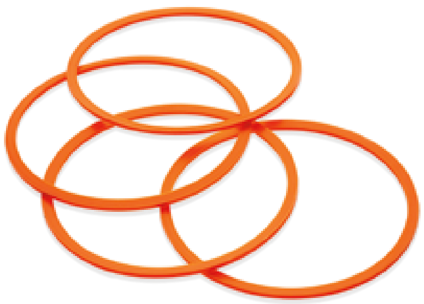
ANTI-EXTRUSION BACK-UP RINGS

GROOVE DESIGN GUIDE

ENGINEERED SEALS & COMPONENTS, LLC.

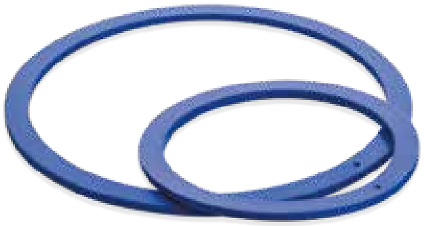
BACK-UPS

STATIC



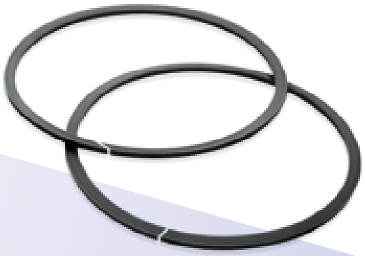
STANDARD

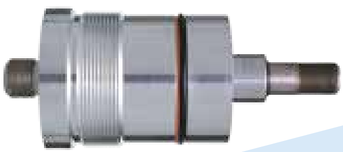
VENTED

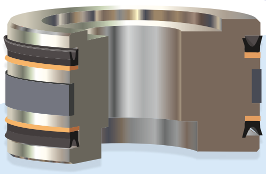


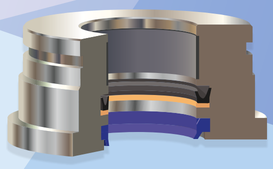
MODULAR

SPLIT NYLON









HISTORY OF THE BACK-UP RING

The anti-extrusion Back-up Ring likely found its roots in the use of leather packings. Leather was used as the sealing device in glands prior to the use of O-Rings. In 1937, Niels A. Christensen was granted a U.S. Patent for "new and useful improvements in packings and the like for power cylinders." This seal was known as the O-ring.

The O-ring provided a much better seal compared to leather. However, the leather packings would fill the extrusion gap without being nibbled, allowing for larger gaps and higher pressures.

The persistent issue that engineers faced was how to take an O-ring that operated optimally with narrow extrusion gaps and extend its service by widening the extrusion gaps.

Answer: The Back-up Ring

The first Back-up ring devices were made from materials like leather. Since leather was used in cup packings at higher pressures and higher clearance gaps, it made sense that a flat washer could be used as an anti-extrusion device for the O-ring. It worked!

The problem with leather was that it could become dry and shrink away from the sealing surface, exposing the elastomer to the same pressures and nibbling, it was intended to protect against. A material less sensitive to these conditions was needed.

Next in 1944 came the invention of PTFE, commonly known as TEFLON®. It was tried as a back-up ring and had much success because it overcame many of the problems of leather.

Introduced in 1960, the molded rubber concaved back-up ring came to market. It had many advantages over both leather and PTFE, especially cost and ease of assembly.

As hydraulic systems started to see larger extrusion gaps and higher temperatures, a more robust material was needed. In 1974 a material known as Hytrel® was introduced. Hytrel® is a copolyester elastomer, "a synthetic rubber", TPC-ET.

Hytrel® plays a big role in the O-ring Back-up ring market today.

Engineered Seals & Components has made this the base material in many of the ESC compounds known as POLY-TREL™. It has superior chemical, temperature and pressure resistance than many other materials.

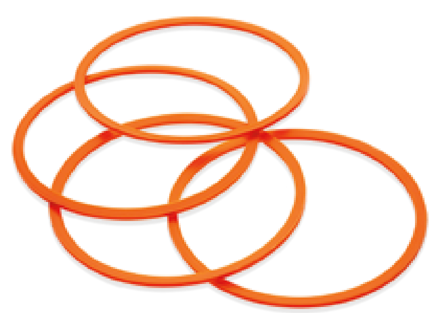
Modern Design and Construction of the Back-up Ring.

Our modern hydraulic systems often find O-rings operating at extreme pressures with the use of Back-up rings made from a variety of materials like POLY-TREL™, Acetal, Nylon, PEEK, and Filled Nylon.

Engineered Seals & Components has always made its' line of Back-up Rings for specific applications so your systems will run at optimal efficiency.

The following pages are the standard product line offerings. ESC has many thousands of custom Back-up Rings designed specifically for the application, whatever it may be.

With today's technology and huge selection of materials, seals can reach the next level of performance with relatively little expense.



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ENGINEERED SEALS & COMPONENTS
EXTRUSION GAPS

The process by which seal material is forced into the clearances between components is called gap extrusion. The dimension of this clearance gap is referred to as the extrusion gap, or "e-gap". **(Fig. 2)**

The resistance of a given seal component to gap extrusion is mainly determined by the material composition and quality. Materials of greater hardness and stiffness typically also have improved resistance to extrusion. There-fore, fullface anti-extrusion or back-up rings of materials harder than the seal material may be used to prevent seal extrusion into the Extrusion-gap. **(Fig.3)**

Pressure is the main culprit of extrusion, but the egap size and system temperatures are also major factors. **Chart 2** shows the pressure resistance of different materials as a function of temperature, at 70F.

While these sample values illustrate the differences in extrusion resistance for standard grades of typical seal materials, there are many variations of each basic composition that impact the extrusion resistance of seals. In addition, the profile design and the seal friction affect extrusion. For maximum allowable pressure, temperature and e-gap of each seal profile, refer to the specific compound and manufacturers recommendations. The maximum egap in a hydraulic cylinder occurs when the cylinder components are at the maximum radial misalignment of components. This misalignment is affected by:

- External forces acting upon the cylinder assembly (acceleration forces, side loads, frictional moments from rotation of cylinder end connections).
- The weight of the cylinder components (especially when used horizontally).
- Deformation of cylinder components (rod flexing, wear ring radial deformation under load).
- The tolerance stack up of multiple cylinder components.

