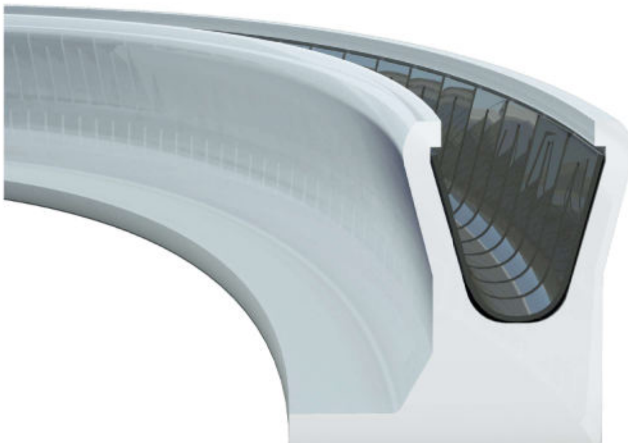
T-LON® "SES" Spring/Elastomer Energized Seals

Energized Lip Seals



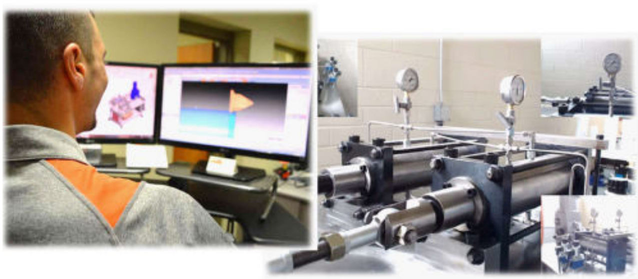
SES™

1110 Richards Rd • Hartland, WI 53029
Telephone 262 / 367-2333 • FAX 262 / 367-8159

T-LON® "SES" Spring/Elastomer Energized Seals

Engineering

T-LON brings a variety of expertise to the engineering world, crossing entire industries and an ever-growing number of applications. T-LON has been taking today's sealing challenges head-on and has been designing and manufacturing seals for OEMs, distributors, and MROs for the past 40+ years. With all this experience — whatever your problem — T-LON has probably seen, solved, and sold it before. Whether it's a standard part from our catalog or a custom product to meet your specific needs, you can depend on the expertise of the T-LON team. The engineering staff at T-LON works on a daily basis to develop unique material compounds that provide sealing solutions for demanding applications. Our experienced staff is able to take a project from inception through installation completing the design, prototyping and production along the way.



Materials

Polytetrafluoroethylene (PTFE) is the world's most widely used fluoropolymer due to its many outstanding physical properties. These properties include low static and dynamic coefficients of friction, chemical inertness and stability over a wide temperature range. Often times PTFE provides the only solution in terms of technical performance. During our 40+ years, we have worked with over 100 different PTFE/filler combinations, all designed to satisfy specific customer requirements

Also offered is a wide range of non PTFE thermoplastic materials. These materials include but are not limited to PEEK, UHMW-PE, Nylon, and Acetal.

Integrated Manufacturing

T-LON is able to accommodate a wide range of customer needs through its integrated molding and machining capabilities.

For our customers with parts that have high-volume requirements, our automatic molding process is as efficient as it is effective. Automation and robotics are used throughout the vertically integrated processes.

Quality

The T-LON Quality System is based on our philosophy of continuous improvement, lot traceability, Statistical Process Control, and ISIR preparation, along with all the requirements of ISO 9001. It is standard procedure in our daily operations to ensure consistent quality of our products and services.

Product quality is the responsibility of every single member of the T-LON team. We use a muli-point check-in process and statistical process control to ensure that our products will continually exceed our clients' expectations.

Markets

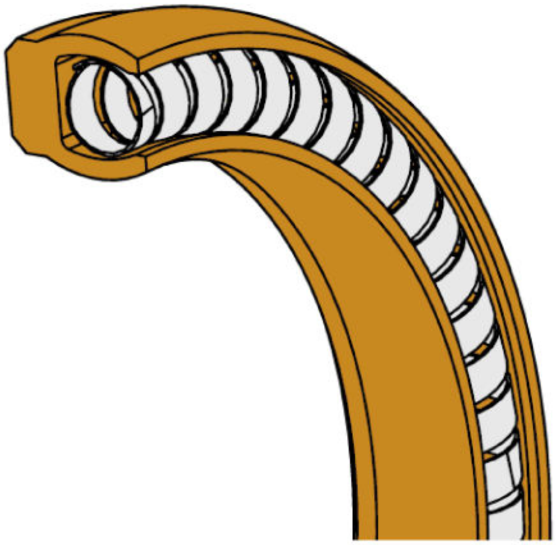
Industrial

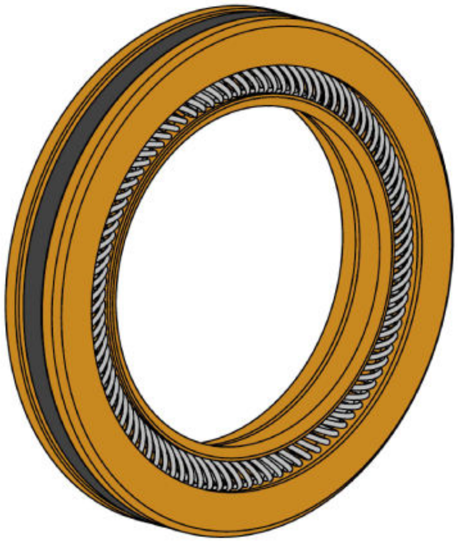
Energy Oil & Gas

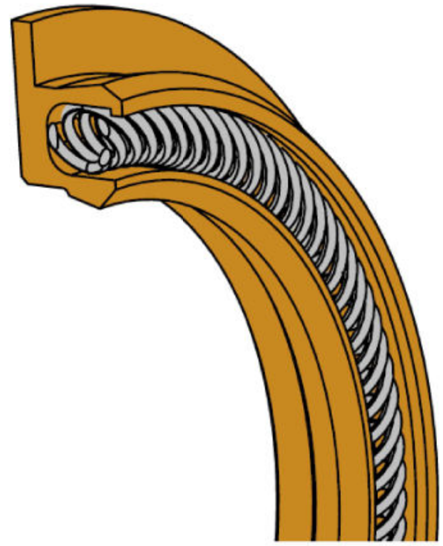
Bio-Technology

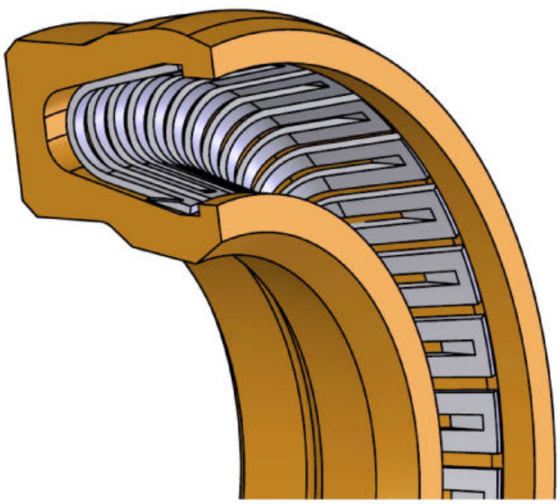
Aerospace

Semiconductor









SES Introduction

Spring energized seals (SES) are typically single-acting, but can be designed for double-acting applications. SES can seal in static and dynamic applications and combine the low friction, wide temperature range, and chemical resistance characteristics of the SES jacket with the chemical resistance and loading force of a metal spring or elastomer energizer. This creates a consistent and long-life seal that can be used in nearly all applications.

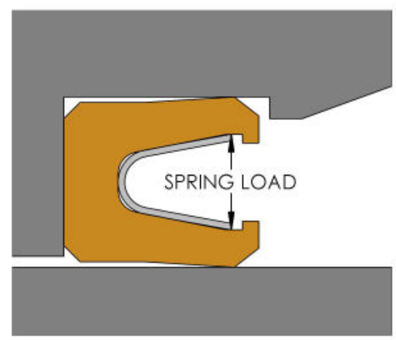
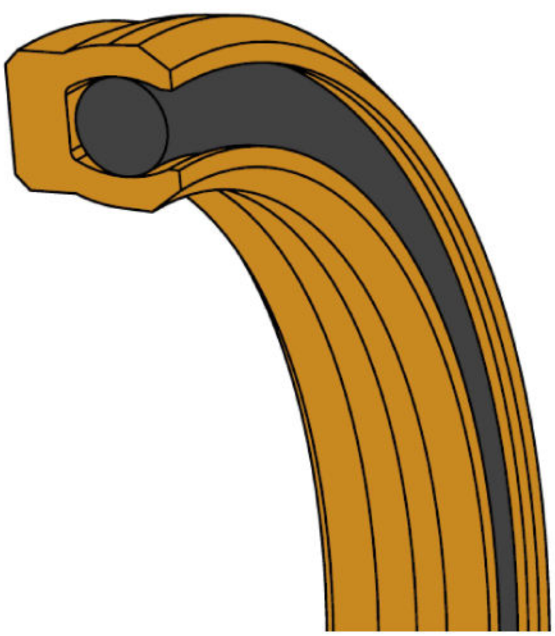


FIGURE 1: NO SYSTEM PRESSURE



T-LON's SES are made with a machined polymer U-shaped profile and an energizer installed into the pocket. These can be used in low and high pressure applications. At low pressures, the energizer expands the seal lips radially creating a uniform sealing force. When pressure is applied, the energizer force and the system pressure will energize the lips of the seal. As system pressure increases, the sealing force increases.
(See Figure 1 and Figure 2)

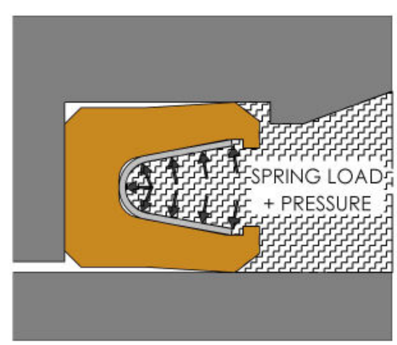


FIGURE 2: SYSTEM PRESSURE APPLIED

Hardware Surface

Spring energized seals require special attention to component surface finish and surface hardness to maximize T-LON seal material life and to exceed leakage performance. For further details, from what is shown, contact the T-LON factory.

Surface finish:

Depending on the application and sealing media, different surface finishes optimize leakage and seal life performance. See Table 1 for typical maximum roughness values to optimize leakage performance. For dynamic seal life, there are 2 main types of wear: abrasive and adhesion. Abrasive wear is from a rough surface finish shearing seal material while adhesive wear is from a too smooth finish causing seal material to flake from adhering to the mating surface. In most cases, avoid <4μin [.1μm] Ra. In some applications, mainly reciprocating air compressor seals, it may be advantageous to target a rougher surface finish that will allow the seal material to imbed into the surface (during a seal break-in period) to optimize seal life while sacraficing initial leakage performance.

Table 1: Maximum Surface Finish to Optimize Leakage Performance

Media	**Rotary Application** e.g. pumps, hydraulic motors,transmissions, mixers, rotary unions		**Reciprocating Application** e.g. piston cylinders (i.e. rod/piston seals), pilot valves		**Static Applications** e.g. valve seats, fittings, face seals	
- Cryogenic Applications **- Low Molecular Weight Gases** (e.g. H, He, N, O)	Rt = 1.00 µm Rz = 0.63 µm Ra = 0.10 µm Mr = 50-90% at C=.25Rz	Rt = 39 µin Rz = 25 µin Ra = 4 µin Mr = 50-90% at C=.25Rz	Rt = 2.50 µm Rz = 1.60 µm Ra = 0.20 µm Mr = 50-90% at C=.25Rz	Rt = 98 µin Rz = 63 µin Ra = 8 µin Mr = 50-90% at C=.25Rz	R_a=.2µm	R_a=8µin
- Low Viscosity Fluids (e.g. water, alcohols, natural gas, air)	Rt = 2.50 µm Rz = 1.60 µm Ra = 0.20 µm Mr = 50-90% at C=.25Rz	Rt = 100 µin Rz = 63 µin Ra = 8 µin Mr = 50-90% at C=.25Rz	Rt = 3.50 µm Rz = 2.20 µm Ra = 0.30 µm Mr = 50-90% at C=.25Rz	Rt = 138 µin Rz = 87 µin Ra = 12 µin Mr = 50-90% at C=.25Rz	R_a=.4µm	R_a=16µin
-All Other Media	Rt = 2.50 µm Rz = 1.60 µm Ra = 0.20 µm Mr = 50-90% at C=.25Rz	Rt = 100 µin Rz = 63 µin Ra = 8 µin Mr = 50-90% at C=.25Rz	Rt = 4.00 µm Rz = 2.50 µm Ra = 0.40 µm Mr = 50-90% at C=.25Rz	Rt = 157 µin Rz = 98 µin Ra = 16 µin Mr = 50-90% at C=.25Rz	R_a=.6µm	R_a=24µin

Ra (Arithmetic average roughness- average height of peak heights and valleys from the mean line, measured within the sampling length)

Rz (Mean roughness height - arithmetic mean value of the single roughness depths of consecutive sampling lengths)

Rt (Max. roughness height - distance from the highest peak to the deepest valley within the evaluation length)

Mr (Material Ratio, % - determined by an intersecting line which separates the peaks from the roughness core profile. It is the ratio between the intersection lengths and the sampling length)

Surface Hardness:

For dynamic applications, depending on the application and sealing media, different surface hardnesses optimize seal performance. It is critical to specify a seal jacket material (see Table 2) with a given mating surface hardness or optimize the surface hardness with a selected jacket material. Surface hardness is critical for avoiding seal adhesion to mating components (increasing seal friction), poor seal life, poor component life, and system failure.

