Parker Seals

Aerospace T-Seals

ISO 9001 Certified

Catalog PPD-5209/USA

Aerospace Piston and Rod T-Seals

WARNING:

Failure, improper selection or improper use of the products and/or systems described herein or related items can cause death, personal injury or property damage.

This document and other information from Parker Hannifin Corporation, its subsidiaries and authorized distributors provides product and/or system options for further investigation by users having technical expertise. It is important that you analyze all aspects of your application and review the information concerning the product or system in the current product catalog. Due to the variety of operating conditions and applications for these products or systems, the user, through his or her own analysis and testing, is solely responsible for making the final selection of the products and systems and assuring that all performance, safety and warning requirements of the application are met.

The products described herein, including without limitation, product features, specifications, designs, availability and pricing, are subject to change by Parker Hannifin Corporation and its subsidiaries at any time without notice.

OFFER OF SALE

The items described in this document are hereby offered for sale by Parker Hannifin Corporation, its subsidiaries and its authorized distributors. This offer and its acceptance are governed by the provisions stated on the separate page of this document entitled “Offer of Sale.”

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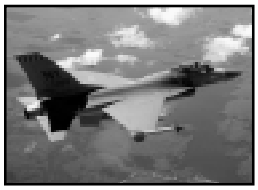
Parker Aerospace T-Seals



PARKER's Aerospace T-Seals employ the latest in compounding and design technology to deliver reliable, effective sealing. Parker Aerospace T-Seals are available for AS4716 / MIL-G-5514F and MS28775 cross-sections and diameters from Dash Size No. -006 through -460. They are available for rods and pistons, and for zero back-up, one back-up and two back-up groove width O-ring replacements.

Parker's Aerospace T-Seals are manufactured under strict procedures conforming to MIL-I-45208. Parker's manufacturing facilities are qualified and certified to the ISO 9001 standard. A wide range of seal and back-up compounds from Parker's advanced materials technology is available to match your application requirements. These seals meet all applicable military specifications.

THE T-SEAL DEVELOPMENT

Parker Aerospace T-seals replace existing O-ring seals in long-lived aircraft hydraulic and pneumatic systems. Their ability to fit into existing grooves means that a retrofit can be made with no re-machining or major revisions to the existing hardware design. This simplifies both field changes and new equipment manufacturing.

THE SEALING ELEMENT

The T-seal's distinctive cross-section is extremely functional. The elastomeric seal element (See Figure 1) consists of a flange and a body, each of which has a multiple purpose. The flange provides the static seal against the bottom of the groove, provides positive radial actuation of the back-up rings, and stabilizes the seal against rolling in the grooves. The body provides the squeeze or interference seal against the dynamic surface, loads the flange to enhance the static seal against the groove, and contributes elastomeric mass to the downstream flange to displace the back-up ring radially. The squeeze effected during installation duplicates that of an O-ring, giving the T-seal its ability to seal at the lowest pressures. Finally, the square or rectangular shape of the T-seal assembly with its back-up rings eliminates the spiral failure mode characteristic of O-rings. Parker T-seals cannot spiral fail (See Figure 2).

Fig. 1

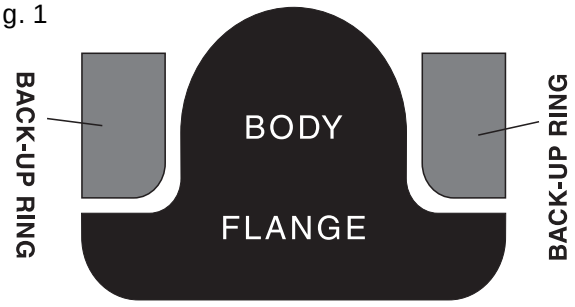


Fig. 2

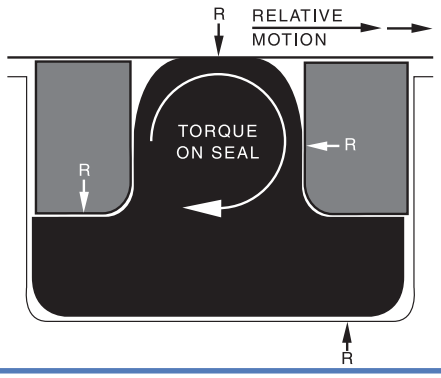


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Fig. 3

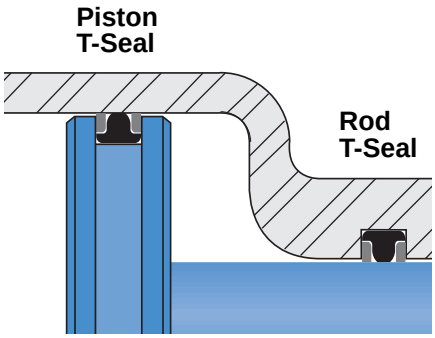
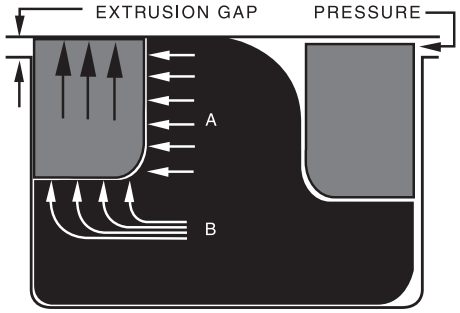


Fig. 4



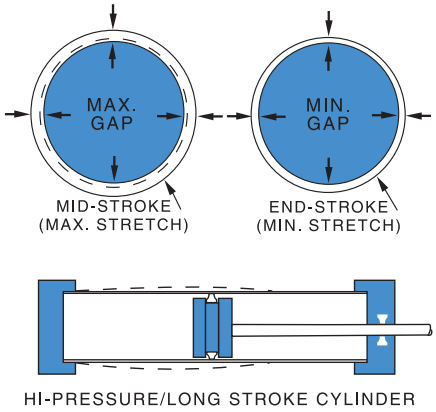
BACK-UP RINGS

Back-up rings are on the outside diameters of piston T-seals, and the inside diameters of rod T-seals (See Figure 3). The unique “hydraulic” loading of the back-up rings by the T-seal flange occurs when the installed seal assembly is exposed to differential pressure causing positive back-up ring actuation. Positive actuation allows the T-seal back-up rings to respond more rapidly than the plastic deformation causes O-ring back-up rings to close an extrusion gap. For this reason T-seals adapt to wider gaps, and respond to shocks and pressure surges immediately by increasing the radial force against the dynamic surface (See Figure 4).

It should be remembered that extrusion gaps are seldom constant throughout a stroke. The gap may vary due to uneven wear along a rod or bore, it may vary as system pressure rises (breathing) and distance from end restraints changes (thereby changing the stretch of cylinder walls). Ovality of cylinder tubes or rod glands due to side-load is not necessarily constant throughout the stroke, and out-of-round tubes may assume a near-perfect circular shape where restrained by the end caps (See Figures 5 & 6).

These numerous possible sources of changing extrusion gaps make Parker T-seals’ speed of response extremely valuable. Despite rapid strokes, lateral shock loads, pressure surges, and uneven wear or stretching, Parker T-seals maintain zero extrusion gaps.

