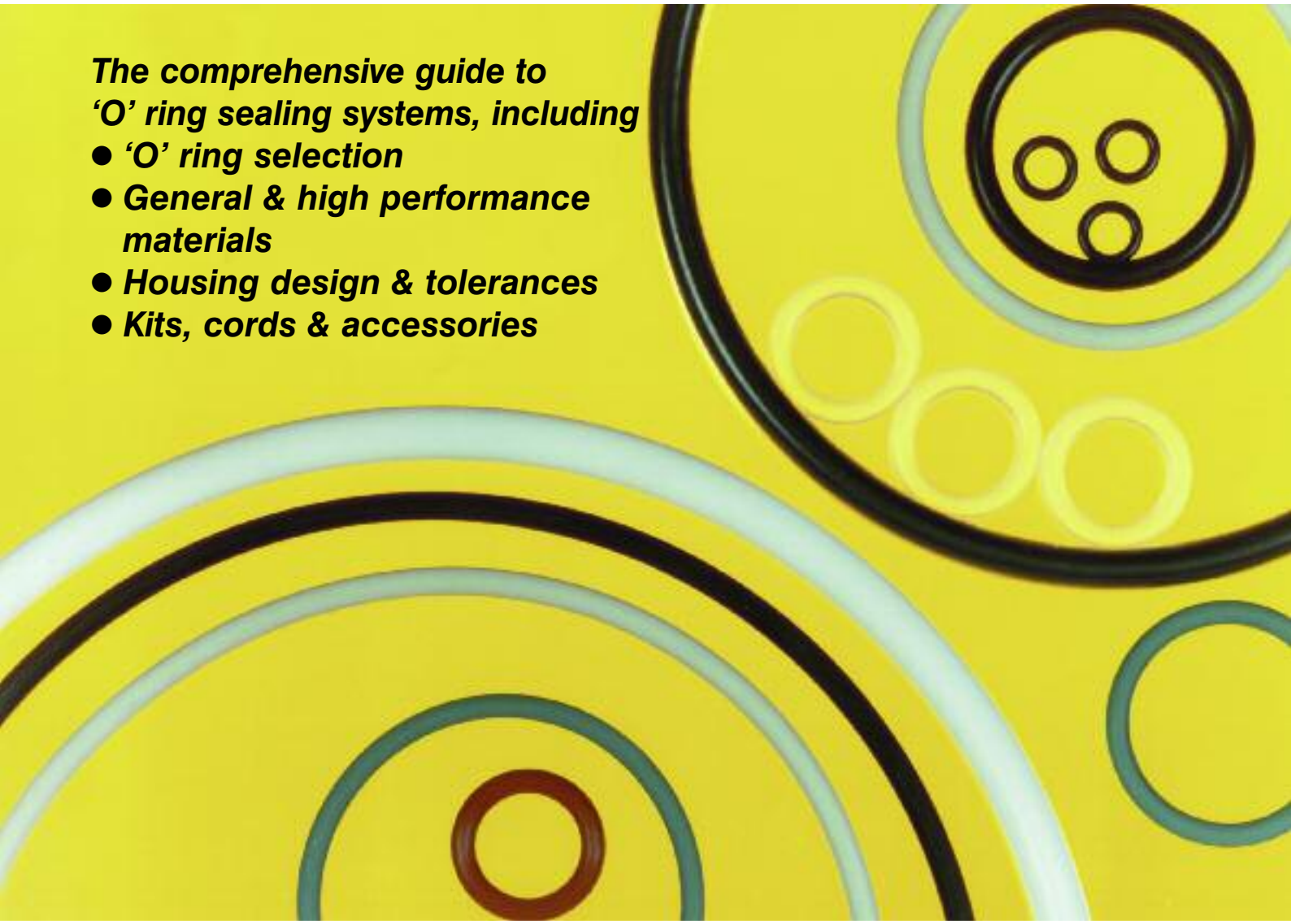
James Walker®

'O' Rings



The comprehensive guide to 'O' ring sealing systems, including

- ***'O' ring selection***
- ***General & high performance materials***
- ***Housing design & tolerances***
- ***Kits, cords & accessories***

High Performance Sealing Technology

James Walker

Guide to ‘O’ rings

Contents

Introduction

The ‘O’ ring, or toroidal seal, is an exceptionally versatile sealing device. Applications ranging from garden hose couplings to critical aerospace or refinery duties make it the world’s most popular volume-produced seal.

‘O’ rings offer many benefits to design engineers and plant operators, they:

- Suit many static and dynamic duties.
- Occupy little space.
- Seal efficiently in both directions.
- Are compatible with most fluid media.
- Can work between –65°C and +315°C when made of elastomer – according to material type.
- Can function at temperatures down to –200°C when made of PTFE.

Today, the design engineer is faced with a bewildering array of ‘O’ ring statistics and advice. In this guide we simplify design data, give concise information on materials and facilitate part selection for specification and ordering purposes.

The result is a document that contains valuable information for use by buyers, designers and maintenance staff.

‘O’ ring stocks

We now stock over seven million ‘O’ rings ready for same-day despatch. If the rings you want are not available off-the-shelf, we can supply them within days from our extensive manufacturing facility. With our flexible production schedules, we can meet the most urgent requests from industry.

Quality

Quality standards
Our quality systems are third-party registered to BS EN ISO 9001:2000. We are also regularly assessed and quality approved by a wide range of industry bodies and individual customers including multinational corporations, utilities and government organisations.

In addition, we hold test equipment for all relevant BS, ISO, ASA, API, ANSI, DIN, DTD and NATO standards. Certificates of conformity are supplied on request. Packaging and labelling is available to individual specifications.

Quality production and inspection
Our Materials Technology Centre houses one of Europe’s most advanced facilities for elastomer batch production. At its heart is a computer-controlled internal mixer that holds formulae for over 300 of our elastomeric compounds.

Together with on-line rheometer testing, this gives us complete batch traceability, regardless of any release certificate requirements.

The post-curing of silicone and fluorocarbon elastomers is also under microprocessor control for temperature level and time. Each cure cycle is trace-recorded as a vital link in our quality chain.

Every ‘O’ ring we manufacture is visually inspected. This is backed by batch inspection of physical dimensions with an even closer study of mismatch, flash and other specific parameters.

Material Safety Data Sheets (MSDS) are available on request.

Trademark acknowledgements

How to use this guide

Selecting an ‘O’ ring

This guide contains three chart sizes:
- **Chart 50** – including BS 1806 and SAE AS 568.
- **Chart 72** – metric sizes to BS 4518.
- **Chart 17000** – James Walker inch sizes.

To match an existing ‘O’ ring
If your existing ‘O’ ring has a BS 1806, SAE AS 568 or BS 4518 reference:

1. Refer to **Chart 50** for BS 1806 and SAE AS 568, or **Chart 72** for BS 4518.
2. Quote appropriate James Walker number.

Table 1: Diameter sections used in JW charts

Chart 50 (BS 1806 & SAE AS 568A)	Chart 72 (BS 4518)	Chart 17000
0.070"/1.78mm	1.6mm	0.063"
0.103"/2.62mm	2.4mm	0.094"
0.139"/3.53mm	3.0mm	0.125"
0.210"/5.33mm	5.7mm	0.188"
0.275"/6.99mm	8.4mm	0.250"

If only the size is known
1. Obtain diameter section A of ‘O’ ring .
2. Consult Table 1 (above) to find the JW chart that covers rings of the appropriate diameter section A.
3. Consult appropriate JW chart, under specific diameter section A.
4. Obtain inside diameter B of ‘O’ ring.
5. Refer to column on JW chart that lists inside diameters B and identify your existing ‘O’ ring.
6. Quote appropriate James Walker number.

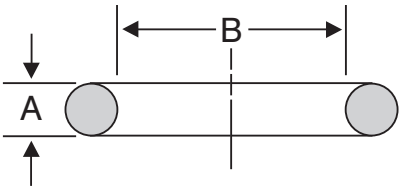


Figure 1: ‘O’ ring diameter section A and inside diameter B

If your ‘O’ ring is a non-standard size
Contact our Technical Services Team. We have in excess of 8000 ‘O’ ring moulding tools in our library and are sure we can help.

For an existing housing
1. Refer to diagrams on page 28.
2. Select the one that matches your housing.
3. Obtain from existing housing the critical dimensions shown on selected diagram.
4. Refer to *Housing Tables 7 & 8* on page 26. These show BS1806/SAE AS 568 in both inch and metric units, and BS 4518 (metric) with more data on pages 18-20.
5. Cross reference dimensions on housing tables.
6. Read off diameter section A, and consult appropriate JW chart under that specific diameter section.
7. Refer to column that shows housing diameter (coded as selected diagram on page 28) and identify the one that matches yours.
8. Quote appropriate James Walker number.

For a new application
1. Refer to *Design notes* section, pages 24-28, for guidance with regard to applications.
2. For metric equipment, select ‘O’ ring from **Chart 72**, pages 18-20.
3. If the metric size you require is not available from **Chart 72**, then select from metric columns in **Chart 50,** pages 11-17.
4. For inch sizes use **Chart 50,** or **Chart 17000** on pages 21-22.

Selecting a back-up ring

One or more back-up rings are used to prevent extrusion of an elastomeric ‘O’ ring under arduous operating conditions. Our standard back-up rings are machined in PTFE and normally supplied in single turn or spiral form. See page 10 for more details of back-up rings.

Back-up ring for use with James Walker ‘O’ ring number
Refer to *How to order* section on page 5 for precise specification details relating to back-up rings for **Chart 50**, **Chart 72** and **Chart 17000** applications.

Back-up ring for use with existing ‘O’ ring
1. Identify appropriate JW chart and James Walker number for existing ‘O’ ring. If necessary, use method outlined on this page in *To match an existing ‘O’ ring*. (***Note**: If a standard ‘O’ ring has been used on a non-standard shaft or cylinder – ie, compressed or stretched into place – the equivalent standard back-up ring must not be used as it cannot be stretched or squeezed in the same way.)*
2. Refer to *How to order* section on page 5 for precise specification details.

Back-up ring for use with non-standard size ‘O’ ring
Contact our Technical Service Team who will recommend the correct back-up ring.

Back-up ring for new application
1. Select the ‘O’ ring you require from JW charts, using method outlined on this page.
2. Refer to *How to order* section on page 5 for precise specification details.

James Walker

How to use this guide

Selecting a material

Table 2: Stocked material details

Standard compound reference	Rubber type	Specifications	Stocked	Colour	ASTM D2000 reference
PB80	Medium nitrile (NBR)	*BS6996 Grade BO80	✓	Black	ASTM D2000 M2BG 810, B14, EF11, EF21, EO14, EO34 BS 5176 2MBG 810, B14, E14, E34, E51, E61
EP18/H/75	Ethylene-propylene (EPM)		✓	Black	ASTM D2000 M3BA 810, A14, B13, Z1 Z1: Hardness 75±5 IRHD
FR10/80	Fluorocarbon (FKM)	**DTD 5612A Grade 80	✓	Black	ASTM D2000 M6HK 810, A1-10, B36
FR25/90	Fluorocarbon (FKM)		✓	Black	ASTM D2000 M7 HK 914, B38, Z1**
FR58/90	Fluorocarbon (FKM)		✓	Black	ASTM D2000 M3HK 910, A1-10, B38, Z1**
Elast-O-Lion® 101	Hydrogenate nitrile (HNBR)		✓	Black	
Elast-O-Lion® 180	Hydrogenated nitrile (HNBR)		✓	Black	
Elast-O-Lion® 985	Hydrogenated nitrile (HNBR)		✓	Black	
SIL 80/2	Silicone (VMQ)	*DTD 5582A Grade 80 (as amended) (Due to be supeseded by BS F153)	✓	White	ASTM D2000 7GE 805, A19, B37, EO36, Z1 Z1: colour white BS 5176 2MGE 805 A19, B17, Z1 Z1: colour white

* All DTD specifications have been declared OBSOLESCENT.
** Suitable for explosive decompression, consult our Technical Services Team.
* Note: Please specify on your enquiry or order if you want 'O' rings to meet these specifications.

Table 2 gives details of our nine most widely demanded stocked materials. We recommend that you specify one of these wherever possible for your 'O' rings. Full details of all readily available materials and their chemical compatibility are given on pages 6-8.

We generally stock compounds of 80 IRHD (International Rubber Hardness Degrees) as these:

- Frequently give extrusion resistance approaching that of 90 IRHD.
- Give sealability comparable to materials of 70 IRHD.

'O' ring sizes shown on **Chart 50**, **Chart 72** and **Chart 17000** are supplied from standard low or high shrinkage tooling without mould charges. Our high shrinkage tooling allows fluorocarbon and silicone 'O' rings to be manufactured within the tolerances shown on page 23.

If you have any doubt about material selection, please consult our Technical Services Team for specific recommendations.

Coloured materials

Quality management systems, product liability and health and safety issues have created a growing need to identify elastomers by their colour. With stocks of black components held in several materials, it is possible for the end user to select the wrong item and cause an equipment malfunction.

Common mistakes include using nitrile NBR seals in phosphate-ester hydraulic fluid systems or ethylene-propylene EPM rubber with mineral oil. To help overcome this, we offer the following non-black compounds:

- Fluorocarbon (FKM) – green.
- Silicone (VMQ) – white or red.
- Ethylene-propylene (EPM) – red.

It should be noted that physical properties may vary from standard materials, also that other colours may be available. Please consult our Technical Services Team for specific recommendations.

How to use this guide

How to order

The following information and examples will enable you to order the correct 'O' ring and back-up ring to meet specific requirements.

For particularly critical applications – including those requiring FEP encapsulated 'O' rings – we recommend that you state the following details to enable us to ensure suitability:

- Pressures.
- Pressure media.
- Operating temperatures.
- Static or dynamic operation (with speeds, if appropriate).
- Housing type.
- Tolerances.
- Any other important factors.

'O' rings
Standard sizes For a standard size 'O' ring, listed on our charts, please state appropriate James Walker number followed by materials reference. ***If no material or application conditions are specified we will supply our medium nitrile grade PB80.***

EXAMPLE: *JW 50-001 PB80*

Other sizes For other sizes, please state inside diameter, diameter section and material reference.

EXAMPLE: *ID 49.4mm, DS 4.1mm. SIL 80/2*

Back-up rings
Back-up rings are supplied in spiral form unless single turn is stated. Also, they are supplied in PTFE as standard, unless otherwise stated.

Back-up rings – Chart 50, inch sizes
When ordering **Chart 50** back-up rings for inch size shafts and cylinders, please state the same JW50 number as for the 'O' ring. Also indicate spiral or single turn, and material.

EXAMPLE: For a JW 50-433 (0.275 inch diameter section) 'O' ring on a 5½ inch diameter shaft or 6 inch diameter cylinder, order *JW 50-433 PTFE spiral back-up ring.*

Back-up rings – Chart 50, metric sizes
When ordering **Chart 50** back-up rings to match our suggested metric shaft and cylinder sizes, please use:

- Prefix 150 for shaft applications.
- Prefix 250 for cylinder applications.

The reason is that 'O' rings can be stretched or squeezed by a small percentage – see *Design notes* pages 24-28 – but the back-up ring must be manufactured exactly to suit the shaft or cylinder. Also indicate spiral or single turn, and material.

EXAMPLE 1: For a 140mm diameter shaft, order *JW 150-433 PTFE spiral back-up ring*.

EXAMPLE 2: For a 155mm diameter cylinder, order *JW 250-433 PTFE spiral back-up ring*.

Back-up rings – Chart 72 When ordering **Chart 72** back-up rings (which cover those to BS 5106), please state the same JW 72 number as the 'O' ring. Also indicate spiral or single turn, and material.

EXAMPLE: *JW 72-1393-57 PTFE spiral back-up ring.*

Back-up rings – Chart 17000 When ordering **Chart 17000** back-up rings, please state the same JW 17000 number as the 'O' ring. Also indicate spiral or single turn, and material.