T-LON® "SES" Spring/Elastomer Energized Seals

Common Seal Jacket Materials

Table 2: TLon Material Codes and Properties (Contact factory for other material options)

Prop. / Mat'l	Color	Wear Resist. (1-5)	Extr. Resist. (1-5)	USP VI / FDA Compliant	Dynamic Surface Abrasion (Relative)	Temp. Range (°F) **App. Depend.	Mating Surface Hardness HRc (Dry)	Typical Applications / Sealing Mode (Static, Reciprocating, Rotary, All)	
		1=Fair / 5=Excellent							
T-Lon-01 Virgin PTFE	White	1	1	FDA USP Class VI	Very Low	-436 to 500	Any	Static	Food Processing Cryogenics/Static Seals
T-Lon-02 Pig. PTFE	Aqua	2	1	FDA	Low	-436 to 500	>25	Recip.	Slow Dynamic Seals Pneumatic Seals
T-Lon-11 25% Glass Filled PTFE	White	4	3	No (FDA/USP VI upon request)	High	-328 to 575	>60	Recip.	General Purpose Seals Reciprocating Seals
T-Lon-15 25% Carbon/ Graphite PTFE	Black	4	5	No	Moderate	-328 to 575	>50	All	Dry/Wet/Steam/ Corrosive Media High Pressure
T-Lon-16 15% Graphite Filled PTFE	Black	2	2	No	Low	-328 to 575	>25	All	Soft Metal Counterfaces Dry/Wet/Steam/ Corrosive Media
T-Lon-22 60% Bronze Filled PTFE	Bronze	4	5	No	Low	-328 to 575	>45	Recip.	High Pressure Reciprocating Seals Slow Rotary Seals
T-Lon-31 Glass/Moly Filled PTFE	Dark Grey	4	3	No	Moderate	-328 to 575	>60	Recip.	Reciprocating and Slow Rotary Seals
T-Lon-34 Ekonol Filled PTFE	Beige	4	3	FDA	Low	-436 to 575	Any	All	Reciprocating Seals Moderate Rotary Sealing Not for Steam > 250°F
T-Lon-37 Polyimide Filled PTFE	Tan	3	3	FDA <212°F	Very Low	-436 to 575	Any	All	Low Friction Reciprocating Seals Moderate Rotary Seals
T-Lon-53 Modified PTFE	Transp. White	1	2	FDA USP Class VI	Very Low	-436 to 550	Any	Static	Food Processing Cryogenics/Static Seals
T-Lon-59 15% Mineral Filled PTFE	Cream	3	3	FDA	Moderate	-328 to 575	>45	All	Filling Equipment / Mixers Moderate Rotary Seals Dynamic Seals for FDA
T-Lon-75 Carbon Fiber Filled PTFE	Brown	5	4	No	High	-328 to 575	>50	Recip.	Wet/Steam/ Corrosive Media Not For Gas Media
T-Lon-D5 Mineral/MoS2 T-SMART®	Dark Grey	4	4	No	Low	-328 to 575	>45	All	High Speed Rotary Seals Improved PV Rating Pneumatic Seals Low Mol. Weight Gasses
T-Lon-D9 Carbon Filled T-SMART®	Black	4	4	FDA	Low	-328 to 575	>45	All	High Speed Rotary Seals Improved PV Rating Pneumatic/Water Media Low Mol. Weight Gasses
T-Lon-E6 PPS/Carbon Filled PTFE	Black	5	4	No	Moderate	-328 to 575	>50	All	Highest PV Rotary Seals High Speed / Pressure Compressor Seals
T-Lon-UH UHMW-PE	White	4	4	FDA	Very Low	-320 to 180	Any	All	Abrasive/Water Media. Limited Chemical Resist.

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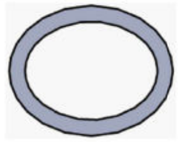
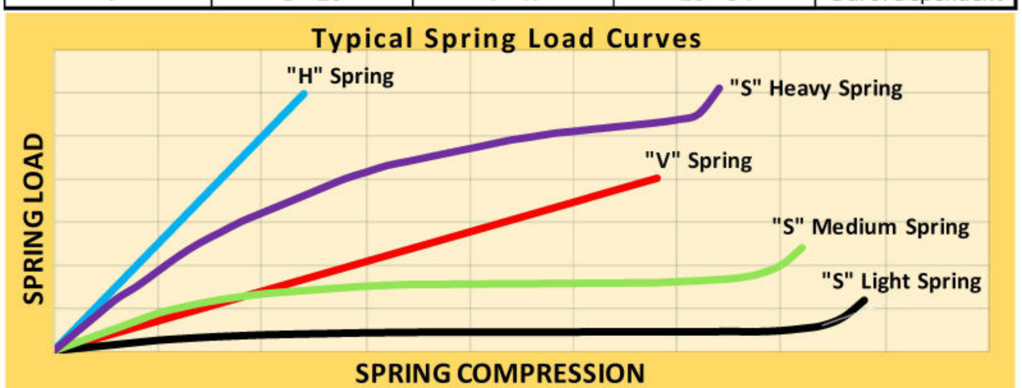
T-LON® "SES" Spring/Elastomer Energized Seals

Table 3: Energizer Descriptions and Typical Loads

	"V" Spring Cantilever	"S" Spring SlantPitch™	"H" Spring Helical	"O" O-ring Energizer
Cross-Section				
Full View				
Spring Load	**Medium**	**Light, Medium, Heavy**	**Heavy**	**Mat'l / Duro. Dependent**
Series	**Typical Spring Loads Available (lbf/linear in.)**			
9 ("S" Only)	N/A	0.2 - 15	N/A	N/A
0	3 - 6	1 - 18	12 - 26	Duro. Dependent
1	8 - 14	3 - 30	8 - 14	Duro. Dependent
2	6 - 14	3 - 27	12 - 24	Duro. Dependent
3	3 - 8	5 - 50	10 - 24	Duro. Dependent
4	3 - 10	4 - 47	16 - 34	Duro. Dependent



Energizer Options

T-Lon SES are available with four main energizer types: "V" cantilever spring, "S" slantpitch spring, "H" helical spring, and "O" elastomer o-rings. The descriptions and loads are shown in **Table 3** and the available spring materials and properties are shown in **Table 4**.

"V" Cantilever Springs:
- Cost effective
- Moderate load over a wide deflection range
- The deflection point is advantageous for scraper lip designs to remove system contaminants

"S" Slantpitch Springs:
- Most versatile with several load options available
- Wide deflection range

"H" Helical Springs:
- High Load for static/slow dynamic applications
- Narrow deflection range

"O" Elastomer o-rings:
- Cost-effective if chemical/temperature resistance and application parameters are within design constraints.

Table 4: Spring Materials and Properties.

Spring Material	Spring Type	Material Code	Recommended Temp Range	Minimum Tensile Strength	Applications
301ss	V	S	-400 to 600°F (-240 to 315°C)	185ksi (1276 MPa)	General purpose for most fluids up to 600 °F. Recommended to 400 °F in corrosive media. Resistance to atmospheric corrosion, food, juices and road de-icing salt is excellent.
302ss	S	B	-400 to 600°F (-240 to 315°C)	285ksi (1966 MPa)	
17-7PH ss	H	P	-400 to 600°F (-240 to 315°C)	200ksi (1379 MPa)	
****316ss**	V | S	A	-400 to 600°F (-240 to 315°C)	(V)175ksi (1207 MPa) (S)235ksi (1621 MPa)	Improved corrosion resistance. Common material for food-contact applications.
****Elgiloy**	V | H	E	-400 to 600°F (-240 to 315°C)	200ksi (1379 MPa)	Sour well, seawater, and numerous corrosive environments.
****C-276**	S	H	-400 to 600°F (-240 to 315°C)	200ksi (1379 MPa)	Sour well, seawater, and acidic and chloride-bearing environments.

**Contact factory for availability and other material options.

T-LON® "SES" Spring/Elastomer Energized Seals

Gland Design Guide

Two Piece Gland

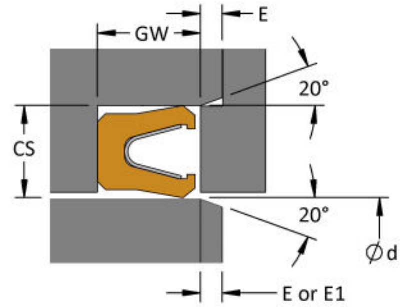
See schematics to the right and **Table 5**.

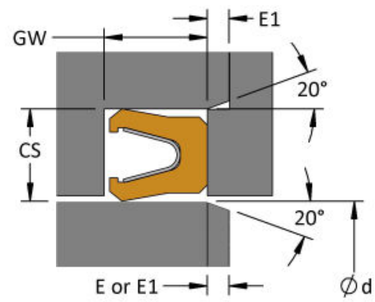
Heel assembled first into gland:
Spring energized seals generally require a two piece gland design to prevent damage during installation. Since the seal is made from rigid polymers, it is not easily stretched or compressed like an o-ring that fits into a one piece gland. Assembling heel side first requires lead-in chamfers, "E".

Lips assembled first into gland:
Assembling the seal lip-side (pressure-side) first requires larger lead-in chamfers, "E1", to prevent seal damage.

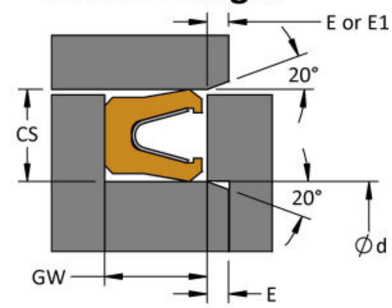
Applications:
Standard u-cup shaped SES (profile codes 00-16 shown on sheets 13-14) are typically used for static and reciprocating applications only. These are permssible to use for rotary applications if surface speeds are <50 sfpm. Otherwise, to prevent the seal from spinning in the gland, alternate design options should be used (e.g. Flanged Gland or Rotary O-ring SES).

Shaft Design:





Piston Design:



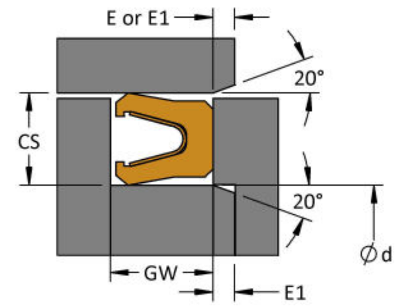


Table 5: Gland Dimensions for Standard 2-piece Glands

Series	Min. "CS"	Tolerance	Min. "GW"	Tolerance	E Min. (Heel First)	E1 Min. (Lips First)	Typ Shaft Ød Range
9*	0.039	+.001/-0	0.063	+.010/-0	0.020	0.040	0.094 - 1.000
0	0.062	+.002/-0	0.094	+.010/-0	0.020	0.050	0.125 - 4.000
1	0.093	+.003/-0	0.141	+.010/-0	0.030	0.070	0.187 - 6.000
2	0.125	+.003/-0	0.188	+.010/-0	0.030	0.090	0.250 - 13.500
3	0.187	+.004/-0	0.281	+.010/-0	0.040	0.110	0.500 - 19.500
4	0.250	+.005/-0	0.375	+.010/-0	0.050	0.140	1.500 - 19.500

Step Cut Gland

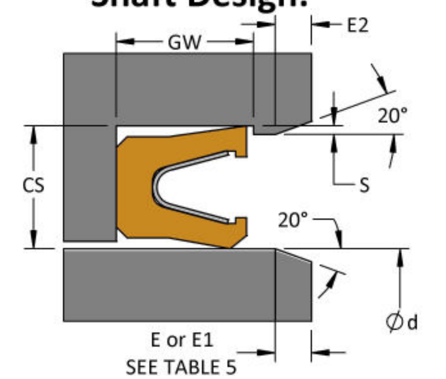
See schematics to the right **Table 6**.

An alternative is the step cut gland where the front of a one piece groove has a machined retention step. The retention step is adequate to retain the seal in most applications. The seal must go into the groove from the heel-side with the open side facing the pressure and retention step.

A scraper lip design (see sheet 12) should be used in step cut glands. The sharp lip snaps in behind the step to improve the retention of the seal

For options to use a step cut gland for smaller diameter seals, contact T-Lon.

Shaft Design:



Piston Design:

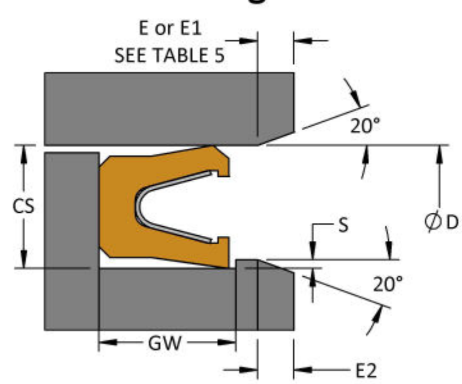


Table 6: Gland Dimensions for Step Cut Glands

Series	Min. "CS"	Tolerance	Min. "GW"	Tolerance	E2 Min.	S		Typ Ød Range		Typ ØD Range
9*	0.039	+.001/-0	0.063	+.010/-0	0.030	.005/.008	Shaft Design	0.625 - 1.000	Piston Design	0.406 - 1.000
0	0.062	+.002/-0	0.094	+.010/-0	0.035	.007/.010		0.750 - 4.000		0.438- 4.000
1	0.093	+.003/-0	0.141	+.010/-0	0.050	.010/.015		1.125 - 6.000		0.688 - 6.000
2	0.125	+.004/-0	0.188	+.010/-0	0.065	.015/.020		1.375 - 13.500		0.750 - 13.500
3	0.187	+.006/-0	0.281	+.010/-0	0.080	.020/.025		1.500 - 19.500		1.094 - 19.500
4	0.250	+.008/-0	0.375	+.010/-0	0.095	.025/.030		1.750 - 19.500		1.750 - 19.500

* 9 series is available in "S" SlantPitch Spring Only.