Fig. 6



In the free state, back-up rings appear quite loose on their seal element. This slack is taken up during installation, since the interference fit of the seal in standard O-ring grooves either stretches (piston seals) or compresses (rod seals) the element to seat the backups (See Figure 7). Parker T-seals are easy to assemble and may be inserted into their grooves manually without special assembly tools.

Fig. 5

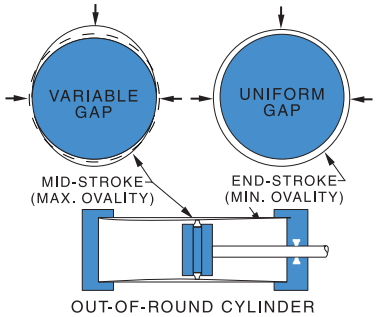


Fig. 7

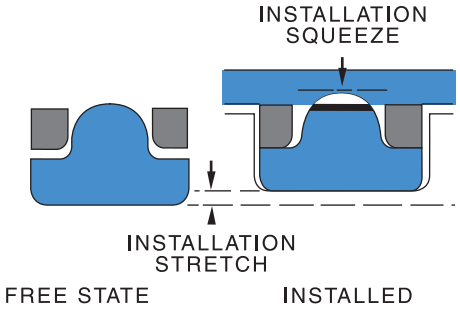


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Fig. 8

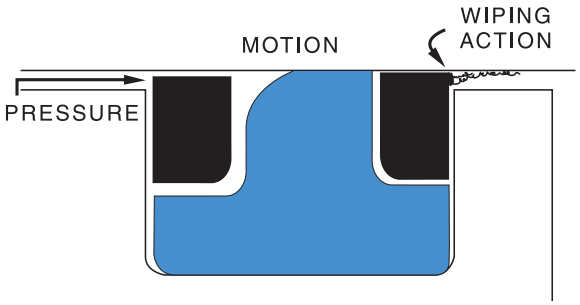
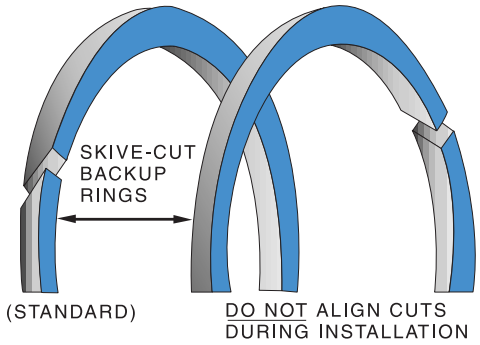


Fig. 9



The Parker T-seal back-up rings' ability to follow changing dynamic surfaces rapidly also makes them very effective wipers, keeping contaminants away from the sealing line (See Figure 8).

SPLIT vs. ENDLESS BACK-UPS

Standard devices in the Parker Aerospace T-Seals use split (skive-cut) back-up rings. Skive-cut rings are simple to install and allow harder and more extrusion-resistant materials to be used without sacrificing their ability to respond quickly to gap changes (See Figure 9). Endless (uncut) rings are normally made of PTFE, which is easily deformed for installation. An exception to this rather broad rule could be made in the case of assembled glands, where the back-up rings need not be excessively stretched or otherwise deformed during installation. In such cases, endless back-ups made of filled nylon or even harder compounds may be installed by direct insertion into an open-end groove, which is subsequently closed by a gland end-piece, which results in loss of positive actuation.

In most cases, Parker Aerospace T-seals may be inserted into their grooves manually without special assembly tools. Where endless nylon back-ups are used, however, it may be necessary to employ installation cones for piston seal back-ups and folding tools for rod seal back-ups, provided small cross sections and thicknesses are being installed.

Special care must be taken when installing radiused back-ups. The radius of the back-up rings must be nested against the radiused surface of the seal element. Improper installation will compromise the sealing ability of the T-seal (See Figures 10 and 11).

FINITE ELEMENT ANALYSIS

Parker utilizes Finite Element Analysis (FEA) tools to simulate installation and operating conditions of your application. As shown in Figure 12 below, correct installation with proper nesting of back-up rings along the radiused corner of the elastomeric T-seal element concentrates the sealing force against the dynamic surface of the application.

Fig. 12

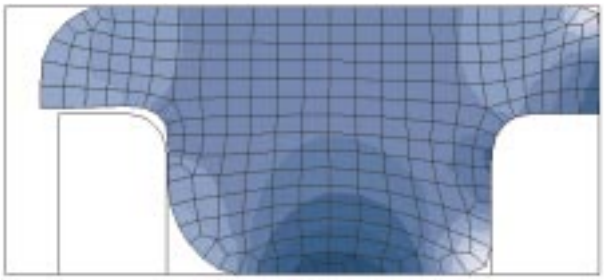


Fig. 10

WRONG!!

Incorrect installation of Aerospace T-Seal with radiused back-up rings.

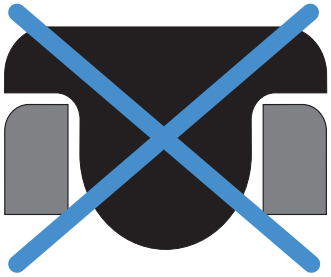


Fig. 11

RIGHT!!

Correct installation of Aerospace T-Seal with radiused back-up rings.

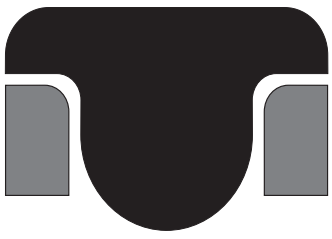


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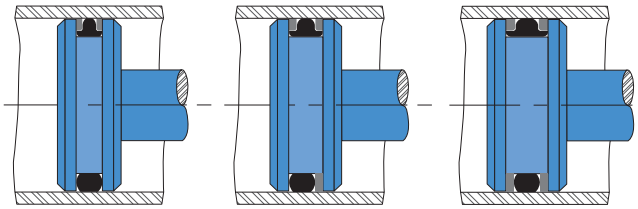
Fig. 13

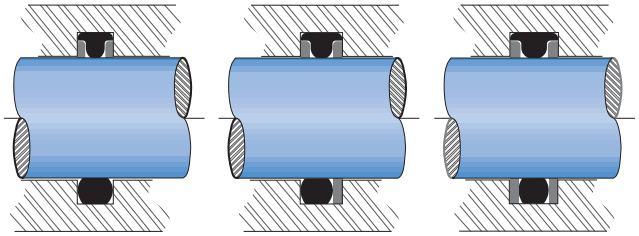
Piston T-Seal



ZERO BACK-UP O-RING GROOVE | ONE BACK-UP O-RING GROOVE | TWO BACK-UP O-RING GROOVE

Fig. 14

Rod T-Seal



ZERO BACK-UP O-RING GROOVE | ONE BACK-UP O-RING GROOVE | TWO BACK-UP O-RING GROOVE

Parker's Aerospace T-seals are available to fit zero, one and two back-up width AS4716/MIL-G-5514F O-ring grooves (See Figures 13 and 14). The standard groove width for Parker Aerospace T-Seals is the "zero back-up" O-ring groove design. One and two back-up widths are available. All standard Aerospace T-seal assemblies have two back-ups regardless of the gland width design.

