Section IV
Static O-Ring Sealing

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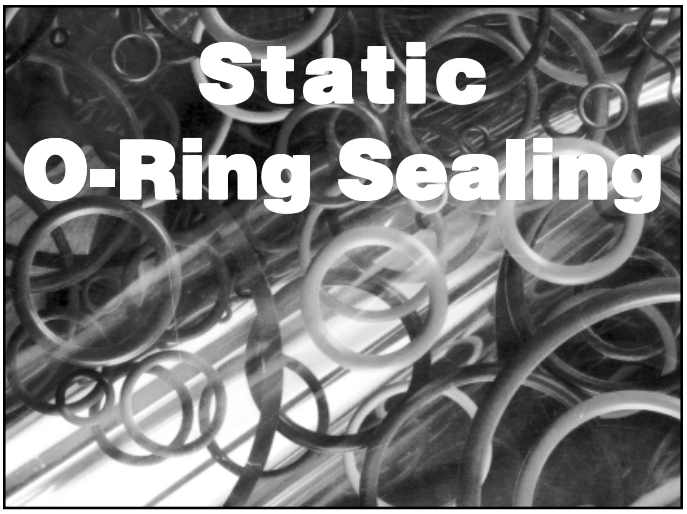

4.0 Introduction

It has been said that O-rings are "the finest static seals ever developed." Perhaps the prime reason for this is because they are almost human proof. No adjustment or human factor comes into play when O-rings are assembled originally or used in repairs if the gland has been designed and machined properly. O-rings do not require high bolting forces (torque) to seal perfectly. O-rings are versatile and save space and weight. They seal over an exceptionally wide range of pressures, temperatures and tolerances. Once seated, they continue to seal even though some feel that they theoretically should not. In addition, they are economical and easy to use. Therefore, we agree that the O-ring is "the finest static seal ever developed."

4.1 Surface Finish for Static O-Ring Seals

The design charts indicate a surface roughness value not to exceed 32 micro-inches (32 rms) on the sealing surfaces for static seals with a maximum of 16 rms recommended for face-type gas seals. These figures are good general guidelines, but they do not tell the whole story.

Equally important is the method used to produce the finish. If the surface is produced by turning the part on a lathe, or by some other method that produces scratches and ridges that follow the direction of the groove, a very rough surface will still seal effectively. Some methods such as end milling or routing, however, will produce scratches that cut across the O-ring. Even these may have a rather high roughness value if the profile across them shows rounded "valleys" that the rubber can readily flow into. Usually, these tool marks have sharp, deep, angular valleys that the O-ring material will not penetrate or fill completely. For this type of surface, the recommended roughness values should not be exceeded.

4.2 Static Male and Female O-Ring Seal Design

Design Chart 4-1 and its accompanying Design Table 4-1 give one set of dimensions for static O-ring seals when the configuration is similar to a piston or rod application with no motion involved. Aerospace Design Standard AS4716, which is shown in Design Chart 5-1 and Design Table 5-1, includes static as well as dynamic usage for the same kind of configuration.

Parker Seal Group normally recommends the 4-1 design for radial squeeze applications. The Aerospace Specification calls for the same squeeze on an O-ring whether it is used dynamically or statically. We feel it is preferable to apply a heavier squeeze in a static application as this increases reliability at low temperature. (The heavier squeeze should not be used in a dynamic seal because it causes too much friction and wear.)

The Aerospace Specification design of Design Table 5-1 in most cases requires less stretch on the inside diameter of the O-ring, and this would tend to reduce aging caused by stress. This can be a definite consideration in the smaller sizes where the Design Table 4-1 installed stretch is well over the recommended 5% maximum. On the other hand, in most sizes, Design Table 4-1 dimensions allow the use of standard stock rod diameters and standard boring tools. This provides real savings in production, while the increase in stretch is such a small percentage over the Design Table 5-1 figures that the difference in useful life would be insignificant.

For applications requiring more than two or three percent stretch in the inside diameter of the O-rings, refer to Figure 3-3 to determine the effective "W" dimension for the stretched ring. The desired percent squeeze should be applied to this cross section diameter. In large male gland assemblies, it may be desirable to use an O-ring one size smaller than indicated in the design chart. The design stretch is so small in these large sizes, that the O-ring tends to sag out of the groove before it is assembled. Using the next smaller size simplifies assembly, but requires a reduced gland depth to attain the proper squeeze.

The need for back-up rings should be investigated for pressures exceeding 103.5 Bar (1500 PSI) (true for all seal types). If there is no extrusion gap, back-up rings are not required. Very high pressures can be sealed without back-up rings if metal-to-metal contact (practically zero clearance) of the gland parts can be maintained. Instances have been reported of sealing pressures of 13,800 Bar (200,100 PSI) with a 70 Shore A durometer O-ring without back-up rings. Vibration or pressure fluctuation sometimes will produce "breathing" which requires back-up rings at average pressures below 103.5 Bar (1500 PSI). When using silicone O-rings, the clearances given in the design charts and tables should be reduced 50%.

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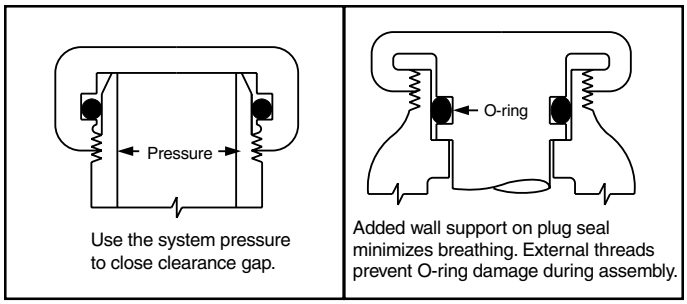

Figure 4-1: End Cap Seal

Figure 4-2: Plug Seal

For examples of static seals, see Figure 4-1 (female gland) and Figure 4-2 (male gland).

4.3 Face Type Seals

Design Chart 4-2 explains how to design an O-ring seal when the groove is cut into a flat surface. Note that when the pressure is outward, the groove outside diameter (OD) is primary, and the groove width then determines the inside diameter. Conversely, when the pressure is inward, the groove inside diameter is primary. This design technique minimizes movement of the O-ring in the groove due to pressure, thereby virtually eliminating wear and pumping leakage. If this principle is used, groove diameters larger or smaller than indicated may be used.

Two possible groove widths are shown in this chart, one for liquids, and the other for vacuum and gases. The extra width for liquids allows for some minimal volume swell. In sealing a liquid that is known to cause no swelling of the O-ring elastomer, the narrower groove would be suitable.

Design Chart 4-2 is preferred over Design Chart 4-1 for static face seals because it calls for a heavier squeeze in all but the smallest (.070) cross-section rings, thus improving reliability at low temperatures.

This is the same reason that the 4-1 design is preferred over the 5-1 for static applications. In this case, however, it is the design rather than the fact of a static seal that permits the extra squeeze. In a male or female gland design, the amount of squeeze required by Design Chart 4-2 is quite difficult to assemble.

The 4-2 design chart is often used for vacuum seals. See O-Ring Applications, Section III, for assistance in finding the best rubber material and calculating the approximate leak rate for a face type static seal used for a vacuum or a gas.

Face type seals are sometimes rectangular. In designing such a seal to receive a standard O-ring, the inside corner radii of the groove should be at least three times the cross-section diameter of the O-ring to avoid over-stressing the ring or causing corner creases that would potentially leak.

4.4 Dovetail and Half-Dovetail Grooves

It is sometimes necessary to mount an O-ring in a face type groove in such a way that it cannot fall out. The dovetail groove described in Design Charts 4-3 and 4-4 will serve this function. This groove is difficult and expensive to machine, and the tolerances are especially critical. It should be used only when it is absolutely necessary. For additional information on dovetail and hald-dovetail grooves, consult the Parker Vacuum Seal Design Guide, ORD5705.

4.5 Boss Seals

The AS568-901 through -932 O-ring sizes (Parker's 3-series) are intended to be used for sealing straight thread tube fittings in a boss. Design Table 4-5 and Design Table 4-6 show the two standard boss designs that are used for this purpose.

Both of these bosses use the same O-ring, but Parker Seal Group recommends the Design Table 4-6 design when there is a choice. It is the newer design, and it has not been fully accepted yet by industry or by the military though there is a military standard for it. The 4-6 dimensions provide for closer tolerance control of the O-ring cavity and distort the O-ring less when assembled. The improved tolerance condition assures much less trouble due to leakage resulting from insufficient squeeze or extrusion when the older cavity is too small. The reduced distortion gives a longer life.

4.6 Failures and Leakage

By far the most common type of failure in static O-ring seals is extrusion. This is relatively easy to prevent if the curves of Figure 3-2 are used when the seal assembly (groove and seal element) is designed.

"Pulsing" or "pumping" leakage occasionally occurs when system pressure alone causes the O-ring to rotate in the groove and the resilience of the seal returns it to its original position. To avoid pumping leakage, design the gland so that the normal position of the seal cross-section will be on the low-pressure side of the gland or use a narrower groove.

Porous castings, eccentric grooves, out-of-tolerance parts, tool marks, and distorted or breathing glands are also frequent contributors to static O-ring seal malfunctioning and failure.

Cast housings, and other parts fabricated from powdered metal are commonly vacuum impregnated with an epoxy to seal minute pores. In this impregnation process, it is standard procedure to wash excess epoxy from the surface with acetone before the parts are given an oven cure. This washing process may be overdone to the point where small fissures on the surface are re-opened causing leakage under the seal in spite of the epoxy impregnant. It is advisable, after the acetone bath, to paint the sealing surface with a

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thin film of epoxy and wipe off the excess before oven curing.

Leakage due to breathing, distortion, and incorrect machining requires a careful analysis of the problem and a consideration of the possible alternatives to find the most economical solution. When one of these causes is suspected, however, the possibility of porous metal should also be considered.

For additional information on O-ring failures, see Section VIII, Failure Analysis, in this handbook.

4.7 O-Ring Glands for Industrial Static Seals

On the following page, Design Chart 4-1 provides the basis for calculating gland dimensions. For standard O-ring sizes, these dimensions have been calculated and are listed in Design Table 4-1. The procedures for the use of Design Table 4-1 are outlined in the guide below.

