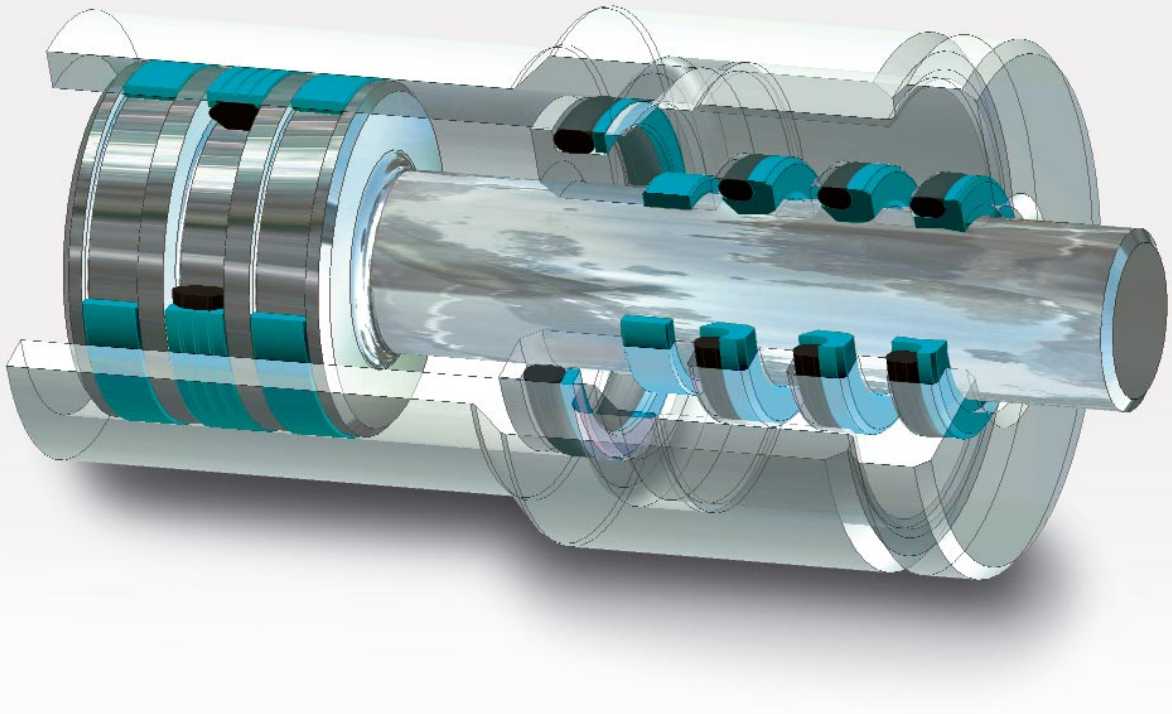
Aerospace sealing systems



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Trelleborg Sealing Solutions
Quality & Service remain!

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Contents

Sealing System Examples

Typical Hydraulic Equipment using Shamban Systems

In each individual case the type of system should be selected based on criteria such as friction, leakage, and cost. In the following examples we have mentioned the main features for each system as a guideline; however, the section describing the individual product should always be consulted to ensure that all operational requirements are fulfilled.

Utility Actuator Systems: Rod Applications

For general purpose hydraulic actuators, Shamban offers a variety of simple and reliable sealing systems:

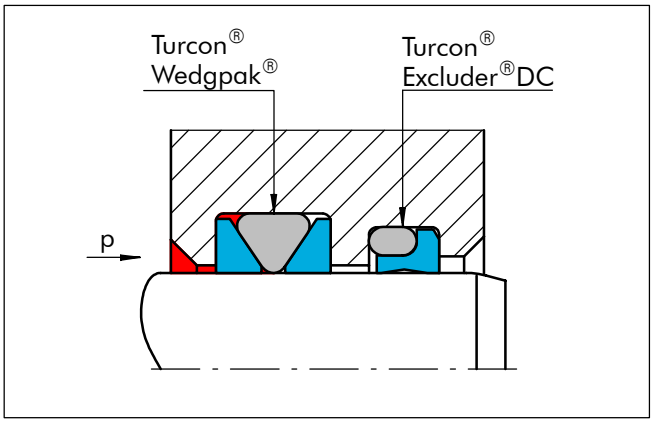


Figure 1 Standard Rod Sealing System

The Wedgpak® and Excluder®DC standard sealing system (Fig. 1) is a simple and effective solution that combines long life with good leakage control. The Wedgpak® is an easy to install, foolproof design, offering excellent leakage control.