When specifing Parker Aerospace T-seals for zero, one or two back-up groove widths, use the following part number designation:

Zero back-up O-ring groove:

N304TA0P1210110E

One back-up O-ring groove:

N304TA1P1210110E

Two back-up O-ring groove:

N304TA2P1210110E

See Page 7 of this catalog for complete part numbering instructions.

CUSTOM DESIGNS

Parker Applications Engineers can assist you in designing custom Aerospace T-seals for out-of-the ordinary applications. Such applications may include the design of dual staged back-ups for actuators, limited dynamics, or high pressure conditions. Custom designs may also be necessary where specialty compounds are warranted.

DUAL STAGED BACK-UPS

While applications which require dual material back-ups on each side of the seal are not a standard design, Parker Applications Engineers can assist you in designing Aerospace T-seals with dual-staged back-up rings to your specifications for applications warranting the same. Great care must be taken in installation of dual-staged back-ups so that the harder material back-up ring is installed adjacent to the extrusion gap, and the softer material back-up ring is installed against the seal body (See Figure 15).

Call the factory for special part numbering configurations on Parker Aerospace T-Seals with staged back-up rings.

PERFLUORINATED ELASTOMERS

Perfluorinated elastomers are used where better resistance to aggressive chemicals or extreme temperature resistance is needed (See Table 1).

Fig. 15

Table 1. Perfluorinated Elastomers

Base Elastomer Compound Number	Duro.	Temp Range °F	Service
HiFluor™			
3819	75	-15 to +400	Better resistance to
3534	90	-15 to +400	aggressive chemicals
Parofluor™			
8545	75	-15 to +500/550	Extreme chemicals
8588	90	-15 to +500/550	Extreme temps

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Parker Aerospace T-Seal Materials

Materials used for Parker Aerospace T-Seal assemblies are chosen for their abrasion resistance, fluid compatibility and temperature range, but the seal element and back-up rings have additional requirements unique to themselves. The seal element, for example, must also have high resistance to compression set, provide good adhesion for a lubricant film, high tear resistance, and long retention of its resilience. Back-up rings, in addition to the common requirements, must also have high shear strength, sufficient hardness to bridge large gaps without extrusion, and either the ability to hold a lubricant film or have self-lubricating properties.

SEALING BODY ELASTOMER MATERIALS

Parker's Aerospace T-Seal series provides sealing bodies in four different standard elastomers (though literally dozens of alternate materials may be specified for special duty). These four elastomeric compounds include:

N304-75 NITRILE (Buna-N or NBR) is one of the most oil-resistant of the conventional seal polymers. It is widely used to seal petroleum-based hydraulic fluids (MIL-H-5606), water/oil emulsions, ethylene glycol fluids, and pneumatic systems where petroleum-based lubricants are added to the gas supply. The N304 compound meets MIL-P-25732, at -65°F to +275°F. Besides meeting all the general and special requirments of T-seal sealing elements, nitriles also remain resilient at -65°F, thereby minimizing leakage during cold start-ups.

E1267-80 ETHYLENE PROPYLENE (EPR or EPDM) is particularly useful in low density and high density phosphate ester fluids such as the Skydrol series, water-glycol fluids, long-term water service, and brake fluids from -65°F to +300°F. Do **not** use ethylene propylene with petroleum lubricants, solvents or other petroleum-based fluids, and especially avoid the practice of lubing the seals during installation with petroleum oils or greases.

V747-75 FLUOROCARBON (FKM, FPN) is a general purpose, 75 Shore A hardness fluorocarbon. Its excellent compression set resistance, high temperature and high pressure resistance make it excellent in sealing petroleum oils and fuels. The V747 compound meets MIL-R-83248. Temperature range is -15°F to +400°F.

V709-90 FLUOROCARBON (FKM, FPN) is a general purpose, 90 Shore A hardness fluorocarbon. Its excellent compression set resistance, high temperature and high pressure resistance make it excellent in sealing petroleum oils and fuels. The V709 compound meets MIL-R-83248. Temperature range is -15°F to +400°F.

BACK-UP RING MATERIALS

As with sealing element compounds, Parker's Aerospace T-Seal series is available in four different standard back-up ring compounds. These materials are non-elastomeric, and are extremely resistant to extrusion.

POLYTETRAFLUOROETHYLENE (PTFE) per MIL-R-8791 is a self-lubricating polymer with the wide temperature range of -350°F to +400°F, and is able to tolerate any fluids found in aerospace service.* PTFE tends to cold flow, and is recommended for pressures up to 3000 psi with maximum diametral clearances of 0.0025 inch.

FILLED PTFE has improved extrusion resistance, wear and temperature ranges by the use of compounding fillers, which increases PTFE's hardness throughout its temperature range. Filled PTFE raises the maximum pressure recommendations (See Table 3).

NYLATRON (Polyamide Resin with Molybdenum Disulfide filler) is also self-lubricating, and also has the ability to hold a strongly adhering film of system lubricant on its surface. Nylatron is extremely tough and wear-resistant, and tolerates most petroleum-based fluids, phosphate ester hydraulic fluids, fuels, lubes, and solvents. It is more resistant to cold flow from -65°F to +250°F than PTFE, though PTFE can actually tolerate higher temperatures. Unlike PTFE, Nylatron does not interfere with the adhesion of lubricating films to the dynamic surfaces. Nylatron may be used to 5000 psi with diametral clearances of 0.0025 inch.

*Overall temperature range dependent on sealing body elastomer.

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Sealing Body Elastomeric Materials:

Table 2. Standard Elastomeric Aerospace T-Seal Compounds

Compound Reference Number	Compound Type	Hardness (Shore A)	Service		Comments/Applications
			Fluids	Temp Range (°F)	
N304	Nitrile	75	General purpose sealing, petroleum oils and fluids, cold water	-65° to +275°	MIL-R-25732 Mil-R-3065 Mil-Std -417 (Military aircraft petroleum-based hydraulic fluids, fuels, lubes)
1267	Ethylene Propylene	80	Phosphate ester-based hydraulic fluids (Skydrol)	-65° to +300°	NAS 1613
V747	Fluoro-carbon	75	Petroleum oils, di-ester base lubri-cants, silicone fluids and greases	-15° to +400°	MIL-R-83248
V709	Fluoro-carbon	90	Petroleum oils, di-ester base lubri-cants, silicone fluids and greases	-15° to +400°	MIL-R-83248

Back-up Ring Materials:

Table 3. Standard Back-up Ring Materials for Aerospace T-Seals

Compound Reference Number	Material	Color	Temp. Range (°F)*	Comments
0110	Virgin PTFE	White	-350° to +400°	Best for static applications requiring positive sealing. Mil-R-8791. Good in vacuum with low gas permeability. Low particulate generation. Excellent in cryogenics. Can be used in slow, infrequent dynamics. Recommended to 3000 psi.
0008	Carbon Fiber/PTFE	Brown	-250° to +550°	Excellent all-purpose material. Best for dynamic applications running on moderate to hard surfaces. High wear material with low abrasion. Recommended to 5000 psi .
0245	Graphite/PTFE	Dk. Gray	-250° to +550°	A dynamic material for softer surfaces and a static material for high temperatures. Good wear resistance with very low abrasion. Recommended to 4000 psi.
4655	Nylatron	Gray	-65° to +250°	Excellent chemical resistance. Recommended to 5000 psi on Dash Size # -006 to -149. Recommended to 10000 psi on Dash Size # -210 to -460.

