hardness: Shore A	ASTM D2240	70.0
Tensile Strength (Mpa)	ASTM D412	9.8
Elongation at Break (%)	ASTM D412	440.0

Heat Ageing in hot air at 125°C for 70hr (ASTM 0573)

Tensile Strength (Mpa)	12-1
Elongation at Break (%)	201.0
Weight loss grams	Negligible

Fluid Immersion in ASTM 3 oil at 150°C for 70hr (ASTM D471)

Volume Change (%)	+2.2
Elongation Change (%)	-12
Tensile Strength Change (Mpa)	-6.8

NEOPRENE RUBBER; VULCAN GRADE VNE11 SPECIFICATION

MATERIAL ANALYSIS

Neoprene	100.0
Magnesium Oxide	4.0
Zinc Oxide	5.0
H.A. Carbon Black	20.0
S.R. Carbon Black	40.0
Di- Octyl-Phthalate	15.0
D.D Accelerator	1.0
C.B.S Accelerator	1.0
E.T Accelerator	0.5
Sulphur	0.5
Steric Acid	1.0

PROPERTIES

Original

Specific Gravity	ASTM D1817	1.50
Hardness: Shore A	ASTM D2240	70
Tensile Strength (Mpa)	ASTM D412	11.3
Elongation at Break (%)	ASTM D412	480

Heat Ageing in hot Air at 100°C for 70hr (ASTM D573)

Hardness change points shore A	+2
Elongation change (%)	-20
Tensile strength change (Mpa)	-0.48
Weight loss grams	Negligible

Fluid Immersion in ASTM 3 oil at 100°C for 70hr (ASTM D471)

Hardness change points shore A	-26.1
Elongation change (Mpa)	-2.0
Tensile Strength change (Mpa)	-3.0

VITON® RUBBER; VULCAN GRADE V3F.FE2602 SPECIFICATION

Vulcan compound is genuine Viton® with a true Viton® mixing content of 75%. The Viton® content is of course vital for the chemical and heat resistant properties of the elastomer. Beware of "Viton®" rubbers with incorrect Viton® content, sometimes only 30% or even less. It is important to obtain the Viton® content specification.

MATERIAL ANALYSIS

Viton®	100.0
S.F Carbon Black	17.0
Hydroxide Calcium	3.0
Magnesium Oxide	10.0
Curing Agent	2.5
Zinc Sterate	1.0

PROPERTIES

Original

Specific Gravity	ASTM D1817	1.85
Hardness: Shore A	ASTM D2240	75
Tensile Strength (Mpa)	ASTM D412	14.2
Elongation at Break (%)	ASTM D412	260

Heat ageing in hot air at 250°C for 70hr (ASTM D573)

Hardness change point shore A	+3
Elongation change (%)	-32
Tensile Strength change (Mpa)	+2.1
Weight loss grams	Negligible

Fluid Immersion in ASTM3 oil for 70hr at 150°C (ASTM D471)

Volume change (%)	+3.8
Hardness change point shore A	0.6
Elongation change (%)	-6.8
Tensile strength change (Mpa)	0.49

AFLAS; VULCAN GRADE SP AFC-3501 SPECIFICATION

MATERIAL ANALYSIS

Aflas Polymer	100.0
Ca (OH)2	6.0
MT Carbon Black	30.0
MgO	3.0
TAIC	3.0
Peroxide	1.0

PROPERTIES

Original

Specific Gravity	ASTM D1817	1.61
Hardness: Shore A	ASTM D2240	72
Tensile Strength (Mpa)	ASTM D412	18.2
Elongation at Break (%)	ASTM D412	220

Heat Ageing in hot Air at 250°C for 96hr

Tensile (%, Retention)	90
Elongation (%, Retention)	80
Hardness (Point, Change)	4

ELASTOMER CODES

CODE	MATERIAL
A	Aflas® Elastomers
D	Combined PTFE wedge & Neoprene 'O'-ring, PTFE gasket on seat (16xx series only)
E	E.P. Elastomers
EN	Double seal, with E.P. Elastomers inboard, and Nitrile outboard
F	FEP/Silicone Encapsulated 'O'-rings
G	FEP/Viton® Encapsulated 'O'-rings
H	HNBR Terban Elastomers
J	PFA/Silicone Encapsulated 'O'-rings
K	Kalrez® 'O'-rings
L	FDA Compliant EP Elastomers
N	Nitrile Elastomers
O	Neoprene Elastomers
P	P.T.F.E. wedges or gaskets
R	Glass filled PTFE wedges and gaskets
V	Viton® Elastomers
X	No Elastomers fitted (Gasket for Type 23, 25 & 27 seats)