The Excluder®DC is superior to the older garter spring energized scraper because it utilizes an uncut scraper ring and is sealed off by an O-Ring on the static side.

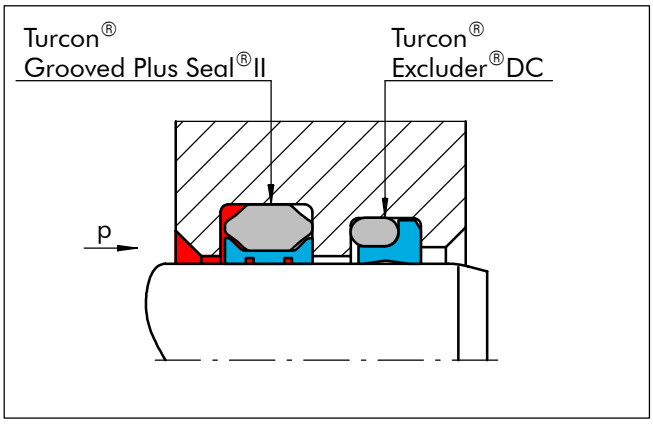


Figure 2 Alternative System I

The Grooved Plus Seal®II (Fig. 2) can be substituted for the Wedgpak® in cases where an elastomeric contact seal is not suitable due to high speeds or long rest periods for the actuator. This seal has nearly the same leakage control, but since it is a slipper seal, speeds of up to 15 m/s (49 ft/s) are acceptable and adhesion is eliminated. The grooves on the dynamic seal surface provide pockets where the hydraulic fluid can accumulate and lubricate the seal, therefore increasing seal life.

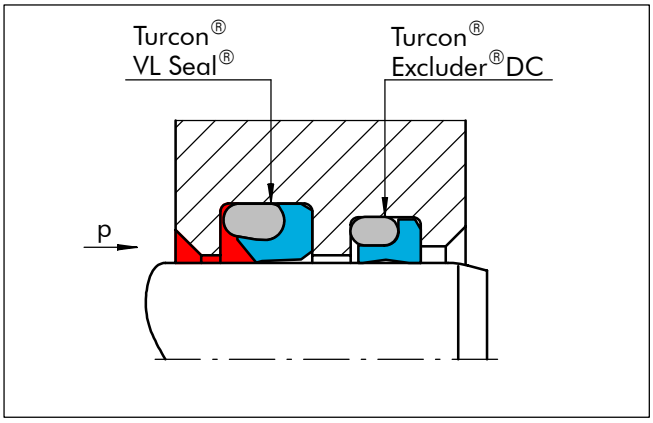


Figure 3 Alternative System II

VL Seal® (Fig. 3) is a good alternative for applications where a dry rod is critical (and typical slipper seals allow too much leakage). VL Seal® is designed to pump any leakage back into the system. A double acting scraper such as the Excluder®DC is used in order to prevent leakage out of the system at the rod end. The VL Seal® /Excluder®DC system has the advantage of being extremely leaktight with a surface finish at max. Ra 0.2 µm.

Note. Recommendations for **Groove Distance**, see figure 123 page 104.

Utility Actuator Systems: Piston Applications

Piston systems are typically simpler than rod systems. They must be of symetrical design to cope with the changing direction of the fluid pressure.

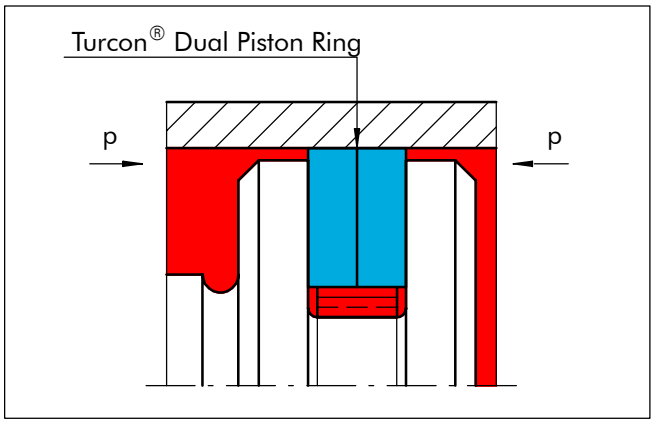


Figure 4 Turcon® Dual Piston Ring

Where controlled leakage is permissible, the Dual Piston Ring offers a good, reliable, low friction seal in a narrow groove width.