*Overall temperature range dependent on sealing body elastomer.

NOTICE:

Parker Packing Applications Engineers will be pleased to suggest special compounds for special applications where standard materials fall short of requirements. Many additional materials are already available as options to the standards, and still more may be qualified to unusual requirements.

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Part Numbering

Parker AerospaceT-Seals may be completely described and ordered by a seven-part composite Part Number (see below). Alpha-numeric codes define all standard seal dimensions, materials and configurations. Special materials or sizes, should be ordered only after consultation with Parker Packing's Applications Engineers, who will help you construct the proper Part Number. The materials and dimensions given in Tables 4 through 8 accommodate most aviation hydraulic and pneumatic requirements, but Parker has many other materials, combinations of materials and special-size capability on request. For special design assistance and custom part numbering, photocopy pages 13 and 14 of this catalog, fill in the required information and fax or mail the same to Parker's Applications Engineers.

Parker Aerospace T-Seal Part Numbers may be constructed as follows:

EXAMPLE: A piston T-seal is required for a cylinder bore of 1.241 inch, to replace an O-ring in a zero back-up AS4716/MIL-G-5514F groove, operating in MIL-H-5605 fluid at 3000 psi and 200°F.

This Part Number would be written in these seven steps:

Elastomer Material	Aircraft T-Seal	Groove Width 0 B/U = 0 1 B/U = 1 2 B/U = 2	Piston / Rod "P" "R"	Dash Size AS4716/ Mil-G-5514F	Back-Up Ring Material	Endless or Split Backup "E" / "S"
N304	TA	0	P	121	0110	E

N304 TA 0 P 121 0110 E

Step 1: Select Sealing Body Elastomeric Material. (See Table 2, Page 6.)

Step 2: Designator for Aerospace T-Seal.

Step 3: Groove Width. Standard groove width is the zero back-up groove width. (See Table 3, Page 6.)

Step 4: Designator for Piston or Rod seal.

Step 5: Dash Size Number AS4716/MIL-G-5514F. (See Tables 4-8, Pages 8-12.)

Step 6: Select Back-up Ring Material. (See Table 3, Page 6.)

Step 7: Designator for Endless or Split Back-up Ring.

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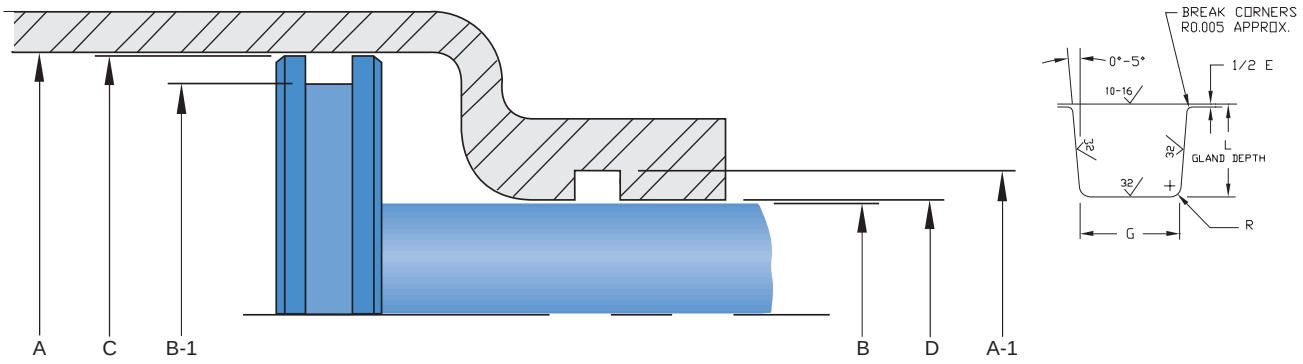

Table 4. Gland Dimensions AS4716 / Mil-G-5514F.

AS4716 Dash Size Number	Piston					Rod					Groove Width		
	Bore Dia.	Groove Dia.	Groove Dia. per Mil-G-5514F	Piston OD	Max. Diametral Clearance	Rod Dia.	Groove Dia.	Groove Dia. per Mil-G-5514F	Bore Dia.	Max. Diametral Clearance	(Back-up Groove Width) G		
											0	1	2
	A	B-1	B-1	C	E	B	A-1	A-1	D	E			
	+.001 -.000	+.000 -.001	+.000 -.001	+.001 -.000		+.000 -.001	+.001 -.000	+.001 -.000	+.000 -.001		+.005 -.000	+.010 -.000	+.010 -.000
-006	.235	.123	.123	.233		.123	.235	.235	.125				
-007	.266	.154	.154	.264		.154	.266	.266	.156		.098*	.154†	.210‡
-008	.297	.189	.185	.295		.185	.294	.297	.187				
-009	.329	.220	.217	.327	.004	.217	.327	.329	.219	.004			
-010	.360	.250	.248	.358		.248	.359	.360	.250				
-011	.422	.312	.310	.420		.310	.421	.422	.312				
-012	.485	.375	.373	.483		.373	.484	.485	.375				
	+.002 -.000	+.000 -.002	+.000 -.002	+.002 -.000		+.000 -.002	+.002 -.000	+.002 -.000	+.000 -.002				
-013	.550	.441	.438	.548		.435	.545	.547	.437				
-014	.613	.504	.501	.611		.498	.608	.610	.500				
-015	.675	.566	.563	.673		.560	.670	.672	.562				
-016	.738	.629	.626	.736		.623	.733	.735	.625				
-017	.800	.691	.688	.798		.685	.795	.797	.687				
-018	.863	.753	.751	.861		.748	.858	.860	.750		.094	.150†	.207
-019	.925	.815	.813	.923	.005	.810	.920	.922	.812	.005			
-020	.991	.881	.879	.989		.873	.983	.985	.875				
-021	1.053	.943	.941	1.051		.935	1.045	1.047	.937				
-022	1.116	1.006	1.004	1.114		.998	1.108	1.110	1.000				
-023	1.178	1.068	1.066	1.176		1.060	1.170	1.172	1.062				
-024	1.241	1.131	1.129	1.239		1.123	1.233	1.235	1.125				
-025	1.303	1.193	1.191	1.301		1.185	1.295	1.297	1.187				
-026	1.366	1.256	1.254	1.384		1.248	1.358	1.360	1.250				
-027	1.428	1.318	1.316	1.426		1.310	1.420	1.422	1.312				
-028	1.491	1.381	1.379	1.489		1.373	1.483	1.485	1.375				

Mil-G-5514F:

*-006 to -009	0 Groove Width	.094
†-006 to -028	1 Groove Width	.149
‡-006 to -009	2 Groove Width	.207

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Table 5. Gland Dimensions AS4716 / Mil-G-5514F.