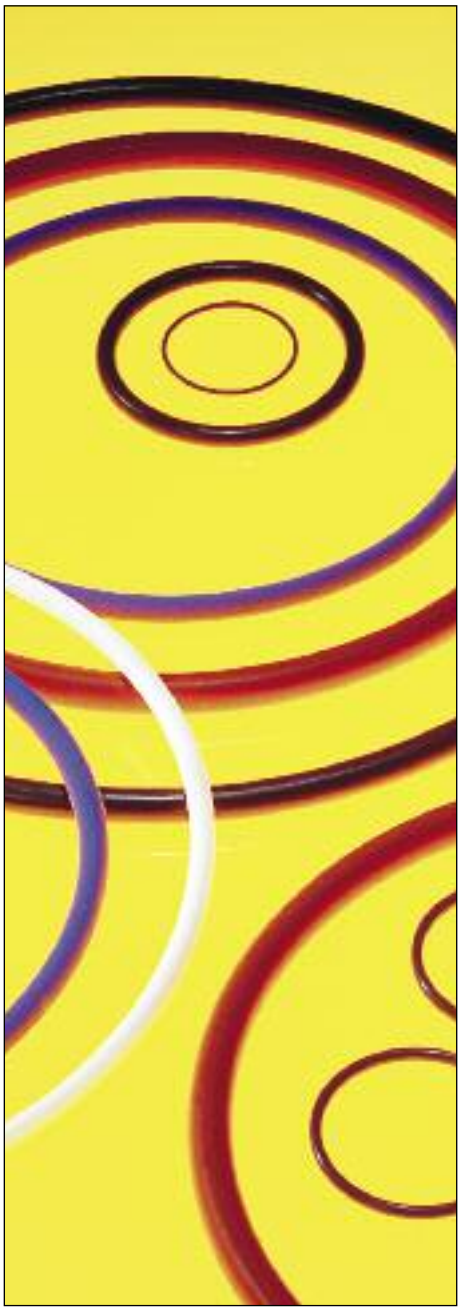
EXAMPLE: *JW 17029 PTFE spiral back-up ring.*

Back-up rings – other sizes When ordering back-up rings to fit 'O' rings that are not listed in our charts, please state the following:

1. Spiral or single turn, and material.
2. Back-up ring size, if known, or
3. 'O' ring inside diameter B; 'O' ring diameter section A; shaft or cylinder diameter (C or D); housing width and depth (E and F). *See page 28.*

EXAMPLE: *PTFE spiral back-up ring to use with a 49.4mm ID x 4.1mm DS 'O' ring on a 50mm diameter shaft. Housing width 7.1mm, depth 3.5mm.*

Subsequent orders
When re-ordering from James Walker, please state the Re-Order Part Number (eg, OB-03400X) shown on our documentation that acknowledges your previous order. Our computerised re-order system will ensure swift service.



Materials & properties

General materials

Note: Materials for stocked 'O' rings are **printed in red**. For specific details see *Selecting a material* on page 4.

Nitrile – acrylonitrile-butadiene (NBR)
Stocked grade PB80
We have a wide range of compounds based on various acrylonitrile/butadiene ratios. Higher acrylonitrile content generally gives better hydrocarbon resistance, whereas low acrylonitrile content gives better low temperature flexibility. Our PB range is suitable for use with mineral oils – particularly hydraulic types – as well as water and some solvents. Our Proteus range is generally suitable for food applications, but please consult our Technical Services Team on specific applications before ordering.

Chloroprene (CR) – *eg, Neoprene*
These general purpose rubbers are largely unaffected by sunlight and atmospheric aging. They will give satisfactory service in many media, such as mineral lubricating oils and greases, dilute acids/alkalis and some solvents.

Natural rubber (NR)
Materials based on natural rubber have high strength and high resilience with good abrasion resistance. They are suitable for use in hot and cold water, ammonia, ethylene glycol, dilute acids and alkalis. Limited resistance to heat, weathering and oils has reduced the use of natural rubbers in favour of synthetic elastomers.

Ethylene-propylene (EPM/EPDM)
Stocked grade EP18/H/75
These compounds have excellent resistance to weathering, ozone, hot and cold water and steam. EPM grades are available for use with water up to +180°C, making them ideal for steam raising plant. These materials also display resistance to aliphatic phosphate-ester hydraulic fluids, acids, alkalis, salt solutions, alcohols, glycols and silicone oils.

Our EP62 range of rubbers for potable water applications is WRAS approved.

Butyl – isobutylene-isoprene (IIR)
Butyl rubber has similar chemical resistance to ethylene-propylene. Very low gas permeability makes butyl popular for vacuum and high pressure gas applications. It must ***not*** be used with mineral oils.

Epichlorhydrin (ECO)
Compounds based on this elastomer have good resistance to mineral oils, fuels and ozone. Corrosive properties and poor compression set resistance limit the use of these materials for sealing applications.

Chlorosulphonated polyethylene (CSM) – *eg, Hypalon*®
These elastomers show excellent resistance to weathering and give good service in many media. They are not recommended for dynamic seal applications as compression set resistance is limited.

Polyurethane (AU/EU)
Stress relaxation at above +50°C often precludes these elastomers from 'O' ring *sealing* applications. However, many polyurethane 'O' rings are used in drive transmissions where their tensile strength, elongation characteristics and wear resistance prove invaluable. These materials also have excellent resistance to weathering and oxygen, and good resistance to hydrocarbon fuels and mineral oils. Resistance to acids is low, and some grades are affected by water and humidity.

Fluorosilicone (FVMQ, FMQ)
Fluorosilicone grades are available for applications involving hydrocarbon oils, petroleum fuels and mineral-based hydraulic fluids. This material is primarily used for static seals in aerospace fuel systems. It has similar mechanical limitations to silicone.

Silicone (VMQ)
Stocked grade SIL 80/2
Many grades of silicone rubber are available. They offer good resistance to weathering and compression set at high temperatures, plus excellent electrical properties. Use is limited by high gas permeability, low tensile strength, and poor resistance to tear and abrasion. Some grades are suitable for food applications.

Commercial 'O' rings

To complement our premium products, we supply general purpose 'commercial quality' 'O' rings for less critical applications. These are available with:
- Competitive prices.
- Full traceability – on request.
- Quantities from one to millions.
- Wide range of material and sizes.

Materials – a comprehensive range including:
- Ethylene-propylene (EPM/EPDM)
- Neoprene (CR)
- Nitrile (NBR)
- Polyurethane (AU/EU)
- Silicone (VMQ)
- Fluoroelastomer (FKM)

Commercial 'O' rings are supplied to James Walker Charts:
- JW46: covering BS 1806 & SAE AS 568.
- JW47: European metric range.
- JW48: metric sizes to BS 4518.
- JW49: Japanese industry sizes.

Non-standard sizes are also available in commercial materials to suit specific customer requirements.

Please contact our Technical Services Team to determine product suitability.

High performance materials

Fluoroelastomers (FKM) – *eg, Viton®, Tecnoflon®, Dyneon™*
Stocked grades FR10/80, FR25/90, FR58/90
Fluoroelastomers operate efficiently under severe chemical conditions and at higher temperatures where many other seal materials cannot survive. According to grade they are well suited to arduous applications involving:

- Temperatures from –30°C to +250°C.
- Petroleum fuels and mineral-based hydraulic fluids.
- Many solvents.

We have developed numerous grades of fluoroelastomer, including the following:

General purpose fluoroelastomers
FR10: Dipolymer-based range with hardnesses of 50 to 90 IRHD. These grades are ideal for general applications and are approved to UK Ministry of Defence low compression set specifications.

FR17: Terpolymer-based range with hardnesses of 65 to 95 IRHD. It has enhanced chemical resistance and better high temperature flexibility characteristics than FR10, although these properties are – to some extent – at the expense of compression set resistance.

FR44: Dipolymer-based range with hardnesses of 50 to 90 IRHD. It comes in a distinctive shade of green for easy identification. These low compression set grades meet many regularly used specifications.

Special fluoroelastomer grades
Many grades are available for specific duties. The following are of particular value:

FR58/90 & 98: These terpolymer-based grades resist explosive decompression (ED) as described on page 9, and have good all round elastomeric properties. We are market leader in seals for ED environments.

FR64/70 & 80: Dipolymer-based compounds developed to offer enhanced performance in steam, hot water and mineral acids.

LR5853: Tetrapolymer-based range with hardnesses of 80, 90 and 98 IRHD. It has enhanced fluid resistance, especially with methanol and gasoline-alcohol blends that adversely affect other fluoroelastomers. These grades stiffen below –5°C, thus LR6316 and FR25 are recommended for low temperature use.

LR6316: Available in hardnesses of 75 and 90 IRHD, these compounds are based on a special tetrapolymer with a similar fluid resistance to LR5853, plus improved low temperature characteristics for service down to –28°C.

FR25: Tetrapolymer-based range with hardnesses of 70 to 90 IRHD. Offers fluid resistance approaching that of the FR10 range plus improved low temperature characteristics for service down to –33°C. FR25/90 is compounded for explosive decompression (ED) resistance.

Aflas® (FEPM)
These compounds have resistance to oils, lubricants and some fuels approaching that of fluorocarbon dipolymers but, in addition, are suitable for sour gas duties or where amines and high temperature water or steam are used.

AF85: Available in hardnesses of 70, 80 and 90 IRHD. Typical maximum service temperature is +200°C although higher temperatures can be sustained in some media: eg, up to +260°C in steam. Other specialised grades are available, such as AF69/90 that is compounded for explosive decompression (ED) resistance.

Kalrez® – perfluoroelastomer (FFKM)
These perfluoroelastomers offer almost universal chemical resistance. Grades are available for continuous operation at up to +315°C. James Walker is authorised UK distributor for Kalrez® products used for fluid sealing and handling duties. *Please ask for technical details and separate literature.*

Fluolion® (PTFE)
Fluolion® is the registered trademark of James Walker products manufactured from polytetrafluoroethylene. PTFE is an extremely inert material, unaffected by virtually every known chemical including most acids, alkalis and solvents. These exceptional properties make PTFE the ideal material for 'O' ring back-up rings.

The flow characteristics of PTFE under stress are usually a disadvantage in 'O' rings.

Elast-O-Lion® – hydrogenated nitrile (HNBR)
Stocked grades Elast-O-Lion® 101, 180, 985
Elast-O-Lion® is the registered trademark of James Walker for its range of high performance hydrogenated nitrile compounds.

These materials have the excellent oil/fuel resistance of traditional nitrile (NBR) elastomers. They also have superior mechanical properties and can sustain higher service temperatures: eg, up to +180°C in oil. In addition, they display superior resistance to aggressive fluids such as sour (H_2S) crude oil, lubricating oil additives and amine corrosion inhibitors. Fully saturated grades of HNBR have excellent resistance to ozone.

Five ranges are available with various acrylonitrile contents from low to ultra high, and hardnesses of 50 to 90 IRHD. In addition, four grades – Elast-O-Lion 101, 201, 301 and 985 – have been specially developed for oilfield duties where a combination of high mechanical strength, resistance to explosive decompression (ED) and chemical resistance is required.

Temperature capability is between –46°C and +180°C depending on material grade and application.

Further information on elastomers
For additional information on our extensive range of high performance elastomers, please refer to our *High Performance Elastomers* guide.

Materials and properties

Guide to material use

Table 3

MATERIAL TYPE		Air or oxygen	Water – up to 80°C	Water – above 80°C	Dilute acids	Dilute alkalis	Lower alcohols	Aldehydes	Amines	Chlorinated solvents	Ethers	Ketones	Hydrocarbons – aliphatic	Hydrocarbons – aromatic	Leaded petrol (gasoline)	Kerosene	Animal oils and fats	Fuel oils and diesel oils	Lubricating oils – mineral	Lubricating oils – synthetic	Silicone oils and grease	Vegetable oils	Hydraulic fluids – mineral based	Chlorinated	Oil in water emulsions	Water in oil emulsions	Water – glycol based	Phosphate esters – aliphatic	Phosphate esters – aromatic	Hydraulic fluids fire resistent	Temperature range (°C)			
																														Low	High – continuous	High – intermittent	Hardness range IRHD	Available to the latest issue of the following specifications
Acrylic	ACM	2	4	4	4	4	4	4	4	3	3	4	1	3	1	1	1	1	1	2	1	1	1	4	4	4	4	4	4	–20	150	175	80	
Aflas®	FEPM	1	1	1[F]	1	2	1	1	1	1	4	4	1	3	2	1	1	1	1	2	1	1	1	2	1	1	1	1	2	0	200	230[F]	70 - 90	
Butyl	IIR	1	1	2	1	1	1	1	2	4	4	1	4	4	4	4	2	4	4	4	1	3	4	4	4	4	1	2	2	–35	120	150	60 - 70	BS 3227
Elast-O-Lion®	HNBR	1	1	1	1	2	1	2	1	2	4	4	1	3	2	1	1	2	1	1	1	1	1	4	2	2	2	1	4	–25[A]	160	200	50 - 90	
Epichlorohydrin	ECO	2	2	3	3	2	2	4	4	4	4	4	3	4	1	1	1	1	1	4	1	1	1	4	2	2	2	4	4	–30	150	175	70 - 90	
Ethylene-propylene	EPM/EPDM	1	1	1	2	1	1	1	2	4	3	1	4	4	4	4	2	4	4	4	1	3	4	4	4	4	1	1	2	–45	120	150[B]	50 - 90	*DTD 5597, 5608
Fluolion®	PTFE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	–200	250			
Fluoroelastomers	FKM	1	1	3	1	2	4[C]	4[C]	4[C]	1	3[C]	4[C]	1	1	1	1	1	1	1	2	1	1	1	2	1	1	2	3	1	–15[D]	200	230[D]	50 - 98	DEF STAN 02-337, *DTD 5543, 5603, 5612, 5613.
Fluorosilicone	FVMQ	1	1	2	3	2	1	4	4	1	3	4	1	1	2	1	1	2	1	2	3	1	2	4	2	2	2	3	3	–60	180	200	60 - 80	*DTD 5583
Hypalon®	CSM	2	1	3	4	1	1	3	4	4	4	4	2	4	4	4	3	3	4	4	1	2	2	4	4	3	1	4	4	–30	120	150	65 - 80	
Kalrez®	FFKM	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	–25	315	350	65 - 95	SAE AMS 7257
Natural rubber	NR	3	2	4	3	2	2	3	2	4	4	4	4	4	4	4	4	4	4	4	1	4	4	4	4	4	3	4	4	–50	100	120	40 - 85	BS 1154, DEF STAN 02-820 & *DEF STAN 22-005
Neoprene	CR	1	2	3	3	2	1	3	2	4	4	4	2	4	3	2	2	3	2	3	1	3	3	4	4	4	3	4	4	–40	120	150	40 - 90	BS 2752
Nitrile	NBR	2	1	3	3	2	1	3	4	3	4	4	1	3	2	1	1	2	1	2	1	1	1	4	3	3	1	4	4	–30[A]	120	150	40 - 90	BS 2751, 6996, 6997, DEF STAN 02-337, *DEF STAN 22-005,*DTD 5509, 5594, 5595, 5606, 5607.
Polyurethane	AU/EU	1	4	4	4	4	4	4	4	3	2	4	2	4	2	2	2	3	2	4	1	2	1	4	4	4	4	4	4	–15	85	100	55 - 95[E]	
Silicone	VMQ	1	1	1	3	2	1	2	2	4	4	3	3	4	4	4	2	4	3	3	4	1	4	3	3	4	2	3	3	–60	200	250	40 - 80	*DTD 818, 5531, 5582, 5605

Key

1 Very Good
2 Good
3 Fair
4 Not Recommended

*These specifications have been declared OBSOLESCENT.
Some DTD specifications are due to be superseded by BS F specifications.
[A]Low acrylonitrile content grades are available for temperatures down to –46°C
[B]EPM grades are available for hot water service up to +180°C
[C]Fluoroelastomer grades are available which offer resistance to these chemicals
[D]Fluoroelastomer grades are available for temperatures from –33°C to +250°C
[E]Polyurethane grades are also available from 60 to 74 hardness Shore D
[F]Aflas® grades suitable for temperatures up to +260°C in hot water and steam

Note: *These figures are provided as a guide only. Actual service life will depend on type of application, whether static or dynamic, specific pressure medium, temperature cycle, time of exposure, etc. The low temperatures quoted are values at atmospheric pressure and may change at elevated pressures.*

Lubricants

We recommend the following lubricants be specified and applied lightly to 'O' rings before assembly (but please note the important ***exceptions***):

- James Walker's Molyon Grease, containing MoS_2, for operating temperatures from –20°C to +150°C.
- James Walker's Silicone Grease, for operating temperatures from –50°C to +200°C.
- James Walker's Copper Anti-Seize Compound or Nickel Anti-Seize Compound for operating temperatures above +200°C.

Exceptions: DO NOT use mineral-based oil or grease, such as our Molyon and Anti-Seize Compounds, on seals made from natural rubber (NR), butyl (IIR) or ethylene-propylene (EPM/EPDM). Likewise, DO NOT use silicone oil or grease on seals made from silicone (VMQ) compounds.

Surface texture

All 'O' rings precision-moulded by James Walker are supplied with surface texture to Grade N of BS ISO 3601-3 *Limits of surface imperfections on elastomeric toroidal sealing rings ('O' rings)*, with the higher Grade S provided if required.

Our Commercial 'O' rings (page 6) and items in our 'O' Ring Kits (page 29) do not necessarily comply with Grade N surface texture. Please consult our Technical Services Team if surface texture is important for your specific application.

Explosive decompression

Although explosive decompression (ED) is a phenomenon generally found in the oil and gas industry, it can be experienced in any application where there is a rapid drop in gas pressure.

ED damage has been noted in sealing applications ranging from paint guns and fire extinguishers to marine stern gland seals and systems containing refrigerants.

'O' rings after explosive decompression.

Explosive decompression damage is structural failure in the forms of blistering, internal cracking and splits caused when the gas pressure, to which the seal is exposed, is rapidly reduced from high to low.

The elastomeric components of a system are, to a greater or lesser extent, susceptible to the permeation and diffusion of gases dissolving in their surface. With time, these components will become saturated with whatever gases are in the system.

Under these conditions – as long as the internal gas pressure of the elastomer remains at equilibrium with the ambient pressure – there is minimal damage, if any, and no deterioration in performance of the elastomeric component occurs (unless caused by other factors such as chemical or thermal degradation or by extrusion damage).