Gland Design Guide

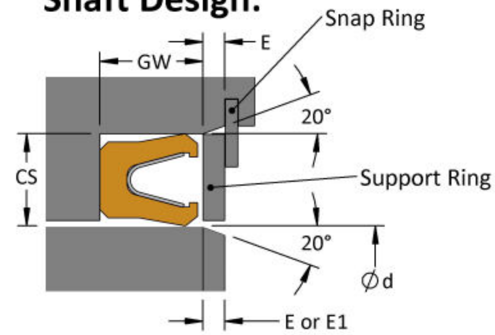
Snap Ring Glands

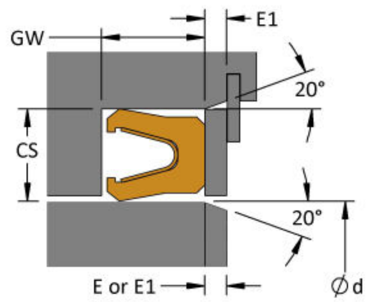
See schematics to the right and refer back to **Table 5**.

Heel assembled first into gland:
With a snap ring retainer, the snap ring groove diameter is offset from the seal gland diameter to ensure that the seal does not pass over the sharp edges of the snap ring groove. A support ring is optional in this configuration.

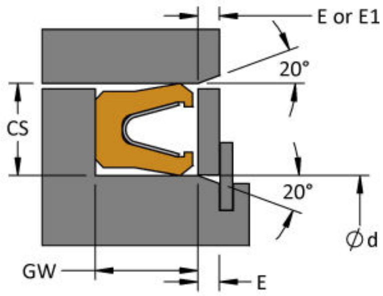
Lips assembled first into gland:
With a support ring and snap ring retainer, the snap-ring groove diameter is also offset from the seal gland diameter to prevent damage to the seal. The support ring must meet extrusion gap recommendations. Load ratings for snap rings and support rings must be considered to prevent failure.

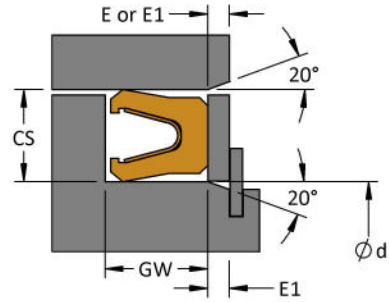
Shaft Design:





Piston Design:





Closed Glands

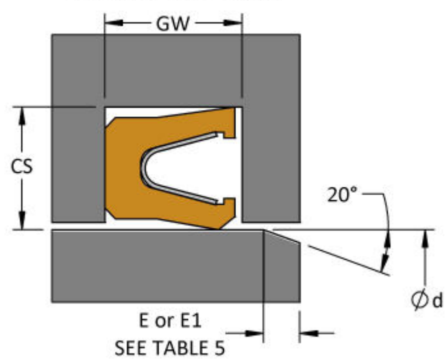
See schematics to the right and **Tables 7 and 8** and refer back to **Table 5**.

The closed gland design should be considered as a last resort option because the seal is prone to damage during installation. The seal cross-section, energier type, diameter, and jacket material determine whether the seal can be stretched (piston design) or deformed (shaft design).

Table 7 is a guide for minimum shaft diameters that can be used for shaft seals and **Table 8** is a guide for minimum bore diameters that can be used for piston seals with closed glands using proper installation and re-sizing tools (see sheet 18).

Note that highly filled PTFE compounds with low tensile elongation are prone to cracking during installation and should be avoided for use in closed glands

Shaft Design:



Piston Design:

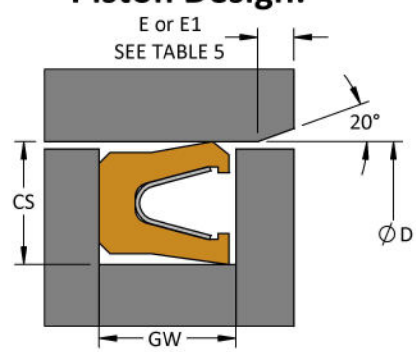


Table 7: Minimum Shaft Diameters for Shaft Design Closed Glands

Series	Min. "CS"	Min Shaft, Ød			
		"V" Spring	"S" Spring	"H" Spring	"O" O-ring
9*	0.039	-	1.000	-	-
0	0.062	1.500	1.000	1.000	1.000
1	0.093	2.750	2.500	2.500	2.500
2	0.125	5.000	4.500	4.500	4.500
3	0.187	11.750	9.000	9.000	9.000
4	0.250	NR	16.000	16.000	16.000

Table 8: Minimum Bore Diameters for Piston Design Closed Glands

Series	Min. "CS"	Min Bore, ØD			
		"V" Spring	"S" Spring	"H" Spring	"O" O-ring
9*	0.039	-	1.000	-	-
0	0.062	1.500	1.000	1.000	1.000
1	0.093	2.000	1.250	1.250	1.250
2	0.125	2.750	2.000	2.000	2.000
3	0.187	4.750	3.000	3.000	3.000
4	0.250	6.000	4.500	4.500	4.500

T-LON® "SES" Spring/Elastomer Energized Seals

Gland Design Guide Continued...

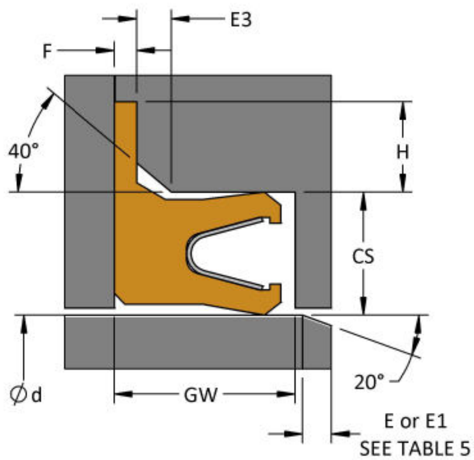
Flanged Gland

See schematics to the right and **Table 9**.

In rotary applications the seal must remain stationary inside the gland and never rotate with the shaft(shaft design)/bore(piston design). To prevent seal rotation, the seal can be mechanically locked into the gland. The flange of the seal is squeezed by the retention plate to act as an anti-rotation device.

The flange seal can also be used in reciprocating applications. The flange keeps the seal locked into place preventing axial movement of the seal in the groove.

Shaft Design:



Piston Design:

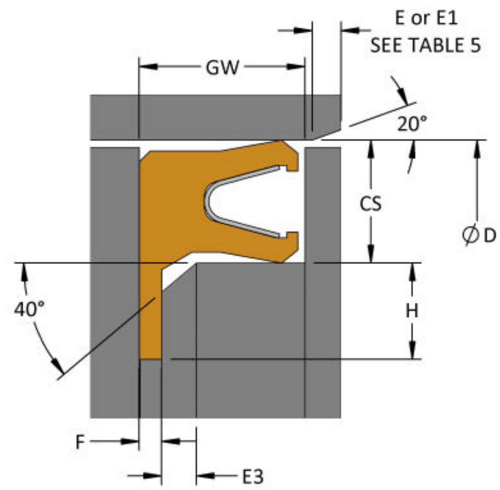


Table 9: Gland Dimensions for Flanged Gland

Series	Min. "CS"	Tolerance	Min. "GW"	Tolerance	E3	F	H Min.	Min. Ød		Min. ØD	
9*	0.039	+.001/-0	0.062	+.010/-0	0.008	.011/.013	0.075	Shaft Design	0.094	Piston Design	0.469
0	0.062	+.002/-0	0.094	+.010/-0	0.020	.011/.013	0.075		0.125		0.531
1	0.093	+.003/-0	0.141	+.010/-0	0.033	.017/.020	0.077		0.187		0.625
2	0.125	+.003/-0	0.188	+.010/-0	0.048	.024/.027	0.093		0.250		0.688
3	0.187	+.004/-0	0.281	+.010/-0	0.068	.028/.032	0.145		0.500		0.938
4	0.250	+.005/-0	0.375	+.010/-0	0.082	.041/.045	0.161		1.500		1.750

* 9 series is available in "S" SlantPitch Spring Only.

Rotary O-ring SES or Metal Encased SES (not shown) Gland

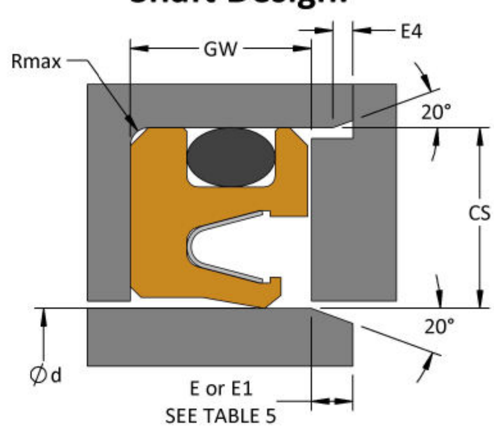
See schematics to the right and **Table 10.**

In rotary applications, the seal must remain stationary inside the gland and not rotate with the shaft(shaft design)/bore(piston design). To prevent seal rotation, the o-ring will squeeze against the static surface to act as an anti-rotation device.

For reciprocating applications with large seal glands, the rotary o-ring gland design can also be used.

In some rotary applications, geometry may be added to the static side of the hardware to retain the seal rather than using an additional retaining feature. Contact T-Lon for more information.

Shaft Design:



Piston Design:

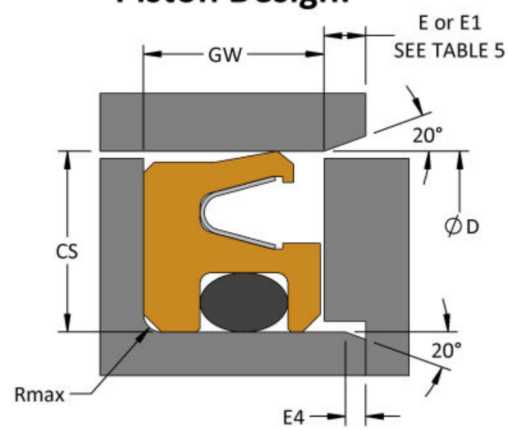


Table 10: Gland Dimensions for Rotary O-ring Gland

Series	Min. "CS"	Tolerance	Min. "GW"	Tolerance	R_{MAX}	E4 Min.	Min. Ød		Min. ØD	
0	0.125	+.002/-0	0.156	+.010/-0	0.010	0.035	Shaft Design	0.125	Piston Design	0.500
1	0.187	+.003/-0	0.188	+.010/-0	0.015	0.040		0.187		0.625
2	0.250	+.003/-0	0.250	+.010/-0	0.025	0.060		0.250		0.750
3	0.375	+.004/-0	0.375	+.010/-0	0.035	0.080		0.500		1.000
4	0.500	+.005/-0	0.500	+.010/-0	0.040	0.120		1.500		1.750

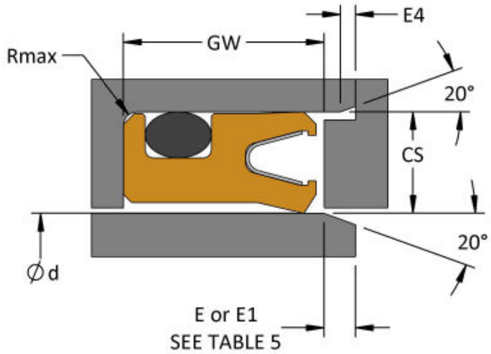
Gland Design Guide Continued...

Heel O-ring Gland

See schematics to the right and **Table 11.**

In rotary applications, the seal must remain stationary inside the gland and not rotate with the shaft(shaft design)/bore(piston design). To prevent seal rotation, the o-ring will squeeze against the static surface to act as an anti-rotation device. If radial space is limited, rather than using the rotary o-ring design, the heel o-ring design offers an alternate solution.

Shaft Design:



Piston Design:

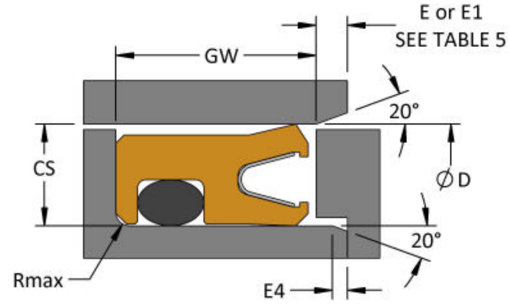


Table 11: Gland Dimensions for Heel O-ring Gland

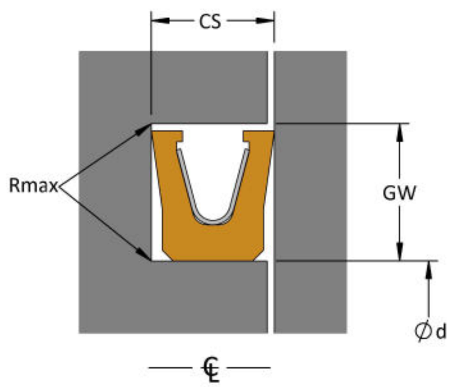
Series	Min. "CS"	Tolerance	Min. "GW"	Tolerance	R_{MAX}	E4 Min.	Min. Ød		Min. ØD	
0	0.094	+.002/-0	0.210	+.010/-0	0.010	0.035	Shaft Design	0.125	Piston Design	0.313
1	0.125	+.003/-0	0.285	+.010/-0	0.015	0.040		0.187		0.437
2	0.187	+.003/-0	0.370	+.010/-0	0.025	0.060		0.250		0.625
3	0.250	+.004/-0	0.450	+.010/-0	0.035	0.080		0.500		1.000

Face Seal Gland

See schematics to the right and **Table 12.**

In static and slow dynamic face seal applications, outside and inside spring energized seals are designed to keep system pressure externally or internally, respectively. The seal u-cup/spring faces positive pressure. Choosing the appropriate spring for closure or squeeze force needs to be determined and specified.