AS4716 Dash Size Number	Piston					Rod					Groove Width		
	Bore Dia.	Groove Dia.	Groove Dia. per Mil-G-5514F	Piston OD	Max. Diametral Clearance	Rod Dia.	Groove Dia.	Groove Dia. per Mil-G-5514F	Bore Dia.	Max. Diametral Clearance	(Back-up Groove Width) G		
											0	1	2
	A	B-1	B-1	C	E	B	A-1	A-1	D	E			
	+.002 - .000	+.000 - .002	+.000 - .002	+.002 - .000		+.000 - .002	+.002 - .000	+.002 - .000	+.000 - .002		+.010 - .000	+.010 - .000	+.010 - .000
-110	.550	.379	.372	.548	.005	.373	.546	.551	.375	.005	.141	.183	.245
-111	.613	.441	.435	.611		.435	.609	.613	.437				
-112	.675	.502	.497	.673		.498	.672	.676	.500				
-113	.738	.565	.560	.736		.560	.734	.738	.562				
-114	.800	.627	.622	.798		.623	.797	.801	.625				
-115	.863	.689	.685	.861		.685	.859	.863	.687				
-116	.925	.751	.747	.923		.748	.923	.926	.750				
-117	.991	.817	.813	.989		.810	.985	.988	.812				
-118	1.053	.879	.875	1.051		.873	1.048	1.051	.875				
-119	1.116	.942	.938	1.114		.935	1.110	1.113	.937				
-120	1.178	1.003	1.000	1.176		.998	1.173	1.176	1.000				
-121	1.241	1.066	1.063	1.239		1.060	1.235	1.238	1.062				
-122	1.303	1.128	1.125	1.301		1.123	1.298	1.301	1.125				
-123	1.366	1.191	1.188	1.364		1.185	1.360	1.363	1.187				
-124	1.428	1.253	1.250	1.426		1.248	1.423	1.426	1.250				
-125	1.491	1.316	1.313	1.489		1.310	1.485	1.488	1.312				
-126*	1.553	1.378	1.375	1.551		1.373	1.548	1.551	1.375				
-127	1.616	1.441	1.438	1.614		1.435	1.610	1.613	1.437	.006			
-128	1.678	1.503	1.500	1.676		1.498	1.673	1.676	1.500				
-129†	1.741	1.566	1.563	1.739		1.560	1.735	1.738	1.562				
-130	1.805	1.631	1.627	1.802	.006	1.623	1.798	1.801	1.625				
-131	1.867	1.693	1.689	1.864		1.685	1.860	1.863	1.687				
-132‡	1.930	1.756	1.752	1.927		1.748	1.923	1.926	1.750				
-133	1.992	1.818	1.814	1.989		1.810	1.984	1.988	1.813	.007			
-134	2.055	1.881	1.877	2.052		1.873	2.047	2.051	1.876				
-135	2.118	1.944	1.940	2.115		1.936	2.110	2.114	1.939				
-136	2.180	2.006	2.002	2.177		1.998	2.172	2.176	2.001				
-137	2.243	2.069	2.065	2.240		2.061	2.235	2.239	2.064				
-138	2.305	2.131	2.127	2.302		2.123	2.297	2.301	2.126				
-139	2.368	2.194	2.190	2.365		2.186	2.360	2.364	2.189				
-140	2.430	2.256	2.252	2.427		2.248	2.422	2.426	2.251				
-141	2.493	2.319	2.315	2.490	.007	2.311	2.485	2.489	2.314				
-142	2.555	2.381	2.377	2.552		2.373	2.547	2.551	2.376				
-143	2.618	2.444	2.440	2.615		2.436	2.610	2.614	2.439				
-144	2.680	2.506	2.502	2.677		2.498	2.672	2.676	2.501				
-145	2.743	2.569	2.565	2.740		2.561	2.735	2.739	2.564				
-146	2.805	2.631	2.627	2.802		2.623	2.797	2.801	2.626				
-147	2.868	2.694	2.690	2.865		2.686	2.860	2.864	2.689				
-148	2.930	2.756	2.752	2.927		2.748	2.922	2.926	2.751				
-149	2.993	2.819	2.815	2.990		2.811	2.985	2.989	2.814				

Mil-G-5514F:

*-126	Rod Max. Diametral Clearance	.005
†-129	Piston Max. Diametral Clearance	.006
‡-132	Rod Max. Diametral Clearance	.007

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Packing Division
Salt Lake City, UT
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Table 6. Gland Dimensions AS4716 / Mil-G-5514F.

AS4716 Dash Size Number	Piston					Rod					Groove Width		
	Bore Dia.	Groove Dia.	Groove Dia. per Mil-G-5514F	Piston OD	Max. Diametral Clearance	Rod Dia.	Groove Dia.	Groove Dia. per Mil-G-5514F	Bore Dia.	Max. Diametral Clearance	(Back-up Groove Width) G		
											0	1	2
	A	B-1	B-1	C	E	B	A-1	A-1	D	E			
	+.002 - .000	+.000 - .002	+.000 - .002	+.002 - .000		+.000 - .002	+.002 - .000	+.002 - .000	+.000 - .002		+.010 - .000	+.010 - .000	+.010 - .000
-210	.991	.750	.748	.989	.005	.748	.989	.991	.750	.005	.188	.235	.304
-211	1.053	.812	.810	1.051		.810	1.051	1.053	.812				
-212	1.116	.874	.873	1.114		.873	1.115	1.116	.875				
-213	1.178	.936	.935	1.176		.935	1.177	1.178	.937				
-214	1.241	.999	.998	1.239		.998	1.240	1.241	1.000				
-215	1.303	1.064	1.060	1.301		1.060	1.302	1.303	1.062				
-216	1.366	1.124	1.123	1.364		1.123	1.365	1.366	1.125				
-217	1.428	1.186	1.185	1.426		1.185	1.427	1.428	1.187				
-218	1.491	1.249	1.248	1.489		1.248	1.490	1.491	1.250				
-219	1.553	1.311	1.310	1.551		1.310	1.552	1.553	1.312				
-220	1.616	1.374	1.373	1.614		1.373	1.615	1.616	1.375				
-221	1.678	1.436	1.435	1.676		1.435	1.677	1.678	1.437				
-222	1.741	1.499	1.498	1.739		1.498	1.740	1.741	1.500				
-223	1.867	1.625	1.624	1.864	.006	1.623	1.865	1.866	1.625	.006			
-224	1.992	1.750	1.749	1.989		1.748	1.990	1.991	1.750				
-225	2.118	1.876	1.875	2.115		1.873	2.115	2.116	1.876	.007			
-226	2.243	2.001	2.000	2.240		1.998	2.240	2.241	2.001				
-227*	2.368	2.126	2.125	2.365		2.123	2.365	2.366	2.126				
-228	2.493	2.251	2.250	2.490	.007	2.248	2.490	2.491	2.251				
-229	2.618	2.376	2.375	2.615		2.373	2.615	2.616	2.376				
-230	2.743	2.501	2.500	2.740		2.498	2.740	2.741	2.501				
-231	2.868	2.626	2.625	2.865		2.623	2.865	2.866	2.626				
-232	2.993	2.751	2.750	2.990		2.748	2.990	2.991	2.751				
-233	3.118	2.876	2.875	3.115		2.873	3.115	3.116	2.876				
-234	3.243	3.001	3.000	3.240		2.997	3.239	3.240	3.000				
-235	3.368	3.126	3.125	3.365		3.122	3.364	3.365	3.125				
-236	3.493	3.251	3.250	3.490		3.247	3.489	3.490	3.250				
-237	3.618	3.376	3.375	3.615		3.372	3.614	3.615	3.375				
-238	3.743	3.501	3.500	3.740		3.497	3.739	3.740	3.500				
-239	3.868	3.626	3.625	3.865		3.622	3.864	3.865	3.625				
-240	3.993	3.751	3.750	3.990		3.747	3.989	3.990	3.750				
-241	4.118	3.876	3.875	4.115		3.872	4.114	4.115	3.875				
-242	4.243	4.001	4.000	4.240		3.997	4.239	4.240	4.000				
-243	4.368	4.126	4.125	4.365		4.122	4.364	4.365	4.125				
-244	4.493	4.251	4.250	4.489	.008	4.247	4.489	4.490	4.250	.008			
-245	4.618	4.376	4.375	4.614		4.372	4.614	4.615	4.375				
-246	4.743	4.501	4.500	4.739		4.497	4.739	4.740	4.501				
-247	4.868	4.626	4.625	4.864		4.622	4.864	4.865	4.626				