When the external gas pressure is removed or pressure fluctuations occur, large pressure gradients are created between the interior and the surface of the elastomeric component. This pressure differential may be balanced by the gas simply diffusing/ permeating out of the elastomer, especially if any external constraints are not removed.

However, if the physical properties of the elastomeric compound cannot resist crack and blister growth during the permeation process, then structural failure is the inevitable result.

Explosive decompression damage can manifest itself in various ways – anything from internal splits that are not visible on the surface of the seal to surface blisters, fractures and complete fragmentation.

James Walker's eight-flange explosive decompression test rigs.

In order to overcome many of the problems associated with high pressure gas systems, we have conducted intensive materials development programmes over the last 20 years. Much of this work was carried out in collaboration with equipment manufacturers, major oil and gas operators, and research bodies.

We offer five standard grades of ED resistant elastomer, all of which have been extensively validated in-house.They are tested, approved and specified by oilfield operators and equipment manufacturers alike.

The formulation, mixing, quality control and processing of these compounds is rigorously controlled and today they are rated by many as the benchmarks by which all others are judged. Although each of these compounds has a broad range of application capability, their particular features are as follows:

- **FR58/90** – A fluoroelastomer (FKM) with excellent chemical and thermal properties, plus ED resistance in hydrocarbon applications. It is approved and specified by many oil producers and equipment manufacturers.
- **FR25/90** – This fluoroelastomer (FKM) combines an improved low temperature capability with excellent thermal and chemical properties. It is ED resistant in hydrocarbon applications.
- **Elast-O-Lion 101 –** An hydrogenated nitrile (HNBR) grade with high mechanical strength and wear resistant properties. It has good resistance to many oilfield chemicals including H_2S and amine corrosion inhibitors. It is resistant to explosive decompression and is approved to many ED specifications.
- **Elast-O-Lion 985 –** This hydrogenated nitrile (HNBR) grade offers improved low temperature capacity, but with reduced mechanical properties and ED resistance compared to Elast-O-Lion 101.
- **AF69/90** – An Aflas® (FEPM) based ED resistant grade with excellent resistance to oilfield media and steam.

Materials and properties

FEP encapsulated ‘O’ rings

FEP encapsulated ‘O’ rings have a core of elastomer that is completely covered with a seamless sheath of FEP fluoropolymer. The elastomeric core is normally either fluorocarbon or silicone.

An encapsulated ‘O’ ring is generally used when:

- A standard elastomer ‘O’ ring has inadequate chemical resistance for a particular application, and
- A solid PTFE ‘O’ ring does not offer sufficient elasticity for reliable, long-term fluid sealing.

They are typically used in the chemical, petrochemical, food and pharmaceutical industries and other sectors where high levels of chemical resistance and/or hygiene are required.

Although FEP encapsulated ‘O’ rings are most suited to static duties, they may be used with slow, short movements on rotary applications such as valve stem sealing.

Their advantages are manifold, including:

- Excellent chemical resistance to a wide range of media – please consult our Technical Services Team for further advice.
- Operational temperature ranges of –60°C to +200°C with silicone core, –20°C to +200°C with fluorocarbon core.
- Low friction and low ‘stick-slip’ effect.
- Can be used with food, pharmaceutical and medical products.
- Far better elasticity than solid PTFE.

Our FEP encapsulated ‘O’ rings are fully interchangeable with standard elastomeric ‘O’ rings. However, due to the FEP sheath, they are less flexible than normal elastomeric ‘O’ rings and have limited stretch with higher permanent deformation. Auxiliary tools may be needed to facilitate efficient fitting.

Back-up rings

Back-up rings are installed to prevent extrusion of the ‘O’ ring. These are manufactured from PTFE, PEEK™, and filled PTFE.

They are normally recommended for applications where:

- Pressure of the fluid medium exceeds 100bar, or
- ‘O’ rings of low strength elastomer are used, or
- Adverse mechanical conditions prevail.

Please consult our Technical Services Team if fluid pressure is likely to exceed 420bar.

Two back-up rings – one either side of the ‘O’ ring in its housing – are needed when the application is double acting.

Back-up rings are normally supplied as a spiral of two turns. This enables the back-up ring to be opened with ease for fitting over a shaft, and ensures the ‘O’ ring is supported around its entire diameter.

Single turn back-up rings can also be supplied and these are usually endless to ensure good support. However, they can be scarf split if required, although we do not recommend this because extrusion can occur at the split.

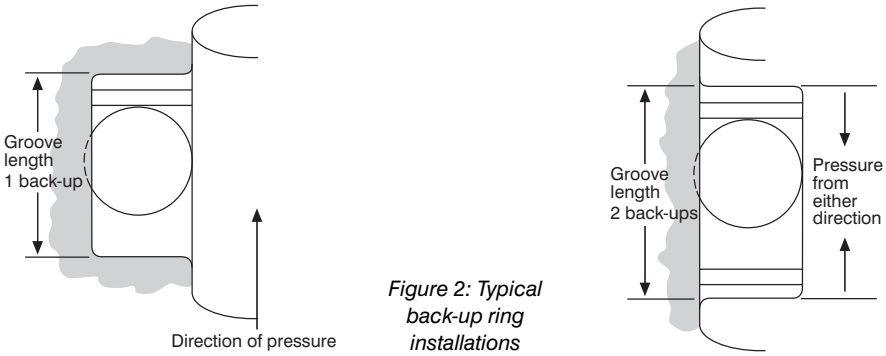


Figure 2: Typical back-up ring installations

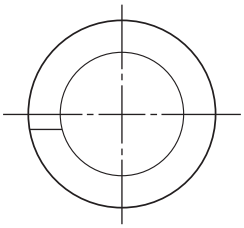


Figure 3: Spiral back-up ring

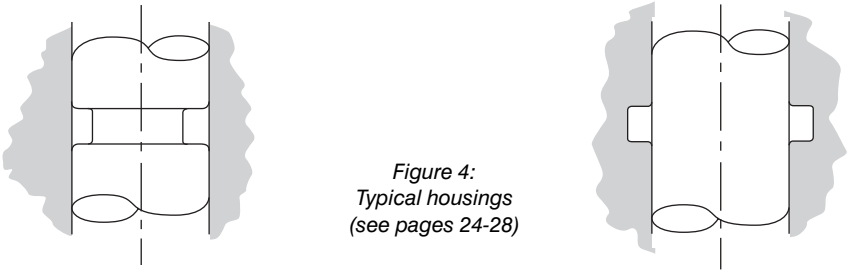


Figure 4: Typical housings (see pages 24-28)

Smaller sizes of back-up ring are available only as a single turn. This is because spiral back-up rings need an inside diameter greater than 3mm for machining purposes.

Chart 50: Inch and metric sizes

To order your Chart 50 'O' ring or back-up ring, see page 5.

For housing details refer to pages 24-28.

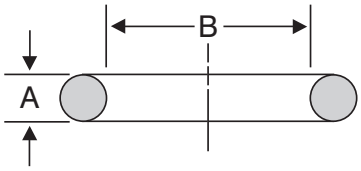
Our **Chart 50** reflects the standards in many countries, particularly those of the UK and USA. Despite UK metrification, inch sizes to BS 1806 are still very popular.

Reference numbers highlighted in red indicate those sizes covered by:

- BS 1806: *Dimensions of toroidal sealing rings ('O' rings) and their housings (inch sizes),* and
- SAE AS 568: American National Standard *Aerospace size standard for 'O' rings*.

Although the basic range is in inches, the 'O' rings can of course be used for sealing metric dimensioned components. The tables below include suggested metric shaft and cylinder sizes for which each individual 'O' ring is suitable. (Note: These figures are NOT merely direct metric conversions of inch sizes. Separate ranges of back-up rings are available for metric shafts and cylinders – see page 5 for ordering references.)

* An asterisk symbol denotes that the ring is suitable for both dynamic and static applications. Other sizes are not recommended for dynamic duties.



James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.040 ±0.003" (1.02 ±0.08mm) Diameter Section A								
50-001	0.029	±0.004	1/32	3/32	0.74	±0.10	0.8	2.5
" 606	0.070	±0.005	5/64	9/64	1.78	±0.13	2	3.6
" 607	0.100	"	7/64	11/64	2.54	"	2.8	4.5
0.050 ±0.003" (1.27 ±0.08mm) Diameter Section A								
50-002	0.042	±0.004	3/64	0.130	1.07	±0.10	1.2	3.3
0.060 ±0.003" (1.52 ±0.08mm) Diameter Section A								
50-003	0.056	±0.004	1/16	11/64	1.42	±0.10	1.5	4.1
0.070 ±0.003" (1.78 ±0.08mm) Diameter Section A								
50-004*	0.070	±0.005	5/64	13/64	1.78	±0.13	2	5
" 005*	0.101	"	7/64	15/64	2.57	"	2.8	6
" 006*	0.114	"	1/8	1/4	2.90	"	3	6.2
" 801*	0.125	"	9/64	17/64	3.18	"	3.5	6.5
" 007*	0.145	"	5/32	9/32	3.68	"	4	7

James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.070 ±0.003" (1.78 ±0.08mm) Diameter Section A								
50-008*	0.176	±0.005	3/16	5/16	4.47	±0.13	4.5	8
" 802*	0.188	"	13/64	21/64	4.76	"	5	8.5
" 009*	0.208	"	7/32	11/32	5.28	"	5.5	9
" 010*	0.239	"	1/4	3/8	6.07	"	6	9.5
" 803*	0.250	"	17/64	25/64	6.35	"	6.5	9.8
" 610*	0.266	"	9/32	13/32	6.75	"	7	10
" 011*	0.301	"	5/16	7/16	7.65	"	7.5	11
" 804*	0.313	"	21/64	29/64	7.94	"	8	11.5
" 611*	0.344	"	11/32	15/32	8.73	"	9	12
" 012*	0.364	"	3/8	1/2	9.25	"	9.5	12.5
" 013	0.426	"	7/16	9/16	10.82	"	11	14.2
" 806	0.438	"	29/64	37/64	11.11	"	11.5	14.5
" 014	0.489	"	1/2	5/8	12.42	"	12.5	16
" 015	0.551	±0.007	9/16	11/16	14.00	±0.18	14	17.5
" 016	0.614	±0.009	5/8	3/4	15.60	±0.23	15.5	19
" 017	0.676	"	11/16	13/16	17.17	"	17	20.5
" 018	0.739	"	3/4	7/8	18.77	"	19	22.5
" 019	0.801	"	13/16	15/16	20.35	"	20	24
" 020	0.864	"	7/8	1	21.95	"	22	25.5
" 021	0.926	"	15/16	1 1/16	23.52	"	23	27
" 022	0.989	±0.010	1	1 1/8	25.12	±0.25	25	29
" 023	1.051	"	1 1/16	1 3/16	26.70	"	27	30
" 024	1.114	"	1 1/8	1 1/4	28.30	"	28	32
" 025	1.176	±0.011	1 3/16	1 5/16	29.87	±0.28	30	34
" 026	1.239	"	1 1/4	1 3/8	31.47	"	31	35
" 027	1.301	"	1 5/16	1 7/16	33.05	"	32	37
" 028	1.364	±0.013	1 3/8	1 1/2	34.65	±0.33	35	38
" 517	1.428	"	1 7/16	1 9/16	36.27	"	36	40
" 029	1.489	"	1 1/2	1 5/8	37.82	"	38	42
" 519	1.553	"	1 9/16	1 11/16	39.45	"	39	43
" 030	1.614	"	1 5/8	1 3/4	41.00	"	40	45
" 031	1.739	±0.015	1 3/4	1 7/8	44.17	±0.38	44	48
" 032	1.864	"	1 7/8	2	47.35	"	47	51
" 033	1.989	±0.018	2	2 1/8	50.52	±0.46	50	55
" 034	2.114	"	2 1/8	2 1/4	53.70	"	53	58
" 035	2.239	"	2 1/4	2 3/8	56.87	"	56	61
" 036	2.364	"	2 3/8	2 1/2	60.05	"	60	65
" 037	2.489	"	2 1/2	2 5/8	63.22	"	63	67
" 038	2.614	±0.020	2 5/8	2 3/4	66.40	±0.51	65	70
" 039	2.739	"	2 3/4	2 7/8	69.57	"	69	75
" 040	2.864	"	2 7/8	3	72.75	"	70	77
" 041	2.989	±0.024	3	3 1/8	75.92	±0.61	75	80
" 532	3.110	"	3 1/8	3 1/4	78.99	"	78	85
" 042	3.239	"	3 1/4	3 3/8	82.27	"	80	88

Chart 50: Inch and metric sizes

James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.070 ±0.003" (1.78 ±0.08mm) Diameter Section A								
50-534	3.360	±0.024	3 3/8	3 1/2	85.34	±0.61	85	90
" 043	3.489	"	3 1/2	3 5/8	88.62	"	88	95
" 536	3.610	±0.027	3 5/8	3 3/4	91.69	±0.69	90	98
" 044	3.739	"	3 3/4	3 7/8	94.97	"	95	100
" 538	3.860	"	3 7/8	4	98.04	"	98	102
" 045	3.989	"	4	4 1/8	101.32	"	100	105
" 540	4.110	"	4 1/8	4 1/4	104.39	"	104	110
" 046	4.239	±0.030	4 1/4	4 3/8	107.67	±0.76	107	112
" 542	4.360	"	4 3/8	4 1/2	110.74	"	110	115
" 047	4.489	"	4 1/2	4 5/8	114.02	"	114	120
" 544	4.610	"	4 5/8	4 3/4	117.09	"	116	122
" 048	4.739	"	4 3/4	4 7/8	120.37	"	120	125
" 546	4.860	±0.037	4 7/8	5	123.44	±0.94	123	130
" 049	4.989	"	5	5 1/8	126.72	"	125	132
" 548	5.095	"	5 1/8	5 1/4	129.41	"	130	135
" 050	5.239	"	5 1/4	5 3/8	133.07	"	132	138
" 550	5.345	"	5 3/8	5 1/2	135.76	"	135	140
" 551	5.470	"	5 1/2	5 5/8	138.94	"	138	145
" 552	5.595	"	5 5/8	5 3/4	142.11	"	140	148
" 553	5.720	"	5 3/4	5 7/8	145.29	"	145	150
" 554	5.845	"	5 7/8	6	148.46	"	148	155
" 555	5.970	"	6	6 1/8	151.64	"	150	158
" 556	6.095	±0.040	6 1/8	6 1/4	154.81	±1.02	155	160
" 557	6.220	"	6 1/4	6 3/8	157.99	"	158	162
" 558	6.345	"	6 3/8	6 1/2	161.16	"	160	165
" 559	6.470	"	6 1/2	6 5/8	164.34	"	165	170
" 560	6.595	"	6 5/8	6 3/4	167.51	"	167	172
" 561	6.720	"	6 3/4	6 7/8	170.69	"	170	175
" 562	6.845	"	6 7/8	7	173.86	"	174	180
0.103 ±0.003" (2.62 ±0.08mm) Diameter Section A								
50-102*	0.049	±0.005	1/16	1/4	1.24	±0.13	1.5	6
" 103*	0.081	"	3/32	9/32	2.06	"	2.3	7
" 104*	0.112	"	1/8	5/16	2.84	"	3	7.5
" 105*	0.143	"	5/32	11/32	3.63	"	4	8.5
" 106*	0.174	"	3/16	3/8	4.42	"	4.5	9.5
" 107*	0.206	"	7/32	13/32	5.23	"	5.5	10
" 108*	0.237	"	1/4	7/16	6.02	"	6	11
" 109*	0.299	"	5/16	1/2	7.59	"	7.5	12.5
" 110*	0.362	"	3/8	9/16	9.19	"	9.5	14
" 613*	0.391	"	13/32	19/32	9.92	"	10	15
" 111*	0.424	"	7/16	5/8	10.77	"	11	16
" 614*	0.469	"	15/32	21/32	11.91	"	11.5	17
" 112*	0.487	"	1/2	11/16	12.37	"	12	17.5
" 807*	0.500	±0.007	-	-	12.70	±0.18	12.5	17.8