After selecting gland dimensions, read horizontally to determine proper O-ring size number. Refer to Basic O-ring Elastomers and O-Ring Applications, Sections II and III respectively, for help in the selection of the proper compound. Remember, the effective part number for an O-ring consists of both a size number and a compound number.

Guide For Design Table 4-1			
If Desired Dimension Is Known For	**Select Closest Dimension In Column**	**Read Horizontally In Column**	**To Determine Dimension For**
Bore Dia. male gland	A	B-1 C G	Groove Dia. (male gland) Plug Dia. (male gland) Groove width
Plug Dia. male gland	C	A B-1 G	Bore Dia. (male gland) Groove (male gland) Groove width
Tube OD female gland	B	A-1 D G	Groove Dia. (female gland) Throat Dia. (female gland) Groove width
Throat Dia. female gland	D	A-1 B G	Groove Dia. (female gland) Tube OD (female gland) Groove width

Design Guide 4-1: Guide for Design Table 4-1

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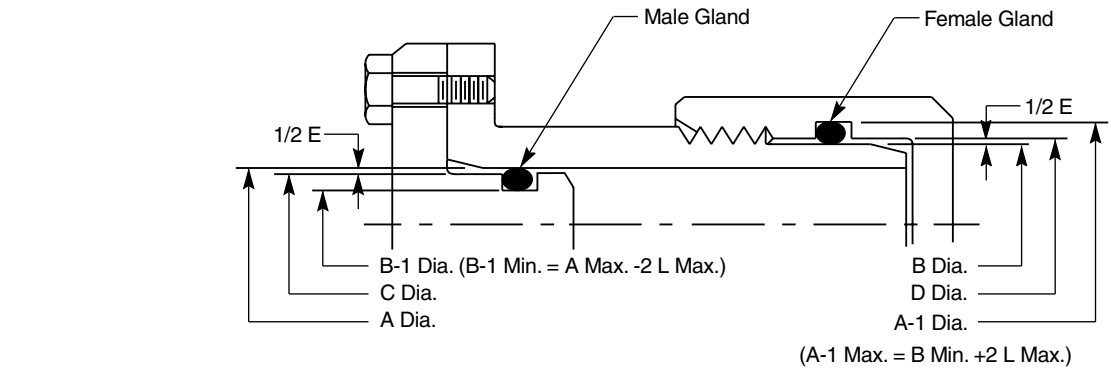
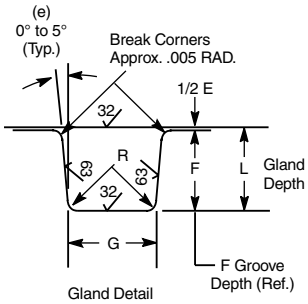
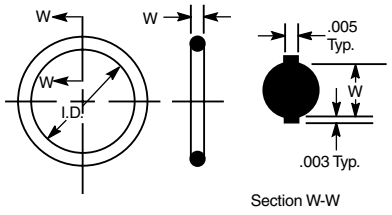
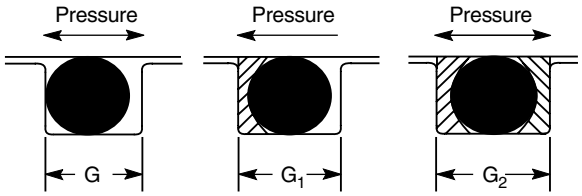
Design Chart 4-1 — Industrial Static Seal Glands









Finishes are RMS values.

Refer to Design Chart 4-1 (below) and Design Table 4-1 for dimensions

Design Chart 4-1 — For Industrial O-Ring Static Seal Glands

O-Ring 2-Size AS568A-	W Cross-Section Nominal	W Cross-Section Actual	L Gland Depth	Squeeze Actual	Squeeze %	E(a) Diametral Clearance	G - Groove Width: No Parbak Ring (G)	G - Groove Width: One Parbak Ring (G_1)	G - Groove Width: Two Parbak Rings (G_2)	R Groove Radius	Max. Eccentricity (b)
004 through 050	1/16	.070 ±.003	.050 to .052	.015 to .023	22 to 32	.002 to .005	.093 to .098	.138 to .143	.205 to .210	.005 to .015	.002
102 through 178	3/32	.103 ±.003	.081 to .083	.017 to .025	17 to 24	.002 to .005	.140 to .145	.171 to .176	.238 to .243	.005 to .015	.002
201 through 284	1/8	.139 ±.004	.111 to .113	.022 to .032	16 to 23	.003 to .006	.187 to .192	.208 to .213	.275 to .280	.010 to .025	.003
309 through 395	3/16	.210 ±.005	.170 to .173	.032 to .045	15 to 21	.003 to .006	.281 to .286	.311 to .316	.410 to .415	.020 to .035	.004
425 through 475	1/4	.275 ±.006	.226 to .229	.040 to .055	15 to 20	.004 to .007	.375 to .380	.408 to .413	.538 to .543	.020 to .035	.005

(a) Clearance (extrusion gap) must be held to a minimum consistent with design requirements for temperature range variation.
(b) Total indicator reading between groove and adjacent bearing surface.
(c) Reduce maximum diametral clearance 50% when using silicone or fluorosilicone O-rings.
(d) For ease of assembly, when Parbaks are used, gland depth may be increased up to 5%.

Design Chart 4-1: For Industrial O-Ring Static Seal Glands

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Design Table 4-1 — Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.†

O-Ring Size	Dimensions				A	A-1		B	B-1		C	D	G†
					Bore Dia. (Male Gland)	Groove Dia. (Female Gland)		Tube OD (Female Gland)	Groove Dia. (Male Gland)		Plug Dia. (Male Gland)	Throat Dia. (Female Gland)	Groove Width
Parker No. 2-	ID	±	W	Mean OD (Ref)	+.002 -.000	-.000	+	+.000 -.002	+.000	-	+.000 .001	+.001 -.000	+.005 -.000
2-001	.029	.004	.040	.109	.105	.101	.002	.040	.044	.002	* .103	.042	.055
002	.042	.004	.050	.142	.138	.132		.053	.059		* .136	.055	.070
003	.056	.004	.060	.176	.172	.162		.067	.077		* .170	.069	.083
004	.070	.005		.210	.206	.181		.081	.106		* .204	.083	
005	.101	.005		.241	.237	.212		.112	.137		* .235	.114	
006	.114	.005		.254	.250	.225		.125	.150		* .248	.127	
007	.145	.005		.285	.281	.256		.156	.181		* .279	.158	
008	.176	.005		.316	.312	.287		.187	.212		* .310	.189	
009	.208	.005		.348	.343	.318		.218	.243		* .341	.220	
010	.239	.005		.379	.375	.350		.250	.275		* .373	.252	
011	.301	.005		.441	.437	.412		.312	.337		* .435	.314	
012	.364	.005		.504	.500	.475		.375	.400		* .498	.377	
013	.426	.005		.566	.562	.537		.437	.462		.560	.439	
014	.489	.005		.629	.625	.600		.500	.525		.623	.502	
015	.551	.007		.691	.687	.662		.562	.587		.685	.564	
016	.614	.009		.754	.750	.725		.625	.650		.748	.627	
017	.676	.009		.816	.812	.787		.687	.712		.810	.689	
018	.739	.009		.879	.875	.850		.750	.775		.873	.752	
019	.801	.009		.941	.937	.912		.812	.837		.935	.814	
020	.864	.009		1.004	1.000	.975		.875	.900		.998	.877	
021	.926	.009		1.066	1.062	1.037		.937	.962		1.060	.939	.093
022	.989	.010	.070	1.129	1.125	1.100	.002	1.000	1.025	.002	1.123	1.002	+.005
023	1.051	.010	±.003	1.191	1.187	1.162		1.062	1.087		1.185	1.064	-.000
024	1.114	.010		1.254	1.250	1.225		1.125	1.150		1.248	1.127	
025	1.176	.011		1.316	1.312	1.287		1.187	1.212		1.310	1.189	
026	1.239	.011		1.379	1.375	1.350		1.250	1.275		1.373	1.252	
027	1.301	.011		1.441	1.437	1.412		1.312	1.337		1.435	1.314	
028	1.364	.013		1.504	1.500	1.475		1.375	1.400		1.498	1.377	
029	1.489	.013		1.629	1.625	1.600		1.500	1.525		1.623	1.502	
030	1.614	.013		1.754	1.750	1.725		1.625	1.650		1.748	1.627	
031	1.739	.015		1.879	1.875	1.850		1.750	1.775		1.873	1.752	
032	1.864	.015		2.004	2.000	1.975		1.875	1.900		1.998	1.877	
033	1.989	.018		2.129	2.125	2.100		2.000	2.025		2.123	2.002	
034	2.114	.018		2.254	2.250	2.225		2.125	2.150		2.248	2.127	
035	2.239	.018		2.379	2.375	2.350		2.250	2.275		2.373	2.252	
036	2.364	.018		2.504	2.500	2.475		2.375	2.400		2.498	2.377	
037	2.489	.018		2.629	2.625	2.600		2.500	2.525		2.623	2.502	
038	2.614	.020		2.754	2.750	2.725		2.625	2.650		2.748	2.627	
039	2.739	.020		2.879	2.875	2.850		2.750	2.775		2.873	2.752	
040	2.864	.020		3.004	3.000	2.975		2.875	2.900		2.998	2.877	
041	2.989	.024		3.129	3.125	3.100		3.000	3.025		3.123	3.002	
042	3.239	.024		3.379	3.375	3.350		3.250	3.275		3.373	3.252	
043	3.489	.024		3.629	3.625	3.600		3.500	3.525		3.623	3.502	

† This groove width does not permit the use of Parbak rings. For pressures above 103.5 Bar (1500 PSI), consult Design Chart 4-1 for groove widths where back-up rings must be used.

* These designs require considerable installation stretch. If assembly breakage is incurred, use a compound having higher elongation or use a two-piece piston.

Design Table 4-1: Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.