Fig. 2

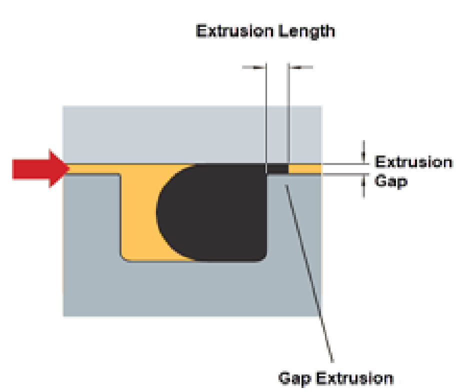
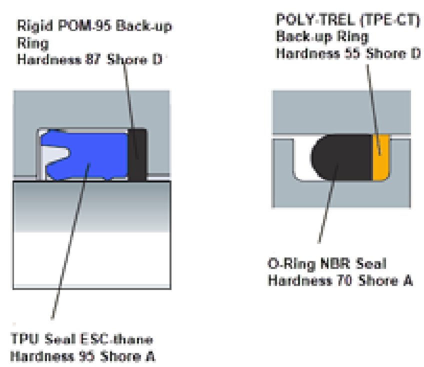
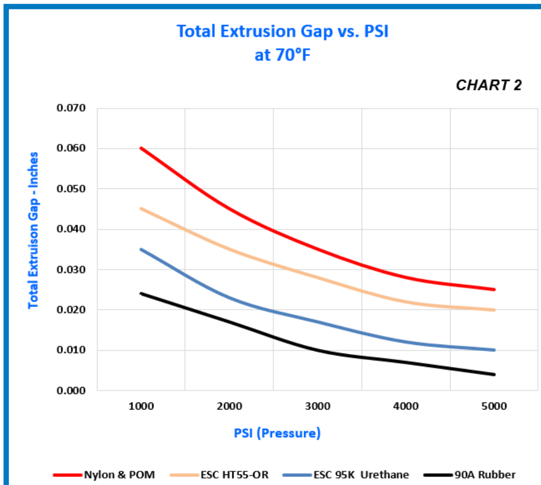


Fig.3





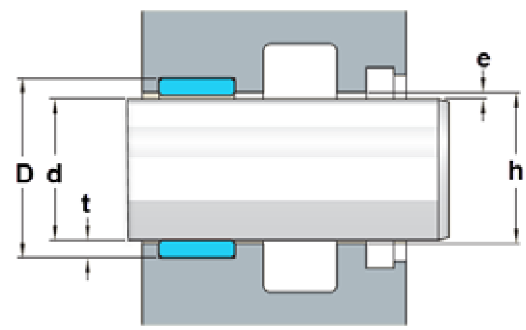
ENGINEERED SEALS & COMPONENTS
EXTRUSION GAPS

It is necessary to calculate the e-gap at the maximum misalignment at minimum material conditions of the cylinder and guide components.

For rod seals, the maximum e-gap should be calculated with the following conditions **(Fig. 5)**:

- Guide ring groove at maximum diameter **D**
- Rod at minimum diameter **d**
- Wear Ring cross section at minimum thickness **t** (considering tolerances and any radial deformation of the Wear Ring under load)
- Rod seal housing throat at maximum diameter **h**
- See **ESC** Wear Ring engineering guide to calculate values.

Fig.5



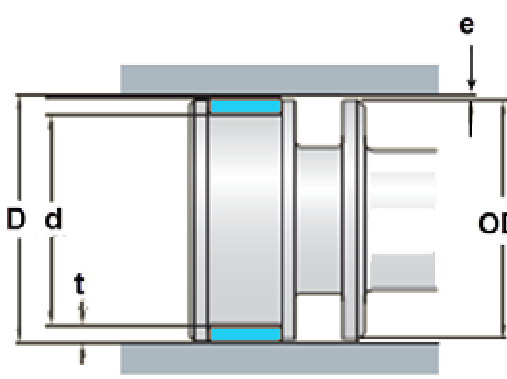
For piston seals, the maximum e-gap should be calculated with the following conditions: **(Fig. 6)**:

- Bore at maximum diameter **D**
- Wear Ring groove at minimum diameter **d**
- Wear Ring cross section at minimum thickness **t** (considering tolerances and any radial deformation of the Wear Ring under load)
- Piston seal housing at minimum outside diameter **OD**

The maximum allowable e-gap is provided in the profile data for each rod seal and piston seal profile by the relevant manufacturer. The e-gap can b kept within these limits by specifying and controlling the tolerances of dimensions described above and shown in **Figs. 5 and 6**.

See **ESC's** Wear Ring Engineering Guide to calculate these dimensions.

Fig. 6



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SERIES 758
STATIC BACK-UPS

Back-up Rings are in the most common anti-extrusion devices in dynamic sealing. They provide simple solutions to safely increase pressure or solve existing seal extrusion problems.

Back-up rings function by positioning a more robust material adjacent to the extrusion gap, taking the seals place and providing a barrier against high pressures and the extrusion gap. They also protect the seals against pressure spikes, and it insure seal performance at higher temperatures.

ESC Series 758 Back-up Rings have been specifically designed for an industrial static O- ring groove. This series was developed to overcome the cross section and diameter problems that "standard industrial" back-up rings have.

The cross section and diameter have been designed to fit the groove properly, and to give the O-ring optimum life. Series 758 will not tip over, bunch up, or get sheared off during assembly.

ESC Series 758 will also fit in an industrial dynamic groove, but just not as efficiently.

ESC has found that manufacturing Series 758 Compound HT55-OR, from a formulation of copolyester elastomer, TPC-ET, gives the Back-up rings advantages Rubber or Urethane do not. For example, better fluid resistance and much better pressure and heat resistance.

Typically, POLY-TREL HT55-OR, has an operating temperature range of -65°F to +275°F. Compound HT55-ORSHS is a Hydrolytically stabilized compound, which is used in water based fluid applications.

ESC Series 758 most popular sizes are molded endless without a imperfection where the material would enter the mold. This proprietary process was developed by ESC engineers to give the back-up rings maximum strength and flexibility.

The back-up rings are imperfection free resulting in a part that will not "neck down" due to the part not having a gate or nit line.

This makes the parts perfectly smooth on both the inside diameter and outside diameter.

ADVANTAGES

- No more twisted back-ups.
- Fire Resistant Fluids.
- Extended Range -65° to +275°.
- **Dynamic Pressure to 7,000 psi**
- **Static Pressure to 20,000 psi**

For Cartridge Valves Too!

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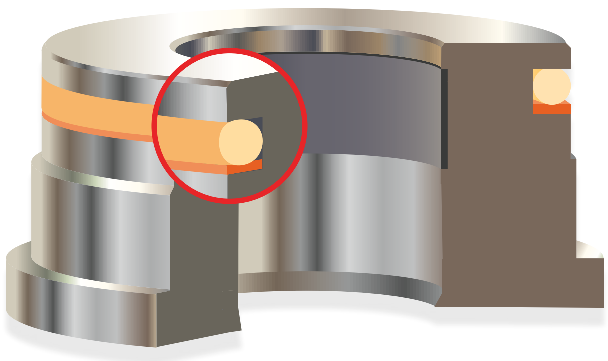
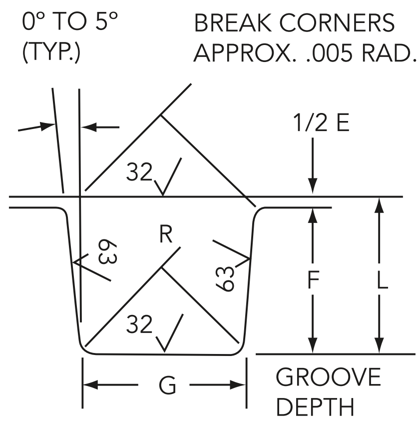
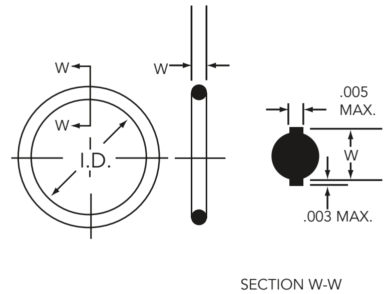
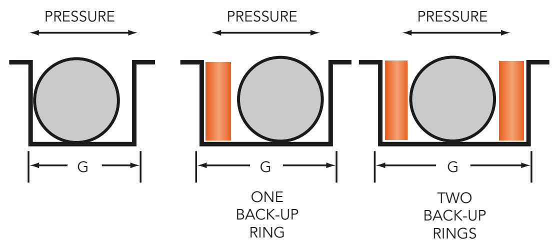
SERIES 758
POLY-TREL BACK-UP & O-RING GROOVE DESIGN GUIDE









INDUSTRIAL O-RING *STATIC SEAL* GLAND GUIDELINE

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

(a) Clearance gap must be held to a minimum consistent with design requirements for temperature range variation.
(b) Total Indicator reading between groove and adjacent bearing surface.
(c) Reduce maximum diametrical clearance 50% when using silicone O-rings.