ELASTOMER GRADES

Secondary Seal Materials		
AFLAS®	-	Vulcan Grade SP AFC-3501
E.P.	-	Vulcan Grade VEP.MAR.4045
FEP/SIL	-	Vulcan manufactured Encapsulated 'O'-Rings - please see our Chem Ring brochure
FEP/VIT	-	Vulcan manufactured Encapsulated 'O'-Rings - please see our Chem Ring brochure
KALREZ®	-	Du Pont ® Grade 4079 or 6375
NEOPRENE	-	Vulcan Grade VNE11
NITRILE	-	Vulcan Grade VN19
PFA/SIL	-	Vulcan manufactured Encapsulated 'O'-Rings - please see our Chem Ring brochure
VITON®	-	Vulcan Grade V3F.FE2602

Unless specified upon order or our quote, the Secondary Seal Material Grades utilised and fitted to elastomer codes are as above.

AFLAS®

Vulcan are now final compounding and moulding AFLAS®. We can offer to produce any of our Mechanical Seals with AFLAS® elastomers and can mould components, parts or 'O'-Rings to customer requirements.

AFLAS® has superior characteristics to Nitrile, E.P or Viton® and can be used to replace all these with one elastomer. For further information, please ask us for an AFLAS® material and technical brochure.

W.R.A.S® APPROVED ELASTOMERS AND SEAL FACE MATERIALS

The elastomers and face materials utilised are generally suitable for use in contact with potable water and food processing. The following materials are UK Water Regulation Advisory Scheme Approved: it is neccessary for you to specify your requirements upon order and obtain our confirmation.

MATERIAL	VULCAN GRADE	APPROVAL NUMBER	NOTES
Silicon Carbide	VES2	0506504	W.R.A.S® approved R.B. SIC.
Alumina Ceramic	V99.CER	0506503	W.R.A.S® approved Ceramic.
Carbon	M825	0509506	Specify Carbon required upon enquiry/order
Alternative Carbon	CN825	0310501	
Viton®	V3F. FE2602	0506502	Moulded components
Nitrile	ME0995	0507521	Available for 'O'-Ring only. Ask for other Nit./E.P. components
E.P.	VEP.MAR.4045	0308510	

Please ask for approval details on other seal materials and elastomers.

VULCAN FACE MATERIALS

A seal's capability, performance and life is significantly influenced by the grade, quality and combination of face materials used. Vulcan's policy is to therefore only utilise the best grades of face materials and to control their specification and manufacture from raw powder.

As such, Vulcan manufacture in-house all of our hard face materials. Silicon Carbide (both Reaction Bonded and Sintered) and Tungsten Carbide (Nickle and Cobalt bound) are produced by Vulcan in all stages, from raw powder to final ground and lapped component.

Extensive research and technological development, allied to advanced manufacturing techniques and facilities, with intensive Quality Control and testing, has enabled Vulcan to produce materials which exceed the standards supplied from competitor, specialist, international T.C./SiC manufacturers.

Vulcan specify and fit 99.5% Purity Alumina Ceramic, as standard, to all seal/seat Types. Practically all of our "single spring seal" competitors utilise the lower cost and quality 95/96% purity and may only offer 99.5%, for improved capability and performance, at a premium cost. Our policy is to specify and utilise as standard, only the best quality on all our face materials.

Vulcan Grade M106K + is thus fitted to all our Single Spring Seals (except moulded face seals Types 60 and 70) giving significant improvements compared to the common standard carbons seen.

Unless specified by the customer the Face Material Grades utilised and fitted, to the codes opposite, are as follows;

Face Materials Grade

Ceramic - Vulcan Grade V99 CER 99.5% Purity Alumina Ceramic.

Ni-Resist - Vulcan Grade Ni-A436-84.

Silicon Carbide - Vulcan Grade VES2 Reaction Bonded SiC is the standard on all seals and seats. Except for 16 Series seals and seats (1609,1645,1659, 1677 and1678) and Type 23, 25 and Type 27 seats, which are sintered Please specify if Sintered SiC (Vulcan Grade VES9) is required on any other product.

Tungsten Carbide - Vulcan Grade Ni10 for rotary seal face and Ni 6 for stationary face, Nickle bonded T.C., If Cobalt bound T.C. is required, please specify.