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Design Table 4-1 — Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.† *(Continued)*

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					Bore Dia. (Male Gland)	Groove Dia. (Female Gland)		Tube OD (Female Gland)	Groove Dia. (Male Gland)		Plug Dia. (Male Gland)	Throat Dia. (Female Gland)	Groove Width
Parker No. 2-	ID	±	W	Mean OD (Ref)	+.002 -.000	-.000	+	+.000 -.002	+.000	-	+.000 .001	+.001 -.000	+.005 -.000
044	3.739	.027	▲	3.879	3.875	3.850	▲	3.750	3.775	▲	3.873	3.752	▲
045	3.989	.027	.070	4.129	4.125	4.100	.002	4.000	4.025	.002	4.123	4.002	.093
046	4.239	.030	±.003	4.379	4.375	4.350	|	4.250	4.275	|	4.373	4.252	+.005
047	4.489	.030	|	4.629	4.625	4.600	|	4.500	4.525	|	4.623	4.502	-.000
048	4.739	.030	|	4.879	4.875	4.850	|	4.750	4.775	|	4.873	4.752	|
049	4.989	.037	|	5.129	5.125	5.100	|	5.000	5.025	|	5.123	5.002	|
050	5.239	.037	▼	5.379	5.375	5.350	▼	5.250	5.275	▼	5.373	5.252	▼
102	.049	.005	▲	.255	.247	.224	▲	.062	.085	▲	* .245	.064	▲
103	.081	.005	|	.287	.278	.256	|	.094	.116	|	* .276	.095	|
104	.112	.005	|	.318	.310	.287	|	.125	.148	|	* .308	.127	|
105	.143	.005	|	.349	.342	.318	|	.156	.180	|	* .340	.158	|
106	.174	.005	|	.380	.374	.349	|	.187	.212	|	* .372	.189	|
107	.206	.005	|	.412	.405	.381	|	.219	.243	|	* .403	.221	|
108	.237	.005	|	.443	.437	.412	|	.250	.275	|	* .435	.252	|
109	.299	.005	|	.505	.500	.474	|	.312	.338	|	* .498	.314	|
110	.362	.005	|	.568	.562	.537	|	.375	.400	|	* .560	.377	|
111	.424	.005	|	.630	.625	.599	|	.437	.463	|	* .623	.439	|
112	.487	.005	|	.693	.687	.662	|	.500	.525	|	* .685	.502	|
113	.549	.007	|	.755	.750	.724	|	.562	.588	|	* .748	.564	|
114	.612	.009	|	.818	.812	.787	|	.625	.650	|	.810	.627	|
115	.674	.009	|	.880	.875	.849	|	.687	.713	|	.873	.689	|
116	.737	.009	|	.943	.937	.912	|	.750	.775	|	.935	.752	|
117	.799	.010	|	1.005	1.000	.974	|	.812	.838	|	.998	.814	|
118	.862	.010	|	1.068	1.062	1.037	|	.875	.900	|	1.060	.877	.140
119	.924	.010	.103	1.130	1.125	1.099	.002	.937	.963	.002	1.123	.939	+.005
120	.987	.010	±.003	1.193	1.187	1.162	|	1.000	1.025	|	1.185	1.002	-.000
121	1.049	.010	|	1.255	1.250	1.224	|	1.062	1.088	|	1.248	1.064	|
122	1.112	.010	|	1.318	1.312	1.287	|	1.125	1.150	|	1.310	1.127	|
123	1.174	.012	|	1.380	1.375	1.349	|	1.187	1.213	|	1.373	1.189	|
124	1.237	.012	|	1.443	1.437	1.412	|	1.250	1.275	|	1.435	1.252	|
125	1.299	.012	|	1.505	1.500	1.474	|	1.312	1.338	|	1.498	1.314	|
126	1.362	.012	|	1.568	1.562	1.537	|	1.375	1.400	|	1.560	1.377	|
127	1.424	.012	|	1.630	1.625	1.599	|	1.437	1.463	|	1.623	1.439	|
128	1.487	.012	|	1.693	1.687	1.662	|	1.500	1.525	|	1.685	1.502	|
129	1.549	.015	|	1.755	1.750	1.724	|	1.562	1.588	|	1.748	1.564	|
130	1.612	.015	|	1.818	1.812	1.787	|	1.625	1.650	|	1.810	1.627	|
131	1.674	.015	|	1.880	1.875	1.849	|	1.687	1.713	|	1.873	1.689	|
132	1.737	.015	|	1.943	1.937	1.912	|	1.750	1.775	|	1.935	1.752	|
133	1.799	.015	|	2.005	2.000	1.974	|	1.812	1.838	|	1.998	1.814	|
134	1.862	.015	|	2.068	2.062	2.037	|	1.875	1.900	|	2.060	1.877	|
135	1.925	.017	|	2.131	2.125	2.099	|	1.937	1.963	|	2.123	1.939	|
136	1.987	.017	|	2.193	2.187	2.162	|	2.000	2.025	|	2.185	2.002	|
137	2.050	.017	▼	2.256	2.250	2.224	▼	2.062	2.088	▼	2.248	2.064	▼

† This groove width does not permit the use of Parbak rings. For pressures above 103.5 Bar (1500 PSI), consult Design Chart 4-1 for groove widths where back-up rings must be used.

* These designs require considerable installation stretch. If assembly breakage is incurred, use a compound having higher elongation or use a two-piece piston.

Design Table 4-1: Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.

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Design Table 4-1 — Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.† *(Continued)*

O-Ring Size	Dimensions				A	A-1		B	B-1		C	D	G†
					Bore Dia. (Male Gland)	Groove Dia. (Female Gland)		Tube OD (Female Gland)	Groove Dia. (Male Gland)		Plug Dia. (Male Gland)	Throat Dia. (Female Gland)	Groove Width
Parker No. 2-	ID	±	W	Mean OD (Ref)	+.002 -.000	-.000	+	+.000 -.002	+.000	-	+.000 .001	+.001 -.000	+.005 -.000
138	2.112	.017		2.318	2.312	2.287		2.125	2.150		2.310	2.127	
139	2.175	.017		2.381	2.375	2.349		2.187	2.213		2.373	2.189	
140	2.237	.017		2.443	2.437	2.412		2.250	2.275		2.435	2.252	
141	2.300	.020		2.506	2.500	2.474		2.312	2.338		2.498	2.315	
142	2.362	.020		2.568	2.562	2.537		2.375	2.400		2.560	2.377	
143	2.425	.020		2.631	2.625	2.599		2.437	2.463		2.623	2.439	
144	2.487	.020		2.693	2.687	2.662		2.500	2.525		2.685	2.502	
145	2.550	.020		2.756	2.750	2.724		2.562	2.588		2.748	2.564	
146	2.612	.020		2.818	2.812	2.787		2.625	2.650		2.810	2.627	
147	2.675	.022		2.881	2.875	2.849		2.687	2.713		2.873	2.689	
148	2.737	.022		2.943	2.937	2.912		2.750	2.775		2.935	2.752	
149	2.800	.022		3.006	3.000	2.974		2.812	2.838		2.998	2.814	
150	2.862	.022		3.068	3.062	3.037		2.875	2.900		3.060	2.877	
151	2.987	.024		3.193	3.187	3.162		3.000	3.025		3.185	3.002	
152	3.237	.024		3.443	3.437	3.412		3.250	3.275		3.435	3.252	
153	3.487	.024		3.693	3.687	3.662		3.500	3.525		3.685	3.502	
154	3.737	.028	.103	3.943	3.937	3.912	.002	3.750	3.775	.002	3.935	3.752	.140
155	3.987	.028	±.003	4.193	4.187	4.162		4.000	4.025		4.185	4.002	+.005
156	4.237	.030		4.443	4.437	4.412		4.250	4.275		4.435	4.252	-.000
157	4.487	.030		4.693	4.687	4.662		4.500	4.525		4.685	4.502	
158	4.737	.030		4.943	4.937	4.912		4.750	4.775		4.935	4.752	
159	4.987	.035		5.193	5.187	5.162		5.000	5.025		5.185	5.002	
160	5.237	.035		5.443	5.437	5.412		5.250	5.275		5.435	5.252	
161	5.487	.035		5.693	5.687	5.662		5.500	5.525		5.685	5.502	
162	5.737	.035		5.943	5.937	5.912		5.750	5.775		5.935	5.752	
163	5.987	.035		6.193	6.187	6.162		6.000	6.025		6.185	6.002	
164	6.237	.040		6.443	6.437	6.412		6.250	6.275		6.435	6.252	
165	6.487	.040		6.693	6.687	6.662		6.500	6.525		6.685	6.502	
166	6.737	.040		6.943	6.937	6.912		6.750	6.775		6.935	6.752	
167	6.987	.040		7.193	7.187	7.162		7.000	7.025		7.185	7.002	
168	7.237	.045		7.443	7.437	7.412		7.250	7.275		7.435	7.252	
169	7.487	.045		7.693	7.687	7.662		7.500	7.525		7.685	7.502	
170	7.737	.045		7.943	7.937	7.912		7.750	7.775		7.935	7.752	
171	7.987	.045		8.193	8.187	8.162		8.000	8.025		8.185	8.002	
172	8.237	.050		8.443	8.437	8.412		8.250	8.275		8.435	8.252	
173	8.487	.050		8.693	8.687	8.662		8.500	8.525		8.685	8.502	
174	8.737	.050		8.943	8.937	8.912		8.750	8.775		8.935	8.752	
175	8.987	.050		9.193	9.187	9.162		9.000	9.025		9.185	9.002	
176	9.237	.055		9.443	9.437	9.412		9.250	9.275		9.435	9.252	
177	9.487	.055		9.693	9.687	9.662		9.500	9.525		9.685	9.502	
178	9.737	.055		9.943	9.937	9.912		9.750	9.775		9.935	9.752	
201	.171	.005	.139	.449	.437	.409		.187	.215		* .434	.190	.187
202	.234	.005	±.004	.512	.500	.472	.002	.250	.278	.002	* .497	.253	+.005
203	.296	.005		.574	.562	.534		.312	.340		* .559	.315	-.000

† This groove width does not permit the use of Parbak rings. For pressures above 103.5 Bar (1500 PSI), consult Design Chart 4-1 for groove widths where back-up rings must be used.