ENGINEERED SEALS & COMPONENTS

ESC Series 750 Back-up Rings have been specifically designed for an industrial O-Ring groove. Series 750 was developed to fit into a groove for either a static or dynamic O-ring. The MS28774 specification was the guide for the sizing of this series.

ESC Series 750 Back-up ring have a larger cross section and generally larger tolerances then Series 758. In some static applications the cross section could be larger than the groove depth making assemble more difficult. Actual sizes have been furnished on the following pages.

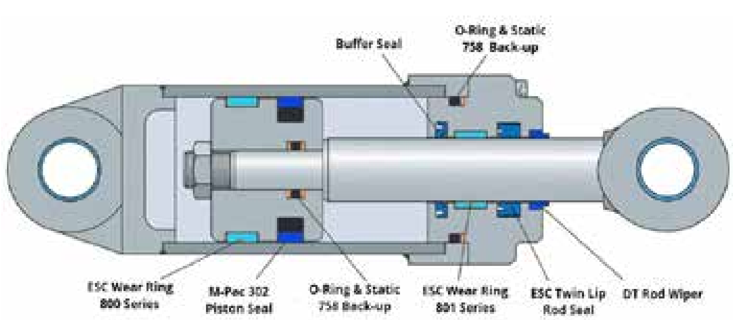
ESC Series 750 has been engineered to fit tightly in the groove. This small difference will make assembly of the hardware easier and faster. Series 750 Back-up rings do not twist or tip over upon assembly.

ESC engineering does not recommend using the 750 series in a double acting piston application where the system pressure oscillates rapidly. Series 756 "Vented" Back-ups are designed for this type system.

ESC Series 750 are molded from compound POLY-TREL HT55-BK, a formulation of DuPont Hytrel®. This 55D polyester elastomer has been formulated for maximum extrusion and chemical resistance. Operating temperatures may range from -65°F to +275°F. A Hydrolytically stable compound HT55-SHS-BK is available for even more demanding applications upon request. ESC also offers a Heat stable compound for extended time at elevated temperature, HT55-HS-BK.

ESC Series 750 most popular sizes are molded endless without a Gate Mark on the part. This proprietary process was developed by ESC to give the parts maximum strength and durability. Another major advantage is the parts will not "neck down" at the gate area, and there is no nit line. This makes for a perfectly smooth part, ID and OD.

Half-thickness back-ups in this series are also available. Ask for Series 750-xxx.5



ADVANTAGES

- No more twisted back-ups.
- For use with Static or Dynamic Glands.
- Fire Resistant Fluids.
- Extended Range -65° to 275°.
- Dynamic pressure to 7,000 psi.
- Static Pressure to 20,000 psi.

For Cartridge Valves Too!

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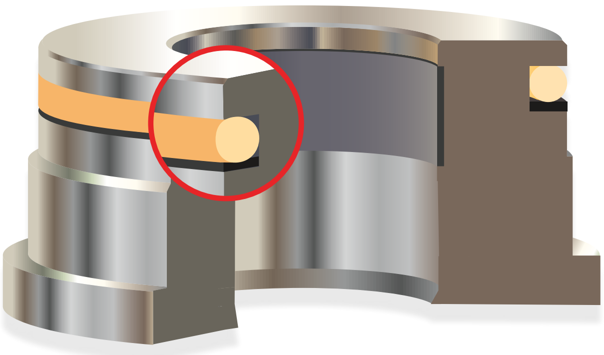
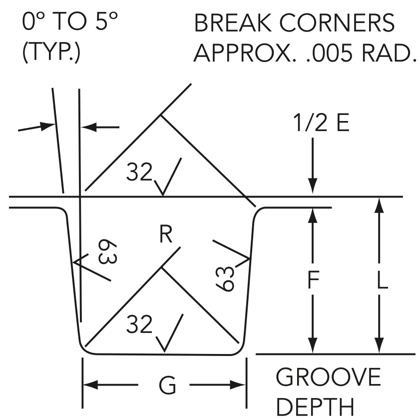
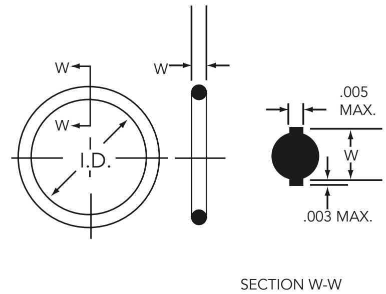
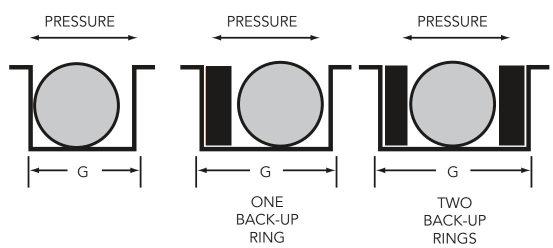
SERIES 750
POLY-TREL BACK-UP & O-RING GROOVE DESIGN GUIDE







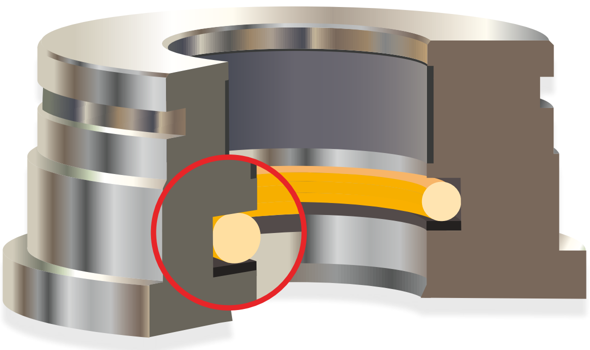


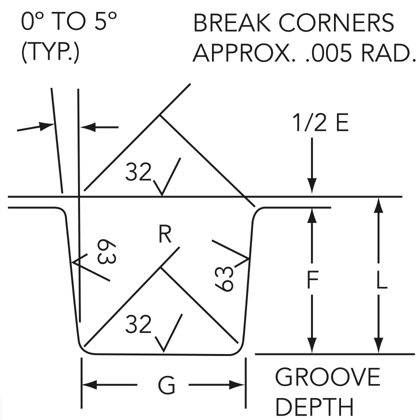
INDUSTRIAL O-RING *STATIC SEAL* GLAND GUIDELINE

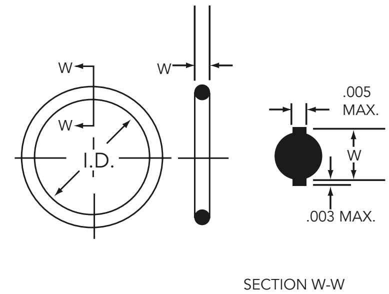
O-Ring Size	W Cross Section		L Gland Depth	Squeeze		E (a) (c) Diameteral Clearance	G Groove Width			R Groove Radius	Eccentricity Max. (b)
	Nominal	Actual		Actual	%		No Back-up Ring	One Back-up Ring	Two Back-up Rings		
044 through 050	1/16	.070 ±.003	.050 to .052	.015 to .023	22 to 32	.002 to .005	.093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