Carbon - as per the following table:

CARBON GRADE	M825/CN825 Triple Phenolic Resin Impregnated Carbon/Graphite	M106K+ Double Phenolic Resin Impregnated Carbon/Graphite	M205K Moulded Phenolic Carbon	KC-6709 Antimony Metal Impregnated Carbon/Graphite
Flexural Strength	78 Mpa	70 Mpa	58.2 Mpa	96 Mpa
Compressive Strength	250 Mpa	220 Mpa	167 Mpa	225 Mpa
Density	1.80 g/cm^3	1.78 g/cm^3	1.65 g/cm^3	3.32 g/cm^3
Hardness	100 Hs	90 Hs	75 Hs	84Hs
Porosity	<0.3%	<0.3%	0.31%	<0.58%
Temperature Limit	260°C	230°C	133°C	350°C
Coefficient of Thermal Expansion	5.0 x 10^{-6}/°C (20-200°C)	5.2 x 10^{-6}/°C (20-200°C)	3.0 x 10^{-4}/°C (20-200°C)	7.0 x 10^{-6}/°C (20-200°C)

Notes:

1. Unless otherwise stated Carbon Grade M106K+ is used on all Vulcan single spring seal range production, except: Type 60/65 and Type 70/75 = M205K, Types A1 - A5 = CN825 and 1677/1678 = KC-6709 All multiple spring Vulcan seals, including the 1609,1659,1645 series, use M825
2. CN825 and M825 are N.W.C. approved for use in contact with potable water. M825 grade technical data is essentially the same as CN825
3. FC-6709 Antimony Impregnated Carbon or CN825 or M825 may be specified to be fitted to any Vulcan seal, at additional cost.

VES2 REACTION BONDED SILICON CARBIDE

Purity of Silicon Carbide	>90	%
Hardness (Vickers)	<2600	Kg/mm^2
Compressive Strength	>2100	Mpa
Fracture Strength (single edge notched beam)	>4	Mpa.m.$^{0.5}$
Flexural Strength	>400	Mpa
Weibull Modulus	>12	-
Density	>3.05	g/cm^3
Grain Size	<15	microns
Thermal Conductivity	>150	W/mK
Themal Expansion	<4.4	10^{-6}/^{0}C
Porosity	0%	-
Youngs Modulus	>380	Gpa
Poisson Ratio	0.15	-
Heat Resistance	>46.5	cal/cm.sec
Maximum Working Temp	1400	^{0}C

WNV2 GRADE SINTERED SILICON CARBIDE

Purity of Pure Silicon Carbide	>98	%
Hardness Vickers)	>2600	Kg/mm^2
Compressive Strength	>2200	Mpa
Fracture Strength (single edge notched beam)	>3.2	Mpa.m.$^{0.5}$
Flexural Strength	>400	Mpa
Weibull Modulus	>10	-
Density	>3.10	g/cm^3
Grain Size	<5	microns
Thermal Conductivity	>110	W/mK
Themal Expansion	<4.8	10^{-6}/^{0}C
Youngs Modulus	>410	Gpa
Maximum Working Temp	1600	^{0}C

NOTE: Vulcans production now off-sets our mirror lapping finish on all SIC rotary faces, in order to avoid the possibility of binding between SIC rotary and stationary faces.

Notes:

Vulcan manufacture and stock Reaction Bonded, and two grades of Sintered, Silicon Carbide. We supply both Reaction Bonded and CNV1 Sintered as standard, so please check the stock code or specify should you require a specific grade.

VULCAN GRADE V99 CER; 99.5% PURITY ALUMINA CERAMIC

Purity	> 99.3%
Density	3.85 - 3.90 gm/cc
Apparent Porosity	0.04
Hardness	> 90 Hs
Bond Strength	> 3000 Kgf/cm^2

SAMPLE DRIED AT 110 DEG C.

Silica	0.15%	(Si02)
Titania	< 0.01%	(Ti02)
Ferric Oxide	0.04%	(Fe203)
Lime	0.04%	(Ca0)
Magnesia	0.55%	(Mg0)
Potash	< 0.01%	(K20)
Soda	< 0.03%	(Na20)
Phosphorus Pentoxide	< 0.02%	(P205)
Chromium Sesquioxide	< 0.01%	(Cr203)
Manganic Oxide	< 0.01%	(Mn304)
Zirconia	< 0.02%	(Zr02)
Hafnia	< 0.01%	(Hf02)
Lead Monoxide	< 0.02%	(Pb0)
Barium Oxide	< 0.01%	(Ba0)
Strontia	< 0.01%	(Sr0)
Stannic Oxide	< 0.01%	(Sn02)
Loss on Ignition	0.04%	
Sulphur Trioxide	< 0.05%	(S03)
Alumina	99.35%	(Al203)

VULCAN NI-RESIST MATERIAL GRADE Ni-A436-84

MATERIAL SPECIFICATION:

Chemical Composition (by weight)

Carbon	=	< 3.0%
Silicon	=	1.0 to 2.8%
Manganese	=	0.5 to 1.5%
Nickle	=	13.5 to 17.5%
Chromium	=	1.5 to 2.5%
Copper	=	5.5 to 7.5%
Sulphur	=	< 0.12%
Iron	=	Balance

Chemical properties;

Tensile Strength	=	> 172 Mpa
Hardness	=	131 - 183 HB
Pressure Strength	=	690 - 828 Mpa
Distortion Modulus	=	31.0 Gpa
Elasticity Modulus	=	83 - 97 Gpa
Bend Strength	=	8895 - 9787 N
Fatigue Strength	=	83 Mpa

VULCAN NICKEL BOUND TUNGSTEN CARBIDE GRADES Ni6 FOR SEAT FACES AND Ni10 FOR SEAL FACES

MATERIAL SPECIFICATION: Ni6 NICKEL BASED T.C.