Mil-G-5514F:

*-227 Piston Max. Diametral Clearance .007

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Table 7. Gland Dimensions AS4716 / Mil-G-5514F.

AS4716 Dash Size Number	Piston					Rod					Groove Width		
	Bore Dia.	Groove Dia.	Groove Dia. per Mil-G-5514F	Piston OD	Max. Diametral Clearance	Rod Dia.	Groove Dia.	Groove Dia. per Mil-G-5514F	Bore Dia.	Max. Diametral Clearance	(Back-up Groove Width) G		
											0	1	2
	A	B-1	B-1	C	E	B	A-1	A-1	D	E			
	+.002 - .000	+.000 - .002	+.000 - .002	+.002 - .000		+.000 - .002	+.002 - .000	+.002 - .000	+.000 - .002		+.010 - .000	+.010 - .000	+.010 - .000
-325	1.867	1.495	1.495	1.864	.006	1.498	1.870	1.870	1.500	.006	.281	.334	.424
-326	1.992	1.620	1.620	1.989		1.623	1.995	1.995	1.625				
-327	2.118	1.746	1.746	2.115		1.748	2.120	2.120	1.750				
-328	2.243	1.871	1.871	2.240		1.873	2.245	2.245	1.876	.007			
-329 *	2.368	1.996	1.996	2.365		1.998	2.370	2.370	2.001				
-330	2.493	2.121	2.121	2.490	.007	2.123	2.495	2.495	2.126				
-331	2.618	2.246	2.246	2.615		2.248	2.620	2.620	2.251				
-332	2.743	2.371	2.371	2.740		2.373	2.745	2.745	2.376				
-333	2.868	2.496	2.496	2.865		2.498	2.870	2.870	2.501				
-334	2.993	2.621	2.621	2.990		2.623	2.995	2.995	2.626				
-335	3.118	2.746	2.746	3.115		2.748	3.120	3.120	2.751				
-336	3.243	2.871	2.871	3.240		2.873	3.245	3.245	2.876				
-337	3.368	2.996	2.996	3.365		2.997	3.369	3.369	3.000				
-338	3.493	3.121	3.121	3.490		3.122	3.494	3.494	3.125				
-339	3.618	3.246	3.246	3.615		3.247	3.619	3.619	3.250				
-340	3.743	3.371	3.371	3.740		3.372	3.744	3.744	3.375				
-341	3.868	3.496	3.496	3.865		3.497	3.869	3.869	3.500				
-342	3.993	3.621	3.621	3.990		3.622	3.994	3.994	3.625				
-343	4.118	3.746	3.746	4.115		3.747	4.119	4.119	3.750				
-344	4.243	3.871	3.871	4.240		3.872	4.244	4.244	3.875				
-345	4.368	3.996	3.996	4.365		3.997	4.369	4.369	4.000				
-346	4.493	4.121	4.121	4.489	.008	4.122	4.494	4.494	4.125				
-347	4.618	4.246	4.246	4.614		4.247	4.619	4.619	4.250				
-348	4.743	4.371	4.371	4.739		4.372	4.744	4.744	4.375				
-349	4.868	4.496	4.496	4.864		4.497	4.869	4.869	4.500				

Mil-G-5514F:

*-329 Piston Max. Diametral Clearance .007

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Table 8. Gland Dimensions AS4716 / Mil-G-5514F.

AS4716 Dash Size Number	Piston					Rod					Groove Width		
	Bore Dia.	Groove Dia.	Groove Dia. per Mil-G-5514F	Piston OD	Max. Diametral Clearance	Rod Dia.	Groove Dia.	Groove Dia. per Mil-G-5514F	Bore Dia.	Max. Diametral Clearance	(Back-up Groove Width) G		
											0	1	2
	A	B-1	B-1	C	E	B	A-1	A-1	D	E			
	+.003 -.000	+.000 -.003	+.000 -.003	+.003 -.000	+.003 -.000	+.000 -.003	+.003 -.000	+.003 -.000	+.000 -.003		+.010 -.000	+.010 -.000	+.010 -.000
-425	4.974	4.497	4.497	4.970	.009	4.497	4.974	4.974	4.501	.009	.375	.475	.579
-426	5.099	4.622	4.622	5.095		4.622	5.099	5.099	4.626				
-427	5.224	4.747	4.747	5.220		4.747	5.224	5.224	4.751				
-428	5.349	4.872	4.872	5.345		4.872	5.349	5.349	4.876				
-429	5.474	4.997	4.997	5.470		4.997	5.474	5.474	5.001				
-430	5.599	5.122	5.122	5.595		5.122	5.599	5.599	5.126				
-431	5.724	5.247	5.247	5.720		5.247	5.724	5.724	5.251				
-432	5.849	5.372	5.372	5.845		5.372	5.849	5.849	5.376				
-433	5.974	5.497	5.497	5.970		5.497	5.974	5.974	5.501				
-434	6.099	5.622	5.622	6.095		5.622	6.099	6.099	5.626				
-435	6.224	5.747	5.747	6.220		5.747	6.224	6.224	5.751				
-436	6.349	5.872	5.872	6.345		5.872	6.349	6.349	5.876				
-437	6.474	5.997	5.997	6.470		5.997	6.474	6.474	6.001				
-438	6.724	6.247	6.247	6.720		6.247	6.724	6.724	6.251				
-439	6.974	6.497	6.497	6.970		6.497	6.974	6.974	6.501				
-440	7.224	6.747	6.747	7.220		6.747	7.224	7.224	6.751				
-441	7.474	6.997	6.997	7.470		6.997	7.474	7.474	7.001				
-442	7.724	7.247	7.247	7.720		7.247	7.724	7.724	7.251				
-443	7.974	7.497	7.497	7.970		7.497	7.974	7.974	7.501				
-444	8.224	7.747	7.747	8.220		7.747	8.224	8.224	7.751				
-445*	8.474	7.997	7.997	8.470		7.997	8.474	8.474	8.001				
-446	8.974	8.497	8.497	8.970	.010	8.497	8.974	8.974	8.501				
	+.004 -.000						+.004 -.000	+.004 -.000					
-447	9.474	8.997	8.997	9.470	.011	8.997	9.474	9.474	9.001	.010			
-448	9.974	9.497	9.497	9.970		9.497	9.974	9.974	9.501				
-449	10.474	9.997	9.997	10.470		9.997	10.474	10.474	10.001				
-450	10.974	10.497	10.497	10.970		10.497	10.974	10.974	10.501				
-451	11.474	10.997	10.997	11.470		10.997	11.474	11.474	11.001				
-452	11.974	11.497	11.497	11.970		11.497	11.974	11.974	11.501				
-453	12.474	11.997	11.997	12.470		11.997	12.474	12.474	12.001				
-454	12.974	12.497	12.497	12.970		12.497	12.974	12.974	12.501				
-455	13.474	12.997	12.997	13.470		12.997	13.474	13.474	13.001				
-456	13.974	13.497	13.497	13.970		13.497	13.974	13.974	13.501				
-457	14.474	13.997	13.997	14.470		13.997	14.474	14.474	14.001				
-458	14.974	14.497	14.497	14.970		14.497	14.974	14.974	14.501				
-459	15.474	14.997	14.997	15.470		14.997	15.474	15.474	15.001				
-460	15.974	15.497	15.497	15.970		15.497	15.974	15.974	15.501				

