Specialists in Seals & Service

Hi-Tech Seals Inc.

O-Ring Sizing and Materials Guide

Contains ISO 3601 Information

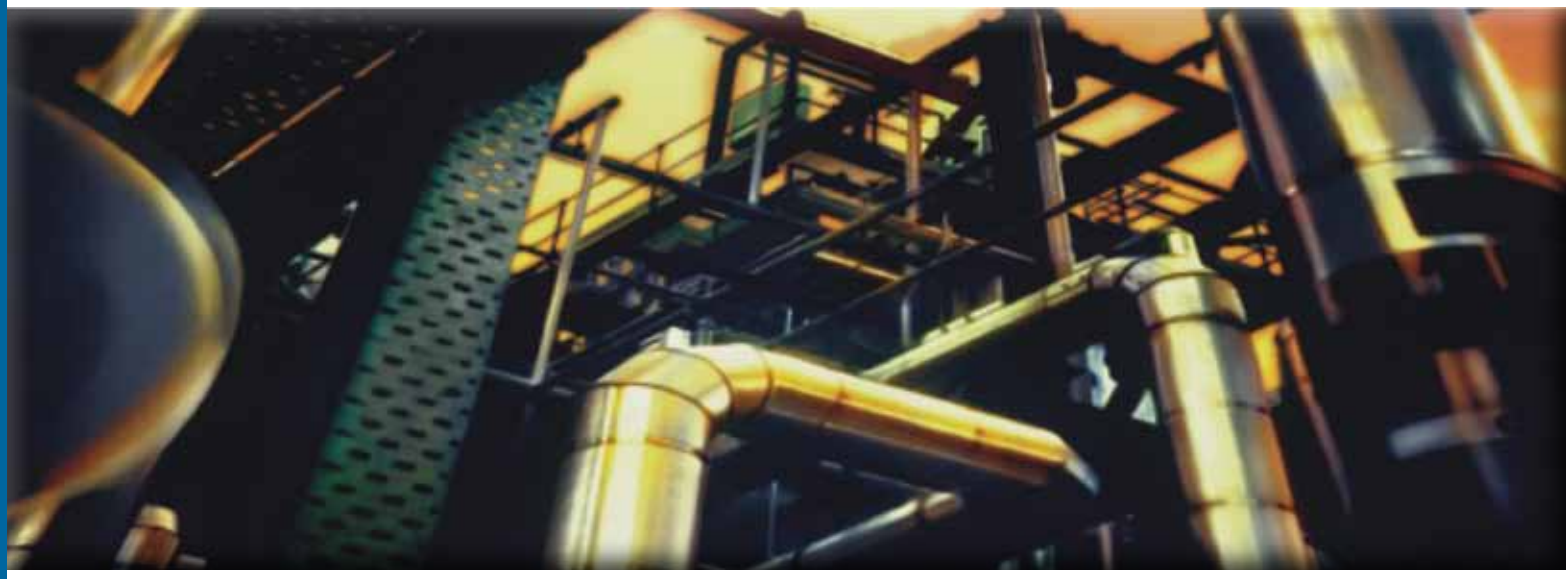
ISD International Sealing Distribution Association

ISO 9001 REGISTERED QMS

Kalrez®

From DuPont Performance Elastomers

Choose Kalrez® O-rings for the most harsh sealing conditions.



What makes Kalrez® a superior elastomer?

- Kalrez® materials have virtually universal chemical resistance
- Minimum swell
- Reduce fugitive emissions
- Service temperature range up to 327°C
- Maintains sealing force to better then most other materials
- Low compression set
- Longer seal life

Kalrez® can save your company money through increased production cycle time and reduced damage to your equipment.

DuPont Performance Elastomers

Specialists in Seals & Service

Hi-Tech Seals Inc.

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Hi-Tech Seals - Popular Compound Specification Guide

Compound	Elastomer Type	Durometer	Temperature Range	Service
N70	Nitrile	70 +/- 5	-40 C to 120 C -40 F to 248 F	A general service Nitrile compound for a wide range of applications including petroleum based fluids. Nitrile compounds also have excellent resistance to compression set, tear and abrasion resistance.
N90	Nitrile	90 +/- 5	-25 C to 120 C -13 F to 248 F	Generally used for higher pressures than the 70 durometer materials, while having comparable media resistance.
LTN	Nitrile	70 +/- 5	-55 C to 120 C -67 F to 248 F	A low temperature Nitrile compound for use in applications where sealability at lower temperatures is important. Due to the lower acrylonitrile content, this compound will show slightly less resistance to petroleum products.
HS7	Highly Saturated Nitrile	70 +/- 5	-40 C to 150 C -40 F to 302 F	This is a hydrogenated Nitrile compound which provides the material with improved resistance to heat, ozone and aging. Similar applications to Nitrile but with improved mechanical properties and media resistance. Excellent for many oilfield and automotive applications. H_2S resistance up to 10%.
HS8	Highly Saturated Nitrile	80 +/- 5	-40 C to 150 C -40 F to 302 F	Generally used for higher pressures than the 70 durometer materials while having comparable media resistance.
HS9	Highly Saturated Nitrile	90 +/- 5	-40 C to 150 C -40 F to 302 F	Generally used for higher pressures than the 80 durometer materials while having comparable media resistance. Improved ED resistance.
V75	Viton®	75 +/- 5	-25 C to 204 C -13 F to 400 F	**Genuine Viton®** compounds have excellent resistance to ozone, weather, oxygen, mineral oil, fuels, hydraulic fluids, aromatics, petroleum fluids, many organic solvents and chemicals. Viton® is also used in high temperature applications. **Viton® Extreme™** TBR and ETP compounds are also available. TBR- Totally Base Resistant compound that provides improved performance over other TFE/Propylene polymers. ETP- Provides the excellent thermal resistance of Viton® along with significantly advanced chemical resistance.
V90	Viton®	90 +/- 5	-25 C to 204 C -13 F to 400 F	**Genuine Viton®** is generally used for higher pressure than the 75 durometer materials while having comparable media resistance.
LTV	Viton® GLT	75 +/- 5	-40 C to 204 C -40 F to 400 F	**Genuine Viton®** GLT is used for lower temperature applications than the 75 durometer materials while having comparable media resistance.
PF7	Perfluoroelastomer	75 +/- 5	-15 C to 300 C 5 F to 572 F	Perfluroelastomer materials combine the best heat and chemical resistance performance compared to other elastomer materials.
PF9	Perfluoroelastomer	90 +/- 5	-4 C to 230 C 25 F to 466 F	Generally used for higher pressures than the 75 durometer materials while having comparable media resistance.
A80	Aflas™	80 +/- 5	0 C to 230 C 32 F to 446 F	Tetrafluoroethylene-Propylene materials exhibit exceptional thermal and chemical resistance including hot water, steam, acids, alkaline solutions, ammonia, amines, brake fluids, petroleum fluids and sour gas. Low temperature may restrict sealing abilities.
NEO	Neoprene	70 +/- 5	-45 C to 135 C -49 F to 275 F	Neoprene is a general purpose material for refrigerants, ozone and weather.
E70	Ethylene-Propylene	70 +/- 5	-54 C to 150 C -65 F to 302 F	Ethylene-Propylene materials exhibit excellent resistance to water, steam, brake fluids and ozone.
E80	Ethylene-Propylene	80 +/- 5	-54 C to 150 C -65 F to 302 F	Generally used for higher pressures than 70 durometer EPDM compounds while having comparable media resistance.
S70	Silicone	70 +/- 5	-55 C to 230 C -67 F to 446 F	Silicone compounds offer the widest elastomer temperature range but typically can not be used in dynamic applications or petroleum based fluids.
FS7	Fluorosilicone	70 +/- 5	-55 C to 200 C -67 F to 392 F	Fluorosilicone for use in petroleum and synthetic oils, greases, amines, amine-treated hydrocarbons and steam.

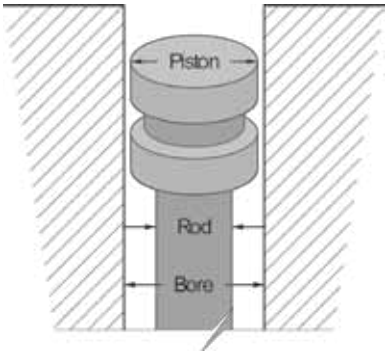
F.D.A., NSF and UL listed or approved materials available upon request. We also offer a complete range of coloured or internally lubed compounds as required. Some materials are available in durometers that range from 40 to 95 shore A. Most compounds available in metric sizing.
Hi-Tech Seals Inc. also offers a complete range of back-up rings, anti-extrusion devices as well as X-rings and square cut rings. These products are available in a variety of sizes and materials, please contact your sales office for more information.

Machining Specifications

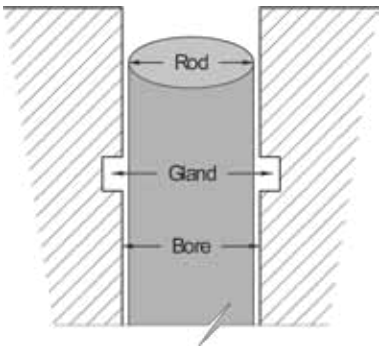
O-Ring Gland Types

O-rings are primarily used to prevent the loss of a fluid or gas. However, O-rings can be used as dust seals, drive belts or on rotating shafts. Most O-ring seals can be classified into one of the three arrangements shown below.

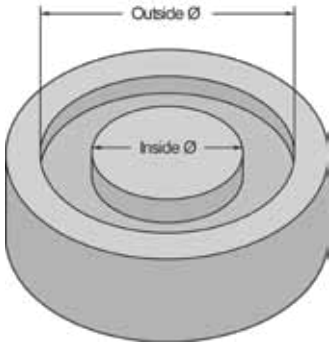
Piston Configuration



Rod Configuration



Face Type Configuration



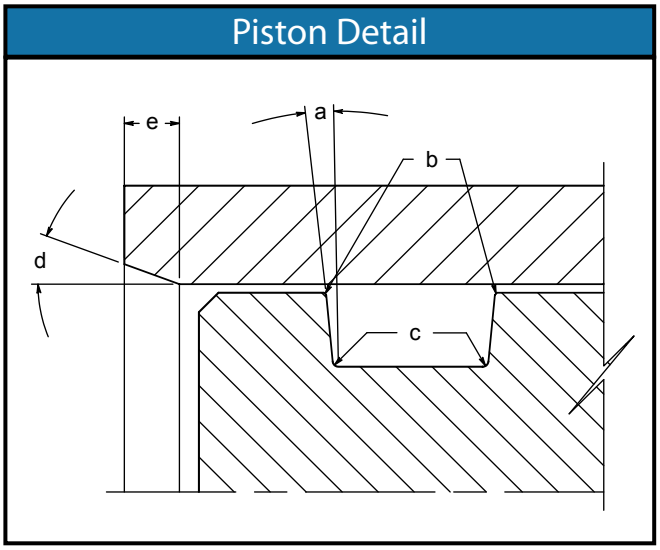
Selecting an O-Ring Cross-Section

Whereas the ID or OD of the O-ring for a design is significantly influenced by the diameter of the mating components (piston/rod and bore), the cross-section of the O-ring is usually fairly arbitrary. The following table describes some of the advantages when opting for a small cross-section or a large cross-section.

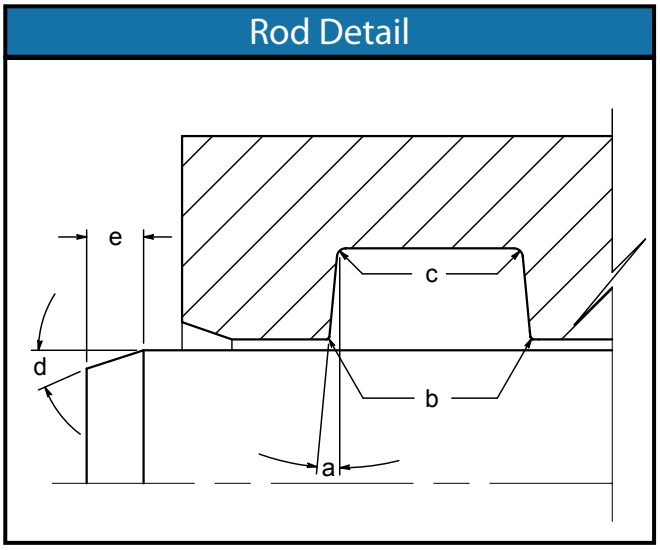
Advantages of Smaller Cross-Section	Advantages of Larger Cross-Section
• More compact • Lighter weight • Less expensive; especially for higher cost elastomers like FKM or fluorosilicone • Less machining required for machined grooves since grooves are smaller • More resistant to explosive decompression	• Less prone to compression set • Less volume swell in liquid on a percentage basis • Allows for larger tolerance while still maintaining acceptable compression squeeze and compression ratio over full stack-up range • Less prone to leakage due to contamination; dirt, lint, scratches, etc.