* These designs require considerable installation stretch. If assembly breakage is incurred, use a compound having higher elongation or use a two-piece piston.

Design Table 4-1: Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.

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Design Table 4-1 — Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.† *(Continued)*

O-Ring Size	Dimensions				A	A-1		B	B-1		C	D	G†
					Bore Dia. (Male Gland)	Groove Dia. (Female Gland)		Tube OD (Female Gland)	Groove Dia. (Male Gland)		Plug Dia. (Male Gland)	Throat Dia. (Female Gland)	Groove Width
Parker No. 2-	ID	±	W	Mean OD (Ref)	+.002 -.000	-.000	+	+.000 -.002	+.000	-	+.000 .001	+.001 -.000	+.005 -.000
204	.359	.005		.637	.625	.597		.375	.403		.622	.378	
205	.421	.005		.699	.687	.659		.437	.465		.684	.440	
206	.484	.005		.762	.750	.722		.500	.528		.747	.503	
207	.546	.007		.824	.812	.784		.562	.590		.809	.565	
208	.609	.009		.887	.875	.847		.625	.653		.872	.628	
209	.671	.009		.949	.937	.909		.687	.715		.934	.690	
210	.734	.010		1.012	1.000	.972		.750	.778		.997	.753	
211	.796	.010		1.074	1.062	1.034		.812	.840		1.059	.815	
212	.859	.010		1.137	1.125	1.097		.875	.903		1.122	.878	
213	.921	.010		1.199	1.187	1.159		.937	.965		1.184	.940	
214	.984	.010		1.262	1.250	1.222		1.000	1.028		1.247	1.003	
215	1.046	.010		1.324	1.312	1.284		1.062	1.090		1.309	1.065	
216	1.109	.012		1.387	1.375	1.347		1.125	1.153		1.372	1.128	
217	1.171	.012		1.449	1.437	1.409		1.187	1.215		1.434	1.190	
218	1.234	.012		1.512	1.500	1.472		1.250	1.278		1.497	1.253	
219	1.296	.012		1.574	1.562	1.534		1.312	1.340		1.559	1.315	
220	1.359	.012	.139	1.637	1.625	1.597	.002	1.375	1.403	.002	1.622	1.378	.187
221	1.421	.012	±.004	1.700	1.687	1.659		1.437	1.465		1.684	1.440	+.005
222	1.484	.015		1.762	1.750	1.722		1.500	1.528		1.747	1.503	-.000
223	1.609	.015		1.887	1.875	1.847		1.625	1.653		1.872	1.628	
224	1.734	.015		2.012	2.000	1.972		1.750	1.778		1.997	1.753	
225	1.859	.015		2.137	2.125	2.097		1.875	1.903		2.122	1.878	
226	1.984	.018		2.262	2.250	2.222		2.000	2.028		2.247	2.003	
227	2.109	.018		2.387	2.375	2.347		2.125	2.153		2.372	2.128	
228	2.234	.020		2.512	2.500	2.472		2.250	2.278		2.497	2.253	
229	2.359	.020		2.637	2.625	2.597		2.375	2.403		2.622	2.378	
230	2.484	.020		2.762	2.750	2.722		2.500	2.528		2.747	2.503	
231	2.609	.020		2.887	2.875	2.847		2.625	2.653		2.872	2.628	
232	2.734	.024		3.012	3.000	2.972		2.750	2.778		2.997	2.753	
233	2.859	.024		3.137	3.125	3.097		2.875	2.903		3.122	2.878	
234	2.984	.024		3.262	3.250	3.222		3.000	3.028		3.247	3.003	
235	3.109	.024		3.387	3.375	3.347		3.125	3.153		3.372	3.128	
236	3.234	.024		3.512	3.500	3.472		3.250	3.278		3.497	3.253	
237	3.359	.024		3.637	3.625	3.597		3.375	3.403		3.622	3.378	
238	3.484	.024		3.762	3.750	3.722		3.500	3.528		3.747	3.503	
239	3.609	.028		3.887	3.875	3.847		3.625	3.653		3.872	3.628	
240	3.734	.028		4.012	4.000	3.972		3.750	3.778		3.997	3.753	
241	3.859	.028		4.137	4.125	4.097		3.875	3.903		4.122	3.878	
242	3.984	.028		4.262	4.250	4.222		4.000	4.028		4.247	4.003	
243	4.109	.028		4.387	4.375	4.347		4.125	4.153		4.372	4.128	
244	4.234	.030		4.512	4.500	4.472		4.250	4.278		4.497	4.253	
245	4.359	.030		4.637	4.625	4.597		4.375	4.403		4.622	4.378	
246	4.484	.030		4.762	4.750	4.722		4.500	4.528		4.747	4.503	
247	4.609	.030		4.887	4.875	4.847		4.625	4.653		4.872	4.628	

† This groove width does not permit the use of Parbak rings. For pressures above 103.5 Bar (1500 PSI), consult Design Chart 4-1 for groove widths where back-up rings must be used.

* These designs require considerable installation stretch. If assembly breakage is incurred, use a compound having higher elongation or use a two-piece piston.

Design Table 4-1: Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.

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Design Table 4-1 — Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.† *(Continued)*

O-Ring Size	Dimensions				A	A-1		B	B-1		C	D	G†
					Bore Dia. (Male Gland)	Groove Dia. (Female Gland)		Tube OD (Female Gland)	Groove Dia. (Male Gland)		Plug Dia. (Male Gland)	Throat Dia. (Female Gland)	Groove Width
Parker No. 2-	ID	±	W	Mean OD (Ref)	+.002 -.000	-.000	+	+.000 -.002	+.000	-	+.000 .001	+.001 -.000	+.005 -.000
248	4.734	.030		5.012	5.000	4.972		4.750	4.778		4.997	4.753	
249	4.859	.035		5.137	5.125	5.097		4.875	4.903		5.122	4.878	
250	4.984	.035		5.262	5.250	5.222		5.000	5.028		5.247	5.003	
251	5.109	.035		5.387	5.375	5.347		5.125	5.153		5.372	5.128	
252	5.234	.035		5.512	5.500	5.472		5.250	5.278		5.497	5.253	
253	5.359	.035		5.637	5.625	5.597		5.375	5.403		5.622	5.378	
254	5.484	.035		5.762	5.750	5.722		5.500	5.528		5.747	5.503	
255	5.609	.035		5.887	5.875	5.847		5.625	5.653		5.872	5.628	
256	5.734	.035		6.012	6.000	5.972		5.750	5.778		5.997	5.753	
257	5.859	.035		6.137	6.125	6.097		5.875	5.903		6.122	5.878	
258	5.984	.035		6.262	6.250	6.222		6.000	6.028		6.247	6.003	
259	6.234	.040		6.512	6.500	6.472		6.250	6.278		6.497	6.253	
260	6.484	.040		6.762	6.750	6.722		6.500	6.528		6.747	6.503	
261	6.734	.040		7.012	7.000	6.972		6.750	6.778		6.997	6.753	
262	6.984	.040		7.262	7.250	7.222		7.000	7.028		7.247	7.003	
263	7.234	.045		7.512	7.500	7.472		7.250	7.278		7.497	7.253	
264	7.484	.045		7.762	7.750	7.722		7.500	7.528		7.747	7.503	
265	7.734	.045	.139	8.012	8.000	7.972	.002	7.750	7.778	.002	7.997	7.753	.187
266	7.984	.045	±.004	8.262	8.250	8.222		8.000	8.028		8.247	8.003	+.005
267	8.234	.050		8.512	8.500	8.472		8.250	8.278		8.497	8.253	-.000
268	8.484	.050		8.762	8.750	8.722		8.500	8.528		8.747	8.503	
269	8.734	.050		9.012	9.000	8.972		8.750	8.778		8.997	8.753	
270	8.984	.050		9.262	9.250	9.222		9.000	9.028		9.247	9.003	
271	9.234	.055		9.512	9.500	9.472		9.250	9.278		9.497	9.253	
272	9.484	.055		9.762	9.750	9.722		9.500	9.528		9.747	9.503	
273	9.734	.055		10.012	10.000	9.972		9.750	9.778		9.997	9.753	
274	9.984	.055		10.262	10.250	10.222		10.000	10.028		10.247	10.003	
275	10.484	.055		10.762	10.750	10.722		10.500	10.528		10.747	10.503	
276	10.984	.065		11.262	11.250	11.222		11.000	11.028		11.247	11.003	
277	11.484	.065		11.762	11.750	11.722		11.500	11.528		11.747	11.503	
278	11.984	.065		12.262	12.250	12.222		12.000	12.028		12.247	12.003	
279	12.984	.065		13.262	13.250	13.222		13.000	13.028		13.247	13.003	
280	13.984	.065		14.262	14.250	14.222		14.000	14.028		14.247	14.003	
281	14.984	.065		15.262	15.250	15.222		15.000	15.028		15.247	15.003	
282	15.955	.075		16.233	16.250	16.222		16.000	16.028		16.247	16.003	
283	16.955	.080		17.233	17.250	17.222		17.000	17.028		17.247	17.003	
284	17.955	.085		18.233	18.250	18.222		18.000	18.028		18.247	18.003	
309	.412	.005		.832	.812	.777		.437	.472		* .809	.440	
310	.475	.005	.210	.895	.875	.840		.500	.535		* .872	.503	.281
311	.537	.007	±.005	.957	.937	.902	.004	.562	.597	.004	* .934	.565	+.005
312	.600	.009		1.020	1.000	.965		.625	.660		.997	.628	-.000
313	.662	.009		1.082	1.062	1.027		.687	.722		1.059	.690	
314	.725	.010		1.145	1.125	1.090		.750	.785		1.122	.753	

† This groove width does not permit the use of Parbak rings. For pressures above 103.5 Bar (1500 PSI), consult Design Chart 4-1 for groove widths where back-up rings must be used.

* These designs require considerable installation stretch. If assembly breakage is incurred, use a compound having higher elongation or use a two-piece piston.

Design Table 4-1: Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.