Chemical Composition (by weight)

Tungsten Carbide:	94%	(+/- 0.25%)
Nickel:	6%	(+/- 0.25%)

DESCRIPTION: Ni6 TUNGSTEN CARBIDE

Hardness Hv30	1450-1550
Density	14.8 -15 gm/cc
Ultimate Compressive Strength	680,000 psi
Ultimate Tensile Strength	210,000 psi
Modulus of Elasticity	94 x 10^6 psi

MATERIAL SPECIFICATION: Ni10 NICKEL BASED T.C.

Chemical Composition (by weight)

Tungsten Carbide:	90%	(+/- 0.25%)
Nickle:	10%	(+/- 0.25%)

DESCRIPTION: Ni10 TUNGSTEN CARBIDE

Hardness Hv30	1300-1400
Density	14.4-14.6 gm/cc
Ultimate Compressive Strength	> 600,000 psi
Ultimate Tensile Strength	> 200,000 psi
Modulus of Elasticity	99.8 x 10^6 psi

Fine grained Tungsten Carbide powder is both more expensive to purchase and difficult to process. However, it produces the finest, most uniform, grain structure and best quality Tungsten Carbide.

This is governed by and microscopically inspected to ISO 4505:1978, whereby minute pores up to 10 micron (A), 10-25 micron (B) and free carbon inclusions (C) are classified on a scale of 1 to 8.

Vulcan have set exceptional standards for this quality in our T.C production and we routinely produce to A02, B02, C02 standard.

FACE COMBINATION CODES

CODE	MATERIAL
A	Antimony Impregnated Carbon Seal Face vs. Ceramic Seat
AD	Antimony Impregnated Carbon Seal Face vs. Silicon Carbide Seat
AH	Antimony Impregnated Carbon Seal Face vs. Tungsten Carbide Seat
AP	Stainless Steel Seal Face vs. Antimony Impregnated Carbon Seat
AQ	Antimony Impregnated Carbon Seal Face vs. Stainless Steel Seat
AS	Antimony Impregnated Carbon Seal Face vs. Sintered Silicon Carbide Seat
B	Ceramic Seal Face vs. Carbon Seat
C	Carbon Seal Face vs. Ceramic Seat
CB	Carbon Seal Face vs. Bronze (Lead Brass) Seat
D	Carbon Seal Face vs. Silicon Carbide Seat
E	Carbon Seal Face vs. Tungsten Carbide Seat
F	Carbon Seal Face vs. Ni-Resist Seat
G	Silicon Carbide Seal Face vs. Ceramic Seat
H	Tungsten Carbide Seal Face vs. Tungsten Carbide Seat
HA	Tungsten Carbide Seal Face vs. Antimony Impregnated Carbon Seat
I	Silicon Carbide Seal Face vs. Tungsten Carbide Seat
J	Tungsten Carbide Seal Face vs. Silicon Carbide Seat
K	Ni-Resist Seal Face vs. Carbon Seat
L	Ni-Resist Seal Face vs. Antimony Impregnated Carbon Seat
M	Chrome Dioxide coated Stainless Steel Seal Face vs. Carbon Seat
N	Antimony Impregnated Carbon Seal Face vs. Ni-resist Seat
O	Carbon Seal Face vs. Chrome Dioxide coated Stainless Steel Seat
P	Stainless Steel Seal Face vs. Carbon Seat
PS	Stainless Steel Seal Face vs. Silicon Carbide Seat
Q	Carbon Seal Face vs. Stainless Steel Seat
QS	Carbon Seal Face vs. Chrome Steel Seat
R	Sintered Silicon Carbide Seal Face vs. Sintered Silicon Carbide Seat
S	Silicon Carbide Seal Face vs Silicon Carbide Seat
SA	Sintered Silicon Carbide Seal Face vs. Antimony Impregnated Carbon Seat
SG	Sintered Silicon Carbide Seal Face vs. Ceramic Seat
SS	Sintered Silicon Carbide Seal Face vs. Silicon Carbide Seat
ST	Sintered Silicon Carbide Seal Face vs. Tungsten Carbide Seat
T	Silicon Carbide Seal Face vs. Carbon Seat
TA	Silicon Carbide Seal Face vs. Antimony Impregnated Carbon Seat
U	Tungsten Carbide Seal Face vs. Carbon Seat
UA	Tungsten Carbide Seal Face vs. Antimony Impregnated Carbon Seat
W	Double Seal Face combination:- Car vs. SiC Inboard, S/S vs. Car Outboard
WC	Double Seal Face combination:- SiC vs. SiC Inboard, S/S vs. Car Outboard
WS	Double Seal Face combination:- SiC vs. SiC Inboard, CrOx vs. Car Outboard
X	No Sealing Faces Fitted
Y	Double Seal Face combination:- Car vs. SiC Inboard, SiC vs. Car Outboard
YC	Double Seal Face combination:- Car vs. SiC Inboard, Car vs. SiC Outboard
Z	Double Seal Face combination:- SiC vs. SiC Inboard, SiC vs. Car Outboard
ZC	Double Seal Face combination:- SiC vs. SiC Inboard, Car vs. Ceramic Outboard
ZH	Double Seal Face combination:- T.C vs. T.C Inboard, T.C vs. T.C Outboard
ZS	Double Seal Face combination:- SiC vs. SiC Inboard, SiC vs. SiC Outboard
ZU	Double Seal Face combination:- T.C vs. T.C Inboard, Car. vs. Ceramic Outboard