Groove Details

Piston Detail



Rod Detail



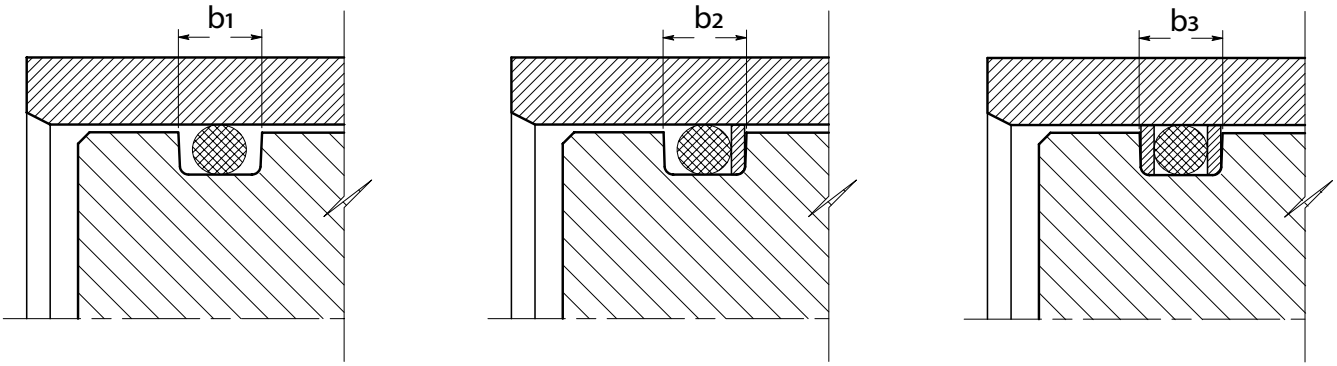
a- wall angle b- break edge c- radius d- angle e- chamfer length

O-Ring Series	O-Ring C/S		a	b	c		-d at 15°- e -d at 20°-			
	Inch	mm			Inch	mm	Inch	mm	Inch	mm
0	0.070	1.78	0-5°	0.004-0.012 Inch	0.008-0.016	0.20-0.40	0.043	1.10	0.035	0.90
100	0.103	2.62			0.008-0.016	0.20-0.40	0.059	1.50	0.043	1.10
200	0.139	3.53		0.10-0.30 mm	0.016-0.031	0.40-0.80	0.071	1.80	0.055	1.40
300	0.210	5.33			0.016-0.031	0.40-0.80	0.106	2.70	0.083	2.10
400	0.275	6.99			0.031-0.047	0.80-1.20	0.142	3.60	0.110	2.80

The surface roughness of the O-ring housing and any mating part has a significant impact on the life and sealing performance of the O-ring. The following are surface roughness values in micrometers (µm):

For a static mating surface: Ra 1.6 / Rz 6.3
For a dynamic mating surface: Ra 0.4 / Rz 1.6

For more information on surface finish values, please contact Hi-Tech Seals Inc. engineering.



O-Ring Series	O-Ring C/S		O-Ring C/S Squeeze (%)			b1	b2	b3
	Inch	mm	HD	PD	HPS	Inch	+ 0.010 - 0.000 / mm	+ 0.25 - 0.00
0	0.070	1.78	13-27	10-24	14-35	0.110/2.80	0.165/4.20	0.220/5.60
100	0.103	2.62	12-24	8-22	13-30	0.150/3.80	0.205/5.20	0.260/6.60
200	0.139	3.53	11-22	7-20	13-30	0.197/5.00	0.252/6.40	0.307/7.80
300	0.210	5.33	11-20	7-18	12-28	0.283/7.20	0.354/9.00	0.429/10.90
400	0.275	6.99	9-19	6-17	10-25	0.374/9.50	0.484/12.30	0.594/15.10

HD- Hydraulic Dynamic Applications
PD- Pneumatic Dynamic Applications
HPS- Hydraulic & Pneumatic Static Applications

Note: For piston applications, b_1, b_2 and b_3, values do not apply for 001-003 and 400-424 series O-rings.

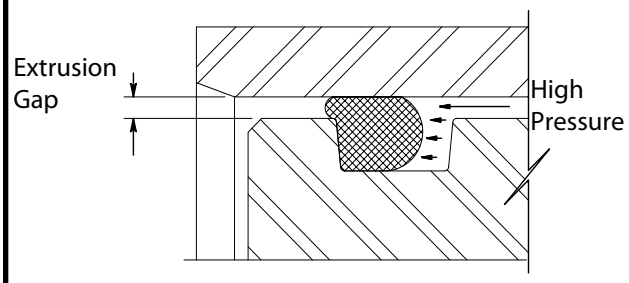
Note: For rod applications b_1, b_2 and b_3 values do not apply for 001-003, 028-050, 135-178, 232-284, 350-395, 400-424 and 430-475.

Extrusion Gap

Extrusion is a concern for radial seals where there is gap between the piston and the bore for a piston type seal or between the rod and the bore for a rod type seal. It is not typically a concern for face type seals where the metal parts to be sealed are in contact line-to-line. The issue is that at higher pressures and especially for softer O-ring elastomers, the O-ring can be forced by the pressure into the small gap between the piston (or rod) and the bore. Unless the bore and the piston (or rod) are ensured to remain concentric by the hardware, we have to assume that entire possible gap can shift to one side (see diagram below).

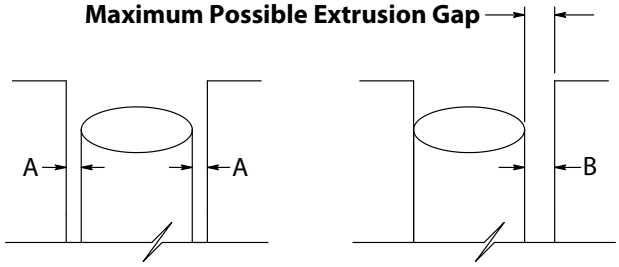
Piston Type Seal	Rod Type seal
Extrusion Gap= Bore Ø- Piston Ø	Extrusion Gap = Bore Ø- Rod Ø

Extrusion



Concentricity & Diametral Clearance

A= Radial Gap
B= Diametrical Gap

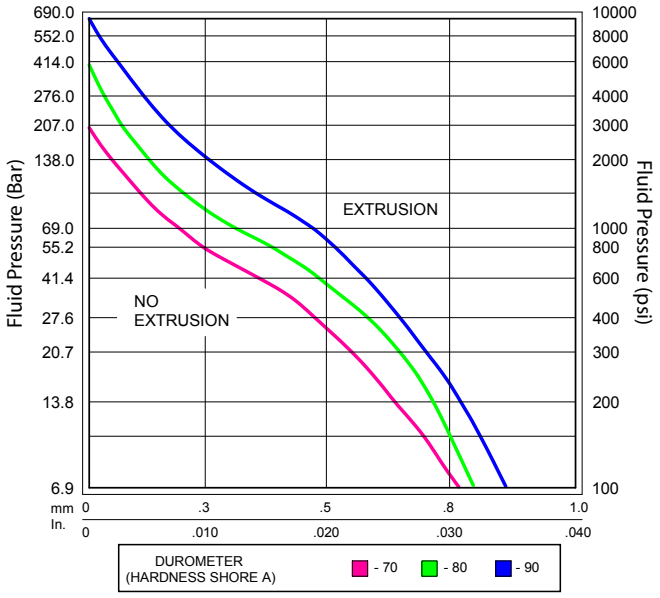


* Extrusion gaps should always be based on maximum diametral gap.

There are different methods to counter O-ring extrusion. One of these methods is to simply increase the durometer rating of the O-ring. However, as you increase the durometer, the O-ring can become less malleable. Another option would be the use of anti-extrusion devices. These are thin rings made of hard plastic materials such as PTFE, Nylon, and PEEK. Once in place these ring will provide essentially zero clearance.

NOTE: The chart on the right is not to ISO specification, it is meant to be used as a reference guide.

LIMITS FOR EXTRUSION



Total Diametral Clearance *
(Radial Clearance if Concentricity Between Piston and Cylinder is Rigidly Maintained)
*Reduce the clearance shown by 60% when using silicone or fluorosilicone elastomers.

ID Stretch/OD Interference

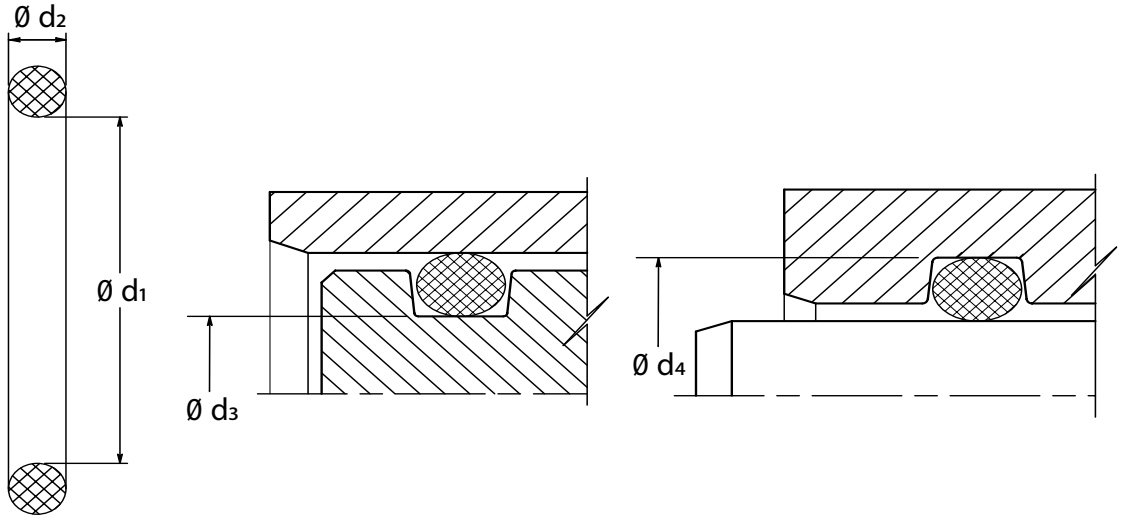
For hydraulic and pneumatic piston sealing applications
The nominal O-ring inside diameter, d_1, should be stretched between 2% and 5% for dynamic applications and 2% and 8% for static applications. For O-rings with a diameter d_1 smaller than 20 mm, this is not always possible which can result in a wider range of stretch. To minimize this range and the maximum stretch, it is necessary to minimize the tolerance of the housing diameter, d_3, and have a less stringent requirement for the minimum O-ring stretch. In dynamic applications, it is important to keep the maximum stretch to 5% or less to avoid detrimental effects on sealing performance.

For hydraulic and pneumatic rod sealing applications
The O-ring outside diameter ($d_1 + 2d_2$) should be at least equal to or larger than the housing outside diameter, d_4, to give interference on the outside diameter. The O-ring outside diameter should not exceed 3% of the housing outside diameter for O-rings with a diameter d_1, greater than 250 mm, or 5% for O-rings with a diameter d_1 smaller than 250 mm. For O-rings with a diameter d_1 smaller than 20 mm, this is not always possible due to tolerance issues, which can result in a greater outside diameter interference.

For hydraulic and pneumatic static axial sealing applications
*A*n O-ring is compressed in the axial direction. An O-ring can be pressurized from an internal or external source. A proper housing design minimizes the number of gaps through which the O-ring can extrude and reduces potential damage to the O-ring during assembly. ***In this case the following housing dimensions apply***:

O-Ring Series	O-Ring C/S		+0.008/-0.000 **w** +0.20/-0.00		**h**	
	Inch	mm	Liquid Applications (Inch/mm)	Gas/Vacuum Applications (Inch/mm)	+0.004/-0.000 Inch	+0.10/-0.00 mm
0	0.070	1.78	0.126/3.20	0.114/2.90	0.051	1.30
100	0.103	2.62	0.157/4.00	0.142/3.60	0.079	2.00
200	0.139	3.53	0.209/5.30	0.189/4.80	0.106	2.70
300	0.210	5.33	0.299/7.60	0.276/7.00	0.165	4.20
400	0.275	6.99	0.354/9.00	0.335/8.50	0.224	5.70

w- width of the O-ring axial housing, h- height of the seal housing



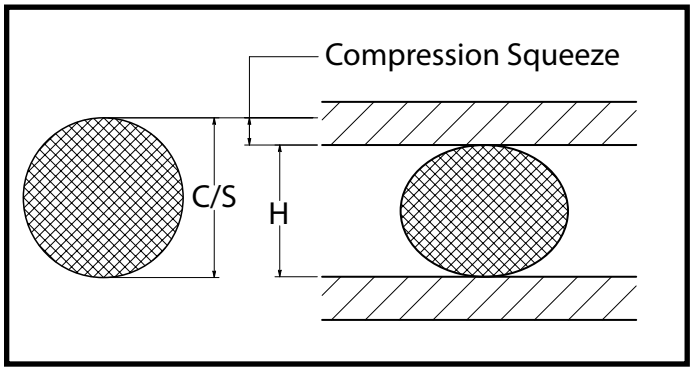
Reduction in Cross-Section

Elastomers seal by their ability to be compressed therefore, if the ID of the O-ring is stretched, the cross-section of the O-ring will decrease. The following table gives the O-ring cross-sections that result of from various percentages of ID stretch.