Outside Face Seal Design:



Inside Face Seal Design:

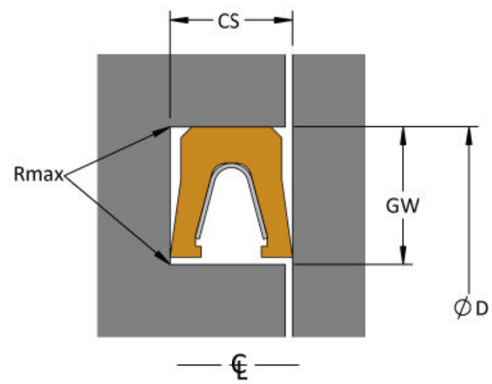


Table 12: Gland Dimensions for Face Seal Glands

Series	Min. "CS"	Tolerance	Min. "GW"	Tolerance	R_{MAX}	Min. Ød		Min. ØD	
0	0.061	+.002/-0	0.094	+.010/-0	0.007	Outside Face Seal	0.187	Inside Face Seal	0.500
1	0.092	+.003/-0	0.141	+.010/-0	0.010		0.375		0.687
2	0.124	+.003/-0	0.188	+.010/-0	0.010		0.625		1.000
3	0.186	+.004/-0	0.281	+.010/-0	0.015		1.500		1.875
4	0.249	+.005/-0	0.375	+.010/-0	0.015		4.500		5.000

T-LON® "SES" Spring/Elastomer Energized Seals

Seal Pressure Rating and Extrusion

Table 13: Allowable Extrusion Gaps

Series	Max Temp. (°F)	Max. Extrusion Gap** (in) at Given Pressures					
		500psi	1000psi	3000psi	5000psi	7500psi	10k psi
9	200	0.006	0.004	0.001	*	*	*
	300	0.004	0.002	*	*	*	*
	400	0.002	0.001	*	*	*	*
	500	0.001	*	*	*	*	*
0	200	0.009	0.005	0.002	0.001	*	*
	300	0.006	0.004	0.001	*	*	*
	400	0.004	0.002	*	*	*	*
	500	0.002	0.001	*	*	*	*
1	200	0.014	0.008	0.003	0.002	0.001	*
	300	0.011	0.005	0.002	0.001	*	*
	400	0.006	0.003	0.001	*	*	*
	500	0.003	0.001	*	*	*	*
2	200	0.023	0.013	0.004	0.003	0.002	*
	300	0.016	0.009	0.003	0.002	0.001	*
	400	0.009	0.004	0.001	0.001	*	*
	500	0.004	0.002	*	*	*	*
3	200	0.032	0.024	0.008	0.005	0.003	0.002
	300	0.024	0.016	0.005	0.003	0.002	0.001
	400	0.016	0.008	0.003	0.001	0.001	*
	500	0.007	0.003	0.001	*	*	*
4	200	0.036	0.032	0.012	0.007	0.005	0.003
	300	0.032	0.024	0.008	0.005	0.003	0.002
	400	0.024	0.012	0.004	0.002	0.001	0.001
	500	0.011	0.005	0.002	0.001	0.001	*

* Consider Extended Heel or Backup Ring. See Table 12.
**Values are provided as a guide only. Qualification in actual system conditions is recommended. Alternate T-Lon compounds offer improved extrusion resistance. Contact T-Lon for more information, specific to your application.

When high pressure is combined with high temperatures and/or large extrusion gaps, extrusion occurs (see **Figure 3**). When using the minimum "CS" and "GW" from the Gland Design Guide, **Table 13** provides the extrusion gaps required for the mating hardware.

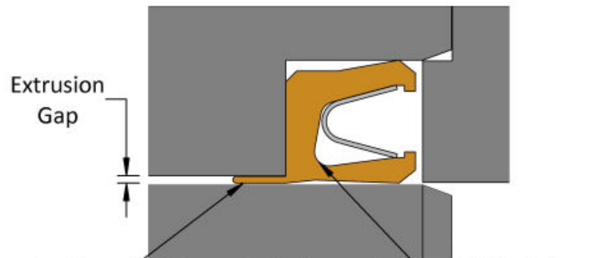


FIGURE 3: Seal Extrusion

Extended heel designs (**Figure 4** and **Table 14**) are intended for use with pressures over 3000 and up to 10k psi. They are also used with lower pressures where excessive extrusion gaps/temperatures are present. The increased material thickness at the back of the seal acts like a built-in back-up ring to prevent extrusion failure.

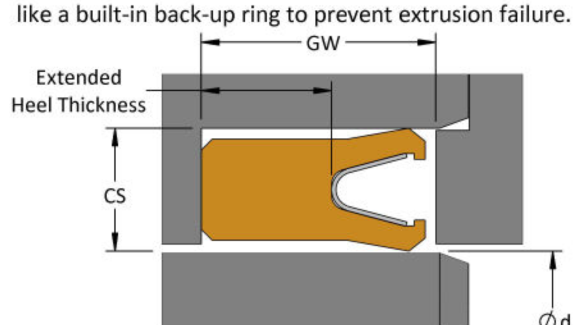


FIGURE 4: Extended Heel Design

Table 14: Extended Heel or Back-up Ring Glands

Series	Min. "CS"	Tolerance	Typical Extended Heel Design		Typ Shaft Ød Range
			"GW"	Tolerance	
9*	0.039	+.001/-0	0.118	+.010/-0	0.094 - 1.000
0	0.062	+.002/-0	0.149	+.010/-0	0.125 - 4.000
1	0.094	+.003/-0	0.183	+.010/-0	0.187 - 6.000
2	0.125	+.003/-0	0.235	+.010/-0	0.250 - 13.500
3	0.187	+.004/-0	0.334	+.010/-0	0.500 - 19.500
4	0.250	+.005/-0	0.475	+.010/-0	1.500 - 19.500

* 9 series is available in "S" SlantPitch Spring Only.

Back-up Rings

For demanding applications, a back-up ring behind the heel of the seal creates a barrier from the seal and the extrusion gap (see **Figures 5, 6, and 7**). The back-up ring is produced from harder materials such as nylon, acetal, PEEK, or bronze (see **Table 15**).

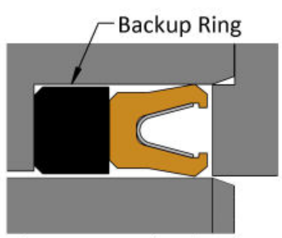


Figure 5: Standard Back-up Design

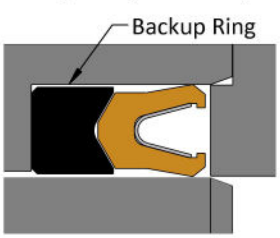


Figure 6: Vee Back-up Design for Additional Scraper Lip and Enclose E-gap

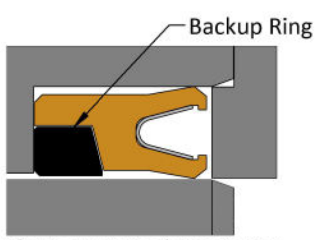


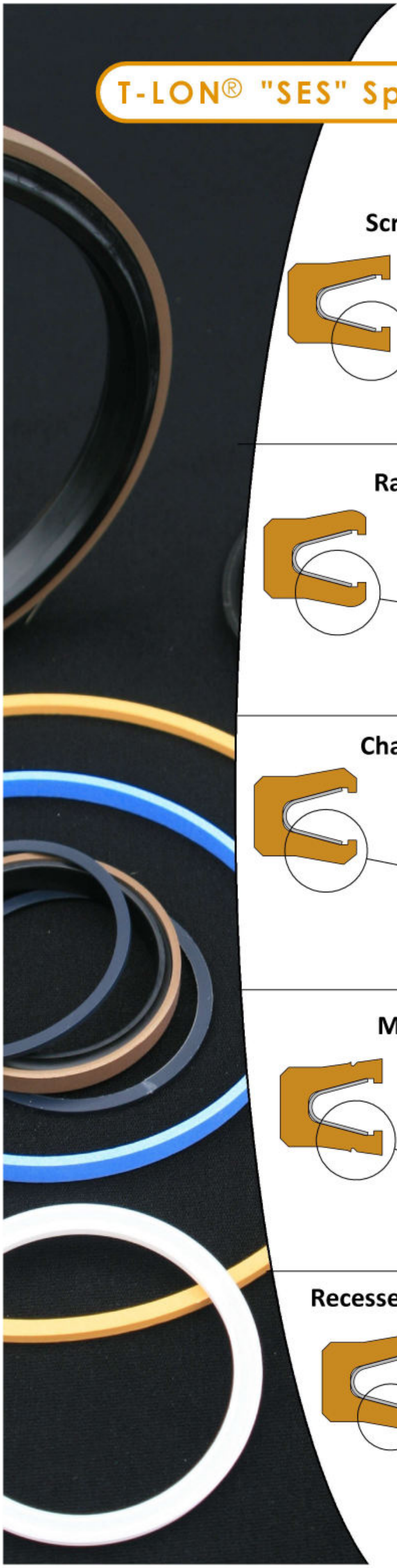
Figure 7: ID Back-up Design to Enclose Shaft E-Gap

Table 15: Back-up Ring Materials

Backup Ring Material	Typ. Max. Pressure (psi)
TLon 6N (Nylon Compound)	10000
TLon 1D (POM)	10000
TLon 92 (PEEK Coompound)	20000
TLon 3B (Bronze Alloy)	40000

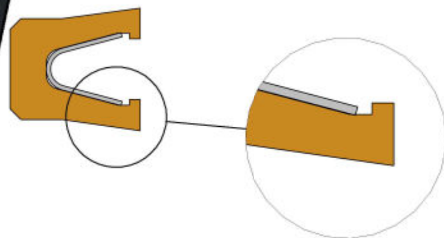
T-LON® "SES" Spring/Elastomer Energized Seals

T-LON



Lip Design Guide

Scraper Lip



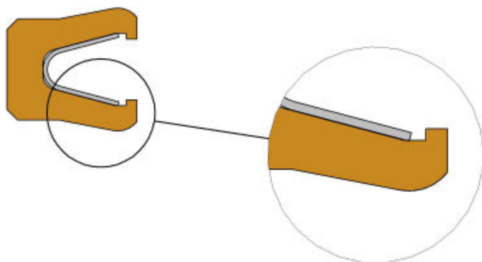
Advantages

Used in abrasive media environments. Sharp angle edge prevents media from lodging between the seal lip and dynamic surface. Low wear rate. Good excluder

Disadvantages

Vulnerable to damage during handling and installation. Requires smooth lead-in chamfer for installation.

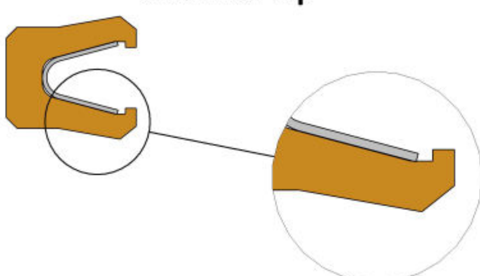
Radial Lip



Used in lubricated or dry operating conditions where no abrasives are present. Radius allows lubrication or PTFE particles under the seal lip to extend life. Reduces potential seal lip damage during installation

Should not be used with abrasive media. Seal lip may hydroplane during high speed reciprocating applications.

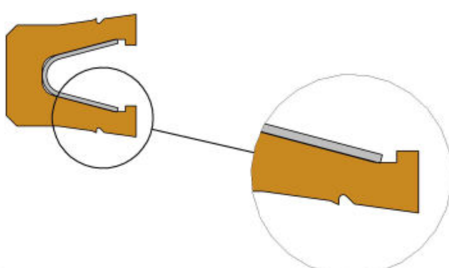
Chamfer Lip



Preferred design for use in lubricated or dry operating conditions where no abrasives are present. Improved stability. Reduces potential seal lip damage during installation.

Should not be used with abrasive media. Seal lip may hydroplane during high speed reciprocating applications.

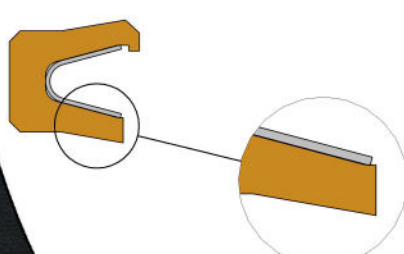
Multi-Lip



Multi lip design will trap fluid between contact points providing added lubrication to seal. Additional sealing lip works well for sealing gases.

Vulnerable to damage during handling and installation. Requires smooth lead-in chamfer for installation.