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Design Table 4-1 — Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.† *(Continued)*

O-Ring Size	Dimensions				A	A-1		B	B-1		C	D	G†
					Bore Dia. (Male Gland)	Groove Dia. (Female Gland)		Tube OD (Female Gland)	Groove Dia. (Male Gland)		Plug Dia. (Male Gland)	Throat Dia. (Female Gland)	Groove Width
Parker No. 2-	ID	±	W	Mean OD (Ref)	+.002 -.000	-.000	+	+.000 -.002	+.000	-	+.000 .001	+.001 -.000	+.005 -.000
315	.787	.010		1.207	1.187	1.152		.812	.847		1.184	.815	
316	.850	.010		1.270	1.250	1.215		.875	.910		1.247	.878	
317	.912	.010		1.332	1.312	1.277		.937	.972		1.309	.940	
318	.975	.010		1.395	1.375	1.340		1.000	1.035		1.372	1.003	
319	1.037	.010		1.457	1.437	1.402		1.062	1.097		1.434	1.065	
320	1.100	.012		1.520	1.500	1.465		1.125	1.160		1.497	1.128	
321	1.162	.012		1.582	1.562	1.527		1.187	1.222		1.559	1.190	
322	1.225	.012		1.645	1.625	1.590		1.250	1.285		1.622	1.253	
323	1.287	.012		1.707	1.687	1.652		1.312	1.347		1.684	1.315	
324	1.350	.012		1.770	1.750	1.715		1.375	1.410		1.747	1.378	
325	1.475	.015		1.895	1.875	1.840		1.500	1.535		1.872	1.503	
326	1.600	.015		2.020	2.000	1.965		1.625	1.660		1.997	1.628	
327	1.725	.015		2.145	2.125	2.090		1.750	1.785		2.122	1.753	
328	1.850	.015		2.270	2.250	2.215		1.875	1.910		2.247	1.878	
329	1.975	.018		2.395	2.375	2.340		2.000	2.035		2.372	2.003	
330	2.100	.018		2.520	2.500	2.465		2.125	2.160		2.497	2.128	
331	2.225	.018		2.645	2.625	2.590		2.250	2.285		2.622	2.253	
332	2.350	.018		2.770	2.750	2.715		2.375	2.410		2.747	2.378	
333	2.475	.020		2.895	2.875	2.840		2.500	2.535		2.872	2.503	
334	2.600	.020		3.020	3.000	2.965		2.625	2.660		2.997	2.628	
335	2.725	.020		3.145	3.125	3.090		2.750	2.785		3.122	2.753	.281
336	2.850	.020	.210	3.270	3.250	3.215	.004	2.875	2.910	.004	3.247	2.878	+.005
337	2.975	.024	±.005	3.395	3.375	3.340		3.000	3.035		3.372	3.003	-.000
338	3.100	.024		3.520	3.500	3.465		3.125	3.160		3.497	3.128	
339	3.225	.024		3.645	3.625	3.590		3.250	3.285		3.622	3.253	
340	3.350	.024		3.770	3.750	3.715		3.375	3.410		3.747	3.378	
341	3.475	.024		3.895	3.875	3.840		3.500	3.535		3.872	3.502	
342	3.600	.028		4.020	4.000	3.965		3.625	3.660		3.997	3.628	
343	3.725	.028		4.145	4.125	4.090		3.750	3.785		4.122	3.753	
344	3.850	.028		4.270	4.250	4.215		3.875	3.910		4.247	3.878	
345	3.975	.028		4.395	4.375	4.340		4.000	4.035		4.372	4.003	
346	4.100	.028		4.520	4.500	4.465		4.125	4.160		4.497	4.128	
347	4.225	.030		4.645	4.625	4.590		4.250	4.285		4.622	4.253	
348	4.350	.030		4.770	4.750	4.717		4.375	4.410		4.747	4.378	
349	4.475	.030		4.895	4.875	4.840		4.500	4.535		4.872	4.503	
350	4.600	.030		5.020	5.000	4.965		4.625	4.660		4.997	4.628	
351	4.725	.030		5.145	5.125	5.090		4.750	4.785		5.122	4.753	
352	4.850	.030		5.270	5.250	5.215		4.875	4.910		5.247	4.878	
353	4.975	.037		5.395	5.375	5.340		5.000	5.035		5.372	5.003	
354	5.100	.037		5.520	5.500	5.465		5.125	5.160		5.497	5.128	
355	5.225	.037		5.645	5.625	5.590		5.250	5.285		5.622	5.253	
356	5.350	.037		5.770	5.750	5.715		5.375	5.410		5.747	5.378	
357	5.475	.037		5.895	5.875	5.840		5.500	5.535		5.872	5.503	
358	5.600	.037		6.020	6.000	5.965		5.625	5.660		5.997	5.628	

† This groove width does not permit the use of Parbak rings. For pressures above 103.5 Bar (1500 PSI), consult Design Chart 4-1 for groove widths where back-up rings must be used.

* These designs require considerable installation stretch. If assembly breakage is incurred, use a compound having higher elongation or use a two-piece piston.

Design Table 4-1: Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.

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Design Table 4-1 — Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.† *(Continued)*

O-Ring Size	Dimensions				A	A-1		B	B-1		C	D	G†
					Bore Dia. (Male Gland)	Groove Dia. (Female Gland)		Tube OD (Female Gland)	Groove Dia. (Male Gland)		Plug Dia. (Male Gland)	Throat Dia. (Female Gland)	Groove Width
Parker No. 2-	ID	±	W	Mean OD (Ref)	+.002 -.000	-.000	+	+.000 -.002	+.000	-	+.000 .001	+.001 -.000	+.005 -.000
359	5.725	.037		6.145	6.125	6.090		5.750	5.785		6.122	5.753	
360	5.850	.037		6.270	6.250	6.215		5.875	5.910		6.247	5.878	
361	5.975	.037		6.395	6.375	6.340		6.000	6.035		6.372	6.003	
362	6.225	.040		6.645	6.625	6.590		6.250	6.285		6.622	6.253	
363	6.475	.040		6.895	6.875	6.840		6.500	6.535		6.872	6.503	
364	6.725	.040		7.145	7.125	7.090		6.750	6.785		7.122	6.753	
365	6.975	.040		7.395	7.375	7.340		7.000	7.035		7.372	7.003	
366	7.225	.045		7.645	7.625	7.590		7.250	7.285		7.622	7.253	
367	7.475	.045		7.895	7.875	7.840		7.500	7.535		7.872	7.503	
368	7.725	.045		8.145	8.125	8.090		7.750	7.785		8.122	7.753	
369	7.975	.045		8.395	8.375	8.340		8.000	8.035		8.372	8.003	
370	8.225	.050		8.645	8.625	8.590		8.250	8.285		8.622	8.253	
371	8.475	.050		8.895	8.875	8.840		8.500	8.535		8.872	8.503	
372	8.725	.050		9.145	9.125	9.090		8.750	8.785		9.122	8.753	
373	8.975	.050		9.395	9.375	9.340		9.000	9.035		9.372	9.003	
374	9.225	.055		9.645	9.625	9.590		9.250	9.285		9.622	9.253	
375	9.475	.055		9.895	9.875	9.840		9.500	9.535		9.872	9.503	
376	9.725	.055		10.145	10.125	10.090		9.750	9.785		10.122	9.753	.281
377	9.975	.055	.210	10.395	10.375	10.340	.004	10.000	10.035	.004	10.372	10.003	+.005
378	10.475	.060	±.005	10.895	10.875	10.840		10.500	10.535		10.872	10.503	-.000
379	10.975	.060		11.395	11.375	11.340		11.000	11.035		11.372	11.003	
380	11.475	.065		11.895	11.875	11.840		11.500	11.535		11.872	11.503	
381	11.975	.065		12.395	12.375	12.340		12.000	12.035		12.372	12.003	
382	12.975	.065		13.395	13.375	13.340		13.000	13.035		13.372	13.003	
383	13.975	.070		14.395	14.375	14.340		14.000	14.035		14.372	14.003	
384	14.975	.070		15.395	15.375	15.340		15.000	15.035		15.372	15.003	
385	15.955	.075		16.375	16.375	16.340		16.000	16.035		16.372	16.003	
386	16.955	.080		17.375	17.375	17.340		17.000	17.035		17.372	17.003	
387	17.955	.085		18.375	18.375	18.340		18.000	18.035		18.372	18.003	
388	18.955	.090		19.373	19.375	19.340		19.000	19.035		19.372	19.003	
389	19.955	.095		20.373	20.375	20.340		20.000	20.035		20.372	20.003	
390	20.955	.095		21.373	21.375	21.340		21.000	21.035		21.372	21.003	
391	21.955	.100		22.373	22.375	22.340		22.000	22.035		22.372	22.003	
392	22.940	.105		23.360	23.375	23.340		23.000	23.035		23.372	23.003	
393	23.940	.110		24.360	24.375	24.340		24.000	24.035		24.372	24.003	
394	24.940	.115		25.360	25.375	25.340		25.000	25.035		25.372	25.003	
395	25.940	.120		26.360	26.375	26.340		26.000	26.035		26.372	26.003	
425	4.475	.033		5.025	5.000	4.952		4.500	4.548		4.996	4.504	
426	4.600	.033		5.150	5.125	5.077		4.625	4.673		5.121	4.629	.375
427	4.725	.033	.275	5.275	5.250	5.202	.004	4.750	4.798	.004	5.246	4.754	+.005
428	4.850	.033	±.006	5.400	5.375	5.327		4.875	4.923		5.371	4.879	-.000
429	4.975	.037		5.525	5.500	5.452		5.000	5.048		5.496	5.004	
430	5.100	.037		5.650	5.625	5.577		5.125	5.173		5.621	5.129	
431	5.225	.037		5.775	5.750	5.702		5.250	5.298		5.746	5.254	

† This groove width does not permit the use of Parbak rings. For pressures above 103.5 Bar (1500 PSI), consult Design Chart 4-1 for groove widths where back-up rings must be used.

* These designs require considerable installation stretch. If assembly breakage is incurred, use a compound having higher elongation or use a two-piece piston.

Design Table 4-1: Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.