James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.103 ±0.003" (2.62 ±0.08mm) Diameter Section A								
50-615*	0.516	±0.007	33/64	45/64	13.10	±0.18	13	18
" 113*	0.549	"	9/16	3/4	13.94	"	14	19
" 616*	0.594	"	19/32	25/32	15.08	"	15	20
" 114*	0.612	±0.009	5/8	13/16	15.54	±0.23	15.5	20.5
" 809*	0.625	"	41/64	53/64	15.88	"	16	21
" 115*	0.674	"	11/16	7/8	17.12	"	17	22
" 810*	0.688	"	45/64	57/64	17.46	"	17.5	22.5
" 617*	0.703	"	23/32	29/32	17.86	"	18	23
" 116*	0.737	"	3/4	15/16	18.72	"	19	24
" 117	0.799	±0.010	13/16	1	20.29	±0.25	20	25.5
" 812	0.813	"	53/64	1 1/64	20.64	"	20.5	26
" 118	0.862	"	7/8	1 1/16	21.89	"	21	27
" 813	0.875	"	57/64	1 5/64	22.23	"	22	27.5
" 119	0.924	"	15/16	1 1/8	23.47	"	23	28.5
" 814	0.938	"	61/64	1 9/64	23.81	"	23.5	29
" 120	0.987	"	1	1 3/16	25.07	"	25	30
" 121	1.049	"	1 1/16	1 1/4	26.64	"	27	32
" 122	1.112	"	1 1/8	1 5/16	28.24	"	28	34
" 123	1.174	±0.012	1 3/16	1 3/8	29.82	±0.30	30	35
" 124	1.237	"	1 1/4	1 7/16	31.42	"	31	37
" 125	1.299	"	1 5/16	1 1/2	32.99	"	32	38
" 126	1.362	"	1 3/8	1 9/16	34.59	"	35	40
" 127	1.424	"	1 7/16	1 5/8	36.17	"	36	42
" 128	1.487	"	1 1/2	1 11/16	37.77	"	38	43
" 129	1.549	±0.015	1 9/16	1 3/4	39.34	±0.38	39	45
" 130	1.612	"	1 5/8	1 13/16	40.94	"	40	47
" 131	1.674	"	1 11/16	1 7/8	42.52	"	42	48
" 132	1.737	"	1 3/4	1 15/16	44.12	"	44	50
" 133	1.799	"	1 13/16	2	45.69	"	45	51
" 134	1.862	±0.017	1 7/8	2 1/16	47.29	±0.43	47	53
" 135	1.925	"	1 15/16	2 1/8	48.90	"	48	55
" 136	1.987	"	2	2 3/16	50.47	"	50	56
" 137	2.050	"	2 1/16	2 1/4	52.07	"	52	58
" 138	2.112	"	2 1/8	2 5/16	53.64	"	53	60
" 139	2.175	"	2 3/16	2 3/8	55.25	"	55	61
" 140	2.237	"	2 1/4	2 7/16	56.82	"	56	62
" 141	2.300	±0.020	2 5/16	2 1/2	58.42	±0.51	58	65
" 142	2.362	"	2 3/8	2 9/16	59.99	"	60	66
" 143	2.425	"	2 7/16	2 5/8	61.60	"	61	67
" 144	2.487	"	2 1/2	2 11/16	63.17	"	63	69
" 145	2.550	"	2 9/16	2 3/4	64.77	"	65	70
" 146	2.612	"	2 5/8	2 13/16	66.34	"	66	72
" 147	2.675	±0.022	2 11/16	2 7/8	67.95	±0.56	68	74
" 148	2.737	"	2 3/4	2 15/16	69.52	"	69	75

Chart 50: Inch and metric sizes

James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.103 ±0.003" (2.62 ±0.08mm) Diameter Section A								
50-149	2.800	±0.022	2 13/16	3	71.12	±0.56	70	77
" 150	2.862	"	2 7/8	3 1/16	72.69	"	72	78
" 640	2.924	±0.024	2 15/16	3 1/8	74.27	±0.61	74	80
" 151	2.987	"	3	3 3/16	75.87	"	75	82
" 641	3.049	"	3 1/16	3 1/4	77.44	"	77	85
" 642	3.174	"	3 3/16	3 3/8	80.62	"	80	87
" 152	3.237	"	3 1/4	3 7/16	82.22	"	82	88
" 643	3.299	"	3 5/16	3 1/2	83.79	"	84	90
" 153	3.487	"	3 1/2	3 11/16	88.57	"	88	95
" 154	3.737	±0.028	3 3/4	3 15/16	94.92	±0.71	95	100
" 155	3.987	"	4	4 3/16	101.27	"	100	110
" 156	4.237	±0.030	4 1/4	4 7/16	107.62	±0.76	107	115
" 157	4.487	"	4 1/2	4 11/16	113.97	"	114	120
" 158	4.737	"	4 3/4	4 15/16	120.32	"	120	130
" 159	4.987	±0.035	5	5 3/16	126.67	±0.89	125	135
" 160	5.237	"	5 1/4	5 7/16	133.02	"	132	140
" 161	5.487	"	5 1/2	5 11/16	139.37	"	138	145
" 162	5.737	"	5 3/4	5 15/16	145.72	"	145	155
" 163	5.987	"	6	6 3/16	152.07	"	150	160
" 164	6.237	±0.040	6 1/4	6 7/16	158.42	±1.02	158	165
" 165	6.487	"	6 1/2	6 11/16	164.77	"	165	170
" 166	6.737	"	6 3/4	6 15/16	171.12	"	170	180
" 167	6.987	"	7	7 3/16	177.47	"	177	185
" 168	7.237	±0.045	7 1/4	7 7/16	183.82	±1.14	183	190
" 169	7.487	"	7 1/2	7 11/16	190.17	"	190	200
" 170	7.737	"	7 3/4	7 15/16	196.52	"	195	205
" 171	7.987	"	8	8 3/16	202.87	"	200	210
" 172	8.237	±0.050	8 1/4	8 7/16	209.22	±1.27	208	215
" 173	8.487	"	8 1/2	8 11/16	215.57	"	215	225
" 174	8.737	"	8 3/4	8 15/16	221.92	"	220	230
" 175	8.987	"	9	9 3/16	228.27	"	225	235
" 176	9.237	±0.055	9 1/4	9 7/16	234.62	±1.40	235	240
" 177	9.487	"	9 1/2	9 11/16	240.97	"	240	250
" 178	9.737	"	9 3/4	9 15/16	247.32	"	245	255

James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.139 ±0.004" (3.53 ±0.10mm) Diameter Section A								
50-201*	0.171	±0.005	3/16	7/16	4.34	±0.13	4.5	11
" 202*	0.234	"	1/4	1/2	5.94	"	6	12.5
" 203*	0.296	"	5/16	9/16	7.52	"	7.5	14
" 204*	0.359	"	3/8	5/8	9.12	"	9.5	16
" 205*	0.421	"	7/16	11/16	10.69	"	11	17.5
" 206*	0.484	"	1/2	3/4	12.29	"	12.5	19
" 207*	0.546	±0.007	9/16	13/16	13.87	±0.18	14	20.5
" 208*	0.609	±0.009	5/8	7/8	15.47	±0.23	15.5	22
" 209*	0.671	"	11/16	15/16	17.04	"	17	24
" 210*	0.734	±0.010	3/4	1	18.64	±0.25	19	25
" 211*	0.796	"	13/16	1 1/16	20.22	"	20	28
" 212*	0.859	"	7/8	1 1/8	21.82	"	22	29
" 213*	0.921	"	15/16	1 3/16	23.39	"	23	30
" 214*	0.984	"	1	1 1/4	24.99	"	25	32
" 618*	1.016	"	1 1/32	1 9/32	25.80	"	26	33
" 215*	1.046	"	1 1/16	1 5/16	26.57	"	27	34
" 216*	1.019	±0.012	1 1/8	1 3/8	28.17	±0.30	28	35
" 217*	1.171	"	1 3/16	1 7/16	29.74	"	30	36
" 218*	1.234	"	1 1/4	1 1/2	31.34	"	31	38
" 219*	1.296	"	1 5/16	1 9/16	32.92	"	32	40
" 220*	1.359	"	1 3/8	1 5/8	34.52	"	35	42
" 221*	1.421	"	1 7/16	1 11/16	36.09	"	36	43
" 222*	1.484	±0.015	1 1/2	1 3/4	37.69	±0.38	38	45
" 824	1.563	"	1 9/16	1 13/16	39.69	"	39	47
" 223	1.609	"	1 5/8	1 7/8	40.87	"	40	48
" 825	1.625	"	-	-	41.28	"	41	49
" 826	1.688	"	1 11/16	1 15/16	42.86	"	42	50
" 224	1.734	"	1 3/4	2	44.04	"	43	51
" 827	1.750	"	-	-	44.45	"	44	52
" 828	1.813	"	1 13/16	2 1/16	46.04	"	45	53
" 225	1.859	±0.018	1 7/8	2 1/8	47.22	±0.46	46	54
" 829	1.875	"	-	-	47.63	"	47	55
" 830	1.938	"	1 15/16	2 3/16	49.21	"	48	56
" 226	1.984	"	2	2 1/4	50.39	"	49	58
" 831	2.000	"	-	-	50.80	"	50	59
" 832	2.063	"	2 1/16	2 5/16	52.39	"	52	60
" 227	2.109	"	2 1/8	2 3/8	53.57	"	53	61
" 833	2.125	"	-	-	53.98	"	54	62
" 834	2.188	"	2 3/16	2 7/16	55.56	"	55	63
" 228	2.234	±0.020	2 1/4	2 1/2	56.74	±0.51	56	64
" 835	2.250	"	-	-	57.15	"	57	65
" 836	2.313	"	2 5/16	2 9/16	58.74	"	58	66
" 229	2.359	"	2 3/8	2 5/8	59.92	"	59	67
" 837	2.375	"	-	-	60.33	"	60	68

James Walker

Chart 50: Inch and metric sizes

James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.139 ±0.004" (3.53 ±0.10mm) Diameter Section A								
50-838	2.438	±0.020	2 7/16	2 11/16	61.91	±0.51	61	69
" 230	2.484	"	2 1/2	2 3/4	63.09	"	62	70
" 839	2.500	"	-	-	63.50	"	63	71
" 840	2.563	"	2 9/16	2 13/16	65.09	"	64	72
" 231	2.609	"	2 5/8	2 7/8	66.27	"	65	73
" 841	2.625	"	-	-	66.68	"	66	74
" 842	2.688	"	2 11/16	2 15/16	68.26	"	67	75
" 232	2.734	±0.024	2 3/4	3	69.44	±0.61	68	76
" 843	2.750	"	-	-	69.85	"	69	77
" 844	2.813	"	2 13/16	3 1/16	71.44	"	70	79
" 233	2.859	"	2 7/8	3 1/8	72.62	"	71	80
" 845	2.875	"	-	-	73.03	"	72	81
" 846	2.938	"	2 15/16	3 3/16	74.61	"	74	82
" 234	2.984	"	3	3 1/4	75.79	"	75	85
" 235	3.109	"	3 1/8	3 3/8	78.97	"	78	88
" 236	3.234	"	3 1/4	3 1/2	82.14	"	80	90
" 237	3.359	"	3 3/8	3 5/8	85.32	"	85	95
" 238	3.484	"	3 1/2	3 3/4	88.49	"	88	98
" 239	3.609	±0.028	3 5/8	3 7/8	91.67	±0.71	90	100
" 240	3.734	"	3 3/4	4	94.84	"	95	102
" 241	3.859	"	3 7/8	4 1/8	98.02	"	98	105
" 242	3.984	"	4	4 1/4	101.19	"	100	110
" 243	4.109	"	4 1/8	4 3/8	104.37	"	104	112
" 244	4.234	±0.030	4 1/4	4 1/2	107.54	±0.76	107	115
" 245	4.359	"	4 3/8	4 5/8	110.72	"	110	120
" 246	4.484	"	4 1/2	4 3/4	113.89	"	114	122
" 247	4.609	"	4 5/8	4 7/8	117.07	"	116	125
" 248	4.734	"	4 3/4	5	120.24	"	120	130
" 249	4.859	±0.035	4 7/8	5 1/8	123.42	±0.89	123	132
" 250	4.984	"	5	5 1/4	126.59	"	125	135

James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.139 ±0.004" (3.53 ±0.10mm) Diameter Section A								
50-251	5.109	±0.035	5 1/8	5 3/8	129.77	±0.89	130	138
" 252	5.234	"	5 1/4	5 1/2	132.94	"	132	140
" 253	5.359	"	5 3/8	5 5/8	136.12	"	135	145
" 254	5.484	"	5 1/2	5 3/4	139.29	"	138	148
" 255	5.609	"	5 5/8	5 7/8	142.47	"	140	150
" 256	5.734	"	5 3/4	6	145.64	"	145	155
" 257	5.859	"	5 7/8	6 1/8	148.82	"	148	158
" 258	5.984	"	6	6 1/4	151.99	"	150	160
" 259	6.234	±0.040	6 1/4	6 1/2	158.34	±1.02	158	170
" 260	6.484	"	6 1/2	6 3/4	164.69	"	165	175
" 261	6.734	"	6 3/4	7	171.04	"	170	180
" 262	6.984	"	7	7 1/4	177.39	"	177	185
" 263	7.234	±0.045	7 1/4	7 1/2	183.74	±1.14	183	195
" 264	7.484	"	7 1/2	7 3/4	190.09	"	190	200
" 265	7.734	"	7 3/4	8	196.44	"	195	205
" 266	7.984	"	8	8 1/4	202.79	"	200	210
" 267	8.234	±0.050	8 1/4	8 1/2	209.14	±1.27	208	220
" 268	8.484	"	8 1/2	8 3/4	215.49	"	215	225
" 269	8.734	"	8 3/4	9	221.84	"	220	230
" 270	8.984	"	9	9 1/4	228.19	"	225	235
" 271	9.234	±0.055	9 1/4	9 1/2	234.54	±1.40	235	245
" 272	9.484	"	9 1/2	9 3/4	240.89	"	240	250
" 273	9.734	"	9 3/4	10	247.24	"	245	255
" 274	9.984	"	10	10 1/4	253.59	"	250	265
" 275	10.484	"	10 1/2	10 3/4	266.29	"	265	275
" 276	10.984	±0.065	11	11 1/4	278.99	±1.65	275	290
" 277	11.484	"	11 1/2	11 3/4	291.69	"	290	300
" 278	11.984	"	12	12 1/4	304.39	"	300	315
" 279	12.984	"	13	13 1/4	329.79	"	330	340
" 280	13.984	"	14	14 1/4	355.19	"	350	365
" 281	14.984	"	15	15 1/4	380.59	"	380	390
" 282	15.955	±0.075	16	16 1/4	405.26	±1.91	400	415
" 283	16.955	±0.080	17	17 1/4	430.66	±2.03	430	440
" 284	17.955	±0.085	18	18 1/4	456.06	±2.16	455	465
0.210 ±0.005" (5.33 ±0.13mm) Diameter Section A								
50-309*	0.412	±0.005	7/16	13/16	10.46	±0.13	11	20.5
" 310*	0.475	"	1/2	7/8	12.07	"	12.5	22
" 311*	0.537	±0.007	9/16	15/16	13.64	±0.18	14	23.5
" 312*	0.600	±0.009	5/8	1	15.24	±0.23	15.5	25
" 313*	0.662	"	11/16	1 1/16	16.81	"	17	27
" 314*	0.725	±0.010	3/4	1 3/8	18.42	±0.25	19	28.5
" 315*	0.787	"	13/16	1 3/16	19.99	"	20	30

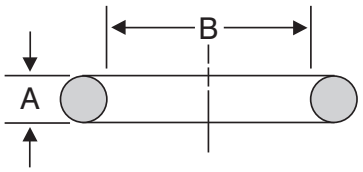
Chart 50: Inch and metric sizes

Coloured 'O' rings on a cartridge mechanical seal.