ISO Sizing Number	Original O-Ring C/S		Reduced O-Ring C/S at % ID Stretch (Inch/mm)				
	Inch	mm	1%	2%	3%	4%	5%
000	0.070	1.78	0.069/1.76	0.069/1.74	0.068/1.73	0.068/1.71	0.068/1.69
100	0.103	2.62	0.102/2.59	0.101/2.57	0.100/2.54	0.100/2.52	0.100/2.49
200	0.139	3.53	0.138/3.49	0.137/3.46	0.136/3.42	0.135/3.39	0.134/3.35
300	0.210	5.33	0.208/5.28	0.206/5.22	0.205/5.17	0.204/5.12	0.203/5.06
400	0.275	6.99	0.272/6.92	0.270/6.85	0.268/6.78	0.267/6.71	0.266/6.64

Compression

The difference between the original O-ring cross-section and the final O-ring cross-section once installed is known as the compression squeeze.



Compression Squeeze = C/S - H

This can usually be expressed as a percentage: O-Ring C/S Squeeze (%) = $\frac{\text{Compression Squeeze}}{\text{C/S}}$ x 100

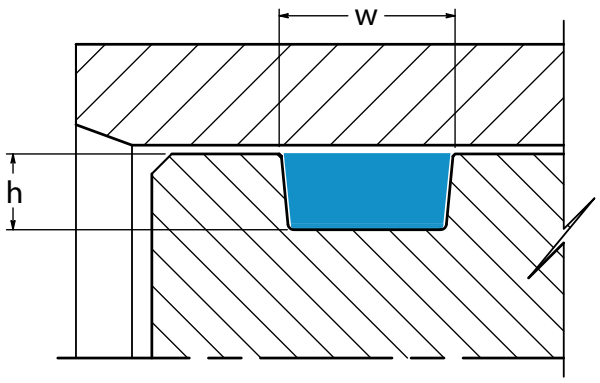
For recommended O-ring C/S squeeze (%) values please refer to page 5.

Gland Fill

The gland fill is the percentage of the gland that is occupied by the O-ring. It is calculated by dividing the cross-sectional area (CSA) of the O-ring by the cross-sectional area of the gland.

Area of a circle = πr^2 and $r = \frac{D}{2}$, where D = diameter (C/S)

Therefore, O-ring CSA = $\pi\left(\frac{C/S}{2}\right)^2$



** Effect of gland angle not addressed.*

Gland CSA = h x w*

$$\text{Gland Fill (\%)} = \frac{\text{O-ring CSA}}{\text{Gland CSA}} \times 100$$

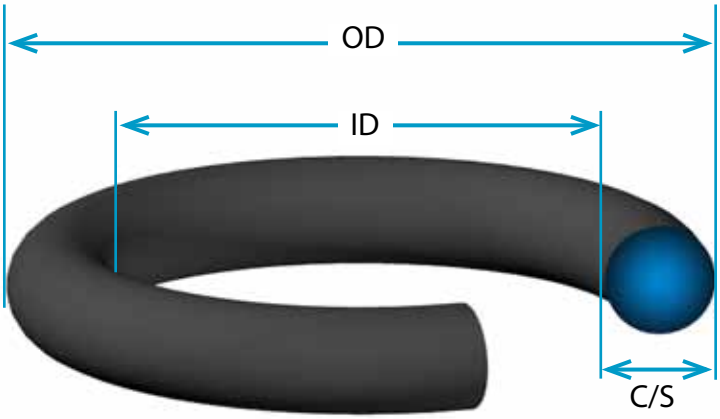
w- housing width
h- housing height

It is important to consider the housing fill or occupancy of the installed O-ring to avoid detrimental effects on radial sealing performance. Housing fill of the installed O-ring should not be more than 85 % to allow for possible O-ring thermal expansion, volume swell due to fluid exposure and effects of tolerances.

Volume change is the increase or decrease of the volume of an elastomer after it has been in contact with a fluid, measured in percent (%). For static O-ring applications volume swell up to 30 % can usually be tolerated. For dynamic applications, 10 or 15 % swell is a reasonable maximum unless special provisions are made in the gland design itself. This is a general rule and there may occasionally be exceptions.

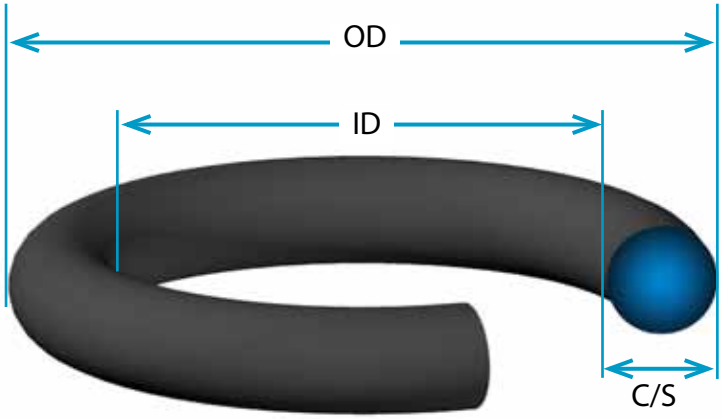
It is also important to note there are significant differences in the coefficients of thermal expansion and contraction between the O-ring material and the housing materials. Elastomers can have coefficients of expansion 7 to 20 times higher than that of metal, such as steel.

O-Ring Sizing Charts



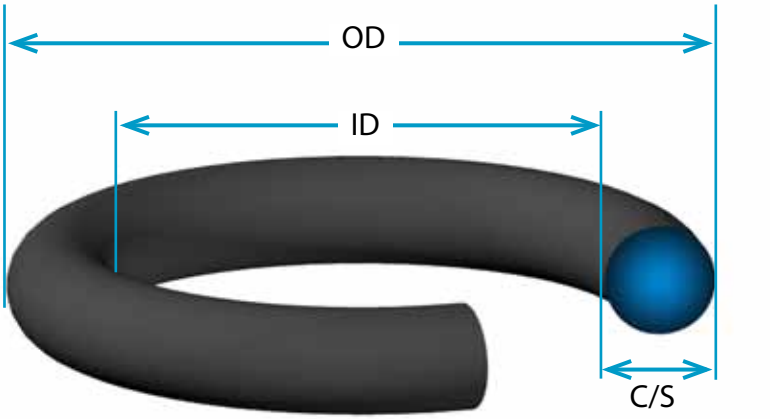
000 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
001	1/32	1/32	0.029	0.004	0.040	0.003	0.74	0.10	1.02	0.08
002	3/64	3/64	0.042	0.004	0.050	0.003	1.07	0.10	1.27	0.08
003	1/16	1/16	0.056	0.004	0.060	0.003	1.42	0.10	1.52	0.08
004	5/64	1/16	0.070	0.005	0.070	0.003	1.78	0.13	1.78	0.08
005	3/32	1/16	0.101	0.005	0.070	0.003	2.57	0.13	1.78	0.08
006	1/8	1/16	0.114	0.005	0.070	0.003	2.90	0.13	1.78	0.08
007	5/32	1/16	0.145	0.005	0.070	0.003	3.68	0.13	1.78	0.08
008	3/16	1/16	0.176	0.005	0.070	0.003	4.47	0.13	1.78	0.08
009	7/32	1/16	0.208	0.005	0.070	0.003	5.28	0.13	1.78	0.08
010	1/4	1/16	0.239	0.005	0.070	0.003	6.07	0.13	1.78	0.08
011	5/16	1/16	0.301	0.005	0.070	0.003	7.65	0.13	1.78	0.08
012	3/8	1/16	0.364	0.005	0.070	0.003	9.25	0.13	1.78	0.08
013	7/16	1/16	0.426	0.005	0.070	0.003	10.82	0.13	1.78	0.08
014	1/2	1/16	0.489	0.005	0.070	0.003	12.42	0.13	1.78	0.08
015	9/16	1/16	0.551	0.007	0.070	0.003	14.00	0.18	1.78	0.08
016	5/8	1/16	0.614	0.009	0.070	0.003	15.60	0.23	1.78	0.08
017	11/16	1/16	0.676	0.009	0.070	0.003	17.17	0.23	1.78	0.08
018	3/4	1/16	0.739	0.009	0.070	0.003	18.77	0.23	1.78	0.08
019	13/16	1/16	0.801	0.009	0.070	0.003	20.35	0.23	1.78	0.08
020	7/8	1/16	0.864	0.009	0.070	0.003	21.95	0.23	1.78	0.08
021	15/16	1/16	0.926	0.009	0.070	0.003	23.52	0.23	1.78	0.08
022	1	1/16	0.989	0.010	0.070	0.003	25.12	0.25	1.78	0.08
023	1-1/16	1/16	1.051	0.010	0.070	0.003	26.70	0.25	1.78	0.08
024	1-1/8	1/16	1.114	0.010	0.070	0.003	28.30	0.25	1.78	0.08
025	1-3/16	1/16	1.176	0.011	0.070	0.003	29.87	0.28	1.78	0.08
026	1-1/4	1/16	1.239	0.011	0.070	0.003	31.47	0.28	1.78	0.08
027	1-5/16	1/16	1.301	0.011	0.070	0.003	33.05	0.28	1.78	0.08
028	1-3/8	1/16	1.364	0.013	0.070	0.003	34.65	0.33	1.78	0.08
029	1-1/2	1/16	1.481	0.013	0.070	0.003	37.62	0.33	1.78	0.08
030	1-5/8	1/16	1.614	0.013	0.070	0.003	41.00	0.33	1.78	0.08
031	1-3/4	1/16	1.739	0.015	0.070	0.003	44.17	0.38	1.78	0.08
032	1-7/8	1/16	1.864	0.015	0.070	0.003	47.35	0.38	1.78	0.08
033	2	1/16	1.989	0.018	0.070	0.003	50.52	0.46	1.78	0.08
034	2-1/8	1/16	2.114	0.018	0.070	0.003	53.70	0.46	1.78	0.08



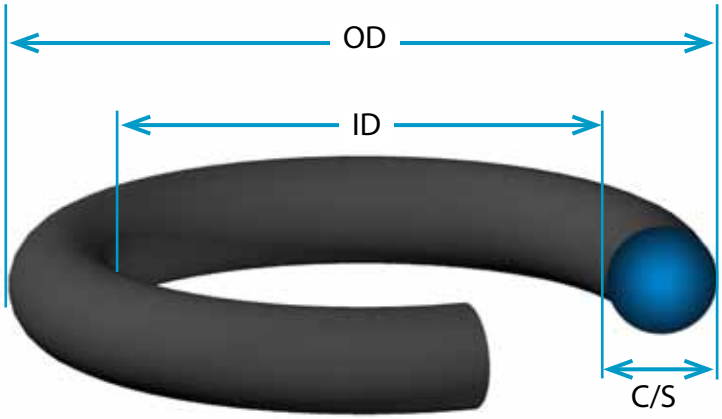
000 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
035	2-1/4	1/16	2.239	0.018	0.070	0.003	56.87	0.46	1.78	0.08
036	2-3/8	1/16	2.364	0.018	0.070	0.003	60.05	0.46	1.78	0.08
037	2-1/2	1/16	2.489	0.018	0.070	0.003	63.22	0.46	1.78	0.08
038	2-5/8	1/16	2.614	0.020	0.070	0.003	66.40	0.51	1.78	0.08
039	2-3/4	1/16	2.739	0.020	0.070	0.003	69.57	0.51	1.78	0.08
040	2-7/8	1/16	2.864	0.020	0.070	0.003	72.75	0.51	1.78	0.08
041	3	1/16	2.989	0.024	0.070	0.003	75.92	0.61	1.78	0.08
042	3-1/4	1/16	3.239	0.024	0.070	0.003	82.27	0.61	1.78	0.08
043	3-1/2	1/16	3.489	0.024	0.070	0.003	88.62	0.61	1.78	0.08
044	3-3/4	1/16	3.739	0.027	0.070	0.003	94.97	0.69	1.78	0.08
045	4	1/16	3.989	0.027	0.070	0.003	101.32	0.69	1.78	0.08
046	4-1/4	1/16	4.239	0.030	0.070	0.003	107.67	0.76	1.78	0.08
047	4-1/2	1/16	4.489	0.030	0.070	0.003	114.02	0.76	1.78	0.08
048	4-3/4	1/16	4.739	0.030	0.070	0.003	120.37	0.76	1.78	0.08
049	5	1/16	4.989	0.037	0.070	0.003	126.72	0.94	1.78	0.08
050	5-1/4	1/16	5.239	0.037	0.070	0.003	133.07	0.94	1.78	0.08