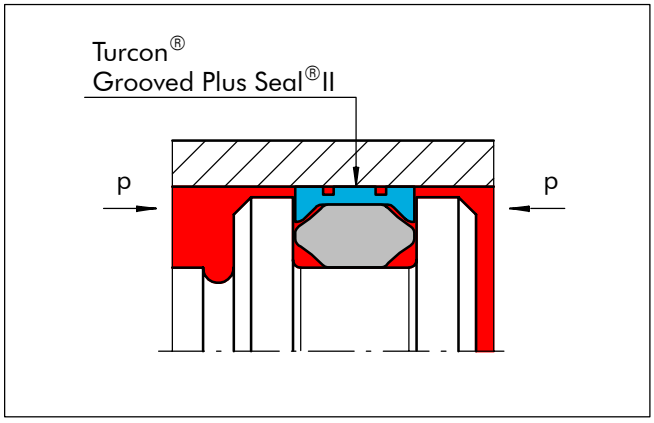


Figure 5 Turcon® Grooved Plus Seal®II

Where leakage is critical, the Grooved Plus Seal®II is widely used and has excellent wear characteristics.

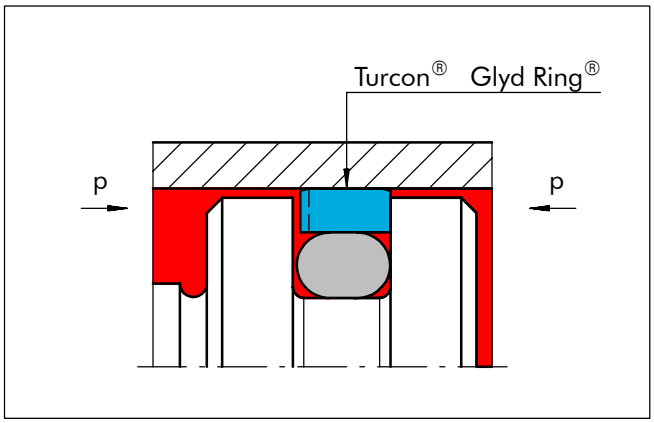


Figure 6 Turcon® Glyd Ring®

The Turcon® Glyd Ring® is a simple, reliable and cost-effective slipper seal that is worthwhile considering as an alternative to the Plus Seal®II if MIL-G-5514F gland design is not mandatory.

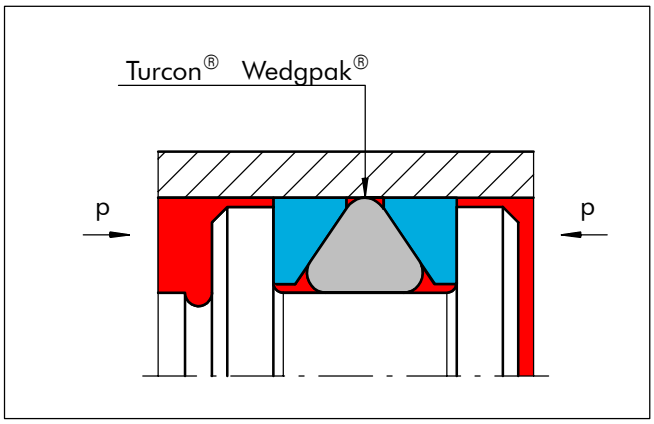


Figure 7 Turcon® Wedgpak®

The Wedgpak is a "zero" leakage elastomer contact seal with outstanding dynamic performance and easy installation.

Advanced Actuator Systems:
Primary Flight Controls
Rod Applications with Dual Unvented Seals

With the increased use of fly-by-wire technology, most primary flight controls use a dual unvented sealing system in order to meet the high performance and long life requirement.