VULCAN SEAL CODING SYSTEM

Example Code;	V3	0250.	12.	L.N.P.	SEAL
Code Section:	A	B	C	D	E

Note:
Seal coding systems are necessarily complex and sometimes difficult to follow. If in doubt, please ask.

Examples are;

V3 0317.20.N.C = 1.1/4" Type 20 Seal and Seat, Nitrile, Carbon, Ceramic, Tubed

V4 0381.20.N.C.SEAL = 1.1/2" Type 20 Seal Only, Nitrile, Carbon, Boxed

Section A =
This is always a two digit code, which relates to the product packaging. If you wish to specify, please use V3 for Individual packaging in tubes and V4 for Bulk-packed in stores shelf sized boxes.

Section B =
Shaft size code in millimetres converted to a standard four digit code. For example;
1.000" = 25.4mm = 0254, 2.875" = 73.0mm = 0730
20mm = 0200, 48mm = 0480 etc.
For stepped shaft balanced seals assemblies, you should specify the seal shaft size.

Section C =
The seal Type as shown in this brochure and company technical data sheets. As can be seen, this varies from one to four digits, with sometimes a prefix or suffix letter. For example, Types 8, 18, 192, 1609, 1688L and A4.

Section D =
For uni-directional seals, the first letter will be L. or R. referring to left-hand or right-hand spring and direction of shaft rotation. For bi-directional seals, this letter is omitted.
Next comes one or two letters which specify the elastomers or gaskets fitted, as shown on the "Elastomer Codes" table (on elastomers page). The final one or two letters set the face materials, as per the "Face Combination Codes" table (on face materials page) or "Seal/Seat Only" table below.
A full stop is used to differentiate between one sub-section and the next. For example; .A.H. alone refers to Aflas® elastomers and T.C. seal and seat face materials. Whereas .HA. Proceeded by a secondary seal material code, say N, = N.HA. will be T.C. vs Antimony Carbon faces with Nitrile elastomers.

Section E =
This suffix section is only used for part assemblies or components. Thus it is left blank for a complete seal and seat. This suffix is used internally on component production drawings, stock bins, inspection sheets etc. Since we do not normally offer to sell components, the only two suffix codes in common external use are .seal and .stat for a seal or a seat assembly only.

Metallurgy
Standard metallurgy for each seal is stated on VES Material Specification Document Ref. Section 1.5. If you require a different grade of, for example, 316 stainless steel on any seal, please add the prefix "W-" to the part code and specify your requirements.

Note; If a seal is etch marked, the code has a prefixed of 'E' & suffix of your account code.

SEAL / SEAT ONLY FACE CODES

SEAL ONLY

CODE	MATERIAL
A	Antimony Impregnated Carbon Seal Face
C	Carbon Seal Face
B	Ceramic Seal Face
M	Chrome Dioxide Coated Stainless Steel Seal Face
K	Ni-Resist Seal Face
S	Silicon Carbide Seal Face
R	Sintered Silicon Carbide Seal Face
P	Stainless Steel Seal Face
H	Tungsten Carbide Seal Face

SEAT ONLY

CODE	MATERIAL
L	Antimony Impregnated Seat Face
P	Carbon Seat Face
C	Ceramic Seat Face
O	Chrome Dioxide Coated Stainless Steel Seat Face
F	Ni-Resist Seat Face
S	Silicon Carbide Seat Face
R	Sintered Silicon Carbide Seat Face
Q	Stainless Steel Seat Face
H	Tungsten Carbide Seat Face

KEY CONVERSION FACTORS

Temperature: °F = (1.8 x °C) + 32°
Common examples within brochure
-40°C = -40°F, 160°C = 320°F
180°C = 356°F, 200°C = 392°F
230°C = 446°F

KEY CONVERSION FACTORS

Pressure: 1psi = 0.06895 bar = 0.0703 kg/cm2
Speed: 1m/s = 39.25 Inches per sec
Size: 1 Inch = 25.4mm

These factors convert the figures used on each seal and seat data page.
For a comprehensive Seal Engineering Conversion Factor List, please contact our Technical Department.