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Design Table 4-1 — Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.† *(Continued)*

O-Ring Size	Dimensions				A	A-1		B	B-1		C	D	G†
					Bore Dia. (Male Gland)	Groove Dia. (Female Gland)		Tube OD (Female Gland)	Groove Dia. (Male Gland)		Plug Dia. (Male Gland)	Throat Dia. (Female Gland)	Groove Width
Parker No. 2-	ID	±	W	Mean OD (Ref)	+.002 -.000	-.000	+	+.000 -.002	+.000	-	+.000 .001	+.001 -.000	+.005 -.000
432	5.350	.037		5.900	5.875	5.827		5.375	5.423		5.871	5.379	
433	5.475	.037		6.025	6.000	5.952		5.500	5.548		5.996	5.504	
434	5.600	.037		6.150	6.125	6.077		5.625	5.673		6.121	5.629	
435	5.725	.037		6.275	6.250	6.202		5.750	5.798		6.246	5.754	
436	5.850	.037		6.400	6.375	6.327		5.875	5.923		6.371	5.879	
437	5.975	.037		6.525	6.500	6.452		6.000	6.048		6.496	6.004	
438	6.225	.040		6.775	6.750	6.702		6.250	6.298		6.746	6.254	
439	6.475	.040		7.025	7.000	6.952		6.500	6.548		6.996	6.504	
440	6.725	.040		7.275	7.250	7.202		6.750	6.798		7.246	6.754	
441	6.975	.040		7.525	7.500	7.452		7.000	7.048		7.496	7.004	
442	7.225	.045		7.775	7.750	7.702		7.250	7.298		7.746	7.254	
443	7.475	.045		8.025	8.000	7.952		7.500	7.548		7.996	7.504	
444	7.725	.045		8.275	8.250	8.202		7.750	7.798		8.246	7.754	
445	7.975	.045		8.525	8.500	8.452		8.000	8.048		8.496	8.004	
446	8.475	.055		9.025	9.000	8.952		8.500	8.548		8.996	8.504	
447	8.975	.055		9.525	9.500	9.452		9.000	9.048		9.496	9.004	
448	9.475	.055		10.025	10.000	9.952		9.500	9.548		9.996	9.504	
449	9.975	.055		10.525	10.500	10.452		10.000	10.048		10.496	10.000	
450	10.475	.060		11.025	11.000	10.952		10.500	10.548		10.996	10.504	
451	10.975	.060		11.525	11.500	11.452		11.000	11.048		11.496	11.004	
452	11.475	.060		12.025	12.000	11.952		11.500	11.548		11.996	11.504	
453	11.975	.060		12.525	12.500	12.452		12.000	12.048		12.496	12.004	.375
454	12.475	.060	.275	13.025	13.000	12.952	.004	12.500	12.548	.004	12.996	12.504	+.005
455	12.975	.060	±.006	13.525	13.500	13.452		13.000	13.048		13.496	13.004	-.000
456	13.475	.070		14.025	14.000	13.952		13.500	13.548		13.996	13.504	
457	13.975	.070		14.525	14.500	14.452		14.000	14.048		14.496	14.004	
458	14.475	.070		15.025	15.000	14.952		14.500	14.548		14.996	14.504	
459	14.975	.070		15.525	15.500	15.452		15.000	15.048		15.496	15.004	
460	15.475	.070		16.025	16.000	15.952		15.500	15.548		15.996	15.504	
461	15.955	.075		16.505	16.500	16.452		16.000	16.048		16.496	16.004	
462	16.455	.075		17.005	17.000	16.952		16.500	16.548		16.996	16.504	
463	16.955	.080		17.505	17.500	17.452		17.000	17.048		17.496	17.004	
464	17.455	.085		18.005	18.000	17.952		17.500	17.548		17.996	17.504	
465	17.955	.085		18.505	18.500	18.452		18.000	18.048		18.496	18.004	
466	18.455	.085		19.005	19.000	18.952		18.500	18.548		18.996	18.504	
467	18.955	.090		19.505	19.500	19.452		19.000	19.048		19.496	19.004	
468	19.455	.090		20.005	20.000	19.952		19.500	19.548		19.996	19.504	
469	19.955	.095		20.505	20.500	20.452		20.000	20.048		20.496	20.004	
470	20.955	.095		21.505	21.500	21.452		21.000	21.048		21.496	21.004	
471	21.955	.100		22.505	22.500	22.452		22.000	22.048		22.496	22.004	
472	22.940	.105		23.490	23.500	23.452		23.000	23.048		23.496	23.004	
473	23.940	.110		24.490	24.500	24.452		24.000	24.048		24.496	24.004	
474	24.940	.115		25.490	25.500	25.452		25.000	25.048		25.496	25.004	
475	25.940	.120		26.490	26.500	26.452		26.000	26.048		26.496	26.004	

† This groove width does not permit the use of Parbak rings. For pressures above 103.5 Bar (1500 PSI), consult Design Chart 4-1 for groove widths where back-up rings must be used.

* These designs require considerable installation stretch. If assembly breakage is incurred, use a compound having higher elongation or use a two-piece piston.

Design Table 4-1: Gland Dimensions for Industrial O-Ring Static Seals, 103.5 Bar (1500 PSI) Max.

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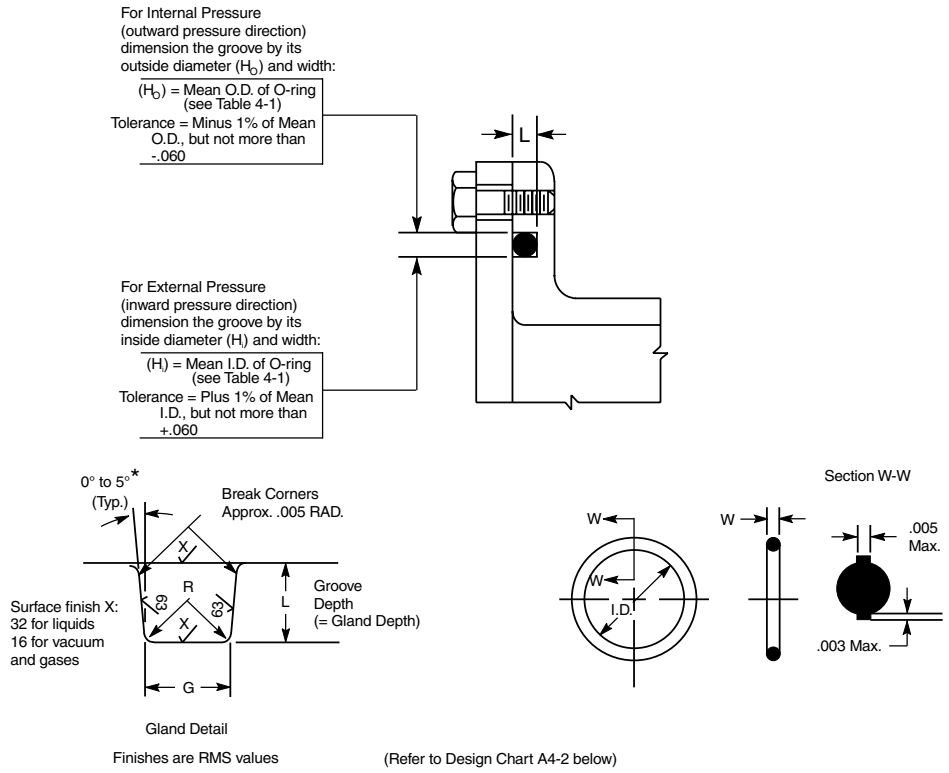
Design Chart 4-2 — Face Seal Glands



Design Chart 4-2 — For O-Ring Face Seal Glands

These dimensions are intended primarily for face type O-ring seals and low temperature applications.

O-Ring Size Parker No. 2	W Cross Section		L	Squeeze		G Groove Width		R
	Nominal	Actual	Gland Depth	Actual	%	Liquids	Vacuum and Gases	Groove Radius
004 through 050	1/16	.070 ±.003	.050 to .054	.013 to .023	19 to 32	.101 to .107	.084 to .089	.005 to .015
102 through 178	3/32	.103 ±.003	.074 to .080	.020 to .032	20 to 30	.136 to .142	.120 to .125	.005 to .015
201 through 284	1/8	.139 ±.004	.101 to .107	.028 to .042	20 to 30	.177 to .187	.158 to .164	.010 to .025
309 through 395	3/16	.210 ±.005	.152 to .162	.043 to .063	21 to 30	.270 to .290	.239 to .244	.020 to .035
425 through 475	1/4	.275 ±.006	.201 to .211	.058 to .080	21 to 29	.342 to .362	.309 to .314	.020 to .035
Special	3/8	.375 ±.007	.276 to .286	.082 to .108	22 to 28	.475 to .485	.419 to .424	.030 to .045
Special	1/2	.500 ±.008	.370 to .380	.112 to .138	22 to 27	.638 to .645	.560 to .565	.030 to .045

Design Chart 4-2: Design Chart for O-Ring Face Seal Glands

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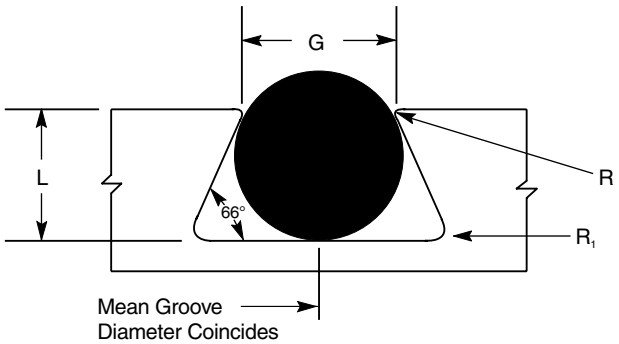
Design Chart 4-3 — Dovetail Grooves

It is often necessary to provide some mechanical means for holding an O-ring in a face seal groove during assembly and maintenance of equipment. An undercut or dovetail groove has proven beneficial in many applications to keep the O-ring in place. This is an expensive groove to machine, however, and thus should be used only when absolutely necessary.