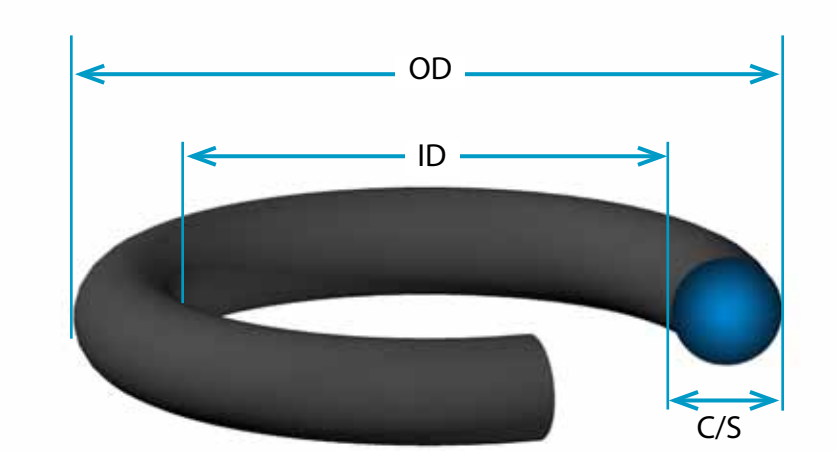
100 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
102	1/16	3/32	0.049	0.005	0.103	0.003	1.24	0.13	2.62	0.08
103	3/32	3/32	0.081	0.005	0.103	0.003	2.06	0.13	2.62	0.08
104	1/8	3/32	0.112	0.005	0.103	0.003	2.84	0.13	2.62	0.08
105	5/32	3/32	0.143	0.005	0.103	0.003	3.63	0.13	2.62	0.08
106	3/16	3/32	0.174	0.005	0.103	0.003	4.42	0.13	2.62	0.08
107	7/32	3/32	0.206	0.005	0.103	0.003	5.23	0.13	2.62	0.08
108	1/4	3/32	0.237	0.005	0.103	0.003	6.02	0.13	2.62	0.08
109	5/16	3/32	0.299	0.005	0.103	0.003	7.59	0.13	2.62	0.08
110	3/8	3/32	0.362	0.005	0.103	0.003	9.19	0.13	2.62	0.08
111	7/16	3/32	0.424	0.005	0.103	0.003	10.77	0.13	2.62	0.08
112	1/2	3/32	0.487	0.005	0.103	0.003	12.37	0.13	2.62	0.08
113	9/16	3/32	0.549	0.007	0.103	0.003	13.94	0.18	2.62	0.08
114	5/8	3/32	0.612	0.009	0.103	0.003	15.54	0.23	2.62	0.08
115	11/16	3/32	0.674	0.009	0.103	0.003	17.12	0.23	2.62	0.08
116	3/4	3/32	0.737	0.009	0.103	0.003	18.72	0.23	2.62	0.08
117	13/16	3/32	0.799	0.010	0.103	0.003	20.29	0.25	2.62	0.08
118	7/8	3/32	0.862	0.010	0.103	0.003	21.89	0.25	2.62	0.08
119	15/16	3/32	0.924	0.010	0.103	0.003	23.47	0.25	2.62	0.08
120	1	3/32	0.987	0.010	0.103	0.003	25.07	0.25	2.62	0.08
121	1-1/16	3/32	1.049	0.010	0.103	0.003	26.64	0.25	2.62	0.08
122	1-1/8	3/32	1.112	0.010	0.103	0.003	28.24	0.25	2.62	0.08
123	1-3/16	3/32	1.174	0.012	0.103	0.003	29.82	0.30	2.62	0.08
124	1-1/4	3/32	1.237	0.012	0.103	0.003	31.42	0.30	2.62	0.08
125	1-5/16	3/32	1.299	0.012	0.103	0.003	32.99	0.30	2.62	0.08
126	1-3/8	3/32	1.362	0.012	0.103	0.003	34.59	0.30	2.62	0.08
127	1-7/16	3/32	1.424	0.012	0.103	0.003	36.17	0.30	2.62	0.08
128	1-1/2	3/32	1.487	0.012	0.103	0.003	37.77	0.30	2.62	0.08
129	1-9/16	3/32	1.549	0.015	0.103	0.003	39.34	0.38	2.62	0.08
130	1-5/8	3/32	1.612	0.015	0.103	0.003	40.94	0.38	2.62	0.08
131	1-11/16	3/32	1.674	0.015	0.103	0.003	42.52	0.38	2.62	0.08
132	1-3/4	3/32	1.737	0.015	0.103	0.003	44.12	0.38	2.62	0.08
133	1-13/16	3/32	1.799	0.015	0.103	0.003	45.69	0.38	2.62	0.08
134	1-7/8	3/32	1.862	0.015	0.103	0.003	47.29	0.38	2.62	0.08
135	1-15/16	3/32	1.925	0.017	0.103	0.003	48.90	0.43	2.62	0.08



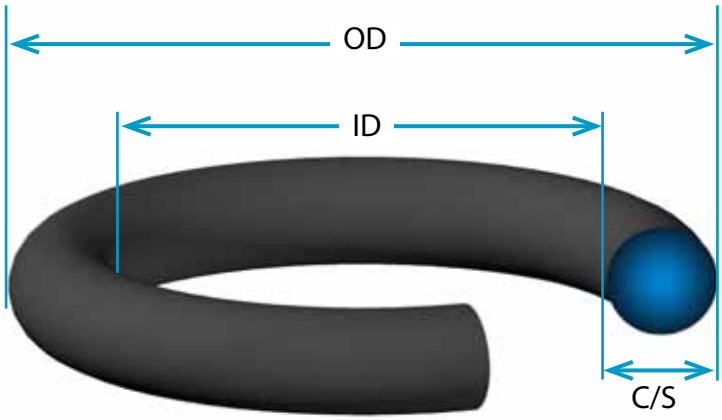
100 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
136	2	3/32	1.987	0.017	0.103	0.003	50.47	0.43	2.62	0.08
137	2-1/16	3/32	2.050	0.017	0.103	0.003	52.07	0.43	2.62	0.08
138	2-1/8	3/32	2.112	0.017	0.103	0.003	53.64	0.43	2.62	0.08
139	2-3/16	3/32	2.175	0.017	0.103	0.003	55.25	0.43	2.62	0.08
140	2-1/4	3/32	2.237	0.017	0.103	0.003	56.82	0.43	2.62	0.08
141	2-5/16	3/32	2.300	0.020	0.103	0.003	58.42	0.51	2.62	0.08
142	2-3/8	3/32	2.362	0.020	0.103	0.003	59.99	0.51	2.62	0.08
143	2-7/16	3/32	2.425	0.020	0.103	0.003	61.60	0.51	2.62	0.08
144	2-1/2	3/32	2.487	0.020	0.103	0.003	63.17	0.51	2.62	0.08
145	2-9/16	3/32	2.550	0.020	0.103	0.003	64.77	0.51	2.62	0.08
146	2-5/8	3/32	2.612	0.020	0.103	0.003	66.34	0.51	2.62	0.08
147	2-11/16	3/32	2.675	0.022	0.103	0.003	67.95	0.56	2.62	0.08
148	2-3/4	3/32	2.737	0.022	0.103	0.003	69.52	0.56	2.62	0.08
149	2-13/16	3/32	2.800	0.022	0.103	0.003	71.12	0.56	2.62	0.08
150	2-7/8	3/32	2.862	0.022	0.103	0.003	72.69	0.56	2.62	0.08
151	3	3/32	2.987	0.024	0.103	0.003	75.87	0.61	2.62	0.08
152	3-1/4	3/32	3.237	0.024	0.103	0.003	82.22	0.61	2.62	0.08
153	3-1/2	3/32	3.487	0.024	0.103	0.003	88.57	0.61	2.62	0.08
154	3-3/4	3/32	3.737	0.028	0.103	0.003	94.92	0.71	2.62	0.08
155	4	3/32	3.987	0.028	0.103	0.003	101.27	0.71	2.62	0.08
156	4-1/4	3/32	4.237	0.030	0.103	0.003	107.62	0.76	2.62	0.08
157	4-1/2	3/32	4.487	0.030	0.103	0.003	113.97	0.76	2.62	0.08
158	4-3/4	3/32	4.737	0.030	0.103	0.003	120.32	0.76	2.62	0.08
159	5	3/32	4.987	0.035	0.103	0.003	126.67	0.89	2.62	0.08
160	5-1/4	3/32	5.237	0.035	0.103	0.003	133.02	0.89	2.62	0.08
161	5-1/2	3/32	5.487	0.035	0.103	0.003	139.37	0.89	2.62	0.08
162	5-3/4	3/32	5.737	0.035	0.103	0.003	145.72	0.89	2.62	0.08
163	6	3/32	5.987	0.035	0.103	0.003	152.07	0.89	2.62	0.08
164	6-1/4	3/32	6.237	0.040	0.103	0.003	158.42	1.02	2.62	0.08
165	6-1/2	3/32	6.487	0.040	0.103	0.003	164.77	1.02	2.62	0.08
166	6-3/4	3/32	6.737	0.040	0.103	0.003	171.12	1.02	2.62	0.08
167	7	3/32	6.987	0.040	0.103	0.003	177.47	1.02	2.62	0.08
168	7-1/4	3/32	7.237	0.045	0.103	0.003	183.82	1.14	2.62	0.08
169	7-1/2	3/32	7.487	0.045	0.103	0.003	190.17	1.14	2.62	0.08



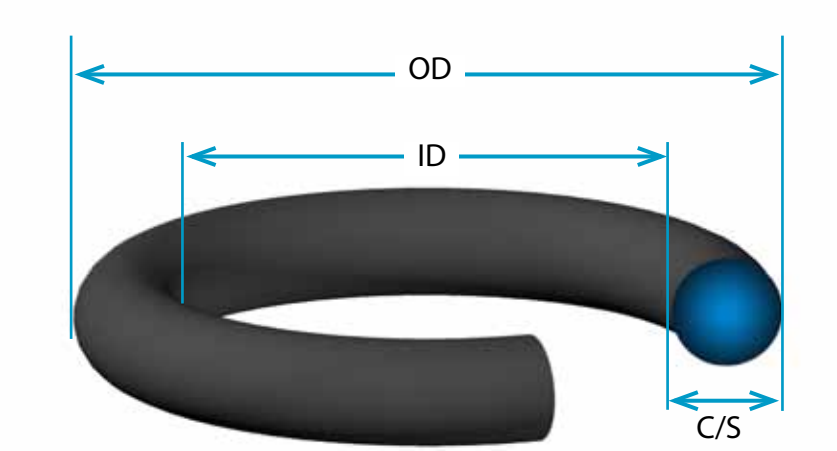
100 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
170	7-3/4	3/32	7.737	0.045	0.103	0.003	196.52	1.14	2.62	0.08
171	8	3/32	7.987	0.045	0.103	0.003	202.87	1.14	2.62	0.08
172	8-1/4	3/32	8.237	0.050	0.103	0.003	209.22	1.27	2.62	0.08
173	8-1/2	3/32	8.487	0.050	0.103	0.003	215.57	1.27	2.62	0.08
174	8-3/4	3/32	8.737	0.050	0.103	0.003	221.92	1.27	2.62	0.08
175	9	3/32	8.987	0.050	0.103	0.003	228.27	1.27	2.62	0.08
176	9-1/4	3/32	9.237	0.055	0.103	0.003	234.62	1.40	2.62	0.08
177	9-1/2	3/32	9.487	0.055	0.103	0.003	240.97	1.40	2.62	0.08
178	9-3/4	3/32	9.737	0.055	0.103	0.003	247.32	1.40	2.62	0.08