Mil-G-5514F:

*-445 Piston Max. Diametral Clearance .010

Parker Hannifin Corporation
Packing Division
Salt Lake City, UT
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Fax: (801) 972-4777

Data Design Request Form

Need Help? If you need assistance, please photocopy this page and the facing page. Fill out the required information, and fax it to Parker Packing Division at (801) 972-4777. Utilize the information below and other information in this guide to determine the dimensions needed. We will contact you to discuss your specific application and make recommendations. If you need help filling out the form, please call Packing Division Applications Engineers at (801) 972-3000.

PACKING DIVISION
DATA REQUEST

SALT LAKE CITY OPERATIONS
2220 SOUTH 3600 WEST
SALT LAKE CITY, UTAH
PHONE (801) 972-3000
FAX (801) 972-4777

GNP OPERATIONS
41 W 195 RAILROAD STREET
HAMPSHIRE, IL 60140-9729
TOLL FREE 1-800-774-2394
PHONE (847) 464-5202
FAX (847) 464-4051

COMPANY_____
ADDRESS_____
CITY_____STATE_____ZIP_____
CONTACT_____TITLE_____
PHONE _____FAX_____
E-MAIL_____
ALT. CONTACT_____TITLE_____
PHONE _____FAX_____
E-MAIL_____

COMPANY_____
ADDRESS_____
CITY_____STATE_____ZIP_____
CONTACT_____TITLE_____
PHONE _____FAX_____
E-MAIL_____
ALT. CONTACT_____TITLE_____
PHONE _____FAX_____
E-MAIL_____

EQUIPMENT _____ MODEL: _____

COMPONENTS_____ PROBLEM: _____

EXISTING SEAL/PART NUMBER:_____ ☐ N/A

PRICE $_____ @ _____PCS USAGE/YEAR: _____
TARGET $_____ @ _____PCS QUOTE QTY: _____
PRODUCT POTENTIAL_____

ISSUE: ☐ PRICING ☐ SEAL PROBLEM (Explain) _____
PROTO QTY:_____ DATE PROTO REQ'D: _____

PROBLEM PARTS INCLUDED ☐ YES ☐ NO

CUSTOMER P/N: _____

SPECIAL INSPECTION REQUIREMENTS? ☐ YES ☐ NO SPECIAL PACKAGING REQUIREMENTS? ☐ YES ☐ NO

PRODUCT TYPE

☐ ROD / SHAFT ☐ PISTON ☐ INTERNAL FACE ☐ EXTERNAL FACE

OPERATING PARAMETERS	UNIT (CIRCLE ONE)		MINIMUM	OPERATING	MAXIMUM
TEMPERATURE	°K °F °C		_____	_____	_____
PRESSURE	PSI BAR	MPA	_____	_____	_____
STROKE LENGTH	INCH	MM	_____	_____	_____
CYCLE RATE	/MIN. /HR	HZ	_____	_____	_____
ROTATION	DEG.	RAD.	_____	_____	_____
RPM			_____	_____	_____
VELOCITY/ SURFACE SPEED	FT/MIN.	MM/MIN.	_____	_____	_____
VACUUM	IN. HG	TORR	_____	_____	_____