Recessed Scraper Lip



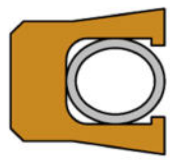
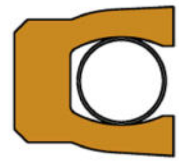
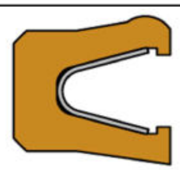
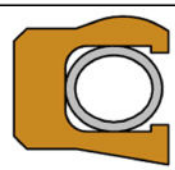
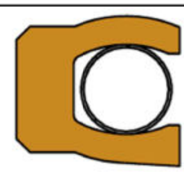
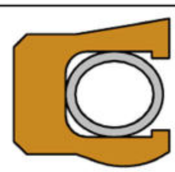
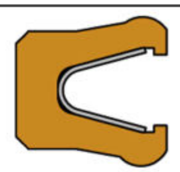
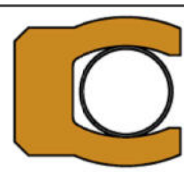
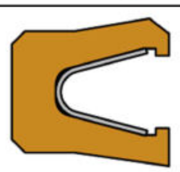
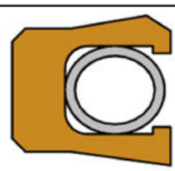
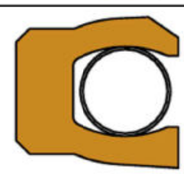
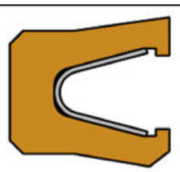
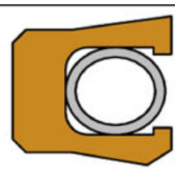
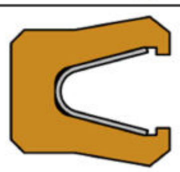
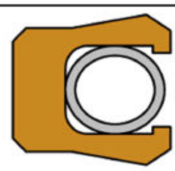
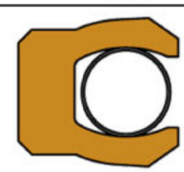
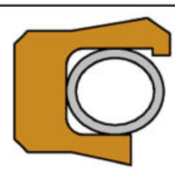
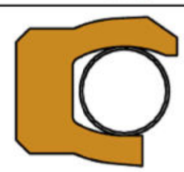
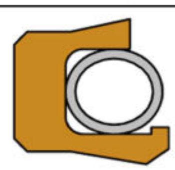
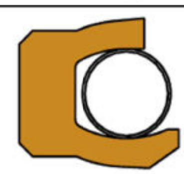
Improved sealability over a regular scraper lip. Reduced probability of seal lip hydroplaning. Preferred lip design for dynamic sealing of abrasive media. Offset lip prevents contact of mating hardware.

Vulnerable to damage during handling and installation. Requires smooth lead-in chamfer for installation. Spring exposed on one seal lip.

T-LON® "SES" Spring/Elastomer Energized Seals

Common SES Profiles

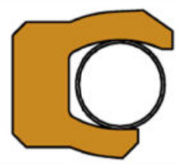
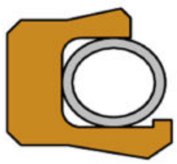
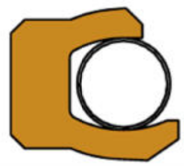
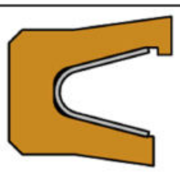
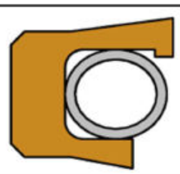
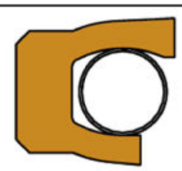
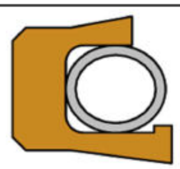
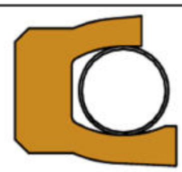
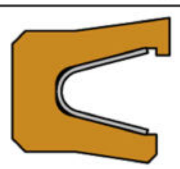
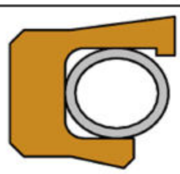
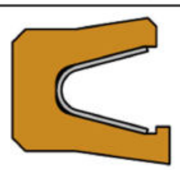
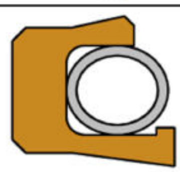
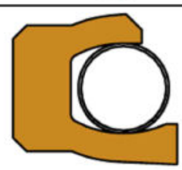
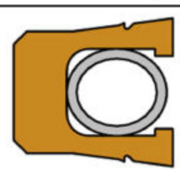
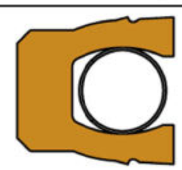
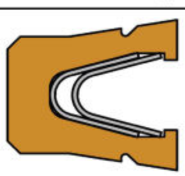
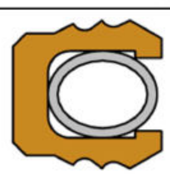
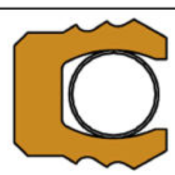
Table 16: SES Profiles (Contact T-Lon for additional profiles)

"V" Cross-Section Energizer Code	"S" Cross-Section Energizer Code	"H" or "O" Cross-Section Energizer Code	Profile Code	Features	TYPICAL USE
			**00**	Scraper ID / OD	Snaps into step piston / step rod gland design. Scrapes contaminants from dynamic surface. Breaks fluid layer on dynamic surface to minimize blow-by.
			**01**	Radius OD / Scraper ID	Snaps into step piston gland design. Scrapes contaminants from rod surface. Breaks fluid layer on dynamic rod surface to minimize blow-by.
			**02**	Scraper OD / Radius ID	Snaps into step rod gland design. Scrapes contaminants from bore surface. Breaks fluid layer on dynamic bore surface to minimize blow-by.
			**03**	Radius OD / Radius ID	Smooth sealing lips similar to o-ring contact area. Reciprocating / slow rotary seals in non-abrasive media
			**04**	Chamfer OD / Scraper ID	Snaps into step piston gland design. Scrapes contaminants from rod surface. Breaks fluid layer on dynamic rod surface to minimize blow-by.
			**05**	Scraper OD / Chamfer ID	Snaps into step rod gland design. Scrapes contaminants from bore surface. Breaks fluid layer on dynamic bore surface to minimize blow-by.
			**06**	Chamfer OD / Chamfer ID	Good sealability for static and slow rotary seals. Reciprocating seals in non-abrasive media
			**07**	Improved Scraper ID / Chamfer OD	Scrapes contaminants from rod surface. Breaks fluid layer on dynamic rod surface to minimize blow-by.
			**08**	Improved Scraper OD / Chamfer ID	Scrapes contaminants from bore surface. Breaks fluid layer on dynamic bore surface to minimize blow-by.

T-LON® "SES" Spring/Elastomer Energized Seals

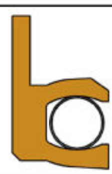
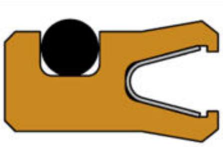
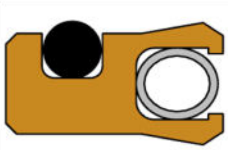
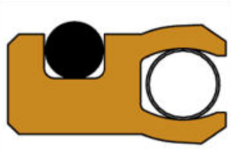
Common SES Profiles Continued...

Table 16 Continued...

"V" Cross-Section Energizer Code	"S" Cross-Section Energizer Code	"H" or "O" Cross-Section Energizer Code	Profile Code	Features	TYPICAL USE
			**09**	Recessed Chamfer ID / Chamfer OD	In lubricated reciprocating applications, the ID lip is optimized for leakage control and maintaining slight fluid layer on dynamic rod surface.
			**10**	Recessed Chamfer OD / Chamfer ID	In lubricated reciprocating applications, the OD lip is optimized for leakage control and maintaining slight fluid layer on dynamic bore surface.
			**11**	Scraper OD / Recessed Scraper ID	Snaps into step rod gland design. Scrapes contaminants and breaks fluid layer on dynamic rod surface to minimize blow-by and hydro-planing of ID lip during reciprocating applications.
			**12**	Scraper ID / Recessed Scraper OD	Snaps into step piston gland design. Scrapes contaminants and breaks fluid layer on dynamic bore surface to minimize blow-by and hydro-planing of OD lip during reciprocating applications.
			**13**	Scraper OD / Recessed Chamfer ID	Snaps into step rod gland design.In lubricated reciprocating applications, the ID lip is optimized for leakage control and maintaining slight fluid layer on dynamic rod surface.
			**14**	Scraper ID / Recessed Chamfer OD	Snaps into step piston gland design. In lubricated reciprocating applications, the OD lip is optimized for leakage control and maintaining slight fluid layer on dynamic bore surface.
			**15**	Improved Leakage Performance Multi-Lip Scraper OD / ID	Scrapes contaminants from dynamic surface. Breaks fluid layer on dynamic surface to minimize blow-by. Additional sealing lip for low molecular weight gasses.
			**16**	Improved Leakage Performance, Multi-Lip OD / ID	High seal contact lip load for improved sealing. Additional sealing lips for low molecular weight gasses
			**17**	Oversized gland, Dual Spring Chamfer OD / ID	Used to retrofit large existing gland cross-sections.

Common SES Profiles Continued...

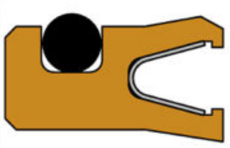
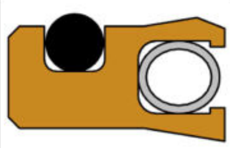
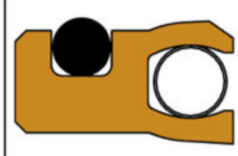
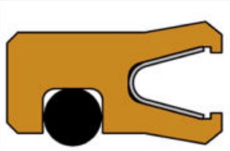
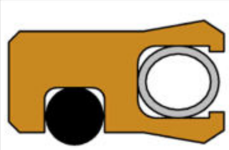
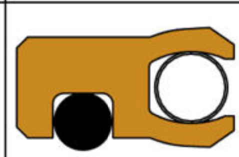
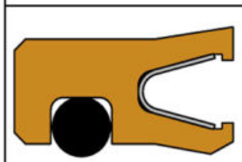
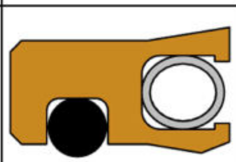
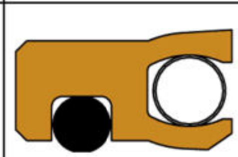
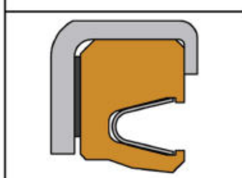
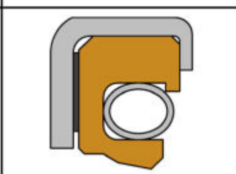
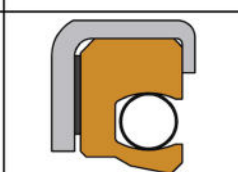
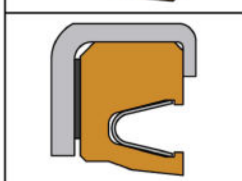
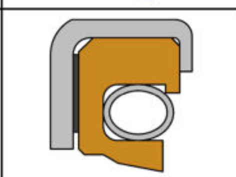
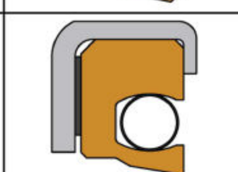
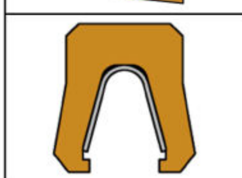
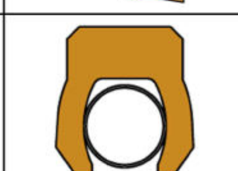
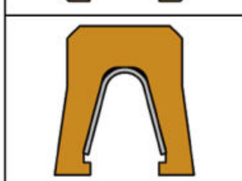
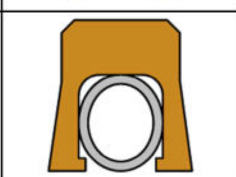
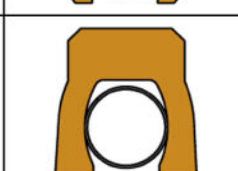
Table 16 Continued...

"V" Cross-Section Energizer Code	"S" Cross-Section Energizer Code	"H" or "O" Cross-Section Energizer Code	Profile Code	Features	TYPICAL USE
			20	Rotary Shaft Seal Chamfer ID	Seal flange clamped in mating hardware to prevent the seal from spinning with the shaft.
			21	Rotary Shaft Seal Scraper ID	Seal flange clamped in mating hardware to prevent the seal from spinning with the shaft. Scraper ID lip prevents debris ingress between lip and shaft.
			22	Rotary Shaft Seal Radius ID	Seal flange clamped in mating hardware to prevent the seal from spinning with the shaft.
			23	Rotary Piston Seal Chamfer OD	Seal flange clamped in mating hardware to prevent the seal from spinning with the bore.
			24	Rotary Piston Seal Scraper OD	Seal flange clamped in mating hardware to prevent the seal from spinning with the bore. Scraper OD lip prevents debris ingress between lip and bore.
			25	Rotary Piston Seal Radius OD	Seal flange clamped in mating hardware to prevent the seal from spinning with the bore.
			26	Rotary Shaft Seal Chamfer ID / OD O-ring	O-ring squeezed in mating hardware to prevent the seal from spinning with the shaft.
			27	Rotary Shaft Seal Scraper ID / OD O-ring	O-ring squeezed in mating hardware to prevent the seal from spinning with the shaft. Scraper ID lip prevents debris ingress between lip and shaft.
			28	Rotary Shaft Seal Chamfer ID / Heel OD O-ring	O-ring squeezed in mating hardware to prevent the seal from spinning with the shaft.

T-LON® "SES" Spring/Elastomer Energized Seals

Common SES Profiles Continued...

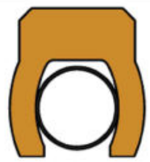
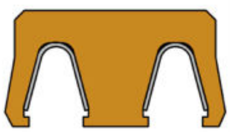
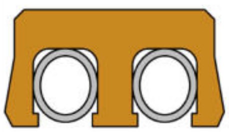
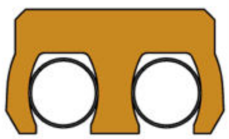
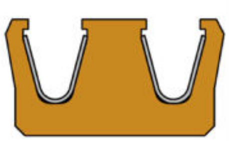
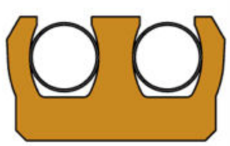
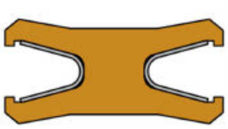
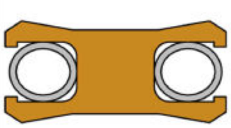
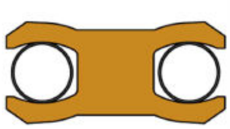
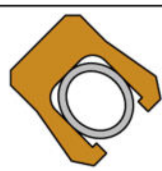
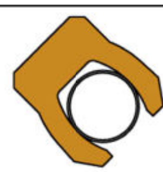
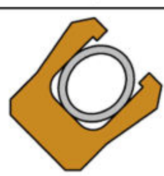
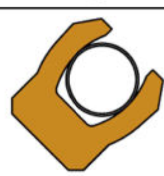
Table 16 Continued...