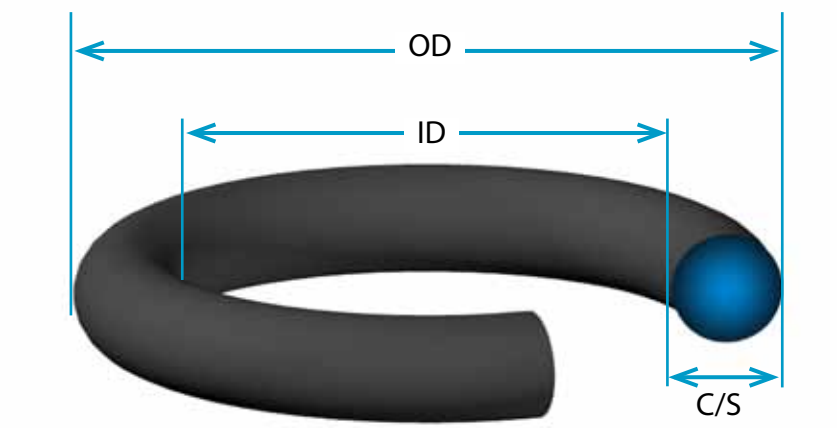
200 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
201	3/16	1/8	0.171	0.005	0.139	0.004	4.34	0.13	3.53	0.10
202	1/4	1/8	0.234	0.005	0.139	0.004	5.94	0.13	3.53	0.10
203	5/16	1/8	0.296	0.005	0.139	0.004	7.52	0.13	3.53	0.10
204	3/8	1/8	0.359	0.005	0.139	0.004	9.12	0.13	3.53	0.10
205	7/16	1/8	0.421	0.005	0.139	0.004	10.69	0.13	3.53	0.10
206	1/2	1/8	0.484	0.005	0.139	0.004	12.29	0.13	3.53	0.10
207	9/16	1/8	0.546	0.007	0.139	0.004	13.87	0.18	3.53	0.10
208	5/8	1/8	0.609	0.009	0.139	0.004	15.47	0.23	3.53	0.10
209	11/16	1/8	0.671	0.009	0.139	0.004	17.04	0.23	3.53	0.10
210	3/4	1/8	0.734	0.010	0.139	0.004	18.64	0.25	3.53	0.10
211	13/16	1/8	0.796	0.010	0.139	0.004	20.22	0.25	3.53	0.10
212	7/8	1/8	0.859	0.010	0.139	0.004	21.82	0.25	3.53	0.10
213	15/16	1/8	0.921	0.010	0.139	0.004	23.39	0.25	3.53	0.10
214	1	1/8	0.984	0.010	0.139	0.004	24.99	0.25	3.53	0.10
215	1-1/16	1/8	1.046	0.010	0.139	0.004	26.57	0.25	3.53	0.10
216	1-1/8	1/8	1.109	0.012	0.139	0.004	28.17	0.30	3.53	0.10
217	1-3/16	1/8	1.171	0.012	0.139	0.004	29.74	0.30	3.53	0.10
218	1-1/4	1/8	1.234	0.012	0.139	0.004	31.34	0.30	3.53	0.10
219	1-5/16	1/8	1.296	0.012	0.139	0.004	32.92	0.30	3.53	0.10
220	1-3/8	1/8	1.359	0.012	0.139	0.004	34.52	0.30	3.53	0.10
221	1-7/16	1/8	1.421	0.012	0.139	0.004	36.09	0.30	3.53	0.10
222	1-1/2	1/8	1.484	0.015	0.139	0.004	37.69	0.38	3.53	0.10
223	1-5/8	1/8	1.609	0.015	0.139	0.004	40.87	0.38	3.53	0.10
224	1-3/4	1/8	1.734	0.015	0.139	0.004	44.04	0.38	3.53	0.10
225	1-7/8	1/8	1.859	0.018	0.139	0.004	47.22	0.46	3.53	0.10
226	2	1/8	1.984	0.018	0.139	0.004	50.39	0.46	3.53	0.10
227	2-1/8	1/8	2.109	0.018	0.139	0.004	53.57	0.46	3.53	0.10
228	2-1/4	1/8	2.234	0.020	0.139	0.004	56.74	0.51	3.53	0.10
229	2-3/8	1/8	2.359	0.020	0.139	0.004	59.92	0.51	3.53	0.10
230	2-1/2	1/8	2.484	0.020	0.139	0.004	63.09	0.51	3.53	0.10
231	2-5/8	1/8	2.609	0.020	0.139	0.004	66.27	0.51	3.53	0.10
232	2-3/4	1/8	2.734	0.024	0.139	0.004	69.44	0.61	3.53	0.10
233	2-7/8	1/8	2.859	0.024	0.139	0.004	72.62	0.61	3.53	0.10
234	3	1/8	2.984	0.024	0.139	0.004	75.79	0.61	3.53	0.10



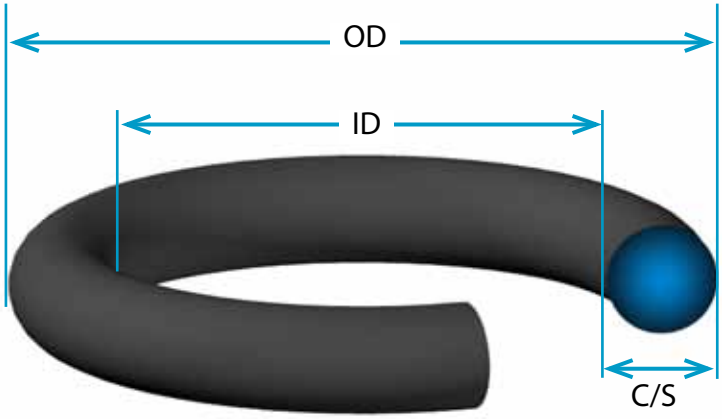
200 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
235	3-1/8	1/8	3.109	0.024	0.139	0.004	78.97	0.61	3.53	0.10
236	3-1/4	1/8	3.234	0.024	0.139	0.004	82.14	0.61	3.53	0.10
237	3-3/8	1/8	3.359	0.024	0.139	0.004	85.32	0.61	3.53	0.10
238	3-1/2	1/8	3.484	0.024	0.139	0.004	88.49	0.61	3.53	0.10
239	3-5/8	1/8	3.609	0.028	0.139	0.004	91.67	0.71	3.53	0.10
240	3-3/4	1/8	3.734	0.028	0.139	0.004	94.84	0.71	3.53	0.10
241	3-7/8	1/8	3.859	0.028	0.139	0.004	98.02	0.71	3.53	0.10
242	4	1/8	3.984	0.028	0.139	0.004	101.19	0.71	3.53	0.10
243	4-1/8	1/8	4.109	0.028	0.139	0.004	104.37	0.71	3.53	0.10
244	4-1/4	1/8	4.234	0.030	0.139	0.004	107.54	0.76	3.53	0.10
245	4-3/8	1/8	4.359	0.030	0.139	0.004	110.72	0.76	3.53	0.10
246	4-1/2	1/8	4.484	0.030	0.139	0.004	113.89	0.76	3.53	0.10
247	4-5/8	1/8	4.609	0.030	0.139	0.004	117.07	0.76	3.53	0.10
248	4-3/4	1/8	4.734	0.030	0.139	0.004	120.24	0.76	3.53	0.10
249	4-7/8	1/8	4.859	0.035	0.139	0.004	123.42	0.89	3.53	0.10
250	5	1/8	4.984	0.035	0.139	0.004	126.59	0.89	3.53	0.10
251	5-1/8	1/8	5.109	0.035	0.139	0.004	129.77	0.89	3.53	0.10
252	5-1/4	1/8	5.234	0.035	0.139	0.004	132.94	0.89	3.53	0.10
253	5-3/8	1/8	5.359	0.035	0.139	0.004	136.12	0.89	3.53	0.10
254	5-1/2	1/8	5.484	0.035	0.139	0.004	139.29	0.89	3.53	0.10
255	5-5/8	1/8	5.609	0.035	0.139	0.004	142.47	0.89	3.53	0.10
256	5-3/4	1/8	5.734	0.035	0.139	0.004	145.64	0.89	3.53	0.10
257	5-7/8	1/8	5.859	0.035	0.139	0.004	148.82	0.89	3.53	0.10
258	6	1/8	5.984	0.035	0.139	0.004	151.99	0.89	3.53	0.10
259	6-1/4	1/8	6.234	0.040	0.139	0.004	158.34	1.02	3.53	0.10
260	6-1/2	1/8	6.484	0.040	0.139	0.004	164.69	1.02	3.53	0.10
261	6-3/4	1/8	6.734	0.040	0.139	0.004	171.04	1.02	3.53	0.10
262	7	1/8	6.984	0.040	0.139	0.004	177.39	1.02	3.53	0.10
263	7-1/4	1/8	7.234	0.045	0.139	0.004	183.74	1.14	3.53	0.10
264	7-1/2	1/8	7.484	0.045	0.139	0.004	190.09	1.14	3.53	0.10
265	7-3/4	1/8	7.734	0.045	0.139	0.004	196.44	1.14	3.53	0.10
266	8	1/8	7.984	0.045	0.139	0.004	202.79	1.14	3.53	0.10
267	8-1/4	1/8	8.234	0.050	0.139	0.004	209.14	1.27	3.53	0.10
268	8-1/2	1/8	8.484	0.050	0.139	0.004	215.49	1.27	3.53	0.10



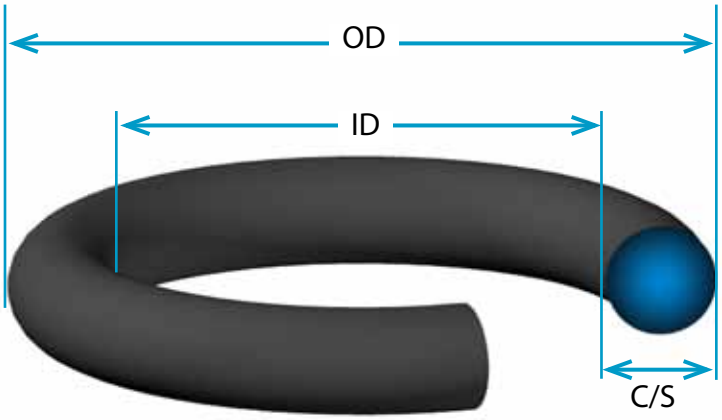
200 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
269	8-3/4	1/8	8.734	0.050	0.139	0.004	221.84	1.27	3.53	0.10
270	9	1/8	8.984	0.050	0.139	0.004	228.19	1.27	3.53	0.10
271	9-1/4	1/8	9.234	0.055	0.139	0.004	234.54	1.40	3.53	0.10
272	9-1/2	1/8	9.484	0.055	0.139	0.004	240.89	1.40	3.53	0.10
273	9--3/4	1/8	9.734	0.055	0.139	0.004	247.24	1.40	3.53	0.10
274	10	1/8	9.984	0.055	0.139	0.004	253.59	1.40	3.53	0.10
275	10-1/2	1/8	10.484	0.055	0.139	0.004	266.29	1.40	3.53	0.10
276	11	1/8	10.984	0.065	0.139	0.004	278.99	1.65	3.53	0.10
277	11-1/2	1/8	11.484	0.065	0.139	0.004	291.69	1.65	3.53	0.10
278	12	1/8	11.984	0.065	0.139	0.004	304.39	1.65	3.53	0.10
279	13	1/8	12.984	0.065	0.139	0.004	329.79	1.65	3.53	0.10
280	14	1/8	13.984	0.065	0.139	0.004	355.19	1.65	3.53	0.10
281	15	1/8	14.984	0.065	0.139	0.004	380.59	1.65	3.53	0.10
282	16	1/8	15.955	0.075	0.139	0.004	405.26	1.91	3.53	0.10
283	17	1/8	16.956	0.080	0.139	0.004	430.68	2.03	3.53	0.10
284	18	1/8	17.955	0.085	0.139	0.004	456.06	2.16	3.53	0.10



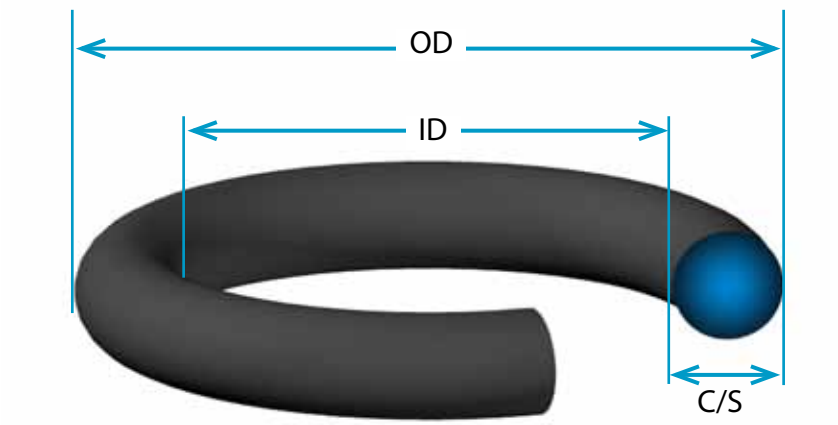
300 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
309	7/16	3/16	0.412	0.005	0.210	0.005	10.46	0.13	5.33	0.13
310	1/2	3/16	0.475	0.005	0.210	0.005	12.07	0.13	5.33	0.13
311	9/16	3/16	0.537	0.007	0.210	0.005	13.64	0.18	5.33	0.13
312	5/8	3/16	0.600	0.009	0.210	0.005	15.24	0.23	5.33	0.13
313	11/16	3/16	0.662	0.009	0.210	0.005	16.81	0.23	5.33	0.13
314	3/4	3/16	0.725	0.010	0.210	0.005	18.42	0.25	5.33	0.13
315	13/16	3/16	0.787	0.010	0.210	0.005	19.99	0.25	5.33	0.13
316	7/8	3/16	0.850	0.010	0.210	0.005	21.59	0.25	5.33	0.13
317	15/16	3/16	0.912	0.010	0.210	0.005	23.16	0.25	5.33	0.13
318	1	3/16	0.975	0.010	0.210	0.005	24.77	0.25	5.33	0.13
319	1-1/16	3/16	1.037	0.010	0.210	0.005	26.34	0.25	5.33	0.13
320	1-1/8	3/16	1.100	0.012	0.210	0.005	27.94	0.30	5.33	0.13
321	1-3/16	3/16	1.162	0.012	0.210	0.005	29.51	0.30	5.33	0.13
322	1-1/4	3/16	1.225	0.012	0.210	0.005	31.12	0.30	5.33	0.13
323	1-5/16	3/16	1.287	0.012	0.210	0.005	32.69	0.30	5.33	0.13
324	1-3/8	3/16	1.350	0.012	0.210	0.005	34.29	0.30	5.33	0.13
325	1-1/2	3/16	1.475	0.015	0.210	0.005	37.47	0.38	5.33	0.13
326	1-5/8	3/16	1.600	0.015	0.210	0.005	40.64	0.38	5.33	0.13
327	1-3/4	3/16	1.725	0.015	0.210	0.005	43.82	0.38	5.33	0.13
328	1-7/8	3/16	1.850	0.015	0.210	0.005	46.99	0.38	5.33	0.13
329	2	3/16	1.975	0.018	0.210	0.005	50.17	0.46	5.33	0.13
330	2-1/8	3/16	2.100	0.018	0.210	0.005	53.34	0.46	5.33	0.13
331	2-1/4	3/16	2.225	0.018	0.210	0.005	56.52	0.46	5.33	0.13
332	2-3/8	3/16	2.350	0.018	0.210	0.005	59.69	0.46	5.33	0.13
333	2-1/2	3/16	2.475	0.020	0.210	0.005	62.87	0.51	5.33	0.13
334	2-5/8	3/16	2.600	0.020	0.210	0.005	66.04	0.51	5.33	0.13
335	2-3/4	3/16	2.725	0.020	0.210	0.005	69.22	0.51	5.33	0.13
336	2-7/8	3/16	2.850	0.020	0.210	0.005	72.39	0.51	5.33	0.13
337	3	3/16	2.975	0.024	0.210	0.005	75.57	0.61	5.33	0.13
338	3-1/8	3/16	3.100	0.024	0.210	0.005	78.74	0.61	5.33	0.13
339	3-1/4	3/16	3.225	0.024	0.210	0.005	81.92	0.61	5.33	0.13
340	3-3/8	3/16	3.350	0.024	0.210	0.005	85.09	0.61	5.33	0.13
341	3-1/2	3/16	3.475	0.024	0.210	0.005	88.27	0.61	5.33	0.13
342	3-5/8	3/16	3.600	0.028	0.210	0.005	91.44	0.71	5.33	0.13