FACE pV VALUES AND CHARTS

The Quality of Vulcan's face materials can be further enhanced by selecting optimum face combinations for the nature of the fluid being pumped and the seal application conditions. Seal face pV Values effectively set the limits of a seal face combination's pressure and circumferential face speed abilities, but also greatly affect the performance and life of the seal, in many demanding applications, within the seal's ultimate limits. Seal pV Charts have been created in each section of this brochure. These charts can be used to establish the guidance theoretical maximum pressure value for standard material face combinations, for all standard seal Types. The table below is to be used in conjunction with the pV charts, where you should apply the relevant multiplying factors from the table, to arrive at the seal's maximum pressure rating. See "How To Determine The Maximum Operating Pressure" below for examples

Application Conditions Table

Factor	Selection Criteria	Multiplier Factor
Speed	Below 1450 rpm	x 1.10
	1450 to 1750 rpm	x 1.00
	Above 1750 rpm	x 0.80
Temperature	Below 70°C	x 1.00
	Between 71°C and 120°C	x 0.85
	Between 121°C and 175°C	x 0.75
	Over 176°C	x 0.60
Product Fluid	Lubricating fluids.	x 1.00
	Aqueous solutions/ water	x 0.85

How To Determine The Maximum Operating Pressure.

Examples:	1	2
Seal Type:	2.000" Type 20	25mm Type 24
Face Combination:	Carbon/Ceramic	Sic/Sic
Speed:	1450 rpm	1800 rpm
Temperature:	50°C	30°C
Product Fluid:	Water	Water

Obtain the nominal pressure rating from the Seal Type pV chart (Parallel Spring Type) where the shaft size intersects with the material combination line. For a 2.000" Type 20 in Carbon/Ceramic this equals 10.5 bar and 12 bar for a 25mm Type 24 in SIC/SIC.

Then apply the multiplying factors from the table to obtain the final approximated guidance maximum pressure value.

1. 2.000" Type 20 = 10.5 bar x 1.0 x 1.0 x 0.85 = 8.9 bar.
2. 25mm Type 24 = 12 bar x 0.8 x 1.0 x 0.85 = 8.1 bar.

The uppermost pressure (bar g) figure on each pV chart is our recommended maximum pressure for that particular design/type of mechanical seal. We have, therefore, not continued the face combination pV lines above this recommended top limit, even though extrapolation of the lines show that the face combinations can frequently handle higher pressures. We don't recommend use of a seal above the conservative maximum recommended pressure, for the seal design.

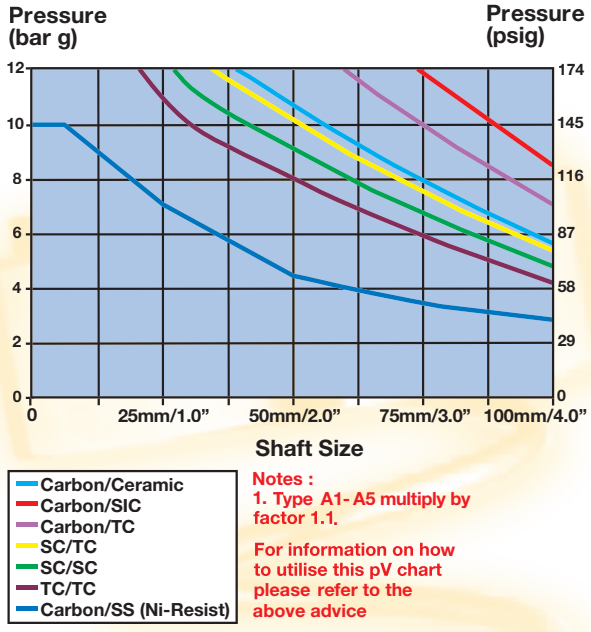
Thus to calculate the pressure rating where the lines are off the chart, find out your multiplier factor from the "Application Conditions Table." Then just extrapolate the line to your shaft size line and see what that would then approximately be, after the multiplier.

In most cases, except close to where the line goes off the graph and as well where the multiplier is less than one, the face pV rating will be above the maximum recommended pressure and thus our recommendation is this maximum recommended pressure. This is based upon conservative seal design considerations not face pV value limits. See example below:-

50mm Type 19 Seal Carbon vs SIC. 1500 RPM, water, ambient temperature.