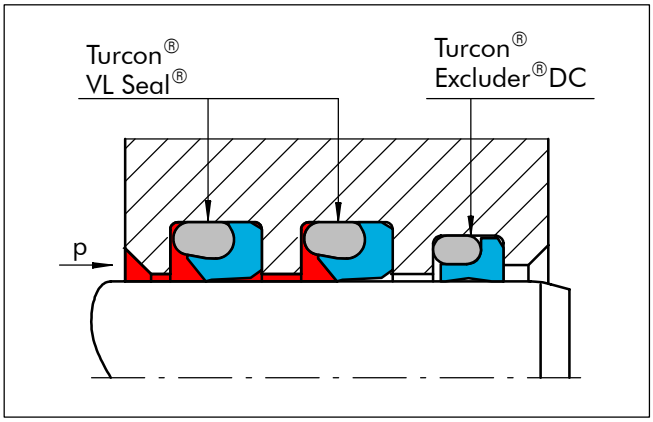


Figure 8 High Frequency System

The tandem VL Seal® combines the low friction characteristics of the slipper seal with a leaktight performance. The dual edge Excluder®DC closes the leakage by low pressure and static stand-by operations.

Although the Hatseal®II and the Wedgpak® have been used for many years for high frequency systems, the tandem VL Seal® system provides increased reliability and can survive high frequency dither stroke applications with increased service life.

Rod Applications with Pressure Relieving Seals

In some cases an interstage pressure build-up can be experienced in a dual unvented sealing system. The following factors are contributing to this phenomenon:

- Stroke frequency
- Stroke length
- Pressure variation
- Extrusion gap
- Surface finish
- Oil viscosity
- Temperature

The following systems are designed to allow the interstage pressure build-up to be relieved back into the system , when the system pressure drops or in the case of the Stepseal®K during the retract stroke of the rod.

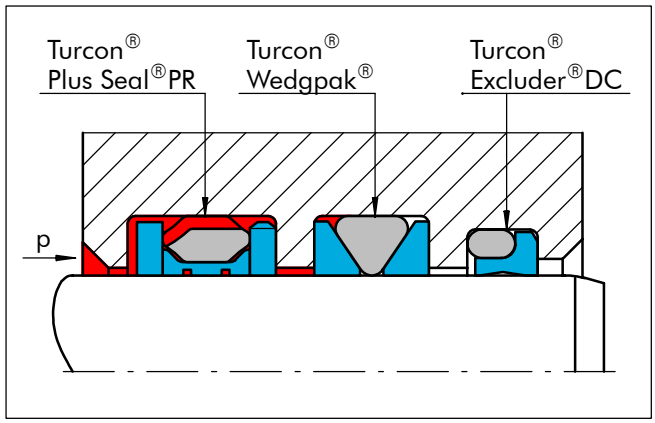


Figure 9 System with Pressure Relieving Plus Seal®PR

The Plus Seal®PR is capable of relieving any interstage pressure.

The Plus Seal®PR is easily fitted into existing grooves as a retrofit if a pressure build-up is noticed, requires a careful installation.

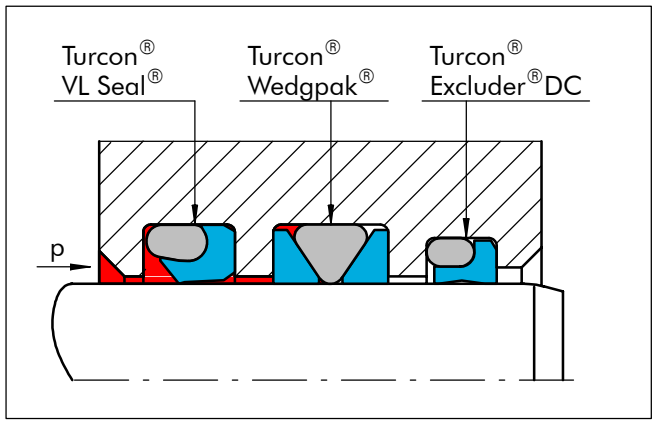


Figure 10 System with Pressure Relieving VL Seal®

Pressure relieving can also be achieved by using the VL Seal® as a primary seal. The sealing lip will lift if the back pressure exceeds approximately 10 bars (145 psi).

VL Seal®/Wedgpak® configuration offers the optimum pressure relieving seal system, due to the VL Seal® design. Pressure trapped in between the two seals is prevented from leaking through by the elastomer contact of the Wedgpak® and the slight tilt of the VL Seal® caused by backpressure, allowing the oil back into the circuit.

Advanced Actuator Systems, i.e.:
Primary Flight Controls
Piston Applications

The piston seals in a flight control are working under less severe conditions than the rod seals because they are well lubricated by the oil.