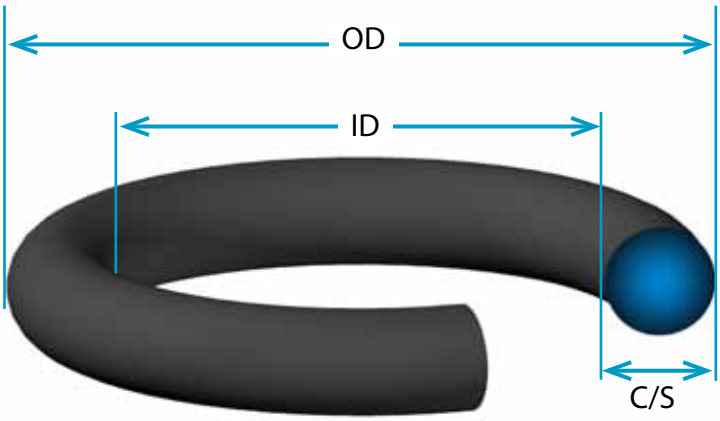
300 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
343	3-3/4	3/16	3.725	0.028	0.210	0.005	94.62	0.71	5.33	0.13
344	3-7/8	3/16	3.850	0.028	0.210	0.005	97.79	0.71	5.33	0.13
345	4	3/16	3.975	0.028	0.210	0.005	100.97	0.71	5.33	0.13
346	4-1/8	3/16	4.100	0.028	0.210	0.005	104.14	0.71	5.33	0.13
347	4-1/4	3/16	4.225	0.030	0.210	0.005	107.32	0.76	5.33	0.13
348	4-3/8	3/16	4.350	0.030	0.210	0.005	110.49	0.76	5.33	0.13
349	4-1/2	3/16	4.475	0.030	0.210	0.005	113.67	0.76	5.33	0.13
350	4-5/8	3/16	4.600	0.030	0.210	0.005	116.84	0.76	5.33	0.13
351	4-3/4	3/16	4.725	0.030	0.210	0.005	120.02	0.76	5.33	0.13
352	4-7/8	3/16	4.850	0.030	0.210	0.005	123.19	0.76	5.33	0.13
353	5	3/16	4.975	0.037	0.210	0.005	126.37	0.94	5.33	0.13
354	5-1/8	3/16	5.100	0.037	0.210	0.005	129.54	0.94	5.33	0.13
355	5-1/4	3/16	5.225	0.037	0.210	0.005	132.72	0.94	5.33	0.13
356	5-3/8	3/16	5.350	0.037	0.210	0.005	135.89	0.94	5.33	0.13
357	5-1/2	3/16	5.475	0.037	0.210	0.005	139.07	0.94	5.33	0.13
358	5-5/8	3/16	5.600	0.037	0.210	0.005	142.24	0.94	5.33	0.13
359	5-3/4	3/16	5.725	0.037	0.210	0.005	145.42	0.94	5.33	0.13
360	5-7/8	3/16	5.850	0.037	0.210	0.005	148.59	0.94	5.33	0.13
361	6	3/16	5.975	0.037	0.210	0.005	151.77	0.94	5.33	0.13
362	6-1/4	3/16	6.225	0.040	0.210	0.005	158.12	1.02	5.33	0.13
363	6-1/2	3/16	6.475	0.040	0.210	0.005	164.47	1.02	5.33	0.13
364	6-3/4	3/16	6.725	0.040	0.210	0.005	170.82	1.02	5.33	0.13
365	7	3/16	6.975	0.040	0.210	0.005	177.17	1.02	5.33	0.13
366	7-1/4	3/16	7.225	0.045	0.210	0.005	183.52	1.14	5.33	0.13
367	7-1/2	3/16	7.475	0.045	0.210	0.005	189.87	1.14	5.33	0.13
368	7-3/4	3/16	7.725	0.045	0.210	0.005	196.22	1.14	5.33	0.13
369	8	3/16	7.975	0.045	0.210	0.005	202.57	1.14	5.33	0.13
370	8-1/4	3/16	8.225	0.050	0.210	0.005	208.92	1.27	5.33	0.13
371	8-1/2	3/16	8.475	0.050	0.210	0.005	215.27	1.27	5.33	0.13
372	8-3/4	3/16	8.725	0.050	0.210	0.005	221.62	1.27	5.33	0.13
373	9	3/16	8.975	0.050	0.210	0.005	227.97	1.27	5.33	0.13
374	9-1/4	3/16	9.225	0.055	0.210	0.005	234.32	1.40	5.33	0.13
375	9-1/2	3/16	9.475	0.055	0.210	0.005	240.67	1.40	5.33	0.13
376	9-3/4	3/16	9.725	0.055	0.210	0.005	247.02	1.40	5.33	0.13



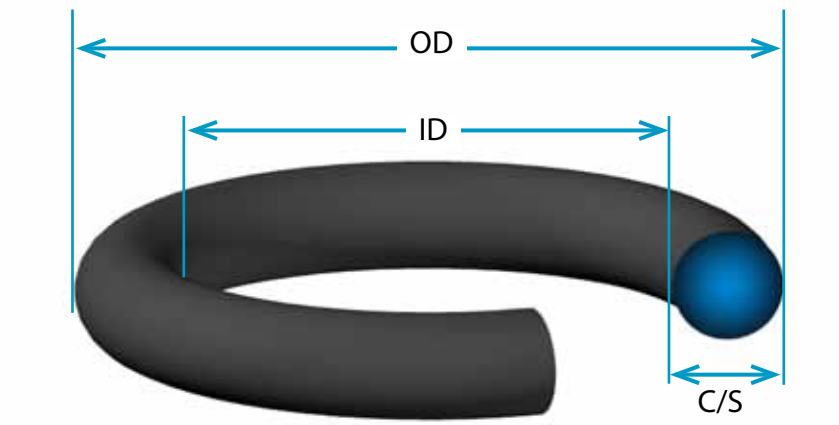
300 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
377	10	3/16	9.975	0.055	0.210	0.005	253.37	1.40	5.33	0.13
378	10-1/2	3/16	10.475	0.060	0.210	0.005	266.07	1.52	5.33	0.13
379	11	3/16	10.975	0.060	0.210	0.005	278.77	1.52	5.33	0.13
380	11-1/2	3/16	11.475	0.065	0.210	0.005	291.47	1.65	5.33	0.13
381	12	3/16	11.975	0.065	0.210	0.005	304.17	1.65	5.33	0.13
382	13	3/16	12.975	0.065	0.210	0.005	329.57	1.65	5.33	0.13
383	14	3/16	13.975	0.070	0.210	0.005	354.97	1.78	5.33	0.13
384	15	3/16	14.975	0.070	0.210	0.005	380.37	1.78	5.33	0.13
385	16	3/16	15.955	0.075	0.210	0.005	405.26	1.91	5.33	0.13
386	17	3/16	16.955	0.080	0.210	0.005	430.66	2.03	5.33	0.13
387	18	3/16	17.955	0.085	0.210	0.005	456.06	2.16	5.33	0.13
388	19	3/16	18.952	0.090	0.210	0.005	481.38	2.29	5.33	0.13
389	20	3/16	19.952	0.095	0.210	0.005	506.78	2.41	5.33	0.13
390	21	3/16	20.952	0.095	0.210	0.005	532.18	2.41	5.33	0.13
391	22	3/16	21.952	0.100	0.210	0.005	557.58	2.54	5.33	0.13
392	23	3/16	22.940	0.105	0.210	0.005	582.68	2.67	5.33	0.13
393	24	3/16	23.940	0.110	0.210	0.005	608.08	2.79	5.33	0.13
394	25	3/16	24.940	0.115	0.210	0.005	633.48	2.92	5.33	0.13
395	26	3/16	25.940	0.120	0.210	0.005	658.88	3.05	5.33	0.13



400 Series*

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
425	4-1/2	1/4	4.475	0.033	0.275	0.006	113.67	0.84	6.99	0.15
426	4-5/8	1/4	4.600	0.033	0.275	0.006	116.84	0.84	6.99	0.15
427	4-3/4	1/4	4.725	0.033	0.275	0.006	120.02	0.84	6.99	0.15
428	4-7/8	1/4	4.850	0.033	0.275	0.006	123.19	0.84	6.99	0.15
429	5	1/4	4.975	0.037	0.275	0.006	126.37	0.94	6.99	0.15
430	5-1/8	1/4	5.100	0.037	0.275	0.006	129.54	0.94	6.99	0.15
431	5-1/4	1/4	5.225	0.037	0.275	0.006	132.72	0.94	6.99	0.15
432	5-3/8	1/4	5.350	0.037	0.275	0.006	135.89	0.94	6.99	0.15
433	5-1/2	1/4	5.475	0.037	0.275	0.006	139.07	0.94	6.99	0.15
434	5-5/8	1/4	5.600	0.037	0.275	0.006	142.24	0.94	6.99	0.15
435	5-3/4	1/4	5.725	0.037	0.275	0.006	145.42	0.94	6.99	0.15
436	5-7/8	1/4	5.850	0.037	0.275	0.006	148.59	0.94	6.99	0.15
437	6	1/4	5.975	0.037	0.275	0.006	151.77	0.94	6.99	0.15
438	6-1/4	1/4	6.225	0.040	0.275	0.006	158.12	1.02	6.99	0.15
439	6-1/2	1/4	6.475	0.040	0.275	0.006	164.47	1.02	6.99	0.15
440	6-3/4	1/4	6.725	0.040	0.275	0.006	170.82	1.02	6.99	0.15
441	7	1/4	6.975	0.040	0.275	0.006	177.17	1.02	6.99	0.15
442	7-1/4	1/4	7.225	0.045	0.275	0.006	183.52	1.14	6.99	0.15
443	7-1/2	1/4	7.475	0.045	0.275	0.006	189.87	1.14	6.99	0.15
444	7-3/4	1/4	7.725	0.045	0.275	0.006	196.22	1.14	6.99	0.15
445	8	1/4	7.975	0.045	0.275	0.006	202.57	1.14	6.99	0.15
446	8-1/2	1/4	8.475	0.055	0.275	0.006	215.27	1.40	6.99	0.15
447	9	1/4	8.975	0.055	0.275	0.006	227.97	1.40	6.99	0.15
448	9-1/2	1/4	9.475	0.055	0.275	0.006	240.67	1.40	6.99	0.15
449	10	1/4	9.975	0.055	0.275	0.006	253.37	1.40	6.99	0.15
450	10-1/2	1/4	10.475	0.060	0.275	0.006	266.07	1.52	6.99	0.15
451	11	1/4	10.975	0.060	0.275	0.006	278.77	1.52	6.99	0.15
452	11-1/2	1/4	11.475	0.060	0.275	0.006	291.47	1.52	6.99	0.15
453	12	1/4	11.975	0.060	0.275	0.006	304.17	1.52	6.99	0.15
454	12-1/2	1/4	12.475	0.060	0.275	0.006	316.87	1.52	6.99	0.15
455	13	1/4	12.975	0.060	0.275	0.006	329.57	1.52	6.99	0.15
456	13-1/2	1/4	13.475	0.070	0.275	0.006	342.27	1.78	6.99	0.15
457	14	1/4	13.975	0.070	0.275	0.006	354.97	1.78	6.99	0.15