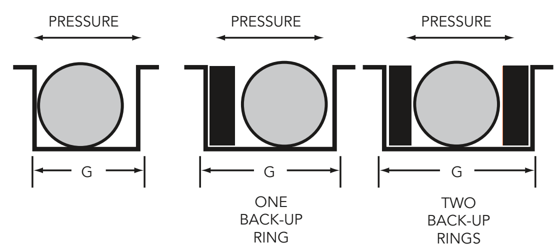
(a) Clearance gap must be held to a minimum consistent with design requirements for temperature range variation.
(b) Total Indicator reading between groove and adjacent bearing surface.
(c) Reduce maximum diametrical clearance 50% when using silicone O-rings.

SERIES 750
POLY-TREL BACK-UP & O-RING GROOVE DESIGN GUIDE









INDUSTRIAL O-RING *DYNAMIC SEAL* GLAND GUIDELINE

O-Ring Size	W Cross Section		L Gland Depth	Squeeze		E (a) (c) Diameteral Clearance	G Groove Width			R Groove Radius	Eccentricity Max. (b)
	Nominal	Actual		Actual	%		No Back-up Ring	One Back-up Ring	Two Back-up Rings		
-044 through -050	1/16	.070 ±.003	.055 to .057	.010 to .018	15 to 25	.002 to .005	.093 to .098	.138 to .143	.205 to .210	.005 to .015	.002
-102 through -178	3/32	.103 ±.003	.088 to .090	.010 to .018	10 to 17	.002 to .005	.140 to .145	.140 to .145	.238 to .243	.005 to .015	.002
-201 through -284	1/8	.139 ±.003	.121 to .123	.012 to .022	9 to 16	.003 to .006	.187 to .192	.187 to .192	.275 to .280	.010 to .025	.003
-309 through -395	3/16	.210 ±.003	.181 to 188	.017 to .030	8 to 14	.003 to .006	.281 to .286	.281 to .286	.410 to .415	.020 to .035	.004
-425 through -475	1/4	.275 ±.003	.237 to .240	.029 to .044	11 to 16	.004 to .007	.375 to .380	.375 to .380	.538 to .543	.020 to .035	.005

(a) Clearance gap must be held to a minimum consistent with design requirements for temperature range variation.
(b) Total Indicator reading between groove and adjacent bearing surface.
(c) Reduce maximum diametrical clearance 50% when using silicone O-rings.

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ESC

SERIES 756
VENTED BACK-UP RINGS

The Vented back-up ring Series 756 was designed to help eliminate pressure trapping between 2 back-up rings and the O-ring. See Figure 1.

In a fast moving, continuous cycling hydraulic cylinders, pressure trapping may occur.

As the piston continues to cycle, the thermal expansion from the friction of the back-up rings rubbing on the cylinder surface causes them to expand. When the back-up rings have become a seal, from thermo expansion and pressure, the fluid trapped in-between the 2 back-ups rings becomes very hot.

As the system continues to cycle, the fluid between the 2 back-up rings become pressurized from the heat. This pressure will become much greater than the system pressure and will cause the back-up rings to extrude in opposite direction from each other. See Figure 1.

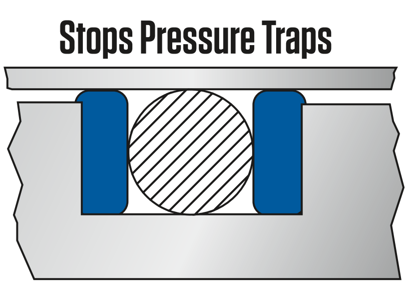

Figure 1

Cylinder applications such as steering cylinders or any cylinder that oscillates or vibrates at a high rate of speed and use an O-ring and two back-ups to seal the piston, are likely to see this phenomenon.

The series 756 Back-up ring was designed to prevent the pressure trapping. The back-up rings are seated on opposite sides of the sealing ring within the annular groove of a hydraulic piston.

The sealing ring is in frictional engagement with the interior of the hydraulic cylinder. The back-up rings are positioned within the cylinder groove and on opposite sides of the sealing ring. See Figure 2.

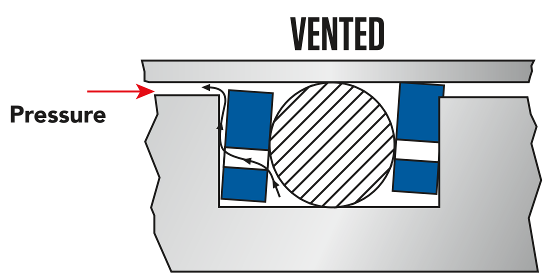

Figure 2

Series 756 back-up rings include a vent hole extending axially there through to permit the alleviation of any fluid pressure accumulating between the two spaced apart Back-up rings.

In Figure 2. the system pressure will push the back- up ring away from the side of the groove, thus releasing any fluid or pressure build-up thru the vent hole. The axial hole then acts as a relief, or vent, and it is unlikely a pressure buildup will occur. It takes very little movement or pressure to make the Series 756 do its job, "VENT".

Series 756 an excellent choice in static ID applications such as the static seal between the piston and rod.

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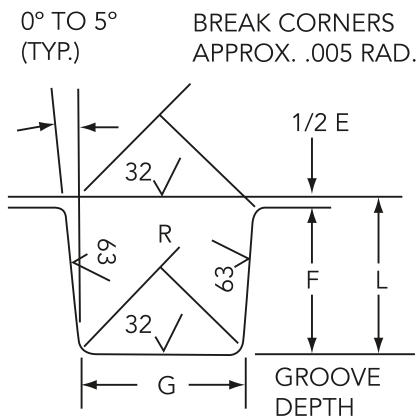
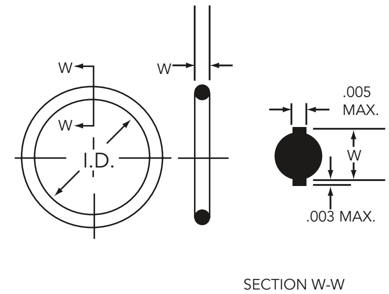
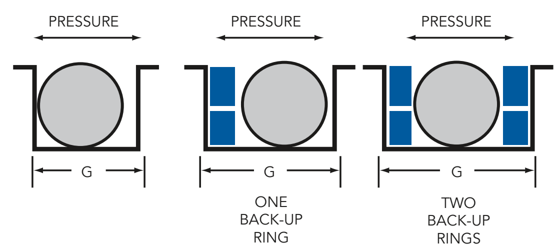
SERIES 756
POLY-TREL BACK-UP & O-RING GROOVE DESIGN GUIDE