James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.210 ±0.005" (5.33 ±0.13mm) Diameter Section A								
50-316*	0.850	±0.010	7/8	1 1/4	21.59	±0.25	22	31.5
" 317*	0.912	"	15/16	1 5/16	23.16	"	23	33
" 318*	0.975	"	1	1 3/8	24.77	"	25	35
" 319*	1.037	"	1 1/16	1 7/16	26.34	"	27	36.5
" 320*	1.100	±0.012	1 1/8	1 1/2	27.94	±0.30	28	38
" 321*	1.162	"	1 3/16	1 9/16	29.51	"	30	40
" 322*	1.225	"	1 1/4	1 5/8	31.12	"	31	42
" 323*	1.287	"	1 5/16	1 11/16	32.69	"	32	43
" 324*	1.350	"	1 3/8	1 3/4	34.29	"	35	45
" 325*	1.475	±0.015	1 1/2	1 7/8	37.47	±0.38	38	48
" 326*	1.600	"	1 5/8	2	40.64	"	40	52
" 327*	1.725	"	1 3/4	2 1/8	43.82	"	42	55
" 328*	1.850	"	1 7/8	2 1/4	46.99	"	45	58
" 329*	1.975	±0.018	2	2 3/8	50.17	±0.46	50	62
" 330*	2.100	"	2 1/8	2 1/2	53.34	"	52	65
" 331*	2.225	"	2 1/4	2 5/8	56.52	"	56	68
" 332*	2.350	"	2 3/8	2 3/4	59.69	"	60	70
" 333*	2.475	±0.020	2 1/2	2 7/8	62.87	±0.51	63	75
" 334*	2.600	"	2 5/8	3	66.04	"	65	78
" 335*	2.725	"	2 3/4	3 1/8	69.22	"	68	80
" 336*	2.850	"	2 7/8	3 1/4	72.39	"	70	83
" 619*	2.938	±0.024	2 15/16	3 5/16	74.61	±0.61	72	85
" 337*	2.975	"	3	3 3/8	75.57	"	75	88

James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.210 ±0.005" (5.33 ±0.13mm) Diameter Section A								
50-338*	3.100	±0.024	3 1/8	3 1/2	78.74	±0.61	78	90
" 620*	3.141	"	-	-	79.78	"	80	92
" 339*	3.225	"	3 1/4	3 5/8	81.92	"	82	95
" 340*	3.350	"	3 3/8	3 3/4	85.09	"	85	98
" 341*	3.475	"	3 1/2	3 7/8	88.27	"	88	100
" 621*	3.531	±0.028	3 9/16	3 15/16	89.69	±0.71	90	101
" 342*	3.600	"	3 5/8	4	91.44	"	92	102
" 343*	3.725	"	3 3/4	4 1/8	94.62	"	95	105
" 344*	3.850	"	3 7/8	4 1/4	97.79	"	98	108
" 622*	3.938	"	3 15/16	4 5/16	100.01	"	100	110
" 345*	3.975	"	4	4 3/8	100.97	"	101	112
" 346*	4.100	"	4 1/8	4 1/2	104.14	"	104	115
" 347*	4.225	±0.030	4 1/4	4 5/8	107.32	±0.76	107	118
" 623*	4.313	"	4 5/16	4 11/16	109.54	"	109	120
" 348*	4.350	"	4 3/8	4 3/4	110.49	"	110	121
" 349*	4.475	"	4 1/2	4 7/8	113.67	"	114	125
" 350	4.600	"	4 5/8	5	116.84	"	116	128
" 860	4.625	"	-	-	117.48	"	117	130
" 351	4.725	"	4 3/4	5 1/8	120.02	"	120	131
" 861	4.750	"	-	-	120.65	"	121	132
" 352	4.850	"	4 7/8	5 1/4	123.19	"	123	134
" 862	4.875	±0.037	-	-	123.82	±0.94	124	135
" 353	4.975	"	5	5 3/8	126.37	"	125	137
" 863	5.000	"	-	-	127.00	"	127	138
" 354	5.100	"	5 1/8	5 1/2	129.54	"	129	140
" 864	5.125	"	-	-	130.18	"	130	141
" 355	5.225	"	5 1/4	5 5/8	132.72	"	132	143
" 865	5.250	"	-	-	133.35	"	133	145
" 356	5.350	"	5 3/8	5 3/4	135.89	"	135	146
" 866	5.375	"	-	-	136.53	"	136	148
" 357	5.475	"	5 1/2	5 7/8	139.07	"	138	150
" 867	5.500	"	-	-	139.70	"	140	151
" 358	5.600	"	5 5/8	6	142.24	"	142	153
" 868	5.625	"	-	-	142.88	"	143	155
" 359	5.725	"	5 3/4	6 1/8	145.42	"	145	156
" 869	5.750	"	-	-	146.05	"	146	158
" 360	5.850	"	5 7/8	6 1/4	148.59	"	148	160
" 870	5.875	"	-	-	149.23	"	149	162
" 361	5.975	"	6	6 3/8	151.77	"	150	165
" 644	6.100	±0.040	6 1/8	6 1/2	154.94	±1.02	155	168
" 362	6.225	"	6 1/4	6 5/8	158.12	"	158	170
" 645	6.350	"	6 3/8	6 3/4	161.29	"	160	172

Chart 50: Inch and metric sizes



James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.210 ±0.005" (5.33 ±0.13mm) Diameter Section A								
50-363	6.475	±0.040	6 1/2	6 7/8	164.47	±1.02	165	175
" 646	6.600	"	6 5/8	7	167.64	"	167	180
" 364	6.725	"	6 3/4	7 1/8	170.82	"	170	182
" 647	6.850	"	6 7/8	7 1/4	173.99	"	174	185
" 365	6.975	"	7	7 3/8	177.17	"	177	190
" 366	7.225	±0.045	7 1/4	7 5/8	183.52	±1.14	183	195
" 367	7.475	"	7 1/2	7 7/8	189.87	"	190	200
" 368	7.275	"	7 3/4	8 1/8	196.22	"	195	210
" 369	7.975	"	8	8 3/8	202.57	"	200	215
" 370	8.225	±0.050	8 1/4	8 5/8	208.92	±1.27	208	220
" 371	8.475	"	8 1/2	8 7/8	215.27	"	215	230
" 372	8.725	"	8 3/4	9 1/8	221.62	"	220	235
" 373	8.975	"	9	9 3/8	227.97	"	225	240
" 374	9.225	±0.055	9 1/4	9 5/8	234.32	±1.40	235	245
" 375	9.475	"	9 1/2	9 7/8	240.67	"	240	255
" 376	9.725	"	9 3/4	10 1/8	247.02	"	245	260
" 377	9.975	"	10	10 3/8	253.37	"	250	265
" 378	10.475	±0.060	10 1/2	10 7/8	266.07	±1.52	265	280
" 379	10.975	"	11	11 3/8	278.77	"	275	290
" 380	11.475	±0.065	11 1/2	11 7/8	291.47	±1.65	290	305
" 381	11.975	"	12	12 3/8	304.17	"	300	315
" 382	12.975	"	13	13 3/8	329.57	"	330	340
" 383	13.975	±0.070	14	14 3/8	354.97	±1.78	350	370
" 384	14.975	"	15	15 3/8	380.37	"	380	395
" 385	15.955	±0.075	16	16 3/8	405.26	±1.91	400	420
" 386	16.955	±0.080	17	17 3/8	430.66	±2.03	430	445
" 387	17.955	±0.085	18	18 3/8	456.06	±2.16	455	470
" 388	18.955	±0.090	19	19 3/8	481.46	±2.29	480	500
" 389	19.955	±0.095	20	20 3/8	506.86	±2.41	505	525
" 390	20.955	"	21	21 3/8	532.26	"	530	550
" 391	21.955	±0.100	22	22 3/8	557.66	±2.54	555	575
" 392	22.940	±0.105	23	23 3/8	582.68	±2.67	580	600
" 393	23.940	±0.110	24	24 3/8	608.08	±2.79	605	625
" 394	24.940	±0.115	25	25 3/8	633.48	±2.92	630	650
" 395	25.940	±0.120	26	26 3/8	658.88	±3.05	655	675
0.275 ±0.006" (6.99 ±0.15mm) Diameter Section A								
50-425*	4.475	±0.033	4 1/2	5	113.67	±0.84	114	127
" 624*	4.516	"	4 9/16	5 1/16	114.70	"	115	128

James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.275 ±0.006" (6.99 ±0.15mm) Diameter Section A								
50-426*	4.600	±0.033	4 5/8	5 1/8	116.84	±0.84	116	130
" 427*	4.725	"	4 3/4	5 1/4	120.02	"	120	135
" 428*	4.850	"	4 7/8	5 3/8	123.19	"	123	137
" 625*	4.906	±0.037	4 15/16	5 7/16	124.62	±0.94	125	138
" 429*	4.975	"	5	5 1/2	126.37	"	126	140
" 430*	5.100	"	5 1/8	5 5/8	129.54	"	130	145
" 431*	5.225	"	5 1/4	5 3/4	132.72	"	132	147
" 626*	5.297	"	5 5/16	5 13/16	134.54	"	135	148
" 432*	5.350	"	5 3/8	5 7/8	135.89	"	136	150
" 433*	5.475	"	5 1/2	6	139.07	"	140	155
" 434*	5.600	"	5 5/8	6 1/8	142.24	"	142	158
" 435*	5.725	"	5 3/4	6 1/4	145.42	"	145	160
" 436*	5.850	"	5 7/8	6 3/8	148.59	"	148	162
" 437*	5.975	"	6	6 1/2	151.77	"	150	165
" 872*	6.125	±0.040	6 1/8	6 5/8	155.58	±1.02	155	170
" 438*	6.225	"	6 1/4	6 3/4	158.12	"	158	172
" 627*	6.281	"	6 5/16	6 13/16	159.54	"	160	175
" 874*	6.375	"	6 3/8	6 7/8	161.93	"	162	178
" 439*	6.475	"	6 1/2	7	164.47	"	165	180
" 628*	6.563	"	6 9/16	7 1/16	166.69	"	166	181
" 876*	6.625	"	6 5/8	7 1/8	168.28	"	168	182
" 440*	6.725	"	6 3/4	7 1/4	170.82	"	170	185
" 878*	6.875	"	6 7/8	7 3/8	174.63	"	175	190
" 441*	6.975	"	7	7 1/2	177.17	"	177	192
" 880*	7.125	±0.045	7 1/8	7 5/8	180.98	±1.14	180	195
" 442*	7.225	"	7 1/4	7 3/4	183.52	"	183	200
" 882*	7.375	"	7 3/8	7 7/8	187.33	"	187	202
" 443*	7.475	"	7 1/2	8	189.87	"	190	205
" 884*	7.625	"	7 5/8	8 1/8	193.68	"	193	208
" 444*	7.725	"	7 3/4	8 1/4	196.22	"	195	210
" 886*	7.875	"	7 7/8	8 3/8	200.03	"	200	215
" 445*	7.975	"	8	8 1/2	202.57	"	202	220
" 445A	8.225	±0.055	8 1/4	8 3/4	208.92	±1.40	208	225
" 446	8.475	"	8 1/2	9	215.27	"	215	230
" 446A	8.725	"	8 3/4	9 1/4	221.62	"	220	240
" 447	8.975	"	9	9 1/2	227.97	"	225	245
" 447A	9.225	"	9 1/4	9 3/4	234.32	"	235	250
" 448	9.475	"	9 1/2	10	240.67	"	240	260
" 448A	9.725	"	9 3/4	10 1/4	247.02	"	245	265
" 449	9.975	"	10	10 1/2	253.37	"	250	270
" 449A	10.225	±0.060	10 1/4	10 3/4	259.72	±1.52	260	275
" 450	10.475	"	10 1/2	11	266.07	"	265	280
" 450A	10.725	"	10 3/4	11 1/4	272.42	"	270	290
" 451	10.975	"	11	11 1/2	278.77	"	275	295

Chart 50: Inch and metric sizes

James Walker Number	INCH DIAMETERS Inside Dia. B		C, P, T	D, Q	METRIC DIAMETERS (mm) Inside Dia. B		Shaft C	Cyl. D
0.275 ±0.006" (6.99 ±0.15mm) Diameter Section A								
50-451A	11.225	±0.060	11 1/4	11 3/4	285.12	±1.52	285	300
" 452	11.475	"	11 1/2	12	291.47	"	290	310
" 452A	11.725	"	11 3/4	12 1/4	297.82	"	295	315
" 453	11.975	"	12	12 1/2	304.17	"	300	320
" 648	12.225	"	12 1/4	12 3/4	310.52	"	310	325
" 454	12.475	"	12 1/2	13	316.87	"	315	330
" 649	12.725	"	12 3/4	13 1/4	323.22	"	320	340
" 455	12.975	"	13	13 1/2	329.57	"	330	345
" 650	13.225	±0.070	13 1/4	13 3/4	335.92	±1.78	335	350
" 456	13.475	"	13 1/2	14	342.27	"	340	360
" 457	13.975	"	14	14 1/2	354.97	"	350	370
" 458	14.475	"	14 1/2	15	367.67	"	365	385
" 459	14.975	"	15	15 1/2	380.37	"	380	400
" 460	15.475	"	15 1/2	16	393.07	"	390	410
" 461	15.955	±0.075	16	16 1/2	405.26	±1.91	400	420
" 462	16.455	"	16 1/2	17	417.96	"	415	435
" 463	16.955	±0.080	17	17 1/2	430.66	±2.03	430	450
" 464	17.455	±0.085	17 1/2	18	443.36	±2.16	440	460
" 465	17.955	"	18	18 1/2	456.06	"	455	470
" 466	18.455	"	18 1/2	19	468.76	"	465	485
" 467	18.955	±0.090	19	19 1/2	481.46	±2.29	480	500
" 468	19.455	"	19 1/2	20	494.16	"	495	510
" 469	19.955	±0.095	20	20 1/2	506.86	±2.41	505	525
" 470	20.955	"	21	21 1/2	532.26	"	530	550
" 471	21.955	±0.100	22	22 1/2	557.66	±2.54	555	575
" 472	22.940	±0.105	23	23 1/2	582.68	±2.67	580	600
" 473	23.940	±0.110	24	24 1/2	608.08	±2.79	605	625
" 474	24.940	±0.115	25	25 1/2	633.48	±2.92	630	650
" 475	25.940	±0.120	26	26 1/2	658.88	±3.05	655	675

'O' rings for pipe fittings

The chart below gives details of 'O' rings for use with inch Unified Standard threads. The sizes are specified in SAE AS 568: American National Standard *Aerospace size standard for 'O' rings*.

James Walker Number	INCH SIZES Diameter Section A		Inside Diameter B		METRIC CONVERSIONS (mm) Diameter Section A		Inside Diameter B	
50-901	0.056	±0.033	0.185	±0.005	1.42	±0.08	4.70	±0.13
" 902	0.064	"	0.239	"	1.63	"	6.07	"
" 903	0.064	"	0.301	"	1.63	"	7.65	"
" 904	0.072	"	0.351	"	1.83	"	8.92	"
" 905	0.072	"	0.414	"	1.83	"	10.52	"
" 906	0.078	"	0.468	"	1.98	"	11.89	"
" 907	0.082	"	0.530	±0.007	2.08	"	13.46	±0.18
" 908	0.087	"	0.644	±0.009	2.21	"	16.36	±0.23
" 909	0.097	"	0.706	"	2.46	"	17.93	"
" 910	0.097	"	0.755	"	2.46	"	19.18	"
" 911	0.116	±0.004	0.863	"	2.95	±0.10	21.92	"
" 912	0.116	"	0.924	"	2.95	"	23.47	"
" 913	0.116	"	0.986	±0.010	2.95	"	25.04	±0.25
" 914	0.116	"	1.047	"	2.95	"	26.59	"
" 916	0.116	"	1.171	"	2.95	"	29.74	"
" 918	0.116	"	1.355	±0.012	2.95	"	34.42	±0.30
" 920	0.118	"	1.475	±0.014	3.00	"	37.47	±0.36
" 924	0.118	"	1.720	"	3.00	"	43.69	"
" 928	0.118	"	2.090	±0.018	3.00	"	53.09	±0.46
" 932	0.118	"	2.337	"	3.00	"	59.36	"

James Walker

Chart 72: Metric sizes

To order your Chart 72 'O' ring or back-up ring, see page 5.

For housing details refer to pages 24-28.

Our **Chart 72** covers
- BS 4518: *Metric dimensions of toroidal sealing rings ('O' rings) and their housings.*

This range is based on a Swedish standard often quoted against NATO requirements. It is now used extensively throughout the UK and other European countries.

If the size you want is not listed, please use the metric columns in **Chart 50** (pages 11-17).

Tolerances on **Chart 72** apply to our standard NBR medium nitrile material PB80. See page 23 for tolerances applying to other materials.

Chart 72 back-up rings cover sizes including those in
- BS 5106: *Dimensions of spiral anti-extrusion back-up rings and their housings*.

Table 4: Pneumatic and static plug housing details to BS 4518
For applications requiring back-up rings, use dynamic housing sizes on pages 26-27.

	PNEUMATIC	STATIC PLUG	
Diameter Section A	Radial Depth F	Groove Width E 'O' Ring Only	Radial Depth F
2.4	2.13/2.20	3.1/3.3	1.84/1.97
3.0	2.70/2.77	3.7/3.9	2.35/2.50
4.1	3.73/3.82	5.0/5.2	3.30/3.45
5.7	5.22/5.38	6.4/6.6	4.70/4.95
8.4	7.75/7.96	9.0/9.2	7.20/7.50

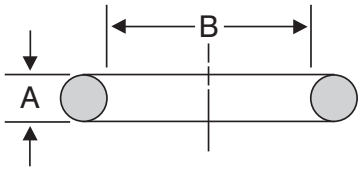
All dimensions in millimetres

For flange applications, the value of groove inside and outside diameters (V and W – see Figure 15, page 28) are shown on **Chart 72**.

BS 4500 tolerances H11 and h11 are given on page 27.

All **Chart 72** dimensions are in millimetres.

* An asterisk symbol denotes that the ring is suitable for both dynamic and static applications. Other sizes are not recommended for dynamic duties.