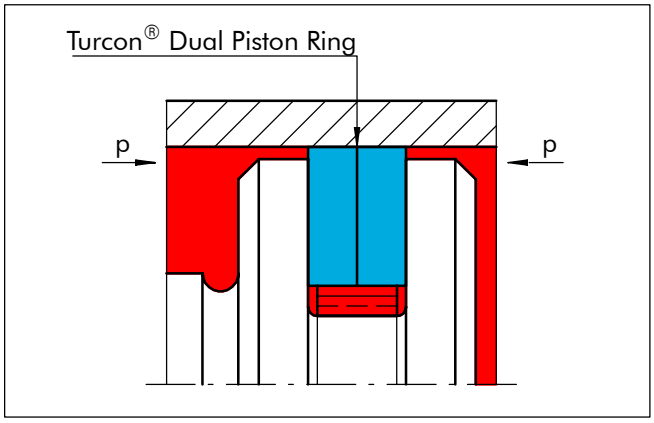


Figure 11 Turcon® Dual Piston Ring

Where controlled leakage is acceptable, the Dual Piston Ring offers a good reliable low friction solution in a narrow groove with minimum hysteresis.

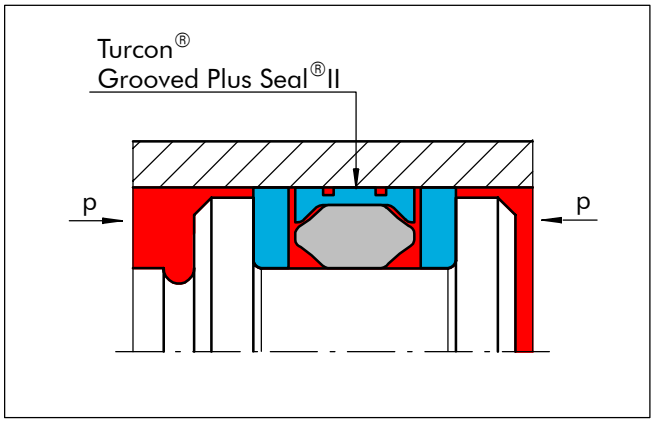


Figure 12 Turcon® Grooved Plus Seal®II

Where leakage is critical, the Grooved Plus Seal®II is widely used and has excellent wear characteristics. In flight controls we recommend Back-up Rings with the Plus Seal®II.

Landing Gear Shock Struts

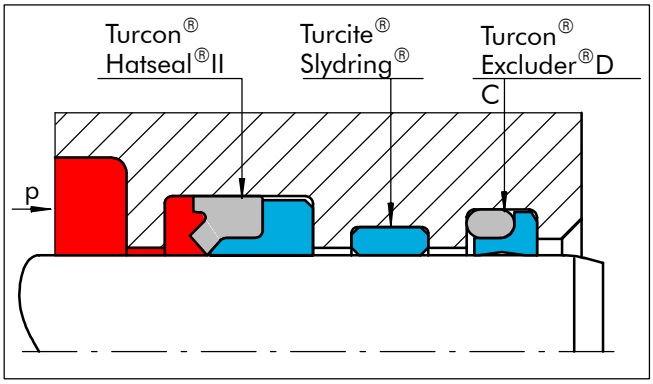


Figure 13 Small Diameter Shock Strut

For smaller diameter shock struts, the Hatseal®II/ Excluder®DC has proven to be a cost effective solution due to the long service life.