INDUSTRIAL O-RING *DYNAMIC SEAL* GLAND GUIDELINE

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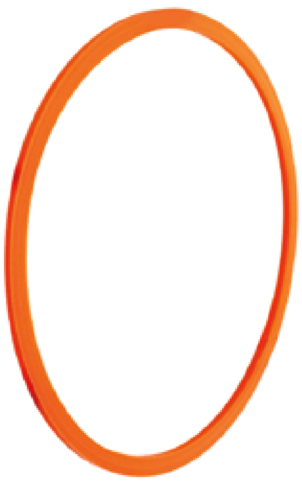
-102 through -178	3/32	.103 ±.003	.088 to .090	.010 to .018	10 to 17	.002 to .005	.140 to .145	.140 to .145	.238 to .243	.005 to .015	.002
-201 through -284	1/8	.139 ±.003	.121 to .123	.012 to .022	9 to 16	.003 to .006	.187 to .192	.187 to .192	.275 to .280	.010 to .025	.003
-309 through -395	3/16	.210 ±.003	.181 to 188	.017 to .030	8 to 14	.003 to .006	.281 to .286	.281 to .286	.410 to .415	.020 to .035	.004
-425 through -475	1/4	.275 ±.003	.237 to .240	.029 to .044	11 to 16	.004 to .007	.375 to .380	.375 to .380	.538 to .543	.020 to .035	.005

(a) Clearance gap must be held to a minimum consistent with design requirements for temperature range variation.
(b) Total Indicator reading between groove and adjacent bearing surface.
(c) Reduce maximum diameteral clearance 50% when using silicone O-rings.

SERIES 790 U-CUP SEAL BACK-UPS



Series 790 Profile

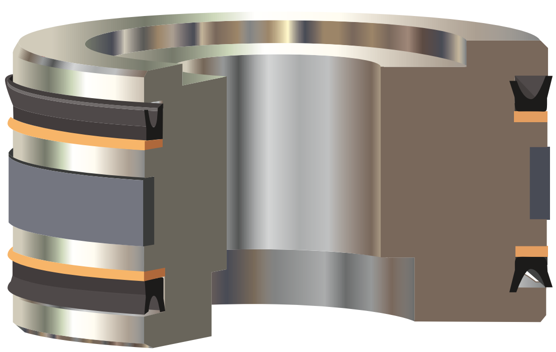
790 Series Back-up. Low Profile Modular Back-Up for Loaded U-Cup Seals and Rubber U-Cup Seals.

790 Series Back-up Rings provide added extrusion resistance for the U-Cups and Loaded U-Cup seals with only minimal increase in gland width. The 790 Series Back-up was originally designed to dramatically increase the pressure rating of Rubber U-Cups in applications where fluid compatibility or temperature prevent the use of urethane U-Cups. Additionally, the 790 Series Back-ups are perfect for adding higher pressure capabilities to medium duty urethane sealing systems. 790 Series Back-up Rings may be purchased either split or solid.

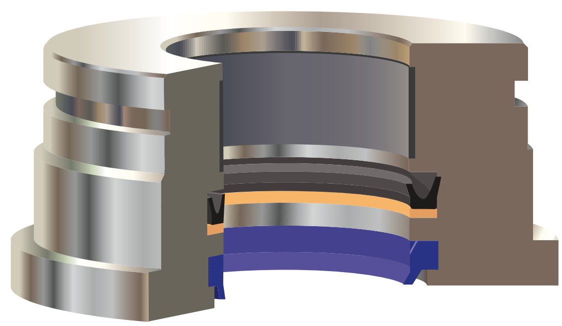
Standard Materials	Temperature	Max. Pressure Range**
HT-55-OR	-65°F to +275°F (-54°C to +135°C)	7,000 psi (482 bar)

Alternate Materials: For applications that may require an alternate material, please contact ESC.

** 4,900 psi (337 bar) with tight-tolerance wear rings (.123/.125 c/s) Series 200 Ultra-Precision Wear Rings.
3,500 psi (241 bar) with stand-tolerance wear rings (.120/.125 c/s).



790 installed in Piston Gland



790 installed in Rod Gland

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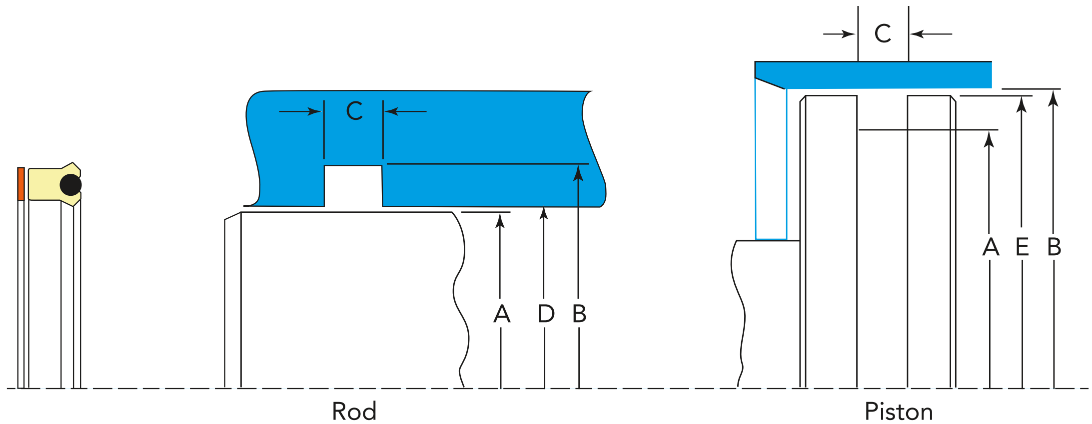
BACK-UP RING GROOVE WIDTH DESIGN GUIDE

How to Determine the Gland Width when using 790 Series Back-up Ring



Series 790 back-up ring allows you to extend the pressure rating of a seal that fits into the common gland used by such seals as Loaded U-cups, Un-Loaded U-Cups, Rubber U-Cups, Symmetrical U-Cups, and many other styles of U- Cup seals.

In order to use the 790 series Back- up ring, the width of the gland, **C**., must be extended to accommodate the height of the back-up ring.

Utilizing the axial gland length you have already calculated per the manufacturer specification, add the value shown in ***Table 790.1*** to the calculated gland width of the seal being used to get the new groove width to be machined.

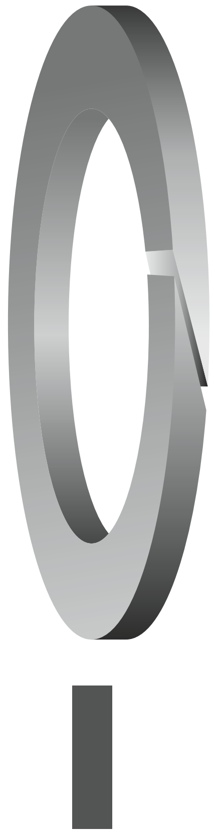
Table 790.1 Added Gland Width Values

Seal Cross Section	Added Gland Width
1/8	.062
3/16	062
1/4	062
5/16	062
3/8	062
7/16	062
1/2	062
5/8	062
3/4	062
1	062

For non-standard cross sections, the added gland width can be determined by adding 0.062” to the width of the groove, C., to be used.