"V" Cross-Section Energizer Code	"S" Cross-Section Energizer Code	"H" or "O" Cross-Section Energizer Code	Profile Code	Features	TYPICAL USE
			**29**	Rotary Shaft Seal Scraper ID / Heel OD O-ring	O-ring squeezed in mating hardware to prevent the seal from spinning with the shaft. Scraper ID lip prevents debris ingress between lip and shaft.
			**30**	Rotary Piston Seal Chamfer OD / ID O-ring	O-ring squeezed in mating hardware to prevent the seal from spinning with the bore.
			**31**	Rotary Piston Seal Scraper OD / ID O-ring	O-ring squeezed in mating hardware to prevent the seal from spinning with the bore. Scraper OD lip prevents debris ingress between lip and bore.
			**32**	Rotary Piston Seal Chamfer OD / Heel ID O-ring	O-ring squeezed in mating hardware to prevent the seal from spinning with the bore.
			**33**	Rotary Piston Seal Scraper OD / Heel ID O-ring	O-ring squeezed in mating hardware to prevent the seal from spinning with the bore. Scraper OD lip prevents debris ingress between lip and bore.
			**34**	Rotary Shaft Seal Chamfer ID / Metal Encased OD	The metal case is the most reliable anti-rotation option to prevent the seal from spinning with the shaft. In some applications, the metal case bore interference is adequate for seal retention in the gland.
			**35**	Rotary Shaft Seal Scraper ID / Metal Encased OD	The metal case is the most reliable anti-rotation option to prevent the seal from spinning with the shaft. In some applications, the metal case bore interference is adequate for seal retention in the gland.
			**40**	Inside Face Seal Chamfer Lips	Seal clamped in a face-style gland to seal internal system pressure.
			**41**	Inside Face Seal Scraper Lips	Seal clamped in a face-style gland to seal internal system pressure.

T-LON® "SES" Spring/Elastomer Energized Seals

Common SES Profiles Continued...

Table 16 Continued...

"V" Cross-Section Energizer Code	"S" Cross-Section Energizer Code	"H" or "O" Cross-Section Energizer Code	Profile Code	Features	TYPICAL USE
			**42**	Inside Face Seal Radius Lips	Seal clamped in a face-style gland to seal internal system pressure.
			**43**	Inside Face Seal Chamfer Lips Dual Spring	Seal clamped in a face-style gland to seal internal system pressure. Used to retrofit large existing gland cross-sections.
			**50**	Outside Face Seal Chamfer Lips	Seal clamped in a face-style gland to seal external system pressure.
			**51**	Outside Face Seal Scraper Lips	Seal clamped in a face-style gland to seal external system pressure.
			**52**	Outside Face Seal Radius Lips	Seal clamped in a face-style gland to seal external system pressure.
			**53**	Outside Face Seal Chamfer Lips Dual Spring	Seal clamped in a face-style gland to seal external system pressure. Used to retrofit large existing gland cross-sections.
			**60**	Bi-directional Seal Low Pressure Chamfer OD/ID	Used for low bi-directional pressure, piston or shaft seals
			**70**	Inside Angled Seal Chamfer Lips	Internal pressure sealing on conical or spherical mating hardware
			**80**	Outside Angled Seal Chamfer Lips	External pressure sealing on conical or spherical mating hardware

Hardware Configuration and Seal Installation

Hardware and installation tools should be free of nicks, burrs, scratches, or any sharp edges. Lead-in chamfers on the hardware are recommended for installation to prevent seal lip damage and squeeze the seal cross-section into the gland. To ease assembly, typical methods include heating the seals between 200-300°F [100-150°C], and/or adding lubrication. To prevent eccentric seal loading and over-compression, use wear rings to keep piston/shaft concentric to the housing. If lead-in's are not present on a shaft or piston, stretch cones should be used (see Figure 8 & 9). Likewise, if lead-in's are not present in a bore or housing, tapered sleeves should be used (see Figure 10). If possible, avoid contacting the seal lips and apply force to the metal spring or energizer to install the seal into the gland or turn the seal around and apply force on the backside of the seal.

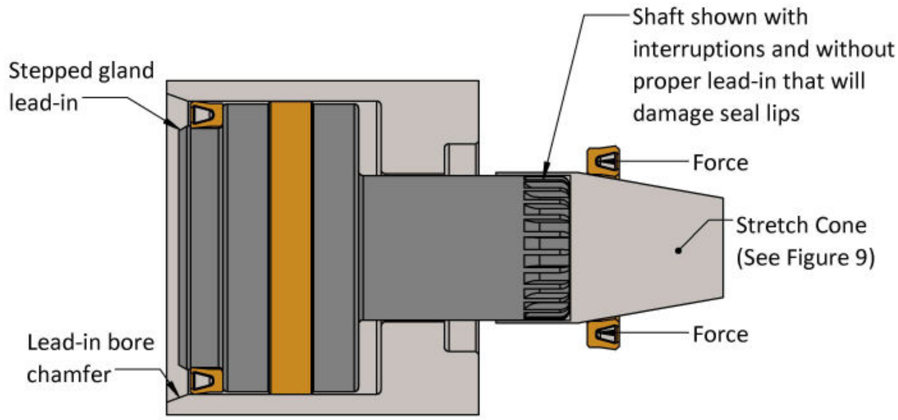


Figure 8: Hardware and Seal Installation Schematic

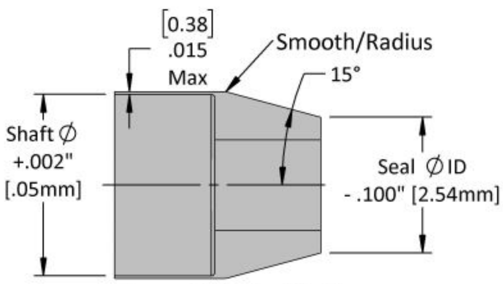


Figure 9: Typical Seal Stretch Cone Design

Using Stretch Cone with Open Gland

1. Place stretch cone onto shaft
2. Place SES seal onto stretch cone
3. Quickly apply uniform force to slide seal onto shaft (DO NOT contact the seal lips)
4. Remove stretch cone
5. Press seal into groove

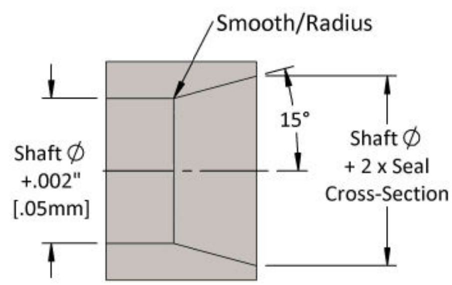


Figure 10: Tapered Sleeve / Resizing Sleeve

For piston designs with closed glands, extreme care must be taken while using a stretch cone and resizing sleeve to force the seal into the gland (see Figures 11-15 for a step by step process).

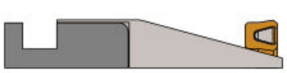


Figure 11: Place Seal On Stretch Cone

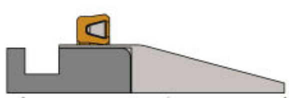


Figure 12: Continue To Push Seal Over Stretch Cone

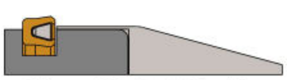


Figure 13: Push Seal Into Gland

Figure 14: Resizing Sleeve Placed On Seal

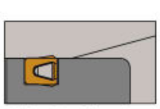


Figure 15: Resize Seal And Compress It Into Gland

For shaft designs with closed glands, extreme care must be taken while using a pusher tool to force and resize the seal into the gland (see Figures 16 & 17 for a step by step process).

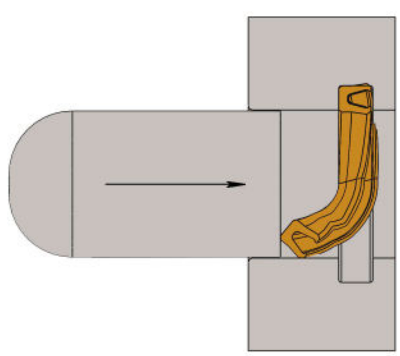


Figure 16: Deform Seal and Apply Force with Pusher Tool Blunt End

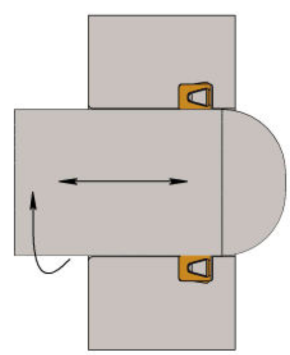


Figure 17: Resize Seal with the Pusher Tool Rounded End

T-LON® "SES" Spring/Elastomer Energized Seals

T-LON

Part Number Structure

_ _ _ - _ _ - _ _ _ _ _ - _ _ _ - _ _ _ _ - _ _ - _ _

TYPE
"S" = SlantPitch Spring
"V" = Cantilever Spring
"H" = Helical Spring
"O" = O-ring

PROFILE CODE
Reference Sheets 13-17

ENERGIZER SIZE/MAT'L
Reference Sheet 6
Examples:
"9A" = 9 Series, 316ss
"1S" = 1 Series, 301ss
"2P" = 2 Series, 17-7PH ss
"2B" = 2 Series, 302ss
"3H" = 3 Series, C-276
"4E" = 4 Series, Elgiloy

GLAND DIAMETER
"ØD"
Reference Schematics
Examples:
"00625" = .625"
"13125" = 13.125"

MINIMUM GLAND CROSS SECTION
"CS"
Reference Schematics
Examples:
"094" = .094"
"250" = .250"

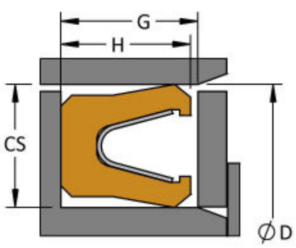
SEAL HEIGHT OR GROOVE WIDTH
Reference Schematics
"H"= Seal Height
"170H" = .170" Seal Height
"G"= Groove Width
"188G" = .188" Min. Groove Width

T-LON MATERIAL
Reference Sheet 5
Examples:
"01"=Virgin PTFE
"16"=15% Graphite PTFE
"UH"=UHMW-PE

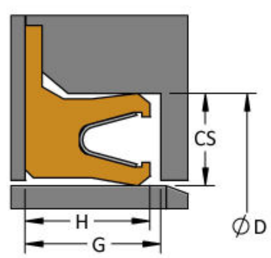
LOADER MAT'L
Reference Profile Codes 26-35
Omit if no loaders req'd
"P" = NBR (-30° to 230° F)
"E" = EPDM (-50° to 300° F)
"V" = FKM (0° to 400° F)

Reference Sheet 25
Omit if no silicone fill
("V" Spring Only)
"Q" = Silicone Filled

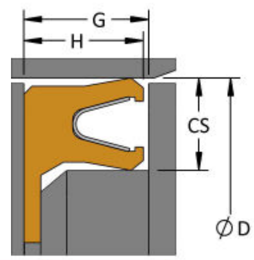
Radial SES (Shaft or Piston)



Flanged Shaft SES



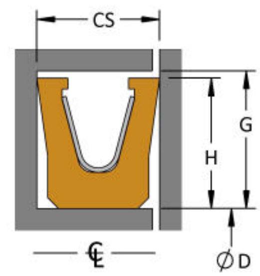
Flanged Piston SES



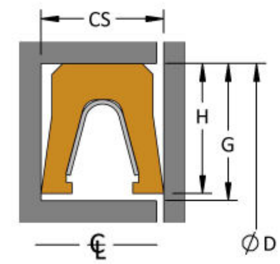
Series	Min. Gland X-section "CS"	Min. Groove Width "G"	Seal Ht Callout "H"	Radial SES and Flanged Shaft SES Min. ØD	Flanged Piston SES Min. ØD
9*	0.039	0.063	0.055	0.172	0.469
0	0.062	0.094	0.083	0.250	0.531
1	0.094	0.141	0.130	0.375	0.625
2	0.125	0.188	0.170	0.500	0.688
3	0.187	0.281	0.260	0.875	0.938
4	0.250	0.375	0.355	2.000	1.750

* 9 series is available in "S" SlantPitch Spring Only.