Extrapolated line indicates 14.5/15 Bar g pressure x 1.0x1.0x0.85 = 12.3 to 12.7 Bar g pressure. Vulcan recommend 12 Bar maximum pressure for this seal/application, based upon the recommended maximum pressure for this design/type of seal.

FOR EXAMPLE; VULCAN PARALLEL SPRING DIAPHRAGM TYPE SEALS PV CHART



Notes :
1. Type A1- A5 multiply by factor 1.1.

For information on how to utilise this pV chart please refer to the above advice

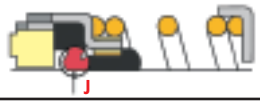
Note.
Our policy is one of continuous technical and efficiency improvement. As such, all specifications may be subject to change without prior notice. Please note that due to the many application variants affecting seal performance, these charts are for guidance only. Theoretical pV values are based on a seal life of 9000hours and were calculated from Vulcan's (and available published) technical knowledge and judgment.

PRINCIPAL METHODS OF SHAFT SEALING

PRODUCT INFORMATION

The Vulcan "Single Spring" Seal Range is divided into four main methods of shaft sealing, namely; Rubber Diaphragm, Rubber Bellows, 'O'-Ring Mounted and PTFE Wedge seals. These single spring mechanical seals have been designed to service the World pump market and are totally inter-changeable, with all other manufacturer's equivalent seals, without any modification to the existing seal housings and gland plates. Such is the variety available from Vulcan, we can offer to replace any single spring seal and seat, practically always straight from stock.

Typical designs of each of the main shaft seal groups are;

RUBBER DIAPHRAGM	
RUBBER BELLOWS	
'O'-RING MOUNTED	
PTFE WEDGE	

DIAPHRAGM SEALING OPERATION

The line drawing above shows the standard section of a Vulcan rubber diaphragm seal. The shaft seal is provided by the rubber diaphragm which is squeezed onto the shaft by the drive ring. Once fitted, the rubber diaphragm will grip the shaft giving a strong static seal and very positive drive, via the drive ring, to the seal face.

As there is no relative movement between the shaft and the rubber diaphragm, shaft fretting, wear and hang-up hysteresis are eliminated and the seal can immediately accommodate some shaft run-out and misalignment. Shaft axial movement and the movement required during the working life of the seal is handled by the elastomer rubber flexing at its junction point (J on dia.). The seal head automatically adjusts to compensate for face misalignment caused by shaft end float/pump body misalignment.

The spring force and the seal pumping pressure force maintain the faces in full contact whilst the rubber diaphragm acts as a bellows providing sustained flexibility. Positive drive of the seal face is transmitted via the drive ring and retaining housing and not via the spring, which merely provides some closing force to the seal faces. These seals can therefore be used to seal shafts rotating in either direction and in vacuum applications.

RUBBER BELLOWS SEALING OPERATION

Vulcan elastomeric bellows seals are of compact design with a sealing action that provides many benefits. The bellow's high strength and flexibility is the key to the very reliable performance of this type of seal as it readily accommodates misalignment, end-float and seal face wear.

The convoluted bellows profile makes these seals ideal for media prone to clogging or for hygienic applications. Designed for confined spaces and limited gland depths, Vulcan rubber bellows seals are bi-directional in operation and provide secure bellows sealing for longer life in a wide range of applications.

'O'-RING MOUNTED SEALING OPERATION

Our conical spring, 'O'-Ring mounted, mechanical seals have been designed by Vulcan to have a small cross-section and a complete recessed 'O'-Ring housing. A narrow seal head width allows the seals to easily fit confined DIN 24960 (EN12756) housings, whilst also providing the benefits of reduced face surface running speed with increased circulation around the seal faces.

Seal loading is provided by conical springs or wave springs, with conical springs being the most common.

Seal drive is provided by the conical spring tightly gripping the shaft at its base. Stock seals are supplied as standard with right-hand drive springs for clockwise shafts. Left-hand springs for anti-clockwise shaft rotation should be specified on order.

Utilisation of wave spring technology in Vulcan seals allows the design of extremely compact seals, in both the axial and radial directions. Wave springs provide equal loading and deflection at the fraction of the free height when compared to helical springs, making them suitable for limited spaces.

Other main advantages for mechanical seal use are their insensitivity to contaminates, whilst providing straightforward fitting. These main characteristics make wave spring seals ideal for food, chemical and restricted fitting applications which are prone to clogging.

Our resilient 'O'-Ring mounted seal designs are technically efficient (readily accommodating misalignment and vibration) and are highly versatile. Vulcan offer a wide range of face material combinations and spring/seat sizes to suit most applications. Our design standard of a narrow cross-section head with full recessed 'O'-Ring groove, combined with alternative seal face materials, maximises seal performance and prolongs seal life.