Series 790 Profile

SERIES 757 ESC-LON BACK-UP RINGS



Series 757 Profile

757 Series Back-up. Low Profile Modular Back-Up for Loaded U-Cup Seals and Urethane U-Cups.

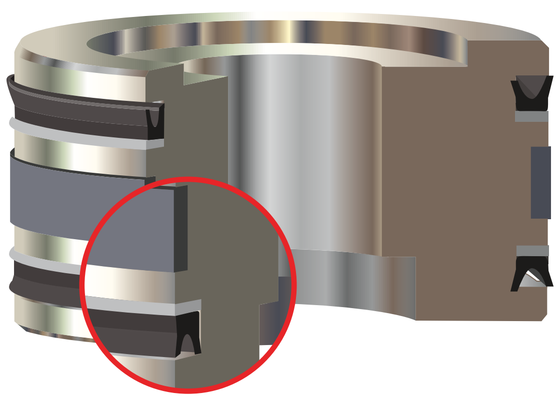
Series 757 Split Back-up rings provide added extrusion resistance over other materials. The specially formulated Glass filled Nylon, PA940, was designed to be used in conjunction with Urethane Loaded U-Cups , Rubber U-Cups, Rubber O-Rings and Un-Loaded Urethane U-Cups. This series will dramatically increase the pressure rating of the mating seal choice.

757 Series are perfect for adding life to a system where the seal is being nibbled from a large extrusion gap. Series 757 are manufactured split to enhance the assembly process.

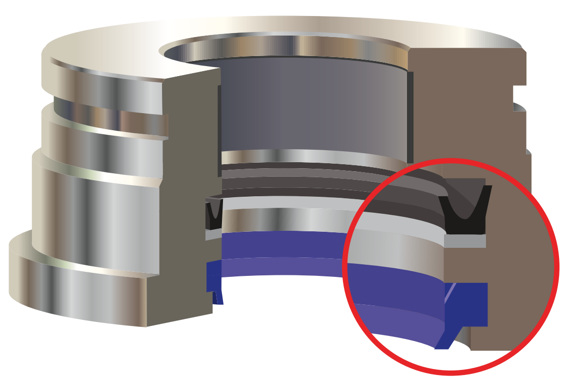
Standard Materials	Temperature	Max. Pressure Range**
PA940	-65°F to +275°F (-54°C to +135°C)	7,000 psi (482 bar)

Alternate Materials: For applications that may require an alternate material, please contact ESC.

** 4,900 psi (337 bar) with tight-tolerance wear rings (.123/.125 c/s) Series 200 Ultra-Precision Wear Rings.
3,500 psi (241 bar) with stand-tolerance wear rings (.120/.125 c/s).
Assumes industry standard clearances, could be more or less depending upon extrusion gap.



757 installed in Piston Gland



757 installed in Rod Gland

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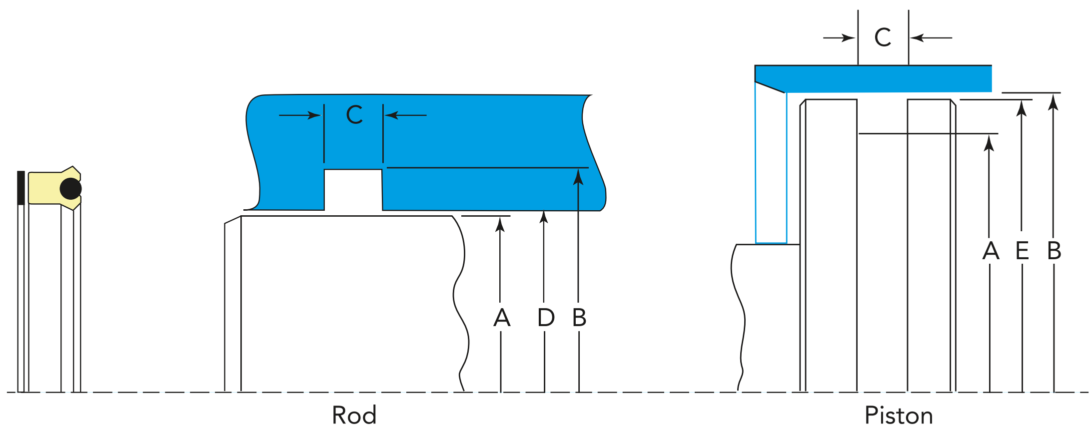
SERIES 757
BACK-UP RING GROOVE WIDTH DESIGN GUIDE

How to Determine the Gland Width when using 757 Series Back-up Ring



Series 757 Back-up Rings allow you to extend the pressure rating of a seal that fits into a common gland at a very low cost.

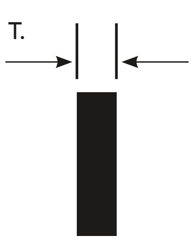
This Series Back-ups are designed to be used in either a Piston or Rod application.

By using Glass filled Nylon, PA940, much larger diametrical clearance may be used. Although Compound PA940 is standard, many other compound choices are also available.

To use the Series 757 Back-up ring, the width of the gland or groove must be extended to a accommodate the height if the back-up ring.

Utilizing the glands axical length you have already calculated per the manufacturer's specification, add the value shown in Table 757 for Width T. Add this dimension to the calculated gland width you will be using.