Outside Face Seal

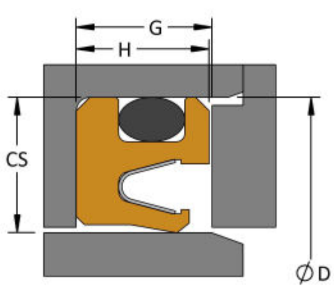


Inside Face Seal

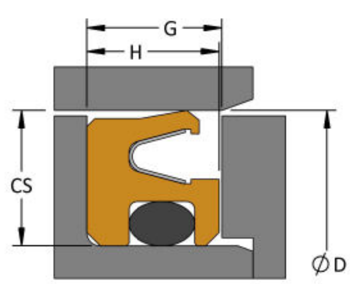


Series	Min. Gland Depth "CS"	Min. Groove Width "G"	Seal Ht Callout "H"	Outside Face Seal Min. ØD		Inside Face Seal Min. ØD	
0	0.061	0.094	0.083	Outside Face Seal	0.187	Inside Face Seal	0.500
1	0.092	0.141	0.130		0.375		0.687
2	0.124	0.188	0.170		0.625		1.000
3	0.186	0.281	0.260		1.500		1.875
4	0.249	0.375	0.355		4.500		5.000

Rotary O-ring Shaft SES



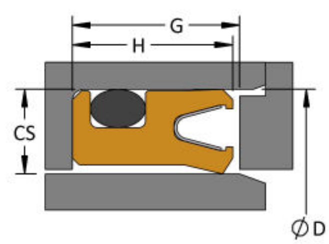
Rotary O-ring Piston SES



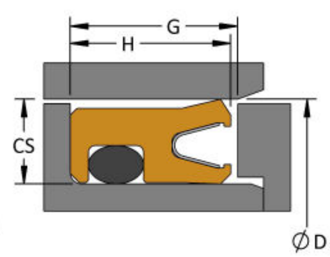
Series	Min. Gland X-section "CS"	Min. Groove Width "G"	Seal Ht Callout "H"	Shaft SES Min. ØD		Piston SES Min. ØD	
0	0.125	0.156	0.151	Shaft Design	0.375	Piston Design	0.500
1	0.187	0.188	0.183		0.561		0.625
2	0.250	0.250	0.245		0.625		0.750
3	0.375	0.375	0.370		0.937		1.000
4	0.500	0.500	0.495		2.500		1.750

Follow Rotary O-ring Glands for Metal Encased SES

Heel O-ring Shaft SES



Heel O-ring Piston SES

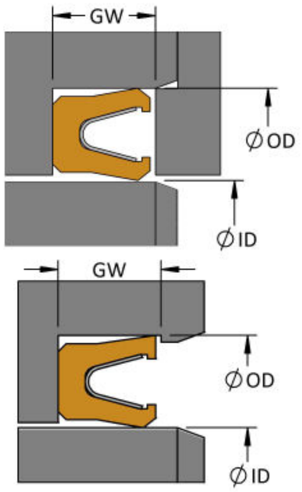


Series	Min. Gland X-section "CS"	Min. Groove Width "G"	Seal Ht Callout "H"	Shaft SES Min. ØD		Piston SES Min. ØD	
0	0.094	0.210	0.195	Shaft Design	0.313	Piston Design	0.500
1	0.125	0.285	0.265		0.437		0.625
2	0.187	0.370	0.345		0.625		0.750
3	0.250	0.450	0.425		1.000		1.000

T-LON® "SES" Spring/Elastomer Energized Seals

T-LON

Dash Size Rod and Piston Glands



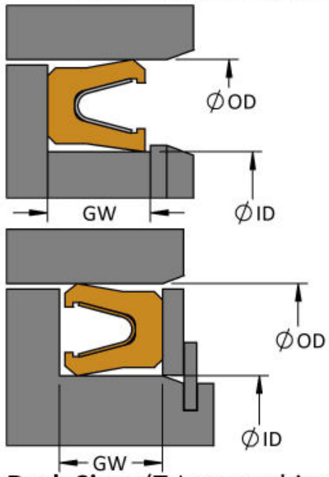


Table 17: Dash Size Groove Widths

Series	Gland Width "GW" Standard Heel	Gland Width "GW" Extended Heel
	+0.010 / -.000	+0.010 / -.000
0	0.094	0.149
1	0.141	0.183
2	0.188	0.235
3	0.281	0.334
4	0.375	0.475

Table 18: Rod and Piston Dash Sizes (T-Lon machines all SES's to order for unlimited seal glands <20" OD)

Dash #	ID	Tol	OD	Tol	Dash #	ID	Tol	OD	Tol	Dash #	ID	Tol	OD	Tol
-006	0.125		0.250		-039	2.750		2.875		-132	1.750		1.937	
-007	0.156		0.281	+.001	-040	2.875		3.000		-133	1.812		2.000	
-008	0.188	+.000	0.313	-.000	-041	3.000	+.000	3.125	+.002	-134	1.875		2.062	
-009	0.219	-.001	0.343		-042	3.250	-.002	3.375	-.000	-135	1.937		2.125	
-010	0.250		0.375		-043	3.500		3.625		-136	2.000		2.187	
-011	0.313		0.437		-044	3.750		3.875		-137	2.062		2.250	
-012	0.375		0.500		-045	4.000		4.125		-138	2.125		2.312	
-013	0.438		0.562		-106	0.187		0.375		-139	2.187		2.375	
-014	0.500		0.625		-107	0.219	+.000	0.406		-140	2.250	+.000	2.437	+.002
-015	0.563		0.687		-108	0.250	-.001	0.437		-141	2.312	-.002	2.500	-.000
-016	0.625		0.750		-109	0.312		0.500		-142	2.375		2.562	
-017	0.688		0.812		-110	0.375		0.562		-143	2.437		2.625	
-018	0.750		0.875		-111	0.437		0.625		-144	2.500		2.687	
-019	0.813		0.937		-112	0.500		0.687		-145	2.562		2.750	
-020	0.875		1.000		-113	0.562		0.750		-146	2.625		2.812	
-021	0.938		1.062		-114	0.625		0.812		-147	2.687		2.875	
-022	1.000		1.125		-115	0.687		0.875		-148	2.750		2.937	
-023	1.063		1.187		-116	0.750		0.937		-149	2.812		3.000	
-024	1.125		1.250	+.002	-117	0.812		1.000		-150	2.875		3.062	
-025	1.188	+.000	1.312	-.000	-118	0.875		1.062	+.002	-151	3.000		3.187	
-026	1.250	-.002	1.375		-119	0.937		1.125	-.000	-152	3.250		3.437	
-027	1.313		1.437		-120	1.000	+.000	1.187		-153	3.500		3.687	
-028	1.375		1.500		-121	1.062	-.002	1.250		-154	3.750		3.937	
-029	1.500		1.625		-122	1.125		1.312		-155	4.000	+.000	4.187	+.003
-030	1.625		1.750		-123	1.187		1.375		-156	4.250	-.003	4.437	-.000
-031	1.750		1.875		-124	1.250		1.437		-157	4.500		4.687	
-032	1.875		2.000		-125	1.312		1.500		-158	4.750		4.937	
-033	2.000		2.125		-126	1.375		1.562		-159	5.000		5.187	
-034	2.125		2.250		-127	1.437		1.625		-160	5.250		5.437	
-035	2.250		2.375		-128	1.500		1.687		-161	5.500		5.687	
-036	2.375		2.500		-129	1.562		1.750		-202	0.250	+.000	0.500	+.002
-037	2.500		2.625		-130	1.625		1.812		-204	0.375	-.002	0.625	-.000
-038	2.625		2.750		-131	1.687		1.875		-206	0.500		0.750	

T-LON® "SES" Spring/Elastomer Energized Seals

Table 18: Rod and PIston Dash Sizes Continued

Dash #	ID	Tol	OD	Tol	Dash #	ID	Tol	OD	Tol	`	ID	Tol	OD	Tol
-208	0.625		0.875		-253	5.375		5.625		-343	3.750		4.125	
-209	0.687		0.937		-254	5.500		5.750		-344	3.875		4.250	
-210	0.750		1.000		-255	5.625		5.875		-345	4.000		4.375	
-211	0.812		1.062		-256	5.750		6.000		-346	4.125		4.500	
-212	0.875		1.125		-257	5.875		6.125		-347	4.250		4.625	
-213	0.937		1.187		-258	6.000	+.000	6.250	+.003	-348	4.375		4.750	
-214	1.000		1.250		-259	6.250	-.003	6.500	-.000	-349	4.500		4.875	
-215	1.062		1.312		-260	6.500		6.750		-350	4.625		5.000	
-216	1.125		1.375		-261	6.750		7.000		-351	4.750		5.125	
-217	1.187		1.437		-262	7.000		7.250		-352	4.875		5.250	
-218	1.250		1.500		-263	7.250		7.500		-353	5.000		5.375	
-219	1.312		1.562		-264	7.500		7.750		-354	5.125		5.500	
-220	1.375	+.000	1.625	+.002	-265	7.750		8.000		-355	5.250	+.000	5.625	+.003
-221	1.437	-.002	1.687	-.000	-266	8.000		8.250		-356	5.375	-.003	5.750	-.000
-222	1.500		1.750		-267	8.250	+.000	8.500	+.004	-357	5.500		5.875	
-223	1.625		1.875		-268	8.500	-.004	8.750	-.000	-358	5.625		6.000	
-224	1.750		2.000		-269	8.750		9.000		-359	5.750		6.125	
-225	1.875		2.125		-270	9.000		9.250		-360	5.875		6.250	
-226	2.000		2.250		-316	0.875		1.250		-361	6.000		6.375	
-227	2.125		2.375		-317	0.938		1.313		-362	6.250		6.625	
-228	2.250		2.500		-318	1.000		1.375		-363	6.500		6.875	
-229	2.375		2.625		-319	1.063		1.438		-364	6.750		7.125	
-230	2.500		2.750		-320	1.125		1.500		-365	7.000		7.375	
-231	2.625		2.875		-321	1.188		1.563		-366	7.250		7.625	
-232	2.750		3.000		-322	1.250		1.625		-367	7.500		7.875	
-233	2.875		3.125		-323	1.313		1.688		-368	7.750		8.125	
-234	3.000		3.250		-324	1.375		1.750	+.002	-369	8.000		8.375	
-235	3.125		3.375		-325	1.500	+.000	1.875	-.000	-370	8.250		8.625	
-236	3.250		3.500		-326	1.625	-.002	2.000		-371	8.500		8.875	
-237	3.375		3.625		-327	1.750		2.125		-372	8.750		9.125	
-238	3.500		3.750		-328	1.875		2.250		-373	9.000		9.375	
-239	3.625		3.875		-329	2.000		2.375		-374	9.250		9.625	
-240	3.750		4.000		-330	2.125		2.500		-375	9.500		9.875	
-241	3.875		4.125		-331	2.250		2.625		-376	9.750		10.125	
-242	4.000	+.000	4.250	+.003	-332	2.375		2.750		-377	10.000	+.000	10.375	+.004
-243	4.125	-.003	4.375	-.000	-333	2.500		2.875		-378	10.500	-.004	10.875	-.000
-244	4.250		4.500		-334	2.625		3.000		-379	11.000		11.375	
-245	4.375		4.625		-335	2.750		3.125		-380	11.500		11.875	
-246	4.500		4.750		-336	2.875		3.250		-381	12.000		12.375	
-247	4.625		4.875		-337	3.000		3.375	+.003	-382	13.000		13.375	
-248	4.750		5.000		-338	3.125		3.500	-.000	-383	14.000		14.375	
-249	4.875		5.125		-339	3.250	+.000	3.625		-384	15.000		15.375	
-250	5.000		5.250		-340	3.375	-.003	3.750		-385	16.000		16.375	
-251	5.125		5.375		-341	3.500		3.875		-386	17.000		17.375	
-252	5.250		5.500		-342	3.625		4.000		-387	18.000		18.375	

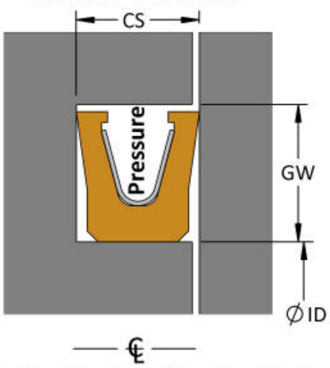
T-LON® "SES" Spring/Elastomer Energized Seals

Table 18: Rod and Piston Dash Sizes Continued

Dash #	ID	Tol	OD	Tol	Dash #	ID	Tol	OD	Tol	Dash #	ID	Tol	OD	Tol
-401	1.500		2.000		-423	4.250		4.750		-445	8.000		8.500	
-402	1.625		2.125		-424	4.375		4.875		-446	8.500		9.000	
-403	1.750		2.250		-425	4.500		5.000		-447	9.000		9.500	
-404	1.875		2.375	+.002	-426	4.625		5.125		-448	9.500		10.000	
-405	2.000		2.500	-.000	-427	4.750		5.250		-449	10.000		10.500	
-406	2.125	+.000	2.625		-428	4.875		5.375		-450	10.500		11.000	
-407	2.250	-.002	2.750		-429	5.000		5.500		-451	11.000		11.500	
-408	2.375		2.875		-430	5.125		5.625		-452	11.500		12.000	
-409	2.500		3.000		-431	5.250		5.750	+.003	-453	12.000		12.500	
-410	2.625		3.125		-432	5.375	+.000	5.875	-.000	-454	12.500		13.000	
-411	2.750		3.250		-433	5.500	-.003	6.000		-455	13.000	+.000	13.500	+.004
-412	2.875		3.375		-434	5.625		6.125		-456	13.500	-.004	14.000	-.000
-413	3.000		3.500		-435	5.750		6.250		-457	14.000		14.500	
-414	3.125		3.625		-436	5.875		6.375		-458	14.500		15.000	
-415	3.250		3.750	+.003	-437	6.000		6.500		-459	15.000		15.500	
-416	3.375		3.875	-.000	-438	6.250		6.750		-460	15.500		16.000	
-417	3.500	+.000	4.000		-439	6.500		7.000		-461	16.000		16.500	
-418	3.625	-.003	4.125		-440	6.750		7.250		-462	16.500		17.000	
-419	3.750		4.250		-441	7.000		7.500		-463	17.000		17.500	
-420	3.875		4.375		-442	7.250		7.750		-464	17.500		18.000	
-421	4.000		4.500		-443	7.500		8.000	+.004	-465	18.000		18.500	
-422	4.125		4.625		-444	7.750	+.000 -.004	8.250	-.000	-466	18.500		19.000	