James Walker Number	DIAMETERS Inside Dia. B		Cyl. C, T	Cyl. D	FLANGE GROOVE DIAMETERS Internal Pressure V max	Internal Pressure W (H11)	External Pressure V (h11)	External Pressure W min
1.6 ±0.08mm Diameter Section A								
72-0031-16	3.1	±0.15	3.5	6	1.0	6.3	3.5	7.5
" 0041-16	4.1	"	4.5	7	2.3	7.3	4.5	8.5
" 0051-16	5.1	"	5.5	8	3.3	8.3	5.5	9.5
" 0061-16	6.1	"	6.5	9	4.3	9.3	6.5	10.5
" 0071-16	7.1	"	7.5	10	5.8	10.3	7.5	11.5
" 0081-16	8.1	"	8.5	11	6.8	11.3	8.5	12.5
" 0091-16	9.1	"	9.5	12	7.8	12.3	9.5	13.5
" 0101-16	10.1	±0.20	10.5	13	8.8	13.3	10.5	14.5
" 0111-16	11.1	"	11.5	14	9.8	14.3	11.5	15.5
" 0121-16	12.1	"	12.5	15	10.8	15.3	12.5	16.5
" 0131-16	13.1	"	13.5	16	11.8	16.3	13.5	17.5
" 0141-16	14.1	"	14.5	17	12.8	17.3	14.5	18.5
" 0151-16	15.1	"	15.5	18	14.0	18.3	15.5	19.5
" 0161-16	16.1	"	16.5	19	15.0	19.3	16.5	20.5
" 0171-16	17.1	"	17.5	20	16.0	20.3	17.5	21.5
" 0181-16	18.1	±0.25	18.5	21	17.0	21.3	18.5	22.5
" 0191-16	19.1	"	19.5	22	18.0	22.3	19.5	23.5
" 0221-16	22.1	"	22.5	25	21.0	25.3	22.5	26.5
" 0251-16	25.1	"	25.5	28	24.0	28.3	25.5	29.5
" 0271-16	27.1	"	27.5	30	26.0	30.3	27.5	31.5
" 0291-16	29.1	"	29.5	32	28.0	32.3	29.5	33.5
" 0321-16	32.1	±0.30	32.5	35	31.0	35.3	32.5	36.5
" 0351-16	35.1	"	35.5	38	34.0	38.3	35.5	39.5
" 0371-16	37.1	"	37.5	40	36.0	40.3	37.5	41.5
2.4 ±0.08mm Diameter Section A								
72-0036-24*	3.6	±0.15	4	8	-	8.4	4	10
" 0046-24*	4.6	"	5	9	1.0	9.4	5	11
" 0056-24*	5.6	"	6	10	2.5	10.4	6	12
" 0066-24*	6.6	"	7	11	4.0	11.4	7	13
" 0076-24*	7.6	"	8	12	5.0	12.4	8	14
" 0086-24*	8.6	"	9	13	6.4	13.4	9	15
" 0096-24*	9.6	"	10	14	7.4	14.4	10	16
" 0106-24*	10.6	±0.20	11	15	8.4	15.4	11	17
" 0116-24*	11.6	"	12	16	9.5	16.4	12	18
" 0126-24*	12.6	"	13	17	10.5	17.4	13	19
" 0136-24*	13.6	"	14	18	11.5	18.4	14	20
" 0146-24*	14.6	"	15	19	12.5	19.4	15	21
" 0156-24*	15.6	"	16	20	13.5	20.4	16	22
" 0166-24*	16.6	"	17	21	14.5	21.4	17	23
" 0176-24*	17.6	"	18	22	15.5	22.4	18	24
" 0186-24	18.6	±0.25	19	23	16.5	23.4	19	25
" 0196-24	19.6	"	20	24	17.5	24.4	20	26
" 0206-24	20.6	"	21	25	18.5	25.4	21	27
" 0216-24	21.6	"	22	26	19.5	26.4	22	28

Chart 72: Metric sizes

James Walker Number	DIAMETERS Inside Dia. B	C, T	Cyl. D	FLANGE GROOVE DIAMETERS Internal Pressure V max	W (H11)	External Pressure V (h11)	W min
2.4 ±0.08mm Diameter Section A							
72-0246-24	24.6 ±0.25	25	29	22.5	29.4	25	31
" 0276-24	27.6 "	28	32	25.5	32.4	28	34
" 0296-24	29.6 "	30	34	27.5	34.4	30	36
" 0316-24	31.6 ±0.30	32	36	29.5	36.4	32	38
" 0346-24	34.6 "	35	39	32.5	39.4	35	41
" 0356-24	35.6 "	36	40	33.5	40.4	36	42
" 0376-24	37.6 "	38	42	35.5	42.4	38	44
" 0396-24	39.6 "	40	44	37.5	44.4	40	46
" 0416-24	41.6 "	42	46	39.5	46.4	42	48
" 0446-24	44.6 "	45	49	42.5	49.4	45	51
" 0456-24	45.6 "	46	50	43.5	50.4	46	52
" 0476-24	47.6 "	48	52	45.5	52.4	48	54
" 0496-24	49.6 "	50	54	47.5	54.4	50	56
" 0516-24	51.6 ±0.40	52	56	49.5	56.4	52	58
" 0546-24	54.6 "	55	59	52.5	59.4	55	61
" 0556-24	55.6 "	56	60	53.5	60.4	56	62
" 0576-24	57.6 "	58	62	55.5	62.4	58	64
" 0586-24	58.6 "	59	63	56.5	63.4	59	65
" 0596-24	59.6 "	60	64	57.5	64.4	60	66
" 0616-24	61.6 "	62	66	59.5	66.4	62	68
" 0626-24	62.6 "	63	67	60.5	67.4	63	69
" 0646-24	64.6 "	65	69	62.5	69.4	65	71
" 0676-24	67.6 "	68	72	65.5	72.4	68	74
" 0696-24	69.6 "	70	74	67.5	74.4	70	76
3.0 ±0.10mm Diameter Section A							
72-0195-30*	19.5 ±0.25	20	25	17	25	20	28
" 0215-30*	21.5 "	22	27	19	27	22	30
" 0225-30*	22.5 "	23	28	20	28	23	31
" 0245-30*	24.5 "	25	30	22	30	25	33
" 0255-30*	25.5 "	26	31	23	31	26	34
" 0265-30*	26.5 "	27	32	24	32	27	35
" 0275-30*	27.5 "	28	33	25	33	28	36
" 0295-30*	29.5 "	30	35	27	35	30	38
" 0315-30*	31.5 ±0.30	32	37	29	37	32	40
" 0325-30*	32.5 "	33	38	30	38	33	41
" 0345-30*	34.5 "	35	40	32	40	35	43
" 0355-30*	35.5 "	36	41	33	41	36	44
" 0365-30*	36.5 "	37	42	34	42	37	45
" 0375-30*	37.5 "	38	43	35	43	38	46
" 0395-30*	39.5 "	40	45	37	45	40	48
" 0415-30*	41.5 "	42	47	39	47	42	50
" 0425-30*	42.5 "	43	48	40	48	43	51
" 0445-30*	44.5 "	45	50	42	50	45	53
" 0495-30*	49.5 "	50	55	47	55	50	58

James Walker Number	DIAMETERS Inside Dia. B	C, T	Cyl. D	FLANGE GROOVE DIAMETERS Internal Pressure V max	W (H11)	External Pressure V (h11)	W min
3.0 ±0.10mm Diameter Section A							
72-0545-30	54.5 ±0.40	55	60	52	60	55	63
" 0555-30	55.5 "	56	61	53	61	56	64
" 0575-30	57.5 "	58	63	55	63	58	66
" 0595-30	59.5 "	60	65	57	65	60	68
" 0625-30	62.5 "	63	68	60	68	63	71
" 0645-30	64.5 "	65	70	62	70	65	73
" 0695-30	69.5 "	70	75	67	75	70	78
" 0745-30	74.5 "	75	80	72	80	75	83
" 0795-30	79.5 "	80	85	77	85	80	88
" 0845-30	84.5 ±0.50	85	90	82	90	85	93
" 0895-30	89.5 "	90	95	87	95	90	98
" 0945-30	94.5 "	95	100	92	100	95	103
" 0995-30	99.5 "	100	105	97	105	100	108
" 1045-30	104.5 "	105	110	102	110	105	113
" 1095-30	109.5 "	110	115	107	115	110	118
" 1145-30	114.5 "	115	120	112	120	115	123
" 1195-30	119.5 "	120	125	117	125	120	128
" 1245-30	124.5 ±0.60	125	130	122	130	125	133
" 1295-30	129.5 "	130	135	127	135	130	138
" 1345-30	134.5 "	135	140	132	140	135	143
" 1395-30	139.5 "	140	145	137	145	140	148
" 1445-30	144.5 "	145	150	142	150	145	153
" 1495-30	149.5 "	150	155	147	155	150	158
" 1545-30	154.5 "	155	160	152	160	155	163
" 1595-30	159.5 "	160	165	157	165	160	168
" 1645-30	164.5 "	165	170	162	170	165	173
" 1695-30	169.5 "	170	175	167	175	170	178
" 1745-30	174.5 "	175	180	172	180	175	183
" 1795-30	179.5 "	180	185	177	185	180	188
" 1845-30	184.5 ±0.80	185	190	182	190	185	193
" 1895-30	189.5 "	190	195	187	195	190	198
" 1945-30	194.5 "	195	200	192	200	195	203
" 1995-30	199.5 "	200	205	197	205	200	208
" 2095-30	209.5 "	210	215	207	215	210	218
" 2195-30	219.5 "	220	225	217	225	220	228
" 2295-30	229.5 "	230	235	227	235	230	238
" 2395-30	239.5 "	240	245	237	245	240	248
" 2445-30	244.5 "	245	250	242	250	245	253
" 2495-30	249.5 "	250	255	247	255	250	258
5.7 ±0.12mm Diameter Section A							
72-0443-57*	44.3 ±0.30	45	55	41	55	45	59
" 0453-57*	45.3 "	46	56	42	56	46	60
" 0493-57*	49.3 "	50	60	46	60	50	64
" 0523-57*	52.3 ±0.40	53	63	49	63	53	67

Chart 72: Metric sizes

James Walker Number	DIAMETERS Inside Dia. B	C, T	Cyl. D	FLANGE GROOVE DIAMETERS Internal Pressure V max	W (H11)	External Pressure V (h11)	W min
5.7 ±0.12mm Diameter Section A							
72-0543-57*	54.3 ±0.40	55	65	51	65	55	69
" 0553-57*	55.3 "	56	66	52	66	56	70
" 0593-57*	59.3 "	60	70	56	70	60	74
" 0623-57*	62.3 "	63	73	59	73	63	77
" 0643-57*	64.3 "	65	75	61	75	65	79
" 0693-57*	69.3 "	70	80	66	80	70	84
" 0743-57*	74.3 "	75	85	71	85	75	89
" 0793-57*	79.3 "	80	90	76	90	80	94
" 0843-57*	84.3 ±0.50	85	95	81	95	85	99
" 0893-57*	89.3 "	90	100	86	100	90	104
" 0943-57*	94.3 "	95	105	91	105	95	109
" 0993-57*	99.3 "	100	110	96	110	100	114
" 1043-57*	104.3 "	105	115	101	115	105	119
" 1093-57*	109.3 "	110	120	106	120	110	124
" 1143-57*	114.3 "	115	125	111	125	115	129
" 1193-57*	119.3 "	120	130	116	130	120	134
" 1243-57*	124.3 ±0.60	125	135	121	135	125	139
" 1293-57*	129.3 "	130	140	126	140	130	144
" 1343-57*	134.3 "	135	145	131	145	135	149
" 1393-57*	139.3 "	140	150	136	150	140	154
" 1443-57*	144.3 "	145	155	141	155	145	159
" 1493-57	149.3 "	150	160	146	160	150	164
" 1543-57	154.3 "	155	165	151	165	155	169
" 1593-57	159.3 "	160	170	156	170	160	174
" 1643-57	164.3 "	165	175	161	175	165	179
" 1693-57	169.3 "	170	180	166	180	170	184
" 1743-57	174.3 "	175	185	171	185	175	189
" 1793-57	179.3 "	180	190	176	190	180	194
" 1843-57	184.3 ±0.80	185	195	181	195	185	199
" 1893-57	189.3 "	190	200	185	199	190	204
" 1943-57	194.3 "	195	205	190	204	195	209
" 1993-57	199.3 "	200	210	195	209	200	214
" 2093-57	209.3 "	210	220	205	219	210	224
" 2193-57	219.3 "	220	230	215	229	220	234
" 2293-57	229.3 "	230	240	225	239	230	244
" 2393-57	239.3 "	240	250	235	249	240	254
" 2493-57	249.3 "	250	260	245	259	250	264
" 2593-57	259.3 ±1.00	260	270	255	269	261	274
" 2693-57	269.3 "	270	280	265	279	271	285
" 2793-57	279.3 "	280	290	275	289	281	295
" 2893-57	289.3 "	290	300	285	299	291	305
" 2993-57	299.3 "	300	310	295	309	301	315
" 3093-57	309.3 ±1.50	310	320	305	319	311	325
" 3193-57	319.3 "	320	330	315	329	321	335

James Walker Number	DIAMETERS Inside Dia. B	C, T	Cyl. D	FLANGE GROOVE DIAMETERS Internal Pressure V max	W (H11)	External Pressure V (h11)	W min
5.7 ±0.12mm Diameter Section A							
72-3393-57	339.3 ±1.50	340	350	335	349	341	355
" 3593-57	359.3 "	360	370	355	369	361	375
" 3793-57	379.3 "	380	390	375	389	381	395
" 3893-57	389.3 "	390	400	385	399	391	405
" 3993-57	399.3 "	400	410	395	409	401	415
" 4193-57	419.3 ±2.00	420	430	415	429	422	436
" 4393-57	439.3 "	440	450	435	449	442	456
" 4593-57	459.3 "	460	470	455	469	462	476
" 4793-57	479.3 "	480	490	475	489	482	496
" 4893-57	489.3 "	490	500	485	499	492	506
" 4993-57	499.3 "	500	510	495	509	502	516
8.4 ±0.15mm Diameter Section A							
72-1441-84*	144.1 ±0.60	145	160	140	160	145	165
" 1491-84*	149.1 "	150	165	145	165	150	170
" 1541-84*	154.1 "	155	170	150	170	155	175
" 1591-84*	159.1 "	160	175	155	175	160	180
" 1641-84*	164.1 "	165	180	160	180	165	185
" 1691-84*	169.1 "	170	185	165	185	170	190
" 1741-84*	174.1 "	175	190	170	190	175	195
" 1791-84*	179.1 "	180	195	175	195	180	200
" 1841-84*	184.1 ±0.80	185	200	180	200	185	205
" 1891-84*	189.1 "	190	205	185	205	190	210
" 1941-84*	194.1 "	195	210	190	210	195	215
" 1991-84*	199.1 "	200	215	195	215	200	220
" 2041-84*	204.1 "	205	220	200	220	205	225
" 2091-84*	209.1 "	210	225	205	225	210	230
" 2191-84*	219.1 "	220	235	215	235	220	240
" 2291-84*	229.1 "	230	245	225	245	230	250
" 2341-84*	234.1 "	235	250	230	250	235	255
" 2391-84*	239.1 "	240	255	235	255	240	260
" 2491-84*	249.1 "	250	265	245	265	250	270

Coloured 'O' rings on a hydraulic cylinder.

Chart 17000: Inch sizes

To order your Chart 17000 'O' ring or back-up ring, see page 5.

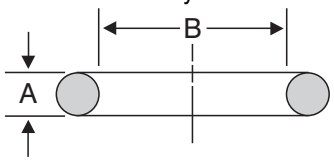
For housing details refer to pages 24-28.

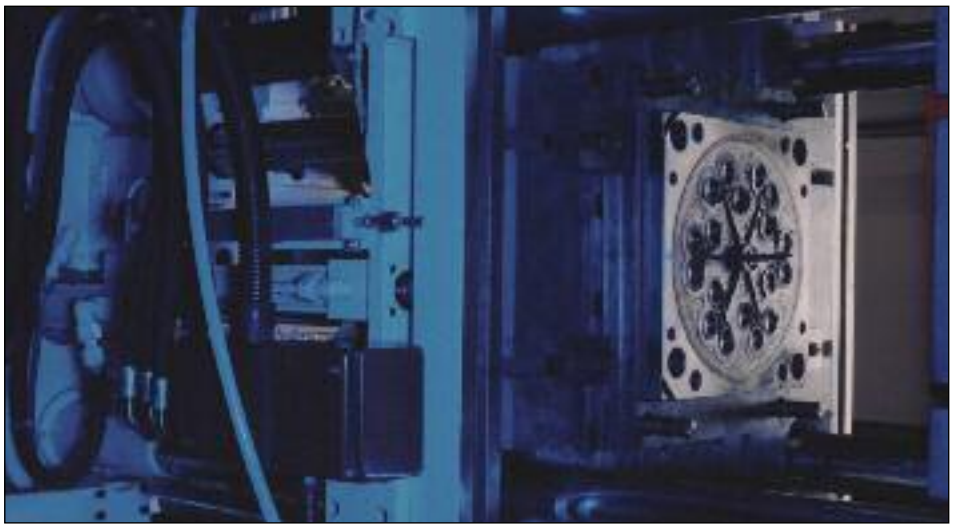
We originally developed this inch range of 'O' rings for the Royal Navy. However, its popularity has led to its use in many industries. This is reflected in it being stocked in our four most popular materials.

If the size you want is not listed, please refer to the inch columns on **Chart 50** (pages 11-17).

Tolerances on **Chart 17000** apply to our standard NBR medium nitrile material PB80. See page 23 for tolerances applying to other materials.

* An asterisk symbol denotes that the ring is suitable for both dynamic and static applications. Other sizes are not recommended for dynamic duties.