C = Previous gland width + T. Width

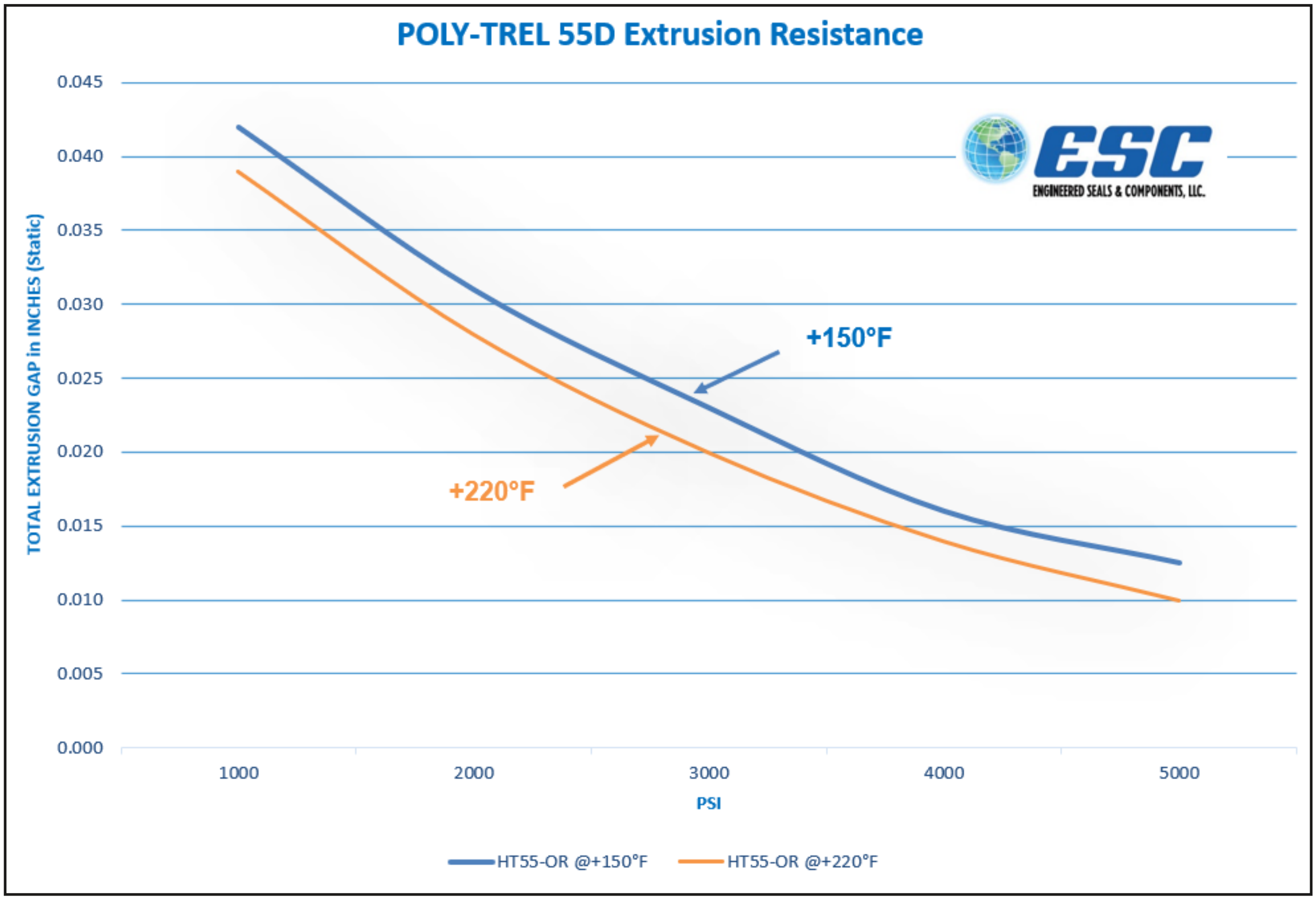


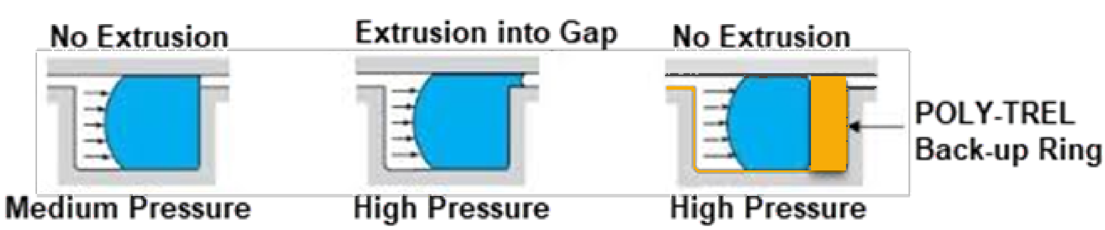
For non-standard cross sections the added gland width can be determined by adding the Width T. of the back-up being used, to the to the width of the groove that was calculated.

Series 757 Profile

POLY-TREL BACK-UP RING EXTRUSION DESIGN GUIDE

POLY-TREL HT55-OR Extrusion Resistance at +150F and +220F





O-Ring Deformation Under Pressure With and with out Back-up Ring

Above data was acquired in a test laboratory. No side load, shock loads, or dynamic motions were applied. Your results may be different. This information is to be used as a guideline only. It is always good practice to test in actual or specific conditions and applications.

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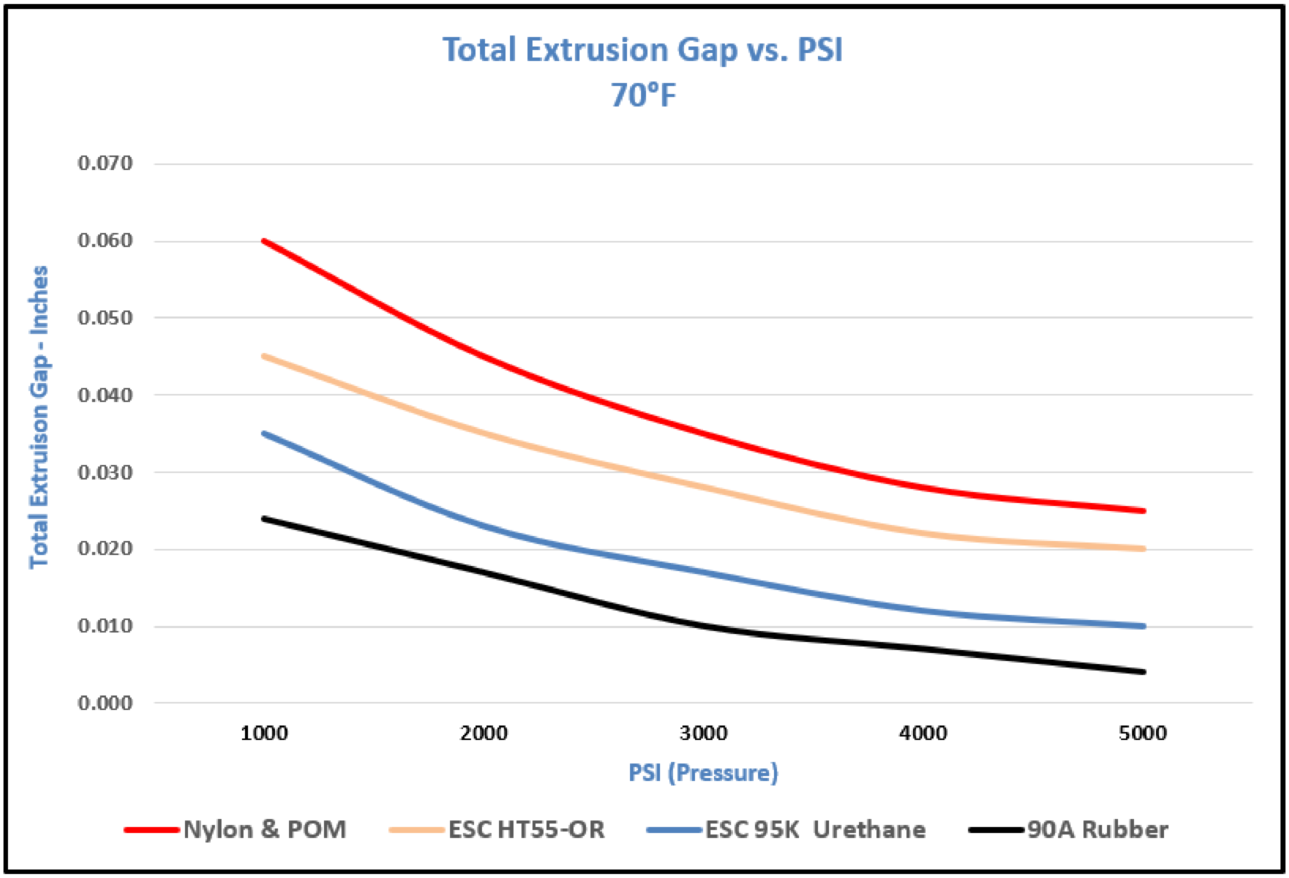
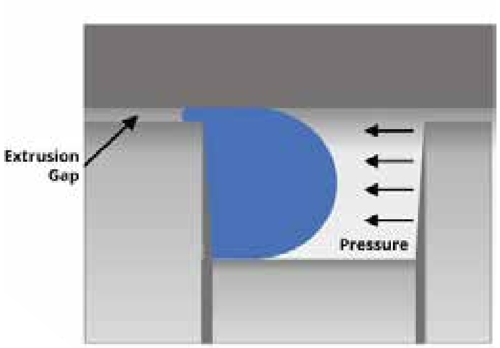
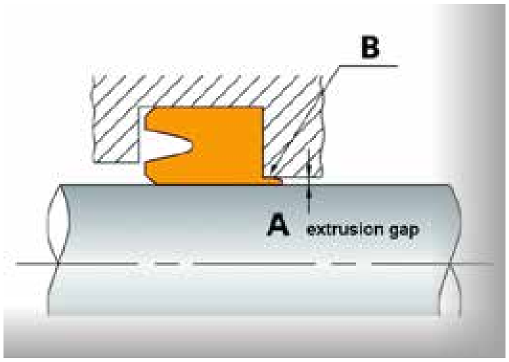
ESC BACK-UP RING EXTRUSION DESIGN GUIDE

Extrusion Resistance at +70F







Whatever the seal type there is always a need for a back-up ring. The chart above helps you determine the compound you should use.