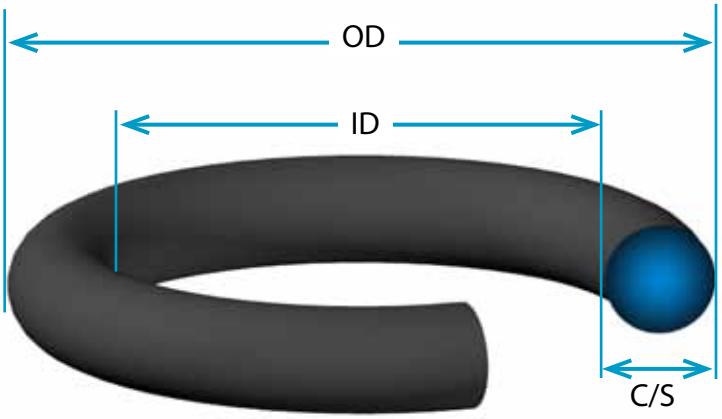


400 Series

ISO Sizing Number	Nominal		Inch Standard (*Actual*)				Metric Standard (*Actual*)			
	ID	C/S	ID	±	C/S	±	ID	±	C/S	±
458	14-1/2	1/4	14.475	0.070	0.275	0.006	367.67	1.78	6.99	0.15
459	15	1/4	14.975	0.070	0.275	0.006	380.37	1.78	6.99	0.15
460	15-1/2	1/4	15.475	0.070	0.275	0.006	393.07	1.78	6.99	0.15
461	16	1/4	15.955	0.075	0.275	0.006	405.26	1.91	6.99	0.15
462	16-1/2	1/4	16.455	0.075	0.275	0.006	417.96	1.91	6.99	0.15
463	17	1/4	16.955	0.080	0.275	0.006	430.66	2.03	6.99	0.15
464	17-1/2	1/4	17.455	0.085	0.275	0.006	443.36	2.16	6.99	0.15
465	18	1/4	17.955	0.085	0.275	0.006	456.06	2.16	6.99	0.15
466	18-1/2	1/4	18.455	0.085	0.275	0.006	468.76	2.16	6.99	0.15
467	19	1/4	18.955	0.090	0.275	0.006	481.46	2.29	6.99	0.15
468	19-1/2	1/4	19.455	0.090	0.275	0.006	494.16	2.29	6.99	0.15
469	20	1/4	19.955	0.095	0.275	0.006	506.86	2.41	6.99	0.15
470	21	1/4	20.955	0.095	0.275	0.006	532.26	2.41	6.99	0.15
471	22	1/4	21.955	0.100	0.275	0.006	557.66	2.54	6.99	0.15
472	23	1/4	22.940	0.105	0.275	0.006	582.68	2.67	6.99	0.15
473	24	1/4	23.940	0.110	0.275	0.006	608.08	2.79	6.99	0.15
474	25	1/4	24.940	0.115	0.275	0.006	633.48	2.92	6.99	0.15
475	26	1/4	25.940	0.120	0.275	0.006	658.88	3.05	6.99	0.15

* Hi-Tech Seals Inc. offers O-rings in sizes ranging from 400-425. These O-ring size dimensions and tolerances are unassigned under ISO 3601. In addition, Hi-Tech Seals stocks specific non-standard cross-section O-rings such as 3/8", 1/2" and 3/4".

O-Rings for Tube Fittings



ORB Series

Sizing Number	Inch Standard *(Actual)*				Metric Standard *(Actual)*			
	ID	±	CS	±	ID	±	CS	±
901	0.185	0.005	0.056	0.003	4.70	0.13	1.42	0.08
902	0.239	0.005	0.064	0.003	6.07	0.13	1.63	0.08
903	0.301	0.005	0.064	0.003	7.65	0.13	1.63	0.08
904	0.351	0.005	0.072	0.003	8.92	0.13	1.83	0.08
905	0.414	0.005	0.072	0.003	10.52	0.13	1.83	0.08
906	0.468	0.005	0.078	0.003	11.89	0.13	1.98	0.08
907	0.530	0.005	0.082	0.003	13.46	0.13	2.08	0.08
908	0.644	0.009	0.087	0.003	16.36	0.23	2.21	0.08
909	0.706	0.009	0.097	0.003	17.93	0.23	2.46	0.08
910	0.755	0.009	0.097	0.003	19.18	0.23	2.46	0.08
911	0.863	0.009	0.116	0.004	21.92	0.23	2.95	0.10
912	0.924	0.009	0.116	0.004	23.47	0.23	2.95	0.10
913	0.986	0.010	0.116	0.004	25.04	0.25	2.95	0.10
914	1.048	0.010	0.116	0.004	26.62	0.25	2.95	0.10
916	1.171	0.010	0.116	0.004	29.74	0.25	2.95	0.10
918	1.355	0.012	0.116	0.004	34.42	0.30	2.95	0.10
920	1.475	0.014	0.118	0.004	37.47	0.36	3.00	0.10
924	1.720	0.014	0.118	0.004	43.69	0.36	3.00	0.10
928	2.090	0.018	0.118	0.004	53.09	0.36	3.00	0.10
932	2.337	0.018	0.118	0.004	59.36	0.36	3.00	0.10

Tolerances for Non-Standard O-Rings

Cross-section tolerances for non-standard O-rings

Cross-section Inch	Tolerance Inch	Cross-section mm	Tolerance mm
$0.031 < d_2 \leq 0.124$	± 0.003	$0.80 < d_2 \leq 3.15$	± 0.08
$0.124 < d_2 \leq 0.177$	± 0.004	$3.15 < d_2 \leq 4.50$	± 0.10
$0.177 < d_2 \leq 0.248$	± 0.005	$4.50 < d_2 \leq 6.30$	± 0.13
$0.248 < d_2 \leq 0.331$	± 0.006	$6.30 < d_2 \leq 8.40$	± 0.15

Inside diameter tolerances for non-standard O-rings

Inside diameter *(d_1)* Inch	Tolerance Inch	Inside diameter *(d_1)* mm	Tolerance mm
0.027 to 0.060	± 0.004	0.68 to 1.53	± 0.10
0.061 to 0.460	± 0.005	1.54 to 11.69	± 0.13
0.461 to 0.530	± 0.006	11.70 to 13.46	± 0.15
0.531 to 0.690	± 0.007	13.47 to 17.53	± 0.18
0.691 to 0.810	± 0.008	17.54 to 20.57	± 0.20
0.811 to 0.940	± 0.009	20.58 to 23.88	± 0.23
0.941 to 1.130	± 0.010	23.89 to 28.70	± 0.25
1.131 to 1.400	± 0.012	28.71 to 35.56	± 0.30
1.401 to 1.700	± 0.014	35.57 to 43.18	± 0.36
1.701 to 2.000	± 0.016	43.19 to 50.80	± 0.41
2.001 to 2.300	± 0.018	50.81 to 58.42	± 0.46
2.301 to 2.620	± 0.020	58.43 to 66.55	± 0.51
2.621 to 2.950	± 0.022	66.56 to 74.93	± 0.56
2.951 to 3.290	± 0.024	74.94 to 83.57	± 0.61
3.291 to 3.630	± 0.026	83.58 to 92.20	± 0.66
3.631 to 4.000	± 0.028	92.21 to 101.60	± 0.71
4.001 to 4.620	± 0.030	101.61 to 117.35	± 0.76
4.621 to 5.560	± 0.035	117.36 to 141.22	± 0.89
5.561 to 6.550	± 0.040	141.23 to 166.37	± 1.02
6.551 to 7.560	± 0.045	166.38 to 192.02	± 1.14
7.561 to 8.610	± 0.050	192.03 to 218.69	± 1.27
8.611 to 9.975	± 0.055	218.70 to 253.37	± 1.40
9.976 to 11.400	± 0.060	253.38 to 289.56	± 1.52
11.401 to 13.700	± 0.070	289.57 to 347.98	± 1.78
13.701 to 16.100	± 0.080	347.99 to 408.94	± 2.03
16.101 to 18.600	± 0.090	408.95 to 472.44	± 2.29
18.601 to 22.500	± 0.100	472.45 to 571.50	± 2.54
22.501 to 28.000	± 0.120	571.51 to 711.20	± 3.05
28.001 to 33.700	± 0.140	711.21 to 855.98	± 3.56
33.701 to 39.600	± 0.160	855.99 to 1005.84	± 4.06
39.601 to 45.800	± 0.180	1005.85 to 1163.32	± 4.57
45.801 to 52.000	± 0.200	1163.33 to 1320.80	± 5.08

Metric Application Gland Dimensions

Face Seal Glands

Metric Sizes				
			Groove Width	
C/S	Gland Depth	±	Liquid $\left(^{+\,0.13}_{-\,0.00}\right)$	Vacuum/Gases (± 0.13)
0.90	0.68	0.02	1.30	1.10
1.00 - 1.02	0.75	0.02	1.45	1.20
1.20	0.90	0.02	1.75	1.45
1.25 - 1.27	0.94	0.02	1.80	1.50
1.42	1.07	0.02	2.05	1.70
1.50	1.13	0.02	2.20	1.80
1.60 - 1.63	1.20	0.03	2.35	1.90
1.78 - 1.80	1.34	0.03	2.60	2.15
1.90	1.43	0.03	2.75	2.30
2.00	1.51	0.04	2.90	2.40
2.20 - 2.21	1.67	0.04	2.90	2.55
2.40	1.82	0.04	3.20	2.80
2.46	1.87	0.04	3.25	2.85
2.50	1.90	0.04	3.30	2.90
2.62	1.99	0.04	3.50	3.05
2.70	2.05	0.04	3.60	3.15
2.95	2.24	0.04	3.90	3.40
3.00	2.27	0.04	3.90	3.45
3.15	2.38	0.05	4.15	3.60
3.50 - 3.53	2.67	0.05	4.60	4.05
3.60	2.72	0.05	4.70	4.10
4.00	3.03	0.06	5.25	4.60
4.50	3.60	0.06	6.10	5.10
4.70	3.76	0.06	6.40	5.35
4.80	3.84	0.06	6.50	5.45
5.00	4.00	0.06	6.80	5.70
5.33- 5.34	4.26	0.08	7.25	6.05
5.50	4.40	0.08	7.45	6.25
5.70	4.56	0.08	7.75	6.50
5.80	4.64	0.08	7.90	6.60
6.00	4.98	0.08	8.00	6.75
6.40	5.31	0.10	8.30	7.20
6.50	5.40	0.10	8.40	7.30
6.90	5.73	0.10	8.95	7.75
6.99	5.80	0.10	9.05	7.85
7.00	5.81	0.10	9.05	7.90
7.50	6.23	0.10	9.70	8.40
8.00	6.64	0.10	10.35	9.00
8.40	6.97	0.15	10.90	9.45

This chart is based on DIN. 3771 information.

Dynamic Reciprocating Applications

Metric Sizes					
C/S	Gland Depth	±	Diametral Clearance	Groove Width $\binom{+0.13}{-0.00}$	Max. Eccentricity
0.90	0.72	0.02	0.10	1.20	0.05
1.00 - 1.02	0.80	0.02	0.10	1.35	0.05
1.20	0.96	0.02	0.10	1.60	0.05
1.25 - 1.27	1.00	0.02	0.10	1.70	0.05
1.42	1.13	0.02	0.10	1.90	0.05
1.50	1.20	0.02	0.10	2.00	0.05
1.60 - 1.63	1.28	0.03	0.10	2.10	0.05
1.78 - 1.80	1.42	0.03	0.10	2.40	0.05
1.90	1.52	0.03	0.10	2.50	0.05
2.00	1.60	0.04	0.10	2.65	0.05
2.20 - 2.21	1.89	0.04	0.10	3.00	0.05
2.40	2.06	0.04	0.10	3.25	0.05
2.46	2.11	0.04	0.10	3.35	0.05
2.50	2.15	0.04	0.10	3.40	0.05
2.62	2.25	0.04	0.10	3.55	0.05
2.70	2.32	0.04	0.10	3.70	0.05
2.95	2.53	0.04	0.10	4.00	0.05
3.00	2.61	0.04	0.15	4.05	0.07
3.15	2.74	0.05	0.15	4.25	0.07
3.50 - 3.53	3.07	0.05	0.15	4.75	0.07
3.60	3.13	0.05	0.15	4.85	0.07
4.00	3.48	0.05	0.15	5.40	0.07
4.50	3.99	0.05	0.15	6.00	0.07
4.70	4.17	0.05	0.15	6.30	0.07
4.80	4.26	0.05	0.15	6.40	0.07
5.00	4.44	0.05	0.15	6.70	0.10
5.33- 5.34	4.73	0.05	0.15	7.15	0.10
5.50	4.88	0.05	0.15	7.40	0.10
5.70	5.06	0.05	0.15	7.60	0.10
5.80	5.15	0.05	0.15	7.75	0.10
6.00	5.19	0.05	0.18	8.15	0.13
6.40	5.54	0.05	0.18	8.70	0.13
6.50	5.63	0.05	0.18	8.85	0.13
6.90	5.97	0.05	0.18	9.40	0.13
6.99	6.05	0.05	0.18	9.50	0.13
7.00	6.06	0.05	0.18	9.55	0.13
7.50	6.49	0.05	0.18	10.20	0.13
8.00	6.92	0.05	0.18	10.90	0.13
8.40	7.27	0.05	0.18	11.45	0.13

This chart is based on DIN. 3771 information.