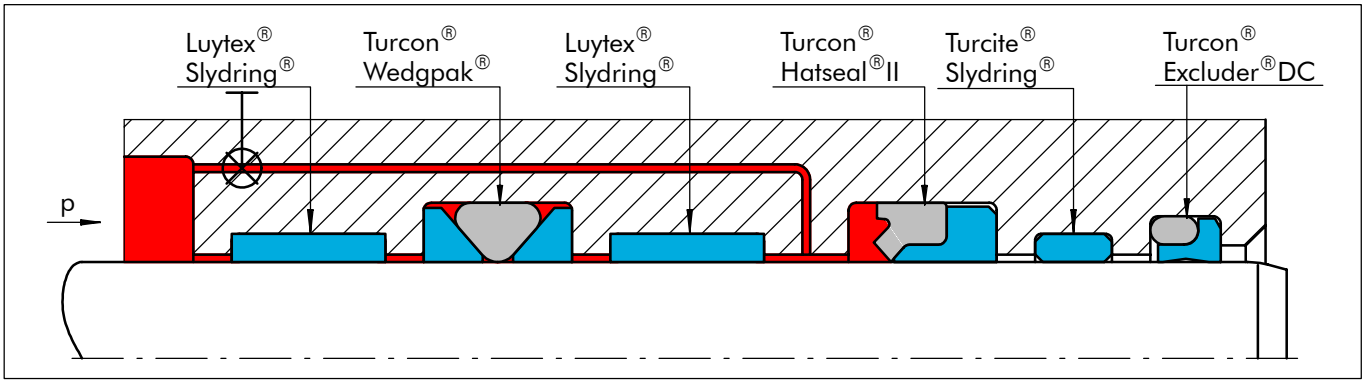


Figure 14 Large Landing Gear with Installed Spare Seal

For medium sized landing gear, it is an advantage to use a tandem sealing system with by-pass around the inboard seal. This means that initially the pressure drop is over the outboard seal, and the inboard seal runs in a lubricated environment. When a leakage is detected, the by-pass can be closed and operations continue on the inboard seal until the next scheduled overhaul.

On landing gears where severe shock strut deflection can be expected, the use of Slydring® is recommended to avoid scoring caused by metal-to-metal contact of the moving parts.

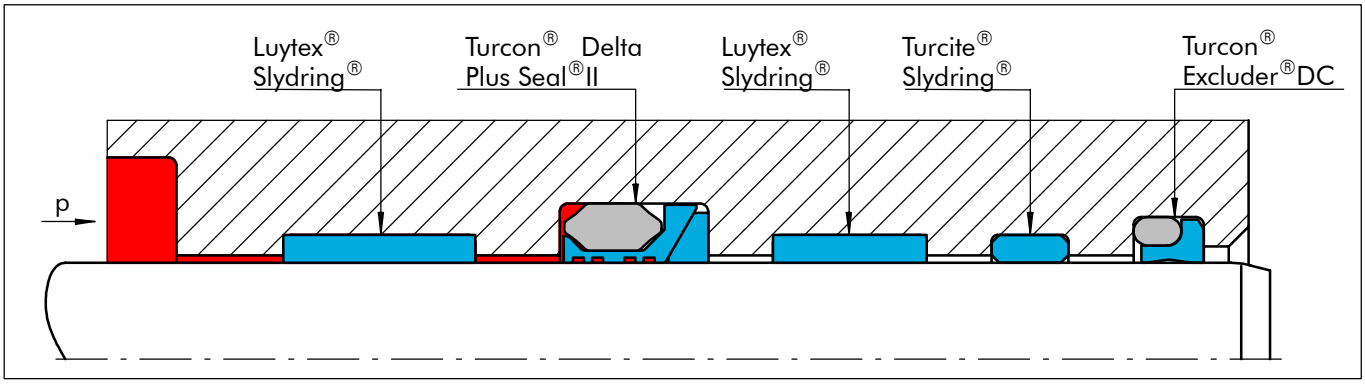


Figure 15 Large Diameter Shock Struts

For large diameter landing gear where heavy deformations and high pressure shocks may occur, it is essential to use a slipper seal without elastomer contact to provide the necessary service life. The use of Luytex® Slydring® are critical to good performance because metal-to-metal contact is avoided.