It should be noted that although this method has been used successfully, it is not generally recommended. The inherent characteristics of the groove design limit the amount of void area. Normally acceptable tolerance extremes, wide service temperature ranges, and fluid media that cause high swell of the elastomer are conditions that cannot be tolerated in this type of groove design.



Design Chart 4-3 — For O-Ring Dovetail Grooves

Radius "R" is CRITICAL. Insufficient radius will potentially cause damage to the O-ring during installation, while excessive radius may contribute to extrusion.

O-Ring Size AS568A-	W Cross Section		L Gland Depth	Squeeze %	G Gland Width (To sharp corner)	R	R_1
	Nominal	Actual					
004 through 050	1/16	.070 ±.003	.050 to .052	27	.055 to .059	.005	1/64
102 through 178	3/32	.103 ±.003	.081 to .083	21	.083 to .087	.010	1/64
201 through 284	1/8	.139 ±.004	.111 to .113	20	.113 to .117	.010	1/32
309 through 395	3/16	.210 ±.005	.171 to .173	18	.171 to .175	.015	1/32
425 through 475	1/4	.275 ±.006	.231 to .234	16	.231 to .235	.015	1/16
Special	3/8	.375 ±.007	.315 to .319	16	.315 to .319	.020	3/32

NOTE: These design recommendations assume metal-to-metal contact. In special applications, for example in the semiconductor industry, deviation from these recommendations may be necessary. When designing with Parofluor™ elastomers, one should take into consideration that perfluorinated elastomers may require more squeeze than an FKM material to obtain optimum sealing performance. To increase squeeze, modifications of the design recommendations shown above are necessary.

Design Chart 4-3: Dovetail Grooves

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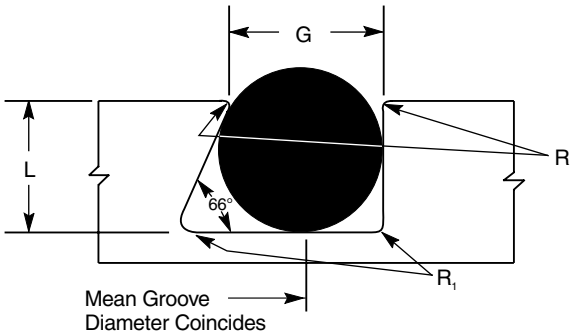
Design Chart 4-4 — Half Dovetail Grooves



Design Chart 4-3 — For O-Ring Dovetail Grooves

Radius "R" is CRITICAL. Insufficient radius will potentially cause damage to the O-ring during installation, while excessive radius may contribute to extrusion.

O-Ring Size AS568A-	W Cross Section		L Gland Depth	Squeeze %	G Gland Width (To sharp corner)	R	R_1
	Nominal	Actual					
004 through 050	1/16	.070 ±.003	.052 to .054	25	.064 to .066	.005	1/64
102 through 178	3/32	.103 ±.003	.083 to .085	19	.095 to .097	.010	1/64
201 through 284	1/8	.139 ±.004	.113 to .115	18	.124 to .128	.010	1/32
309 through 395	3/16	.210 ±.005	.173 to .176	17	.171 to .175	.015	1/32
425 through 475	1/4	.275 ±.006	.234 to .238	15	.255 to .257	.015	1/16
Special	3/8	.375 ±.007	.319 to .323	14	.350 to .358	.020	3/32

NOTE: These design recommendations assume metal-to-metal contact. In special applications, for example in the semiconductor industry, deviation from these recommendations may be necessary. When designing with Parofluor™ elastomers, one should take into consideration that perfluorinated elastomers may require more squeeze than an FKM material to obtain optimum sealing performance. To increase squeeze, modifications of the design recommendations shown above are necessary.

Design Chart 4-4: Half Dovetail Grooves

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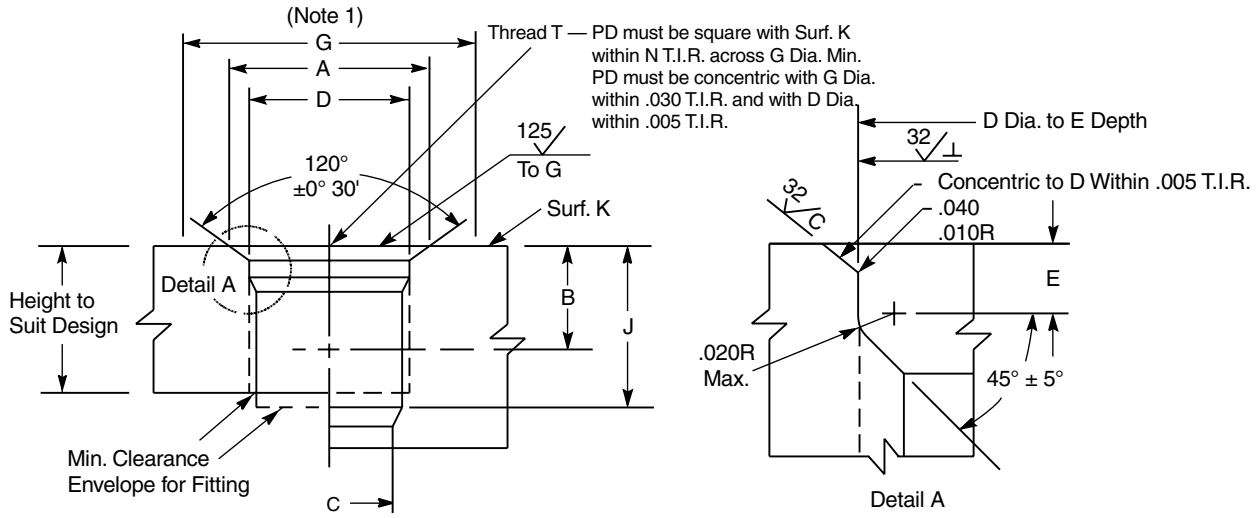
Design Table 4-5 — Tube Fitting Boss Seals



Note 1: Min. flat boss face. Clearance provisions for fitting, wrench, fitting installation and tool fillet radii must be added as required.
Note 2: Tube fittings per MS33656

Design Table 4-5 — Boss Dimensions for Military Straight Thread Tube Fitting O-ring Gaskets per MS33649 (Supersedes AND10049 and AND10050)

Parker O-ring Size No.*	Actual O-Ring Dimensions W	Actual O-Ring Dimensions ID	Equiv. Tube Dash No.	Tube OD Min.	Thread T Per Mil-S-8879	A Dia. +.015 -.000	B Full Thd. Depth	C Dia.	D Dia. +.005 -.000	E +.015 -.000	G Dia. Min.	J Min.	N
3-902	.064 ± .003	.239 ± .005	2	.125	.3125-24UNJF-3B	0.438	0.482	0.062	0.328	0.063	0.602	0.577	0.003
3-903	.064 ± .003	.301 ± .005	3	.188	.3750-24UNJF-3B	0.500	0.538	0.125	0.390		0.665	0.583	
3-904	.072 ± .003	.351 ± .005	4	.250	.4375-20UNJF-3B	0.562	0.568	0.172	0.454	0.075	0.728	0.656	
3-905	.072 ± .003	.414 ± .005	5	.312	.5000-20UNJF-3B	0.625		0.234	0.517		0.790		
3-906	.078 ± .003	.468 ± .005	6	.375	.5625-18UNJF-3B	0.688	0.598	0.297	0.580	0.083	0.852	0.709	0.004
3-907	.082 ± .003	.530 ± .007	7	.438	.6250-18UNJF-3B	0.750	0.614	0.360	0.643	0.094	0.915	0.725	
3-908	.087 ± .003	.644 ± .009	8	.500	.7500-16UNJF-3B	0.875	0.714	0.391	0.769		1.040	0.834	
3-909	.097 ± .003	.706 ± .009	9	.562	.8125-16UNJF-3B	0.938	0.730	0.438	0.832	0.107	1.102	0.850	
3-910	.097 ± .003	.755 ± .009	10	.625	.8750-14UNJF-3B	1.000	0.802	0.484	0.896		1.165	0.960	
3-911	.116 ± .004	.863 ± .009	11	.688	1.0000-12UNJF-3B	1.156	0.877	0.547	1.023	0.125	1.352	1.064	0.005
3-912	.116 ± .004	.924 ± .009	12	.750	1.0625-12UNJF-3B	1.234		0.609	1.086		1.415		
3-914	.116 ± .004	1.047 ± .010	14	.875	1.1875-12UNJF-3B	1.362		0.734	1.211		1.540		
3-916	.116 ± .004	1.171 ± .010	16	1.000	1.3125-12UNJF-3B	1.487		0.844	1.336		1.665		
3-918	.116 ± .004	1.355 ± .012	18	1.125	1.5000-12UNJF-3B	1.675		0.953	1.524		1.790	1.116	0.008
3-920	.118 ± .004	1.475 ± .014	20	1.250	1.6250-12UNJF-3B	1.800		1.078	1.648		1.978		
3-924	.118 ± .004	1.720 ± .014	24	1.500	1.8750-12UNJF-3B	2.050		1.312	1.898		2.228	1.127	0.010
3-928	.118 ± .004	2.090 ± .018	28	1.750	2.2500-12UNJF-3B	2.425		1.547	2.273		2.602	1.243	
3-932	.118 ± .004	2.337 ± .018	32	2.000	2.5000-12UNJF-3B	2.675	0.907	1.781	2.524		2.852	1.368	

*Parker dash numbers correspond with those of AS568A

Design Table 4-5: Boss Dimensions for Military Straight Thread Tube Fitting O-ring Gaskets per MS33649 (Supersedes AND10049 and AND10050)