PTFE WEDGE SEALING OPERATION

The chemically resistant PTFE component is spring loaded, to force the flexible angular lip of the wedge, into tight contact with the shaft. The same spring force impacts a sufficient load to the rotary face to create a suitable seal interface with a varied choice of standard stationary seats. The features associated with the wedge seal design make these seals ideally suited for chemical process pumps and many other aggressive applications.

VULCAN MECHANICAL SEALS

SERVICE CAPABILITIES

The limits of pressure, temperature and speed are dependant upon the materials specified for the rotary seals and seats, as well as the nature of the media to be sealed. The maximum capabilities of each seal type are shown on the individual data sheets.

Changes in single spring seal operating capabilities are partially a factor of each seal design but are mainly influenced by selection of elastomer type and seal face materials.

Elastomer selection primarily sets temperature and chemical resistance;

Material	Standard Recommendation	Temperature Range
Medium Nitrile	For general duties	–30 to +120 deg. C
Ethylene Propylene	For general duties especially hot water	–40 to +140 deg. C
Viton®	For general chemical applications	–30 to +230 deg. C
Aflas®	For enhanced chemical and temperature capacity	–50 to +250 deg. C
Neoprene	For refrigeration applications	–50 to +100 deg. C
FEP/PFA	For near universal chemical resistance	–60 to +205/260 deg. C
Kalrez®	For absolute chemical and temperature capability	–50 to +310 deg. C

Differing face material combinations affect seal capability, performance and life. Their pV (pressure x velocity) value largely determines the suitability of material combinations of seal faces and specifically the amount of heat generated at the faces. The ability of the face material to resist wear increases the life of the seal particularly in abrasive applications.

Vulcan offer face combinations, from carbon, solid ceramic and stainless steel materials, as standard. We recommend fine-grained, reaction-bonded silicon carbide as ***the*** superior "hard face" material, to be used for both faces for maximum wear resistance, or to run against carbon for ultimate pV capability.

IMPORTANT NOTE

All information in this brochure is given in good faith, but without warranty, and is based on our functional evaluations, experience and published technical data.

As such the "Service Capabilities" shown in this brochure are indicative only. Particularly, they should not be used in conjunction as maximums applicable in any application. Service and equipment conditions greatly affect product capability and performance.

All specifications, dimensions and data may change without notice. You should confirm any necessary detail with our technical specialists or distributors.

The purchaser should thoroughly test any application and independently conclude satisfactory performance of the product, for his intended use.

Vulcan Engineering Limited accept no claim(s) for legal action rising as a result of the information contained in this document, and shall not be liable for the misuse of the full, or any part of the document, over and above its intended use for information on Vulcan products only.

Seat Selection

Correct seat selection lays the foundation for maximising seal performance. Preferred seat types are shown with each seal. However, Vulcan offer any seat design to be used with any seal, thereby giving a maximum range of possible combinations.

Seat housings, for all Vulcan seats, are recommended to have a machined lead in of 1.5 to 2.0 mm at 20 to 30 degrees angle.

Principle Advantages of Single Spring Mechanical Seals

Single Spring – gives superior axial and angular flexibility. The seal's design compensates for misalignment and machinery tolerances.

Non-clogging – large single spring, plus free-movement of the elastomer rubber shaft seal, combats seal failure through build up of solid material.

Self-adjusting – the flexible moving rubber shaft seals accommodate shaft end float and take up wear.

Minimal Wear – strong static seal to the shaft minimises shaft fretting.

Versatile – Compact in design and simple to fit. Standard designs and sizes for all common imperial, metric and DIN 24960 (EN12756) housings are standard.

Extremely cost effective – low capital cost, proven reliability of design, easy to fit and accommodating in use, excellent seal performance and ex-stock service on a complete range of seal types, materials and sizes, make Vulcan single spring seals ***the*** choice for the majority of applications.

Vulcan Quality Assurance

Our "Single Spring" Seal programme is designed to be totally responsive to all customer requirements. A vast array of types, sizes and materials are held in computer automated stock to enable same day despatch. The seals have been designed for maximum technical efficiency and ease of use. All Vulcan seals and components are manufactured in our own state of the art factories which are approved to ISO 9001.

All components are inspected before supply. Vulcan Engineering Limited work to established Quality Control Procedures and the company system in our Sheffield headquarters, is approved to ISO9001.2000. Vulcan operate a company T.Q.M. Programme to constantly monitor and improve performance.

Our policy of total customer service is further enhanced by the widest range and largest stock of seals in the market, plus an extensive network of distributors. We reserve the right to change specifications without notice.

BRAND NAMES ®

All brand names and product names used in this catalogue are trade names, service marks, trade marks or registered trade marks of their respective owners.

All products are manufactured to Vulcan drawings. Use of other brand names is for informational purposes only.