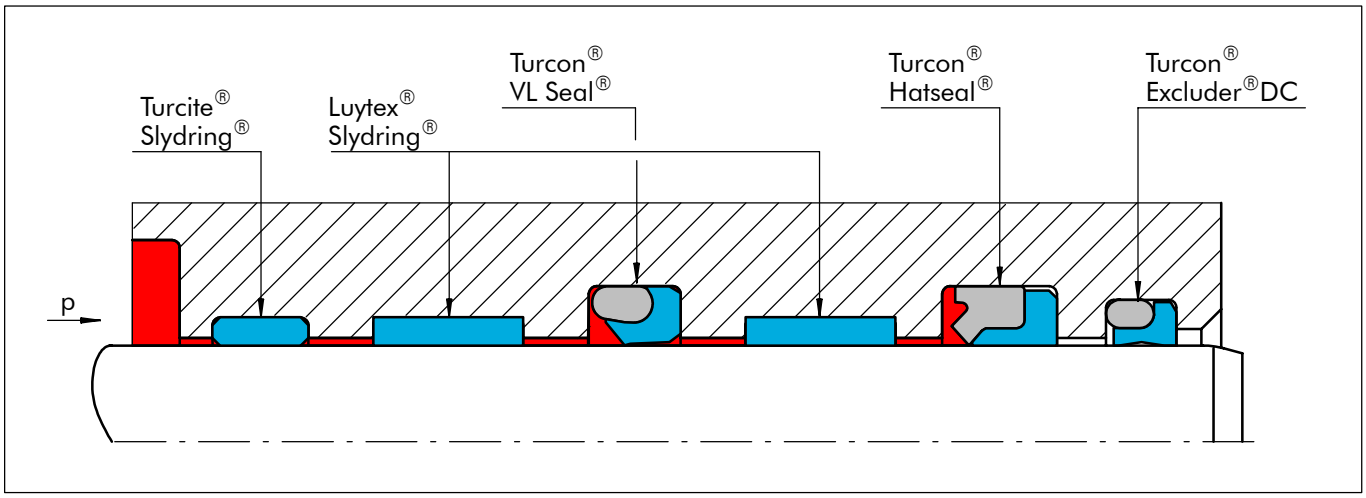


Figure 16 Future Landing Gear Sealing System

Tandem sealing systems represent the ultimate sealing solution for landing gear, with the new Series 600 cross section, and there is room for it. The Turcon® VL Seal® as the primary seal to take up the peak and pulsation pressure, protecting the Turcon® Hatseal®II as the leaktight performer with the lip. Both seal designs are considered the superior strut seals and the combination of the seal designs will only improve the performance.

Shamban seals and bearings are among others used for the following Landing Gear applications:

A320, A380/340
B737, B747, B757 and B767,
ATP, F-5, Eurofighter, J31, HS748, Spitfire, EMB 145, PC7 and PC9.

Rotary Vane Sealing System

A rotary vane sealing system consists of a rectangular cap seal with a centerplate, and an O-Ring to energize and seal between the chambers. The corner seal can be designed in various shapes to control the leakpath between chambers and rod. The Turcon® Wedgpak® is positioned as rotary seal with a small elastomer contact to prevent leakage even at low pressure. Finally the Excluder®DC prevents contamination from entering the system. If space is available, a Slydring® is recommended between the rod seal and the Excluder®DC.

Please consult your Shamban sales engineer for further recommendations.

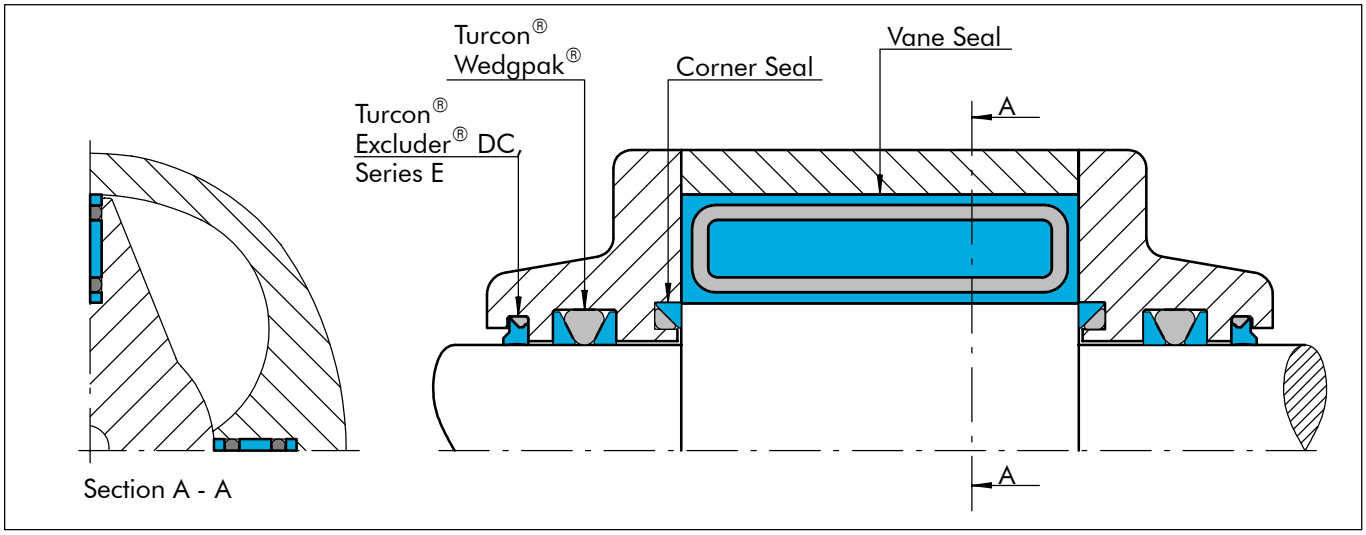


Figure 17 Rotary Actuator Sealing System

Accumulators

The Turcon® AQ-Seal®5 is a leak-tight, long-lasting piston seal. The use of Slydring® is recommended to avoid leakage resulting from piston misalignment with the bore.