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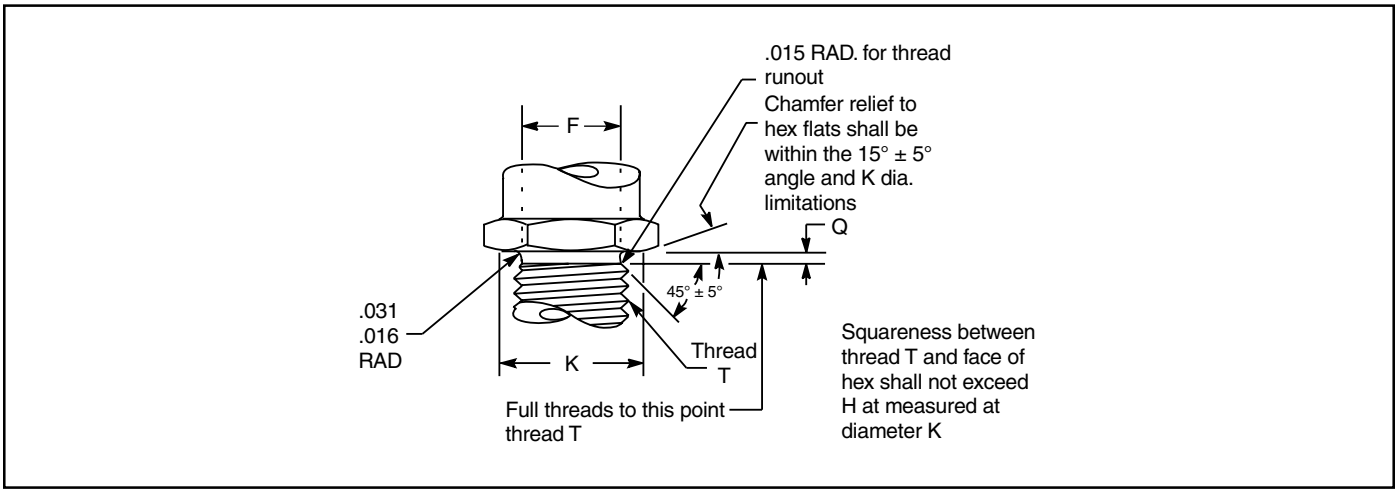
Design Table 4-6 — Tube Fitting Boss Seals

Use fitting end per MS33656



Design Table 4-6 — Fitting End MS33656 Used with MS16142 and MS33649 Bosses

(Only the dimensions that define the O-ring Cavity are shown below.)

O-ring Size No.	Parker Tubing OD	Thread T		E Dimension Across Hex Flats		F +.002 -.003	H Max.	K Dia. ±.010	Q +.015 -.000
3-902	1/8	5/16-24		.563		.250		.549	.063
3-903	3/16	3/8-24		.625		.312		.611	.063
3-904	1/4	7/16-20		.688	+.003	.364		.674	.075
3-905	5/16	1/2-20	UNJF-3A	.750	-.004	.426	.005	.736	.075
3-906	3/8	9/16-18		.813		.481		.799	.083
3-908	1/2	3/4-16		1.000		.660		.986	.094
3-910	5/8	7/8-14		1.125		.773		1.111	.107
3-912	3/7	1 1/16-12		1.375		.945		1.361	
3-914*	7/8	1 3/16-12		1.500		1.070		1.475	
3-916	1	1 5/16-12	UNJ-3A	1.625	±.016	1.195	.008	1.599	.125
3-920	1 1/4	1 5/8-12		1.875		1.507		1.879	
3-924	1 1/2	1 7/8-12		2.125	±.020	1.756		2.095	
3-932	2	2 1/2-12		2.750		2.381		2.718	

*No fitting end for the 3-914 O-ring size is included in MS33656, but the dimensions shown here follow the same pattern.

Design Table Table 4-6: Fitting End MS33656 Used With MS16142 and MS33649 Bosses (only the dimensions that define the O-ring cavity are shown.)

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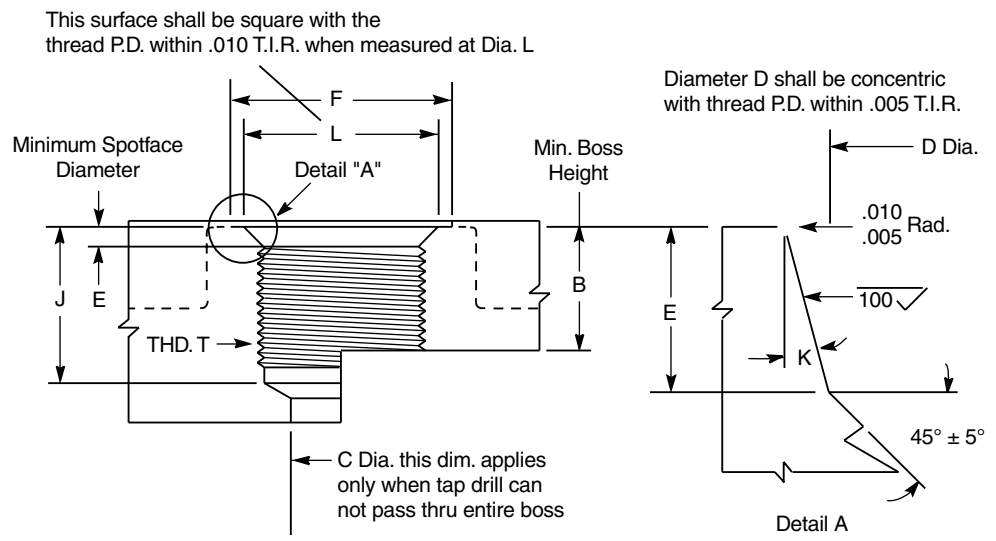
Design Table 4-7 — Tube Fitting Boss Seals



Finished tapered counterbore (Detail A) shall be be free from longitudinal and spiral tool marks. Annular tool marks up to 100 micro-inches maximum will be permissible.

Design Table 4-7 — Boss Dimensions for Industrial Straight Thread Tube Fittings

Parker O-ring Size No.	Actual O-Ring Dimensions W	Actual O-Ring Dimensions ID	Tube OD	Thread T		B Min. Thread Depth	C Min.	D +.005 -.000	E +.015 -.000	F Min.	J Min.	K ±1°	L Min.
3-902	.064 ± .003	.239 ± .005	1/8	5/16-24		.390	.062	.358	.074	.672	.468	12°	.438
3-903	.064 ± .003	.301 ± .005	3/16	3/8-24		.390	.125	.421	.074	.750	.468	12°	.500
3-904	.072 ± .003	.351 ± .005	1/4	7/16-20		.454	.172	.487	.093	.828	.547	12°	.563
3-905	.072 ± .003	.414 ± .005	5/16	1/2-20	UNF-2B	.454	.234	.550	.093	.969	.547	12°	.625
3-906	.078 ± .003	.468 ± .005	3/8	9/16-18		.500	.297	.616	.097	.909	.609	12°	.688
3-908	.087 ± .003	.644 ± .009	1/2	3/4-16		.562	.391	.811	.100	1.188	.688	15°	.875
3-910	.097 ± .003	.755 ± .009	5/8	7/8-14		.656	.484	.942	.100	1.344	.781	15°	1.000
3-912	.116 ± .004	.924 ± .009	3/4	1 1/16-12		.750	.609	1.148	.130	1.625	.906	15°	1.250
3-913	.116 ± .004	.986 ± .010	13/16										
3-914	.116 ± .004	1.047 ± .010	7/8	1 3-16-12		.750	.719	1.273	.130	1.765	.906	15°	1.375
3-916	.116 ± .004	1.171 ± .010	1	1 5/16-12	UN-2B	.750	.844	1.398	.130	1.910	.906	15°	1.500
3-918	.116 ± .004	1.355 ± .012	1 1/8										
3-920	.118 ± .004	1.475 ± .014	1 1/4	1 5/8-12		.750	1.078	1.713	.132	2.270	.906	15°	1.875
3-941	.118 ± .004	1.720 ± .014	1 1/2	1 7/8-12		.750	1.312	1.962	.132	2.560	.906	15°	2.125
3-932	.118 ± .004	2.337 ± .018	2	2 1/2-12		.750	1.781	2.587	.132	3.480	.906	15°	2.750

Design Table 4-7: Boss Dimensions for Industrial Straight Thread Tube Fitting O-ring Gaskets Per SAE J1926 and MS16142

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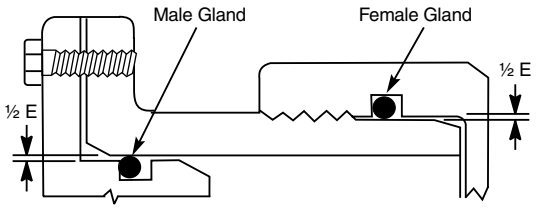
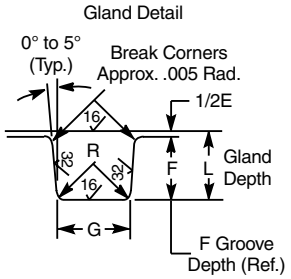
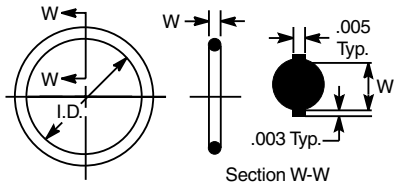
Design Chart 4-5 — For Static Vacuum Seal Glands





Finishes are RMS values



Refer to Design Chart 4-5 (below) for dimensions.

Design Chart 4-5 For Static Vacuum Seal Glands

O-Ring Size AS568A-	W Cross-Section Nominal	W Cross-Section Actual	L Gland Depth	E Squeeze Actual	E Squeeze %	Diametral Clearance	G Groove Width	R Groove Radius	Max.* Eccentricity
004 through 050	1/16	.070 ±.003	.050 to .052	.015 to .023	22 to 32	.002 to .005	.093 to .098	.005 to .015	.002
102 through 178	3/32	.103 ±.003	.081 to .083	.017 to .025	17 to 24	.002 to .005	.140 to .145	.005 to .015	.002
201 through 284	1/8	.139 ±.004	.111 to .113	.022 to .032	16 to 23	.003 to .006	.187 to .192	.010 to .025	.003
309 through 395	3/16	.210 ±.005	.170 to .173	.032 to .045	15 to 21	.003 to .006	.281 to .286	.020 to .035	.004
425 through 475	1/4	.275 ±.006	.226 to .229	.040 to .055	15 to 20	.004 to .007	.375 to .380	.020 to .035	.005

*Total indicator reading between groove and adjacent bearing surface.

Design Chart 4-5: Design Chart for Static Vacuum Seal Glands

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