James Walker Number	INCH SIZES Dias. B,C,P,T	Tol. on B	Dias. D, Q
0.063 ±0.003" Diameter Section A			
17001	0.125	±0.004	0.250
17002	0.156	"	0.281
17003	0.188	±0.005	0.313
17004	0.219	"	0.344
17005	0.250	"	0.375
17006	0.281	"	0.406
17007	0.313	"	0.438
17008	0.344	"	0.469
17009	0.375	"	0.500
17010	0.406	±0.006	0.531
17011	0.438	"	0.563
17012	0.469	"	0.594
17013	0.500	"	0.625
0.094 ±0.003" Diameter Section A			
17014*	0.469	±0.006	0.656
17015*	0.500	"	0.688
17016*	0.531	"	0.719
17017*	0.563	±0.006	0.750
17018*	0.594	"	0.781
17019*	0.625	"	0.813
17020*	0.656	"	0.844
17021*	0.688	"	0.875
17022*	0.719	"	0.906
17023*	0.750	"	0.938
17024*	0.781	"	0.969
17025*	0.813	±0.008	1.000
17026*	0.875	"	1.063
17027*	0.938	"	1.125
17028*	1.000	"	1.188
0.125 ±0.004" Diameter Section A			
17029*	1.000	±0.008	1.250
17030*	1.063	"	1.313
17031*	1.125	"	1.375
17032*	1.188	"	1.438
17033*	1.250	"	1.500
17034*	1.313	"	1.563
17035*	1.375	"	1.625
17036*	1.438	"	1.688
17037*	1.500	±0.011	1.750
17038*	1.563	"	1.813
17039*	1.625	"	1.875

James Walker Number	INCH SIZES Dias. B,C,P,T	Tol. on B	Dias. D, Q
0.125 ±0.004" Diameter Section A			
17040*	1.688	±0.011	1.938
17041*	1.750	"	2.000
17042*	1.813	"	2.063
17043*	1.875	"	2.125
17044*	1.938	"	2.188
17045*	2.000	"	2.250
17046*	2.125	"	2.375
17047*	2.250	"	2.500
17048*	2.375	"	2.625
17049*	2.500	"	2.750
17050*	2.625	"	2.875
17051*	2.750	"	3.000
17052*	2.875	±0.016	3.125
17053*	3.000	"	3.250

Chart 17000: Inch sizes

James Walker Number	INCH SIZES Dias. B,C,P,T	Tol. on B	Dias. D, Q
0.188 ±0.005" Diameter Section A			
17054*	3.000	±0.016	3.375
17055*	3.125	"	3.500
17056*	3.250	"	3.625
17057*	3.375	"	3.750
17058*	3.500	"	3.875
17059*	3.625	"	4.000
17060*	3.750	"	4.125
17061*	3.875	"	4.250
17062*	4.000	"	4.375
17063*	4.125	"	4.500
17064*	4.250	"	4.625
17065*	4.375	"	4.750
17066*	4.500	"	4.875
17067*	4.625	"	5.000
17068*	4.750	"	5.125
17069*	4.875	"	5.250
17070*	5.000	"	5.375
17071*	5.125	±0.021	5.500
17072*	5.250	"	5.625
17073*	5.375	"	5.750
17074*	5.500	"	5.875
17075*	5.625	"	6.000
17076*	5.750	"	6.125
17077*	5.875	"	6.250
17078*	6.000	"	6.375

James Walker Number	INCH SIZES Dias. B,C,P,T	Tol. on B	Dias. D, Q
0.250 ±0.006" Diameter Section A			
17079*	6.000	±0.021	6.500
17080*	6.250	"	6.750
17081*	6.500	"	7.000
17082*	6.750	"	7.250
17083*	7.000	"	7.500
17084*	7.250	±0.030	7.750
17085*	7.500	"	8.000
17086*	7.750	"	8.250
17087*	8.000	"	8.500
17088	8.250	"	8.750
17089	8.500	"	9.000
17090	8.750	"	9.250
17091	9.000	"	9.500
17092	9.250	"	9.750
17093	9.500	"	10.000
17094	9.750	"	10.250
17095	10.000	"	10.500
17096	10.250	±0.040	10.750
17097	10.500	"	11.000
17098	10.750	"	11.250
17099	11.000	"	11.500
17100	11.250		11.750
17101	11.500	"	12.000
17102	11.750	"	12.250
17103	12.000	"	12.500

James Walker Number	INCH SIZES Dias. B,C,P,T	Tol. on B	Dias. D, Q
0.250 ±0.006" Diameter Section A			
17104	12.500	±0.040	13.000
17105	13.000	"	13.500
17106	13.500	"	14.000
17107	14.000	"	14.500
17108	14.500	"	15.000
17109	15.000	"	15.500
17110	15.500	"	16.000
17111	16.000	±0.055	16.500
17112	16.500	"	17.000
17113	17.000	"	17.500
17114	17.500	"	18.000
17115	18.000	"	18.500
17116	18.500	"	19.000
17117	19.000	"	19.500
17118	19.500	"	20.000
17119	20.000	±0.075	20.500
17120	20.500	"	21.000
17121	21.000	"	21.500
17122	21.500	"	22.000
17123	22.000	"	22.500
17124	22.500	"	23.000
17125	23.000	"	23.500
17126	23.500	"	24.000
17127	24.000	"	24.500

Non-standard sizes

Methods of production

Using one of the following techniques, we are able to produce any size of 'O' ring you require.

Moulded
For this, our main method of manufacture, we hold a growing inventory approaching 10,000 moulding tools. We also have one of the largest presses of its type in the world for moulding endless rings up to 2.2 metres diameter.

This press is used to produce high-integrity seals, including those for nuclear fuel transportation flasks. The nature of such an application demands stringent quality procedures. James Walker design technologists worked closely with our customer on this successful project.

Extruded and mould-joined
This approach is particularly economical when a high degree of precision is unnecessary: eg, for large diameter non-standard 'O' rings in static duties. The ring is made from a length of extruded cord by vulcanising the ends together in a moulding tool.

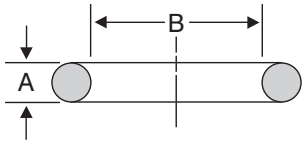
Rings must have a minimum section diameter of 3mm and a minimum inside diameter of 200mm. Maximum inside diameter is unlimited.

NOTE: This method must not be confused with rings joined by contact adhesive. Generally, the use of such adhesives results in a less secure join with operational temperature limitations below that of the cord material.

Moulded and mould-joined
This method is used when the non-standard 'O' ring must have a diameter section to very close tolerances and a mould-join is acceptable. It is often applied to sizes above 2.2 metres diameter, when two or more smaller rings are manufactured, then cut and mould-joined.

Tolerances

Tables 5 and 6 below show the tolerances, on diameter section A and inside diameter B, that can be achieved using various production methods.



For standard materials
- PB80 – **Low shrinkage.**
- EP18/H/75, FR10/80, FR58/90, SIL 80/2, Elast-O-Lion® 101, 180 and 985 – **High shrinkage**.

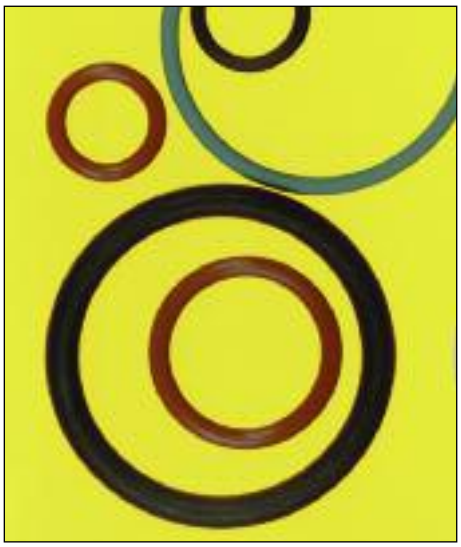


Table 5: Tolerances on Diameter Section A

Diameter Section A		Moulded including mould joined	Extruded and mould joined
Above	Up to and Including		
-	2.7	±0.08	–
2.7	3	±0.10	+0.38 –0.10
3	3.5	±0.10	+0.40 –0.10
3.5	4	±0.10	+0.42 –0.11
4	5	±0.12	+0.46 –0.12
5	6	±0.13	+0.50 –0.14
6	7	±0.15	+0.54 –0.16
7	8	±0.18	+0.58 –0.18
8	10	±0.21	+0.66 –0.21
10	12.7	±0.25	+0.75 –0.25

All dimensions in millimetres

Table 6: Tolerances on Inside Diameter B

Inside Diameter B		Low Shrinkage	High Shrinkage and mould joined
Above	Up to and Including		
-	2.6	±0.10	±0.13
2.6	4	±0.10	±0.15
4	10	±0.13	±0.18
10	20	±0.15	±0.22
20	38	±0.20	±0.28
38	70	±0.28	±0.40
70	127	±0.40	±0.60
127	180	±0.55	±0.75
180	260	±0.75	±1.10
260	400	±1.00	±1.60
400	500	±1.40	±1.90
500	700	±1.90	±2.60
700	900	±2.40	±3.30
900	1100	±2.90	±4.00
1100	1400	±3.60	±5.00
1400	1700	±4.30	±6.00
1700	-	±5.00	±7.00

All dimensions in millimetres

Design notes: General

How 'O' rings work
Rubber has a very high bulk modulus and is therefore virtually incompressible. This means that an 'O' ring must be deformed on the diameter section to give it an initial sealing force within a housing (see Figure 5).

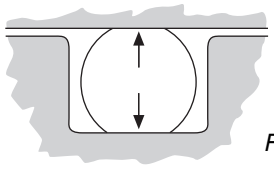


Figure 5

When system pressure is applied, the 'O' ring deforms further (see Figure 6). But because of the initial squeeze, the sealing force always exceeds the force exerted on the 'O' ring by the system pressure.

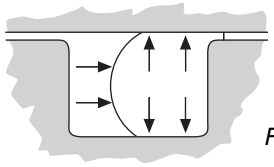


Figure 6

At higher pressures, back-up rings may be required to prevent 'O' ring extrusion (see page 10). Leakage problems often arise due to lack of initial squeeze, or the 'O' ring diameter section being too large for its housing.

Reciprocating applications
'O' rings marked (*) on our charts are recommended for both static and light/medium reciprocating duties. Other sizes are not recommended for dynamic applications.

Rotary applications
'O' rings may be used for rotating applications where peripheral speeds are low. For recommendations, please consult our Technical Services Team.

'O' ring tolerances
Tolerances quoted on **Charts 50, 72** and **17000** apply to our standard NBR medium nitrile material PB80. For tolerances applying to other materials, see page 23.

Non-standard housing diameters
Individual 'O' rings can be stretched or squeezed very slightly to fit housing diameters that do not match the dimensions specified in **Chart 50, Chart 72** and **Chart 17000**. The amount of allowable deformation varies according to the application, as follows:

- ***Groove in cylinder application:*** A maximum of 3 per cent squeeze is acceptable on an 'O' ring outside diameter to fit a shaft diameter C that is not covered by JW chart sizes. *See page 28.*
- ***Groove in piston applications:*** A maximum of 4 per cent stretch is acceptable on an 'O' ring inside diameter to fit a cylinder diameter D that is not covered by JW chart sizes. *See page 28.*
- ***Flange and triangular groove applications:***
  A maximum of 2 per cent stretch is acceptable on an 'O' ring inside diameter when the seal is used on an external pressure flange, or housed in a triangular groove. Likewise, a maximum of 1 per cent squeeze is acceptable on an 'O' ring outside diameter when the seal is used on an internal pressure flange.

Cylinder and piston housing tolerances
It is important that tolerances on housing diameters for cylinders and pistons meet the requirements of the formulae given on page 28 (ie, dimensions C and D as shown on Figures 9-12).

Surface finish of metal parts
For maximum seal life the surface finish of metal parts in contact with an 'O' ring should not exceed:

- 0.8μm (32μin) CLA or Ra in the case of static parts, or
- 0.4μm (16μin) for moving parts.

A finish finer than 0.15μm (6μin) should be avoided in dynamic applications as a lubricating film may not be retained. For details of these finishes, please refer to BS1134: *Assessment of surface texture*.

Diametral clearance G
Under no circumstances should the maximum total diametral clearance (G max) indicated on our housing tables (pages 26-27) be exceeded. This is to ensure that, if complete shaft offset occurs, the maximum extrusion gap at any point of the 'O' ring does not exceed G.

Pressure restrictions
'O' rings are generally suitable for pressures up to 100bar. Where higher pressures are involved, we recommend the use of back-up rings, as described on page 10.

For stuffing box applications we recommend piston-type grooves, although triangular grooves are generally acceptable for pressures below 100bar (see Figures 7 and 8).

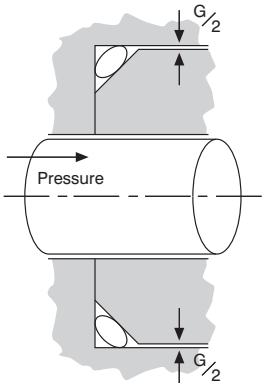


Figure 7

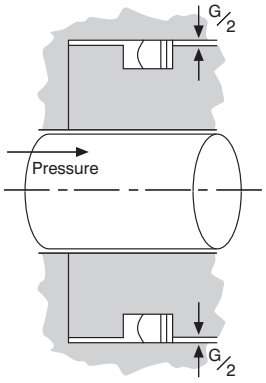


Figure 8

For flange applications, 'O' rings will normally be suitable for sealing pressures above 100bar where metal-to-metal contact prevents extrusion.

Complex dynamic, high vacuum or high temperature duties
Groove dimensions quoted allow for expansion, swell and retention of interference over the longest possible seal life.

However, these dimensions may not suit complex dynamic applications, static duties with high vacuum, or high temperature duties. If in doubt, please consult our Technical Services Team.

Six useful hints

- Select the largest diameter section ‘O’ ring to fit the nominal groove size. This will absorb adverse tolerances in metal parts and aid durability, particularly in high temperature applications.

  Explosive decompression (ED) environments are an exception – see page 9. To minimise gas permeation, the smallest possible diameter section, that does not compromise mechanical sealing efficiency, should be used. Please ask for separate literature on our high performance elastomers and ED resistant materials.

- Consider how the ‘O’ ring will pass over other parts during assembly. Provide the lead-ins as recommended on page 28 (Figures 9 and 11), remove all burrs, and use thin fitting sleeves where appropriate.

- Smear seals lightly with a suitable lubricant before assembly (see page 8 for recommendations).

- On reciprocating applications always check whether a standard ‘O’ ring is suitable. Those that are suitable are indicated (*****) on **Chart 50**, **Chart 72** and **Chart 17000**.

- With a cylinder or piston groove, where the ‘O’ ring inside diameter is less than three times the diameter section, a two part recess – with component split at the ‘O’ ring housing – may be required to facilitate assembly. This is because it is impractical to stretch or squeeze the seal into position without causing damage.

- Always store ‘O’ rings under conditions that meet the requirements of BS ISO 2230 *Rubber products – guidelines for storage*, or BS F68: *Controlled storage of rubbers for use in aerospace applications*.

Design notes: Housings

Table 7: Metric Groove Dimensions

All dimensions in millimetres.