Dissimilar materials work the best.

Above data was acquired in a test lab. No side loads, shock loads, or dynamic motions were applied. Your results may be different. This information is to be used as a guideline only. It is always good practice to test in your specific conditions and applications.

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TYPICAL COMPOUND USAGE AND TEMPERATURE GUIDE

Compound Number			Description	Temperature Range °C	°F	Typical Usages
ESC-lon™	Compound	PA940	Glass Filled Nylon 6	-54°/+135°	-65°/+275°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-lon™	Compound	PA940-B	Glass Filled Nylon 6 / Lub	-54°/+135°	-65°/+275°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-lon™	Compound	PA940-CB	Glass Filled Nylon 6 / Lub (Blue "CB")	-54°/+135°	-65°/+275°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-lon™	Compound	PA940-15	Glass Filled Nylon 6 / PTFE	-54°/+135°	-65°/+275°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-lon™	Compound	PA101-N	Nylon Unfilled 6/6	-54°/+135°	-65°/+275°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-lon™	Compound	PA101-BK	Nylon Unfilled 6/6 Black	-54°/+135°	-65°/+275°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-lon™	Compound	PA101-BLU	Nylon Unfilled 6/6 Blue	-54°/+135°	-65°/+275°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-lon™	Compound	PA933-BK	Glass Filled Nylon 6/6	-54°/+135°	-65°/+275°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-lon™	Compound	HTN20-C	Hi Temp. "No Swell" Carbon Filled	-54°/+148°	-65°/+300°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-lon™	Compound	HTN30-C	Hi Temp. "No Swell" Carbon Filled	-54°/+148°	-65°/+300°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-lon™	Compound	HTN-30	Hi Temp. "No Swell" Glass Filled	-54°/+148°	-65°/+300°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-lon™	Compound	HTN-40	Hi Temp. "No Swell" Glass Filled	-54°/+148°	-65°/+300°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-tal™	Compound	POM95-BK	Acetal Unfilled	-43°/+100°	-45°/+200°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-tal™	Compound	POM-30G	Acetal Glass Filled	-43°/+100°	-45°/+200°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-tal™	Compound	POM-10C-RED	Acetal Carbon Filled	-43°/+100°	-45°/+200°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-tal™	Compound	POM-30C	Acetal Carbon Filled	-43°/+100°	-45°/+200°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-comp™	Compound	V-100	Laminate Composite	-40°/+100°	-40°/+200°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-comp™	Compound	V-111	Laminate Composite	-40°/+100°	-40°/+200°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-comp™	Compound	V-131A	Laminate Composite	-40°/+100°	-40°/+200°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
ESC-comp™	Compound	V-333A	Laminate Composite	-40°/+148°	-40°/+300°	Wear Rings, Back-ups, Piston Seals, Guide Rings, Bearings
POLY-trel™	Compound	HT40-BK	TPC-ET 40 Shore D, Black	-54°/+121°	-65°/+250°	Back-up Rings, Rod Wipers, Seals, Gaskets, Cushions
POLY-trel™	Compound	HT47-BK	TPC-ET 47 Shore D, Black	-54°/+121°	-65°/+250°	Back-up Rings, Rod Wipers, Seals, Gaskets, Cushions
POLY-trel™	Compound	HT47-N	TPC-ET 47 Shore D, Off White	-54°/+121°	-65°/+250°	Back-up Rings, Rod Wipers, Seals, Gaskets, Cushions
POLY-trel™	Compound	HT47-BLU	TPC-ET 47 Shore D, Blue	-54°/+121°	-65°/+250°	Back-up Rings, Rod Wipers, Seals, Gaskets, Cushions
POLY-trel™	Compound	HT50-OR	TPC-ET 50 Shore D, Orange	-54°/+135°	-65°/+275°	Back-up Rings, Rod Wipers, Seals, Gaskets, Cushions
POLY-trel™	Compound	HT55-OR	TPC-ET 55 Shore D, Orange	-54°/+135°	-65°/+275°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
POLY-trel™	Compound	HT55-5OR	TPC-ET 55 Shore D, Orange / Fiber Glass	-54°/+135°	-65°/+275°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
POLY-trel™	Compound	HT55-OR	TPC-ET 55 Shore D, Orange	-54°/+135°	-65°/+275°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
POLY-trel™	Compound	HT55-BK	TPC-ET 55 Shore D, Black	-54°/+135°	-65°/+275°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
POLY-trel™	Compound	HT55-BLU	TPC-ET 55 Shore D, Blue	-54°/+135°	-65°/+275°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
POLY-trel™	Compound	HT55SH-OR	TPC-ET 55 Shore D, Orange- Heat Stabilized	-54°/+135°	-65°/+275°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
POLY-trel™	Compound	HT55-SHS-OR	TPC-ET 55 Shore D, Orange -Hydrolytically Stabilized	-54°/+135°	-65°/+275°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
POLY-trel™	Compound	HT63-N	TPC-ET 63 Shore D, Off White	-54°/+135°	-65°/+275°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
POLY-trel™	Compound	HT63-OR	TPC-ET 63 Shore D, Orange	-54°/+135°	-65°/+275°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
POLY-trel™	Compound	HT-63-5-OR	TPC-ET 63 Shore D, Orange / Fiber Glass	-54°/+135°	-65°/+275°	Back-up Rings, Piston Seals, Filler Rings
POLY-trel™	Compound	HT-72-N	TPC-ET 72 Shore D, Off White	-54°/+135°	-65°/+275°	Back-up Rings, Piston Seals, Filler Rings
ESC-thane™	Compound	U95K-BLU	TPU Urethane 95 Shore A, Blue	-40°/+121°	-40°/+250°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
ESC-thane™	Compound	U95K-BLK	TPU Urethane 95 Shore A, Black	-40°/+121°	-40°/+250°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
ESC-thane™	Compound	U94-BK	TPU Urethane 94 Shore A, Black	-40°/+110°	-40°/+230°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
ESC-thane™	Compound	U94-BLU	TPU Urethane 94 Shore A, Blue	-40°/+110°	-40°/+230°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
ESC-thane™	Compound	U65D-N	Urethane 65 Shore D, Milky	-40°/+110°	-40°/+230°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
ESC-thane™	Compound	U95-HT	Urethane PPDI 95 Shore A	-40°/+135°	-40°/+275°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets
ESC-thane™	Compound	U95-LT	Urethane PPDI 95 Shore A	-54°/+121°	-65°/+250°	Back-up Rings, Rod Wipers, Rod Seals, Piston Seals, Gaskets

Complete physical specifications can be found at www. engseals.com

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