MOTION
☐ STATIC
☐ RECIPROCATING
☐ ROTARY
☐ OSCILLATORY

PRESSURE DIRECTION
☐ UNIDIRECTIONAL
☐ BI-DIRECTIONAL

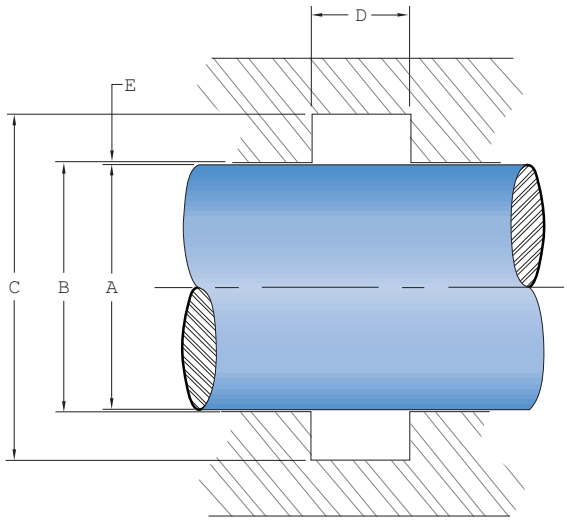
DIRECTION OF ROTATION ☐ CLOCKWISE ☐ COUNTER CLOCKWISE ☐ BI-DIRECTIONAL

MEDIA TO BE SEALED_____

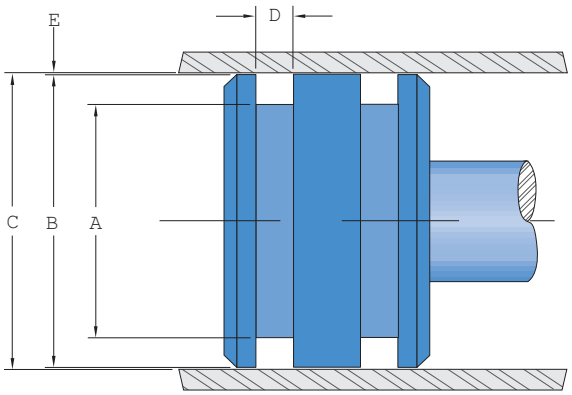
Data Design Request Form

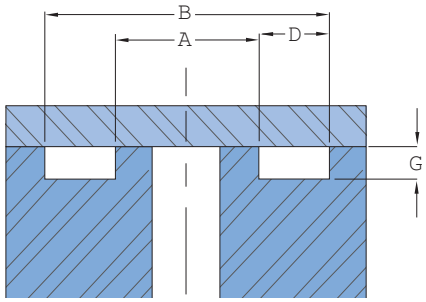
HARDWARE

ROD SEAL



PISTON SEAL





HARDWARE DRAWINGS INCLUDED WITH DATA REQUEST ☐ YES ☐ NO STEP CUT ☐ YES ☐ NO

A DIAMETER	MIN. _____	MAX. _____	HARDNESS _____	FINISH _____	MAT'L _____	
B DIAMETER	MIN. _____	MAX. _____	HARDNESS _____	FINISH _____	MAT'L _____	
C DIAMETER	MIN. _____	MAX. _____	HARDNESS _____	FINISH _____	MAT'L _____	
D GROOVE WIDTH	MIN. _____	MAX. _____				
E RADIAL CLEARANCE	MIN. _____	MAX. _____				
F ROD/PISTON STEP HEIGHT	MIN. _____	MAX. _____				
G FACE SEAL GROOVE DEPTH	MIN. _____	MAX. _____				
H RUNOUT (TIR)	MIN. _____	MAX. _____				

GLAND TYPE
☐ SPLIT ☐ OPEN
☐ SOLID ☐ STEPPED

METRIC
☐ YES ☐ NO
☐ YES ☐ NO

SIDE LOAD (LBS NEWTONS): _____
AS4716/MIL-G-5514F DASH # _____ BACK-UP WIDTH: ☐ ZERO ☐ ONE ☐ TWO

PERFORMANCE REQUIREMENTS
(CIRCLE ONE)
FRICTION _____ LBS OZ GMS ☐ BREAKOUT ☐ DYNAMIC
EXPECTED LIFE: _____ CYC HRS YRS
MAX LEAKAGE: _____ DROPS CC/MIN _____

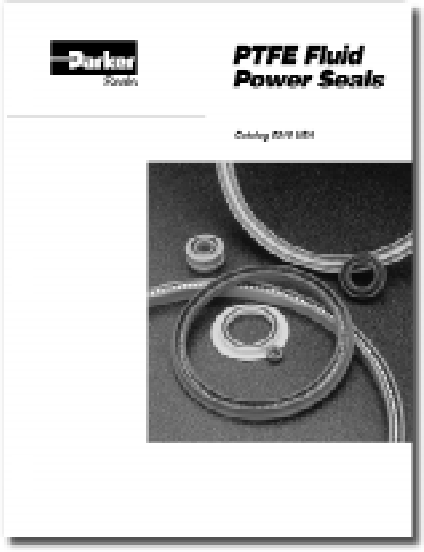
MOST CRITICAL ASPECT (check only one) ☐ SEAL LIFE ☐ PRICE ☐ LEAKAGE ☐ FRICTION ☐ OTHER (EXPLAIN)
_____
_____

CONTAMINATION: _____

Parker Hannifin Corporation
Packing Division
Salt Lake City, UT
Phone: (801) 972-3000
Fax: (801) 972-4777

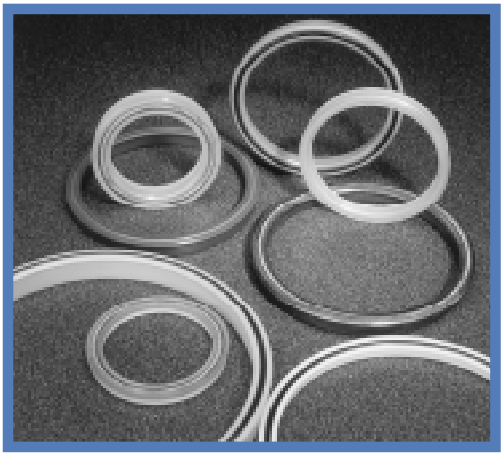
SPRING-ENERGIZED RUBBER U-CUPS

Fluid Power Seals
Catalog PPD-5310/USA



FlexiSeal™
Catalog PPD-5315/USA

SPRING-ENERGIZED POLYPAK™ SEALS



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7. Special Tooling: A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture items sold pursuant to this contract. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges buy Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller which is utilized in the manufacture of the items sold hereunder, even if such apparatus has been specially converted

8. Buyer's Property: Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property, may be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer placing an order for the items which are manufactured using such property. Seller shall not be responsible for any loss or damage to such property while it is in Sellerís possession or control.

9. Taxes: Unless otherwise indicated on the face hereof, all prices and charges are exclusive of excise, sales, use, property, occupational or like taxes which may be imposed by any taxing authority upon the manufacture, sale or delivery of the items sold hereunder. If any such taxes must be paid by Seller or if Seller is liable for the collection of such tax, the amount thereof shall be in addition to the amounts for the items sold. Buyer agrees to pay all such taxes or to reimburse Seller therefore upon receipt of its invoice. If Buyer claims exemption from any sales, use or other tax imposed by any taxing authority, Buyer shall save Seller harmless from and against any such tax, together with any interest or penalties thereon which may be assessed if the items are held to be taxable.

10. Indemnity For Infringement of Intellectual Property Rights: Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Part 10. Seller will defend and indemnify Buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, trade dress and trade secrets (hereunder "Intellectual Property Rights"). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that an item sold pursuant to this contract infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after the Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an items sold hereunder is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using said item, place or modify said item so as to make it noninfringing, or offer to accept return of said item and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to items delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any item sold hereunder. The foregoing provisions of this Part 10 shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

If a claim is based on information provided by Buyer or if the design for an item delivered hereunder is specified in whole or in party by Buyer, Buyer shall defend and indemnify Seller for all costs, expenses or judgements resulting from any claim that such item infringes any patent, trademark, copyright, trade dress, trade secret or any similar right.

11. Force Majeure: Seller does not assume the risk of and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter "Events of Force Majeure"). Events of Force Majeure shall include without limitation, accidents, acts of God, strikes or labor disputes, acts, laws, rules or regulations of any government or government agency, fires, floods, delays or failures in delivery of carriers or suppliers, shortages of materials and any other cause beyond Seller's control.

12. Any special requirements for items to be provided by Seller hereunder including without limitation; compliance with military specifications, special documentation, or testing requirements, must be communicated to Seller in writing at the time the items are first requested. Any such requests that are communicated to Seller after preparation to manufacture an item has commenced may result in additional charges for rework or remanufacture of the item.

13. Entire Agreement/Governing Law: The terms and conditions set forth herein, together with any amendments, modifications and any different terms or conditions expressly accepted by Seller in writing, shall constitute the entire Agreement concerning the items sold, and there are no oral or other representations or agreements which pertain thereto. This Agreement shall be governed in all respects by the law of the State of Ohio. No actions arising out of the sale of the items sold hereunder or this Agreement may be brought by either more than two (2) years after the cause of action accrues.

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