Dash Size Inside and Outside Face Seal Glands

Outside Face Seal



Inside Face Seal

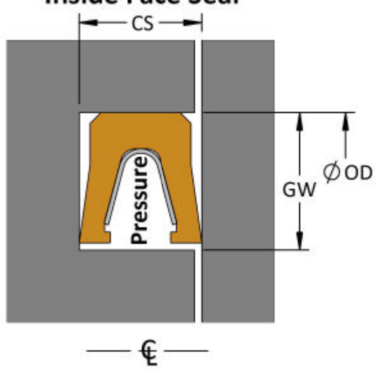


Table 19: Face Seal Dash Size Grooves

Series	Gland Depth "CS"	Gland Width "GW" Standard Heel +0.010 / -.000	Gland Width "GW" Extended Heel +0.010 / -.000
0	.061/.063	0.094	0.149
1	.092/.094	0.141	0.183
2	.124/.126	0.188	0.235
3	.186/.188	0.281	0.334
4	.249/.251	0.375	0.475

Table 20: Outside/Inside Face Seal Dash Sizes (T-Lon machines all SES's to order for unlimited seal glands <20" OD)

Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000	Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000	Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000	Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000
-008	0.187	N/A	-014	0.500	0.625	-020	0.875	1.000	-026	1.250	1.375
-009	0.219	N/A	-015	0.563	0.687	-021	0.938	1.062	-027	1.313	1.437
-010	0.250	N/A	-016	0.625	0.750	-022	1.000	1.125	-028	1.375	1.500
-011	0.313	N/A	-017	0.688	0.812	-023	1.063	1.187	-029	1.500	1.625
-012	0.375	0.500	-018	0.750	0.875	-024	1.125	1.250	-030	1.625	1.750
-013	0.438	0.562	-019	0.813	0.937	-025	1.188	1.312	-031	1.750	1.875

T-LON® "SES" Spring/Elastomer Energized Seals

Table 20: Outside/Inside Face Seal Dash Sizes Continued

Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000	Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000	Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000	Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000
-032	1.875	2.000	**-137**	2.062	2.250	**-220**	1.375	1.625	**-261**	6.750	7.000
-033	2.000	2.125	**-138**	2.125	2.312	**-221**	1.437	1.687	**-262**	7.000	7.250
-034	2.125	2.250	**-139**	2.187	2.375	**-222**	1.500	1.750	**-263**	7.250	7.500
-035	2.250	2.375	**-140**	2.250	2.437	**-223**	1.625	1.875	**-264**	7.500	7.750
-036	2.375	2.500	**-141**	2.312	2.500	**-224**	1.750	2.000	**-265**	7.750	8.000
-037	2.500	2.625	**-142**	2.375	2.562	**-225**	1.875	2.125	**-266**	8.000	8.250
-038	2.625	2.750	**-143**	2.437	2.625	**-226**	2.000	2.250	**-267**	8.250	8.500
-039	2.750	2.875	**-144**	2.500	2.687	**-227**	2.125	2.375	**-268**	8.500	8.750
-040	2.875	3.000	**-145**	2.562	2.750	**-228**	2.250	2.500	**-269**	8.750	9.000
-041	3.000	3.125	**-146**	2.625	2.812	**-229**	2.375	2.625	**-270**	9.000	9.250
-042	3.250	3.375	**-147**	2.687	2.875	**-230**	2.500	2.750	**-271**	9.250	9.500
-043	3.500	3.625	**-148**	2.750	2.937	**-231**	2.625	2.875	**-272**	9.500	9.750
-044	3.750	3.875	**-149**	2.812	3.000	**-232**	2.750	3.000	**-273**	9.750	10.000
-045	4.000	4.125	**-150**	2.875	3.062	**-233**	2.875	3.125	**-274**	10.000	10.250
-110	0.375	N/A	**-151**	3.000	3.187	**-234**	3.000	3.250	**-275**	10.500	10.750
-111	0.437		**-152**	3.250	3.437	**-235**	3.125	3.375	**-276**	11.000	11.250
-112	0.500	0.687	**-153**	3.500	3.687	**-236**	3.250	3.500	**-277**	11.500	11.750
-113	0.562	0.750	**-154**	3.750	3.937	**-237**	3.375	3.625	**-278**	12.000	12.250
-114	0.625	0.812	**-155**	4.000	4.187	**-238**	3.500	3.750	**-279**	13.000	13.250
-115	0.687	0.875	**-156**	4.250	4.437	**-239**	3.625	3.875	**-280**	14.000	14.250
-116	0.750	0.937	**-157**	4.500	4.687	**-240**	3.750	4.000	**-281**	15.000	15.250
-117	0.812	1.000	**-158**	4.750	4.937	**-241**	3.875	4.125	**-325**	1.500	1.875
-118	0.875	1.062	**-159**	5.000	5.187	**-242**	4.000	4.250	**-326**	1.625	2.000
-119	0.937	1.125	**-160**	5.250	5.437	**-243**	4.125	4.375	**-327**	1.750	2.125
-120	1.000	1.187	**-161**	5.500	5.687	**-244**	4.250	4.500	**-328**	1.875	2.250
-121	1.062	1.250	**-162**	5.750	5.937	**-245**	4.375	4.625	**-329**	2.000	2.375
-122	1.125	1.312	**-163**	6.000	6.187	**-246**	4.500	4.750	**-330**	2.125	2.500
-123	1.187	1.375	**-164**	6.250	6.437	**-247**	4.625	4.875	**-331**	2.250	2.625
-124	1.250	1.437	**-165**	6.500	6.687	**-248**	4.750	5.000	**-332**	2.375	2.750
-125	1.312	1.500	**-208**	0.625	N/A	**-249**	4.875	5.125	**-333**	2.500	2.875
-126	1.375	1.562	**-209**	0.687		**-250**	5.000	5.250	**-334**	2.625	3.000
-127	1.437	1.625	**-210**	0.750	1.000	**-251**	5.125	5.375	**-335**	2.750	3.125
-128	1.500	1.687	**-211**	0.812	1.062	**-252**	5.250	5.500	**-336**	2.875	3.250
-129	1.562	1.750	**-212**	0.875	1.125	**-253**	5.375	5.625	**-337**	3.000	3.375
-130	1.625	1.812	**-213**	0.937	1.187	**-254**	5.500	5.750	**-338**	3.125	3.500
-131	1.687	1.875	**-214**	1.000	1.250	**-255**	5.625	5.875	**-339**	3.250	3.625
-132	1.750	1.937	**-215**	1.062	1.312	**-256**	5.750	6.000	**-340**	3.375	3.750
-133	1.812	2.000	**-216**	1.125	1.375	**-257**	5.875	6.125	**-341**	3.500	3.875
-134	1.875	2.062	**-217**	1.187	1.437	**-258**	6.000	6.250	**-342**	3.625	4.000
-135	1.937	2.125	**-218**	1.250	1.500	**-259**	6.250	6.500	**-343**	3.750	4.125
-136	2.000	2.187	**-219**	1.312	1.562	**-260**	6.500	6.750	**-344**	3.875	4.250

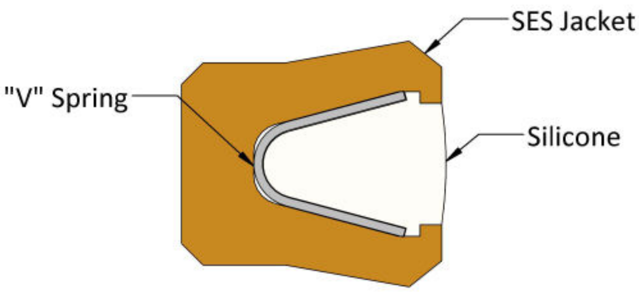
T-LON® "SES" Spring/Elastomer Energized Seals

Table 20: Outside/Inside Face Seal Dash Sizes Continued

Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000	Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000	Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000	Dash #	Outside Face Seal ID +.000 -.005	Inside Face Seal OD +.005 -.000
-345	4.000	4.375	-367	7.500	7.875	-425	4.500	5.000	-446	8.500	9.000
-346	4.125	4.500	-368	7.750	8.125	-426	4.625	5.125	-447	9.000	9.500
-347	4.250	4.625	-369	8.000	8.375	-427	4.750	5.250	-448	9.500	10.000
-348	4.375	4.750	-370	8.250	8.625	-428	4.875	5.375	-449	10.000	10.500
-349	4.500	4.875	-371	8.500	8.875	-429	5.000	5.500	-450	10.500	11.000
-350	4.625	5.000	-372	8.750	9.125	-430	5.125	5.625	-451	11.000	11.500
-351	4.750	5.125	-373	9.000	9.375	-431	5.250	5.750	-452	11.500	12.000
-352	4.875	5.250	-374	9.250	9.625	-432	5.375	5.875	-453	12.000	12.500
-353	5.000	5.375	-375	9.500	9.875	-433	5.500	6.000	-454	12.500	13.000
-354	5.125	5.500	-376	9.750	10.125	-434	5.625	6.125	-455	13.000	13.500
-355	5.250	5.625	-377	10.000	10.375	-435	5.750	6.250	-456	13.500	14.000
-356	5.375	5.750	-378	10.500	10.875	-436	5.875	6.375	-457	14.000	14.500
-357	5.500	5.875	-379	11.000	11.375	-437	6.000	6.500	-458	14.500	15.000
-358	5.625	6.000	-380	11.500	11.875	-438	6.250	6.750	-459	15.000	15.500
-359	5.750	6.125	-381	12.000	12.375	-439	6.500	7.000	-460	15.500	16.000
-360	5.875	6.250	-382	13.000	13.375	-440	6.750	7.250	-461	16.000	16.500
-361	6.000	6.375	-383	14.000	14.375	-441	7.000	7.500	-462	16.500	17.000
-362	6.250	6.625	-384	15.000	15.375	-442	7.250	7.750	-463	17.000	17.500
-363	6.500	6.875	-385	16.000	16.375	-443	7.500	8.000	-464	17.500	18.000
-364	6.750	7.125	-386	17.000	17.375	-444	7.750	8.250	-465	18.000	18.500
-365	7.000	7.375	-387	18.000	18.375	-445	8.000	8.500	-466	18.500	19.000
-366	7.250	7.625									

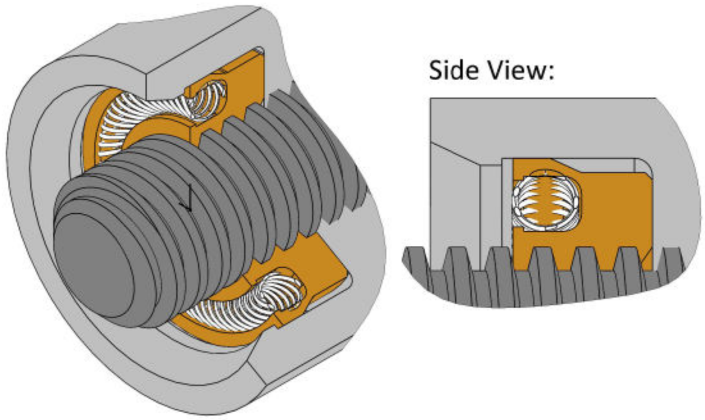
Additional Design Options

Silicone Filled Pocket



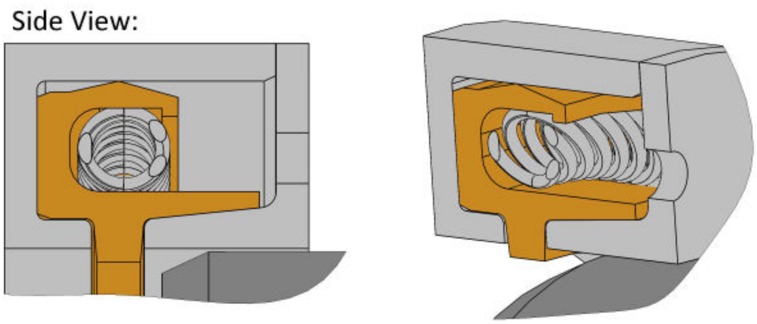
The "V" spring SES has the option to fill the pocket with high temperature, FDA and NSF 51 compliant silicone. Typically, this is used in food, beverage, and pharmaceutical applications to prevent media entrapment within the seal and ease of cleaning.

Thread Wiper SES



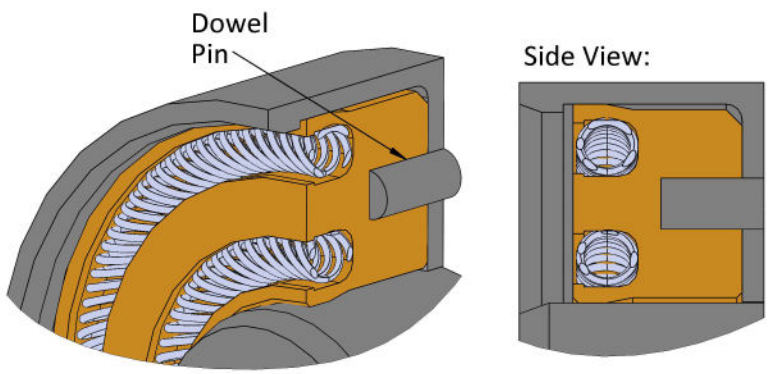
A linear actuator transversing in and out of a gearbox needs the grease removed from a threaded rod. Solution: an SES with the thread profile machined into the ID lip.

Anti-Blowout Seal



In some valve designs, the shaft disengages the ID lip of the seal. When this happens, a standard SES ID lip will blowout as media flows past the seal / pressure is relieved. The anti-blowout design prevents the ID lip from damage during this process.

Dual Spring - Locking Dowel



High PV (pressure and velocity) applications along with wide temperature ranges require a more robust design to ensure the seal does not rotate with the shaft, causing premature failure. A more cost-effective design than a metal-encased seal is locking in the SES with dowel pins.