Static Radial Applications

Metric Sizes					
C/S	Gland Depth	±	Diametral Clearance	Groove Width $\binom{+0.13}{-0.00}$	Max. Eccentricity
0.90	0.65	0.02	0.10	1.20	0.05
1.00 - 1.02	0.72	0.02	0.10	1.35	0.05
1.20	0.87	0.02	0.10	1.60	0.05
1.25 - 1.27	0.91	0.02	0.10	1.65	0.05
1.42	1.03	0.02	0.10	1.90	0.05
1.50	1.09	0.02	0.10	2.00	0.05
1.60 - 1.63	1.16	0.03	0.10	2.10	0.05
1.78 - 1.80	1.29	0.03	0.10	2.35	0.05
1.90	1.38	0.03	0.10	2.50	0.05
2.00	1.45	0.04	0.10	2.65	0.05
2.20 - 2.21	1.74	0.04	0.10	3.00	0.05
2.40	1.90	0.04	0.10	3.25	0.05
2.46	1.94	0.04	0.10	3.35	0.05
2.50	1.98	0.04	0.10	3.40	0.05
2.62	2.07	0.04	0.10	3.55	0.05
2.70	2.13	0.04	0.10	3.65	0.05
2.95	2.33	0.04	0.10	4.00	0.05
3.00	2.40	0.04	0.15	4.05	0.07
3.15	2.52	0.05	0.15	4.25	0.07
3.50 - 3.53	2.82	0.05	0.15	4.75	0.07
3.60	2.88	0.05	0.15	4.85	0.07
4.00	3.20	0.06	0.15	5.40	0.07
4.50	3.64	0.06	0.15	6.00	0.07
4.70	3.80	0.06	0.15	6.30	0.07
4.80	3.88	0.06	0.15	6.40	0.07
5.00	4.04	0.06	0.15	6.70	0.10
5.33- 5.34	4.31	0.08	0.15	7.15	0.10
5.50	4.45	0.08	0.15	7.35	0.10
5.70	4.61	0.08	0.15	7.65	0.10
5.80	4.69	0.08	0.15	7.75	0.10
6.00	4.91	0.08	0.18	8.15	0.13
6.40	5.24	0.10	0.18	8.70	0.13
6.50	5.32	0.10	0.18	8.85	0.13
6.90	5.65	0.10	0.18	9.40	0.13
6.99	5.72	0.10	0.18	9.50	0.13
7.00	5.73	0.10	0.18	9.55	0.13
7.50	6.14	0.10	0.18	10.20	0.13
8.00	6.55	0.10	0.18	10.90	0.13
8.40	6.87	0.15	0.18	11.45	0.13

This chart is based on DIN. 3771 information.

Common O-Ring Failures

Extrusion (and/or Nibbling)

Description: The seal develops ragged edges (generally on the low-pressure side) which appear tattered.

Contributing Factors: Excessive clearances. Excessive pressure. Low-modulus/hardness elastomer. Excessive gland fill. Irregular clearance gaps. Sharp gland edges. Improper sizing.

Suggested Solutions: Decrease clearances. Higher-modulus/hardness elastomer. Proper gland design. Use of polymer backup rings.

Over-Compression

Description: The seal exhibits parallel flat surfaces (corresponding to the contact areas) and may develop circumferential splits within the flattened surfaces.

Contributing Factors: Improper design-failure to account for thermal or chemical volume changes, or excessive compression.

Suggested solutions: Gland design should take into account material responses to chemical and thermal environments.

Spiral Failure

Description: The seal exhibits cuts or marks which spiral around its circumference.

Contributing Factors: Difficult or tight installation (static). Slow reciprocating speed. Low-modulus/hardness elastomer. Irregular O-ring surface finish (including excessive parting line). Excessive gland width. Irregular or rough gland surface finish. Inadequate lubrication.

Suggested Solutions: Correct installation procedures. Higher-modulus elastomers. Internally-lubed elastomers. Proper gland design. Gland surface finish of 8-16 microinch RMS. Possible use of polymer backup rings.

Compression Set

Description: The seal exhibits a flat-sided cross-section, the flat side corresponding to the mating seal surfaces.

Contributing Factors: Excessive compression. Excessive temperature. Incompletely cured elastomer. Elastomer with high compression set. Excessive volume swell in chemical.

Suggested Solutions: Low compression set elastomer. Proper gland design for the specific elastomer. Confirm material compatibility.

Outgassing/Extraction

Description: The failure is often very difficult to detect from examination of the seal. The seal may exhibit a decrease in cross-sectional size.

Contributing Factors: Improper or improperly cured elastomer. High vacuum levels. Low hardness/plasticized elastomer.

Suggested Solutions: Avoid plasticized elastomers. Ensure all seals are properly post-cured to minimize outgassing.

Installation Damage

Description: The seal or parts of the seal may exhibit small cuts, nicks or gashes.

Contributing Factors: Sharp edges on the glands or components. Improper sizing of elastomer. Low-modulus/ hardness elastomer. Elastomer surface contamination.

Suggested Solutions: Remove all sharp edges. Proper gland design. Proper elastomer sizing. Higher-modulus/ hardness elastomer.

Chemical Degradation

Description: The seal may exhibit many signs of degradation including blisters, cracking, voids or discoloration. In some cases, the degradation is observable only by measurement of physical properties.

Contributing Factors: Incompatibility with the chemical and/or thermal environment

Suggested Solutions: Selection of more chemically resistant elastomer.

Thermal Degradation

Description: The seal may exhibit radial cracks located on the highest temperature surfaces. In addition, certain elastomers may exhibit signs of softening-a shiny surface as a result of excessive temperatures.

Contributing Factors: Elastomer thermal properties. Excessive temperature excursions or cycling.

Suggested Solutions: Selection of an elastomer with improved thermal stability. Evaluation of the possibility of cooling sealing surfaces.

Explosive Decompression

Description: The seal exhibits blisters, pits or pocks on its surface. Absorption of gas at high pressure and the subsequent rapid decrease in pressure. The absorbed gas blisters and ruptures the elastomer surface as the pressure is rapidly removed.

Contributing Factors: Rapid pressure changes. Low-modulus hardness elastomer.

Suggested Solutions: Higher-modulus/hardness elastomer. Slower decompression (release of pressure).

Plasma Degradation

Description: The seal often exhibits discolouration, as well as powdered residue on the surface and possible erosion of elastomer in the exposed area.

Contributing Factors: Chemical reactivity of the plasma. Ion bombardment (sputtering). Electron bombardment (heating). Improper gland design. Incompatible seal material.

Suggested Solutions: Plasma-compatible elastomer and compound. Minimize exposed area. Examine gland design.

Contamination

Description: The seal exhibits foreign materials on the surface and/or within the O-ring.

Contributing Factors: Process environment deposition. Reactions or degradation of the elastomer. Non-semiconductor-grade elastomer.

Suggested Solutions: Specify contamination level including manufacturing and packaging of the seals.

Abrasion

Description: The seal or parts of the seal exhibit a flat surface parallel to the direction or motion. Loose particles and scrapes may be found on the seal surface.

Contributing Factors: Rough sealing surfaces. Excessive temperature. Process environment containing abrasive particles. Dynamic motion. Poor elastomer surface finish.

Suggested Solutions: Use recommended gland surface finishes. Consider internally lubed elastomers. Eliminate abrasive components.

Material Guide

AFLAS™ (TFE/P)
-9°C to +232°C
+16°F to +450°F

• Good high temperature capability
• Resistant to strong acids and bases, amines, solvents and hot water
• Aflas™ is found in numerous applications in the oilfield industry
• Poor low temperature performance and low resilience

CARBOXYLATED NITRILE (CBX, XNBR)
-20°C to +135°C
-4°F to +275°F

• Increased strength, improved tensile and tear properties, plus excellent abrasion resistance compared to a standard Nitrile compound
• Lower solvent swell
• Excellent chemical resistance to petroleum oils and fluids
• Commonly used in dynamic applications
• Do not use with polar solvents, glycol brake fluids, aromatic hydrocarbons, chlorinated hydrocarbons and strong acids

CHLOROPRENE (CR) (Neoprene DuPont™)
-40°C to +121°C
-40°F to +250°F

• Has exceptional ozone, weather, and good chemical resistance
• Good mechanical properties are retained over a wide temperature range
• Exhibits good resistance to refrigerants (R12)

ETHYLENE PROPYLENE (EPDM, EPR)
-54°C to +150°C
-65°F to +302°F

• Excellent resistance to ozone, hot water, steam and aging
• Wide temperature range
• Commonly used with brake fluids and refrigerants
• Poor resistance to petroleum fluids and mineral oils

FLUOROCARBON (FKM, FPM)(Viton® DuPont™)
-26°C to +204°C
-15°F to +400°F

• Excellent resistance to higher temperatures, petroleum oils, gasoline
• Wide range of chemical resistance
• Very good ozone, weather and aging resistance
• Poor compatibility with H_2S over 2%, amines, acetone, hot water and steam
• Poor low temperature characteristics although some compounds are suitable to -40°C/-40°F

VITON® EXTREME™ (FKM)(DuPont™)
-20°C to +204°C
-4°F to +400°F

• Viton® Extreme™ is a fluorocarbon compound that exhibits significantly improved performance over regular Viton®
• Two types are available- TBR and ETP
• TBR- Totally Base Resistant compound that provides improved performance over other TFE/Propylene polymers
• ETP- provides the excellent thermal resistance of Viton® along with significantly advanced chemical resistance

FLUOROSILICONE (FVMQ)
-56°C to +204°C
-69°F to +400°F

• Wide temperature range
• Excellent resistance to hydrocarbon fuels, petroleum oils and silicone oils
• Relatively low tear strength, abrasion resistance and tensile strength
• Generally not suited for dynamic applications

HIGHLY SATURATED NITRILE (HSN, HNBR)
-40°C to +160°C
-40°F to +320°F

• A Nitrile based compound with improved chemical resistance
• Wider temperature range than standard Nitrile
• High strength material that resists extrusion, abrasion and wear
• Water and steam resistance to +149°C/+300°F
• H_2S resistance up to 10%
• Commonly used with petroleum oils and CO_2
• Do not use with chlorinated hydrocarbons, polar solvents or strong acids
• Low temperature compounds available down to -54°C/-65°F

HYTREL® (TPC- ET)(DuPont™)
-54°C to +149°C
-65°F to +300°F

• A thermoplastic elastomer able to handle high temperature's and hostile fluids
• Has excellent strength and toughness properties
• Demonstrates high resilience and flexibility which permits easier installation than PTFE materials
• Not suitable with water and phosphate fluids above +80°C/+176°F

NITRILE (NBR)
-40°C to +120°C
-40°F to +248°F

• Presently the most widely used elastomer in the seal industry
• Provides an exceptional balance of good mechanical properties, wear properties and chemical resistance
• Resistant to most mineral oils and greases
• Do not use with glycol based brake fluids and strong acids
• Low temperature compounds to -54°C

PERFLUOROELASTOMER (FFKM)
(Kalrez® DuPont™)
-15°C to +250°C
+5°F to +482°F

• Has the broadest chemical resistance of any elastomeric material
• Combines the sealing integrity of elastomers with chemical resistance approaching that of PTFE
• Not suitable with liquid sodium and potassium, fluorinated solvents and refrigerants
• Compounds available to+325°C/+617°F
• **Kalrez® 4079-** A low compression set 75 durometer compound with excellent chemical resistance, good mechanical properties and outstanding hot air aging properties.
• **Kalrez® Spectrum™ 6380**- An 80 durometer compound specifically developed for chemical processes involving hot, aggressive amines; in addition it has excellent overall chemical resistance.
• **Kalrez® Spectrum™ 7090**- A 90 durometer compound that is specifically targeted for use in applications requiring high hardness/higher modulus properties. This compound has excellent mechanical properties including compression set resistance and explosive decompression resistance.

POLYURETHANE (AU, EU)
-54°C to +105°C
-65°F to +220°F

• A thermoplastic elastomer with higher tensile strength, toughness and wear resistance
• A good combination of hardness and elasticity
• Good low temperature flexibility
• Can be used in high pressure hydraulic systems where parts are subject to wear

PEEK
-70°C to +260°C
-94°F to +500°F

• High strength
• Able to retain it's mechanical properties at high temperatures
• Commonly used for anti-extrusion purposes
• Do not use with Hydrochloric, Nitric, or Sulphuric acids

PTFE (Teflon® DuPont™)
-200°C to +250°C
-328°F to +482°F

• Has virtually universal chemical resistance
• Very low coefficient or friction
• Fillers such as bronze, moly, glass and carbon are commonly added to alter mechanical properties

SILICONE (VMQ)
-65°C to +232°C
-85°F to +450°F

• Excellent resistance to oxidation and ozone degradation
• Wide temperature range
• Most commonly used in static applications due to its poor tensile strength and wear resistance
• Popular for food and medical applications

Material information given is intended to serve as a general guideline only. Actual testing in the application environment is always recommended.

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