Diameter Section A	Groove Width E			Radial Depth F	Diametrical Clearance G max	Flange Groove		Triangular Groove			Groove Radii		Dovetail Groove	
	'O'ring only	+1 back-up	+2 back-up			Depth H	K min	L min	Chamfer M	R max	R1 max	R2	Depth X	Width Y
1.0/1.02	1.5/1.6	#	#	0.81/0.86	0.11	0.7/0.8	1.8	#	#	#	0.2	0.11/0.22	#	#
1.27	1.8/1.9	#	#	1.06/1.11	0.11	0.9/1.0	2.1	#	#	#	0.3	0.11/0.22	#	#
1.5/1.52	2.1/2.2	#	#	1.26/1.32	0.12	1.1/1.2	2.4	3.0	2.08/2.20	0.8	0.3	0.12/0.24	#	#
1.6	2.3/2.5	3.7/3.9	5.0/5.2	1.18/1.25	0.12	1.2/1.3	2.4	4.0	2.20/2.32	0.8	0.2	0.20/0.40	1.37/1.43	1.34/1.40
1.78	2.3/2.5	3.8/3.9	5.3/5.4	1.52/1.57	0.13	1.3/1.5	2.4	4.8	2.41/2.54	0.8	0.8	0.13/0.25	1.50/1.56	1.50/1.56
2.0	2.6/2.7	4.1/4.2	5.6/5.7	1.72/1.79	0.12	1.6/1.7	2.8	4.0	2.71/2.83	1.0	0.4	0.12/0.24	1.65/1.72	1.70/1.77
2.4	3.2/3.4	4.6/4.8	6.0/6.2	1.97/2.09	0.14	1.7/1.8	3.7	5.0	3.30/3.42	1.3	0.5	0.20/0.40	1.96/2.04	2.05/2.13
2.5	3.2/3.3	4.7/4.8	6.2/6.3	2.17/2.25	0.13	2.0/2.1	3.4	5.0	3.46/3.59	1.3	0.5	0.13/0.26	2.05/2.13	2.15/2.23
2.62	3.5/3.7	5.0/5.1	6.5/6.6	2.31/2.39	0.13	2.1/2.3	3.6	6.4	3.68/3.81	1.0	0.8	0.13/0.25	2.16/2.24	2.26/2.34
3.0	4.0/4.2	5.4/5.6	6.8/7.0	2.50/2.65	0.15	2.2/2.3	4.5	6.0	4.20/4.32†	2.0	1.0	0.20/0.40	2.46/2.55†	2.58/2.67
3.5/3.53	4.7/4.9	6.2/6.4	7.7/7.9	3.10/3.18	0.15	2.8/3.0	4.8	7.9	4.95/5.08†	1.5	0.8	0.13/0.25	2.89/2.99†	3.03/3.13
4.0	5.1/5.3	6.6/6.8	8.1/8.3	3.52/3.62	0.15	3.2/3.4	5.5	8.0	5.75/5.90	2.0	0.8	0.15/0.30	3.32/3.42†	3.48/3.58
4.1	5.5/5.7	7.1/7.3	8.7/8.9	3.50/3.67	0.16	3.1/3.2	6.0	8.0	5.60/5.72†	2.5	1.0	0.20/0.40	3.39/3.50†	3.59/3.70
4.5	5.8/6.0	7.6/7.8	9.4/9.6	3.96/4.07	0.16	3.7/3.9	6.0	9.0	6.45/6.61	2.3	0.9	0.16/0.32	3.74/3.85†	3.92/4.03
5.0	6.4/6.6	8.2/8.4	10.0/10.2	4.42/4.54	0.16	4.1/4.3	6.7	10.0	7.18/7.34	2.5	1.0	0.16/0.32	4.23/4.35	4.37/4.49
5.33	7.0/7.2	8.8/9.0	10.6/10.8	4.67/4.78	0.18	4.3/4.5	7.1	11.1	7.49/7.62	2.3	0.8	0.13/0.25	4.54/4.67	4.64/4.77
5.7	7.5/7.7	9.3/9.5	11.1/11.3	4.95/5.18	0.18	4.4/4.5	8.1	10.0	7.80/7.92†	3.0	1.0	0.20/0.40	4.80/4.94	4.98/5.12
6.0	7.8/8.0	9.6/9.8	11.4/11.6	5.31/5.45	0.18	5.0/5.2	7.9	12.0	8.64/8.82	3.0	1.2	0.18/0.36	5.02/5.16	5.25/5.39
6.99/7.0	9.4/9.6	12.0/12.2	14.6/14.8	6.22/6.35	0.20	5.9/6.1	9.4	14.3	10.03/10.16	2.5	0.8	0.13/0.25	5.85/6.01	6.12/6.28
8.0	10.7/10.9	13.3/13.5	15.9/16.1	7.09/7.27	0.20	6.7/6.9	10.6	16.0	11.61/11.81	4.0	1.6	0.20/0.40	6.70/6.88	7.01/7.19
8.4	11.0/11.2	13.6/13.8	16.2/16.4	7.50/7.75	0.20	6.6/6.7	12.0	14.0	11.50/11.62†	4.0	1.0	0.20/0.40	7.02/7.21	7.34/7.53
9.0	12.3/12.5	15.6/15.8	18.9/19.1	7.97/8.17	0.21	7.5/7.7	12.1	18.0	13.08/13.29	4.5	1.8	0.21/0.42	7.54/7.74	7.89/8.09
9.5/9.53	13.1/13.3	16.4/16.6	19.7/19.9	8.43/8.64	0.22	8.0/8.2	12.7	19.0	13.83/14.05	4.8	1.9	0.22/0.44	7.97/8.18	8.34/8.55
10.0	13.8/14.0	17.1/17.3	20.4/20.6	8.89/9.10	0.23	8.4/8.6	13.3	20.0	14.58/14.81	5.0	2.0	0.23/0.46	8.41/8.62	8.80/9.01
12.5/12.7	18.5/18.8	21.8/22.1	25.1/25.4	11.13/11.39	0.26	10.5/10.8	17.4	25.0	18.30/18.56	6.3	2.5	0.26/0.52	10.52/10.78	11.01/11.27

Table 8: Inch Groove Dimensions

All dimensions in inches.

Diameter Section A	Groove Width E			Radial Depth F	Diametrical Clearance G max	Flange Groove		Triangular Groove			Groove Radii		Dovetail Groove	
	'O'ring only	+1 back-up	+2 back-up			Depth H	K min	L min	Chamfer M	R max	R1 max	R2	Depth X	Width Y
0.040	.059/.063	#	#	.032/.034	.004	.028/.032	.068	#	#	#	.008	.004/.008	#	#
0.050	.069/.073	#	#	.042/.044	.004	.037/.041	.078	#	#	#	.010	.004/.008	#	#
0.060	.080/.085	#	#	.051/.053	.005	.045/.050	.091	.120	.082/.087	.030	.012	.005/.010	#	#
0.063	.084/.089	.142/.147	.200/.205	.053/.055	.005	.047/.052	.094	.125	.086/.091	.031	.013	.005/.010	.054/.056	.053/.055
0.070	.089/.099	.147/.152	.205/.210	.060/.062	.005	.051/.061	.095	.188	.095/.100	.030	.030	.005/.010	.059/.062	.059/.062
0.094	.121/.126	.179/.184	.237/.242	.081/.084	.005	.075/.080	.129	.188	.129/.134	.047	.019	.005/.010	.077/.080	.080/.083
0.103	.136/.146	.194/.199	.252/.257	.091/.094	.005	.081/.091	.140	.250	.145/.150	.040	.030	.005/.010	.085/.088	.089/.092
0.125	.159/.164	.217/.222	.275/.280	.110/.114	.005	.102/.107	.168	.250	.183/.188	.063	.025	.005/.010	.103/.107†	.107/.111
0.139	.183/.193	.241/.247	.299/.305	.122/.125	.006	.110/.120	.190	.313	.195/.200†	.060	.030	.005/.010	.115/.119†	.120/.124
0.188	.240/.246	.312/.318	.384/.390	.166/.171	.006	.155/.161	.248	.375	.269/.275	.094	.038	.006/.012	.156/.161†	.163/.168
0.210	.276/.286	.348/.355	.420/.427	.184/.188	.007	.170/.180	.280	.438	.295/.300	.090	.030	.005/.010	.179/.184	.183/.188
0.250	.328/335	.430/.437	.532/.539	.221/.227	.007	.207/.214	.333	.500	.360/.367	.125	.050	.007/.014	.208/.214	.218/.224
0.275	.370/.380	.472/.480	.574/.582	.245/.250	.008	.231/.241	.370	.563	.395/.400	.100	.030	.005/.010	.230/.236	.241/.247
0.375	.514/.523	.644/.653	.774/.783	.333/.341	.009	.314/.323	.501	.750	.545/.554	.188	.075	.009/.018	.315/.323	.329/.337
0.500	.718/.728	.848/.858	.978/.988	.446/.456	.010	.421/.431	.674	1.000	.733/.743	.250	.100	.010/.020	.421/.431	.441/.451

Key: Chart 50 | Chart 72 | Chart 17000

BS 1806, BS 4518 and BS 5106 figures are given in red.

\# Diameter Section A indicated is too small for this groove type

† These dimensions can only be used with moulded 'O' rings.
Use Tables 10 and 11, page 27 for 'O' rings manufactured by other methods.

Table 9: BS 4500 *ISO Limits and Fits* Extract (See Figures 13 - 15, page 28)

Nom. Diameter Above	up to and including	Tolerance H11	Tolerance h11
-	3	+0/+0.060	–0/–0.060
3	6	+0/+0.075	–0/–0.075
6	10	+0/+0.090	–0/–0.090
10	18	+0/+0.110	–0/–0.110
18	30	+0/+0.130	–0/–0.130
30	50	+0/+0.160	–0/–0.160
50	80	+0/+0.190	–0/–0.190
80	120	+0/+0.220	–0/–0.220
120	180	+0/+0.250	–0/–0.250
180	250	+0/+0.290	–0/–0.290

Table 9 continued

Nom. Diameter Above	up to and including	Tolerance H11	Tolerance h11
250	315	+0/+0.320	–0/–0.320
315	400	+0/+0.360	–0/–0.360
400	500	+0/+0.400	–0/–0.400
500	630	+0/+0.440	–0/–0.440
630	800	+0/+0.500	–0/–0.500
800	1000	+0/+0.560	–0/–0.560
1000	1250	+0/+0.660	–0/–0.660
1250	1600	+0/+0.780	–0/–0.780
1600	2000	+0/+0.920	–0/–0.920
2000	2500	+0/+1.100	–0/–1.100

All dimensions in millimetres

For ‘O’ rings manufactured by extrusion

Table 10: Triangular Groove Sizes

Diameter Section A	Triangular Chamfer M
Metric (mm)	
3.0	4.48/4.63
3.5/3.53	5.10/5.25
4.1	6.00/6.16
5.7	8.18/8.36
8.4	12.18/12.38
Inch	
0.139	.201/.207

Table 11: Dovetail Groove Sizes

Diameter Section A	Dovetail Depth X
Metric (mm)	
3.0	¥
3.5/3.53	¥
4.0	3.48/3.58
4.1	3.59/3.70
4.5	3.88/3.99
Inch	
0.125	¥
0.139	¥
0.188	.159/.164

¥ ’O’ rings not suitable for dovetail grooves.

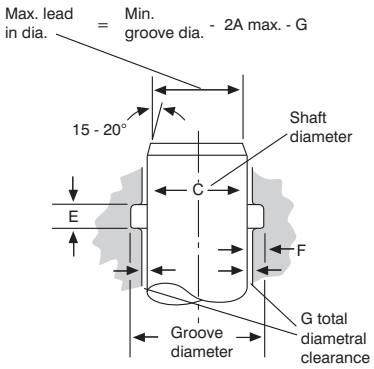
General Information

Health warning: If PTFE products are heated to elevated temperatures, fumes will be produced which may give unpleasant effects, if inhaled. Whilst some fumes are emitted below 300°C, the effect at these temperatures is negligible. Care should be taken to avoid contaminating tobacco with PTFE particles or dispersion which may remain on hands or clothing. Material Safety Data Sheets (MSDS) are available on request.

Information in this publication and otherwise supplied to users is based on our general experience and is given in good faith, but because of factors which are outside our knowledge and control and affect the use of products, no warranty is given or is to be implied with respect to such information. Specifications are subject to change without notice. Statements of operating limits quoted in this publication are not an indication that these values can be applied simultaneously. Materials Safety Data Sheets (MSDS) are available on request.

Housing arrangements

Figure 9: Groove in cylinder



Max. groove dia. = C min. + 2F max.
Min. groove dia. = C max. + 2F min.

Figure 10: Plug groove, terminology as figures 9 and 18

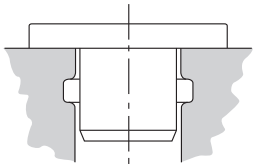
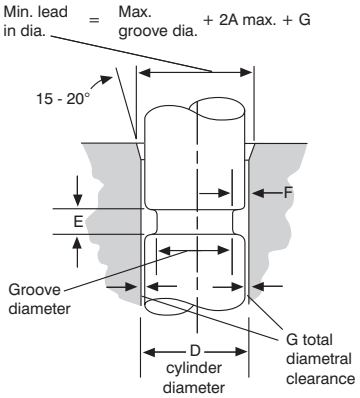


Figure 11: Groove in piston



Max. groove dia. = D min. - 2F min.
Min. groove dia. = D max. - 2F max.

Figure 12: Plug groove, terminology as figures 11 and 18

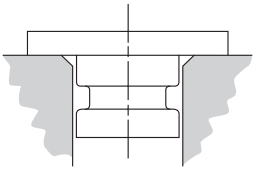


Figure 13: Groove in flange, external pressure

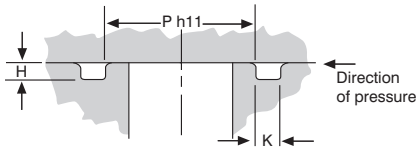


Figure 14: Groove in flange, internal pressure

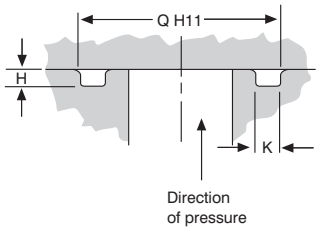


*Figure 15: Groove in flange, **Chart 72***

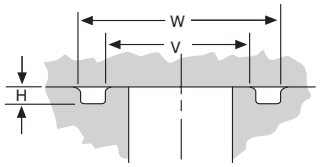


Figure 16: Triangular groove

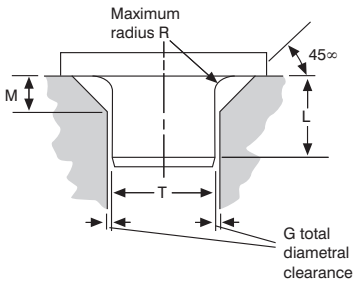


Figure 17: Dovetail groove

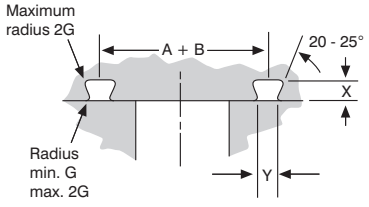
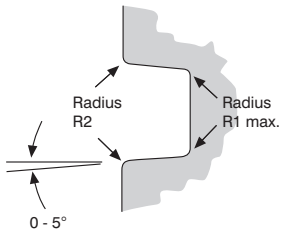
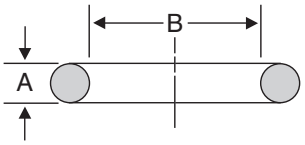


Figure 18: Groove radii and taper for figures 9 - 15





List of symbols

The following symbols are used throughout this guide:

A	'O' ring diameter section
B	'O' ring inside diameter
C	Shaft diameter
D	Cylinder diameter
E	Groove width
F	Groove radial depth
G	Maximum diametral clearance
H	Flange groove depth
h11	BS 4500 tolerance (shafts)
H11	BS 4500 tolerance (holes)
K	Minimum flange groove width
L	Minimum spigot length
M	Triangular groove chamfer
P	Flange groove inside diameter
Q	Flange groove outside diameter
R	Triangular groove radius
R1	Corner radius (maximum) at groove base
R2	Corner radius at groove entrance
T	Triangular groove inside diameter
V	BS 4518 flange groove inside diameter
W	BS 4518 flange groove outside diameter
X	Dovetail groove depth
Y	Dovetail groove width

James Walker

‘O’ ring cords & kits

‘O’ ring cord

We manufacture a large selection of ‘O’ ring cord in metric and inch cross sections in the following elastomers:

FR10/80 Fluorocarbon (80 IRHD)
PB70 Nitrile (70 IRHD)
EP21/E/80 Ethylene-propylene (80 IRHD)
GN/W/70 Neoprene (70 IRHD)

Standard cross sections:

1.6mm	1/16 inch
1.78mm	0.070 inch
2.0mm	
2.4mm	3/32 inch
2.62mm	0.103 inch
3.0mm	
3.18mm	1/8 inch
3.53mm	0.139 inch
4.0mm	5/32 inch
4.5mm	
4.76mm	3/16 inch
5.0mm	
5.33mm	0.210 inch
5.7mm	
6.0mm	
6.35mm	1/4 inch
6.99mm	0.275 inch
8.0mm	5/16 inch
8.73mm	11/32 inch
9.5mm	3/8 inch
10mm	
10.32mm	13/32 inch
11.11mm	7/16 inch
11.91mm	15/32 inch
12.7mm	1/2 inch

How supplied: by the metre to any length.

Most of the above elastomers and cord sizes are available from stock or on short lead times. Other sizes and elastomers can be supplied on request. All these cords are manufactured to BS 3734-1 and ISO3302-1.

‘O’ ring kits

These three boxed kits represent excellent value for money in terms of quantity, quality and convenience.

Each kit has been carefully assembled for maintenance engineers and equipment refurbishers who need a good selection of rings constantly available to suit many industrial applications.

The boxes are designed to withstand industrial maintenance activities, and have partitions to hold all items separately and securely. From the kit layouts, users can readily see when they are running low on a particular size of ring or cord.

‘O’ ring sealing kit – metric sizes
(JW order code ZL000186)
Box containing nitrile (NBR) elastomer rings of 70 IRHD:

- 404 ‘O’ rings in total.
- In 30 sizes ranging from 3mm ID x 2mm section up to 45mm ID x 4mm section.

NOTE: Hardeness values quoted are nominal.

‘O’ ring sealing kit – inch sizes
(JW order code ZL000097)
Box containing nitrile (NBR) elastomer rings of 70 IRHD:

- 382 ‘O’ rings in total.
- In 30 sizes ranging from 1/8 inch ID x 1/16 inch section up to 1 3/4 inch ID x 3/16 inch section.

Service kit – ‘O’ ring cord
(JW order code ZL000275)
Box containing tools and nitrile (NBR) elastomer ‘O’ ring cord of 70 IRHD:

- 14 off 2m lengths: 1.78mm diameter (0.070 inch), 2.0mm, 2.4mm, 2.62mm (0.103 inch), 3.0mm, 3.5mm (0.138 inch), 4.0mm, 4.5mm, 5.0mm, 5.33mm (0.210 inch), 5.7mm, 6.0mm, 6.99mm (0.275 inch), 8.0mm.
- Tape measure, retractable blade knife, splicing aid and adhesive for forming rings.
- Full instructions.

Special packaging and kits

Special packaging and bagging can be provided for all of our ‘O’ rings – from individually bagged rings to complete sealing kits containing a variety of sizes and materials.

These can be custom-branded and over printed with dedicated part numbers to simplify ordering, stocking and issuing routines.

Your own company name and logo can be printed on the bag or label to provide a custom packaged kit with your own references to save additional repackaging if you are re-selling.

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