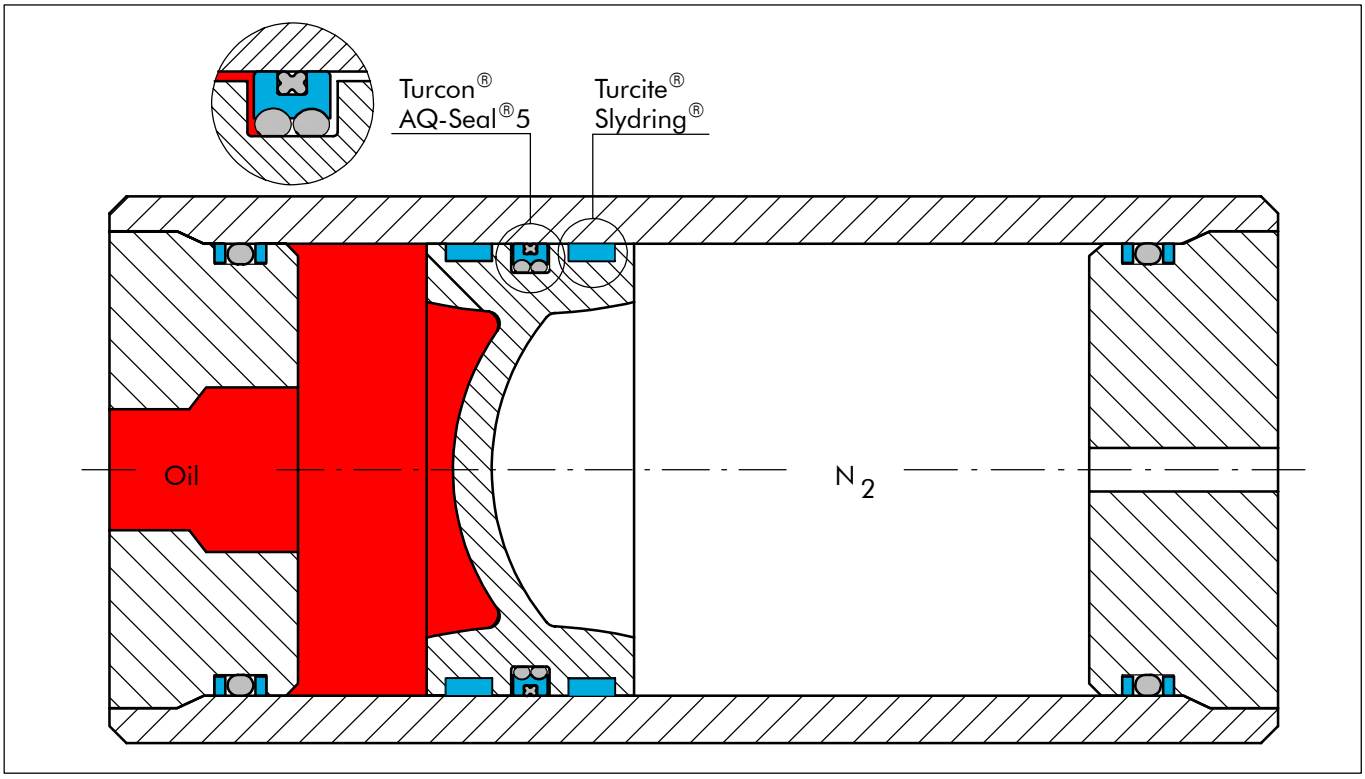


Figure 18 Accumulator Sealing Systems. Application Example: Sikorsky H60

Spool Valves

Reduced gland width can be achieved by using a Turcon® Glyd Ring® internally, and a Turcon® Wedgpak® with elastomer contact to prevent external leakage.

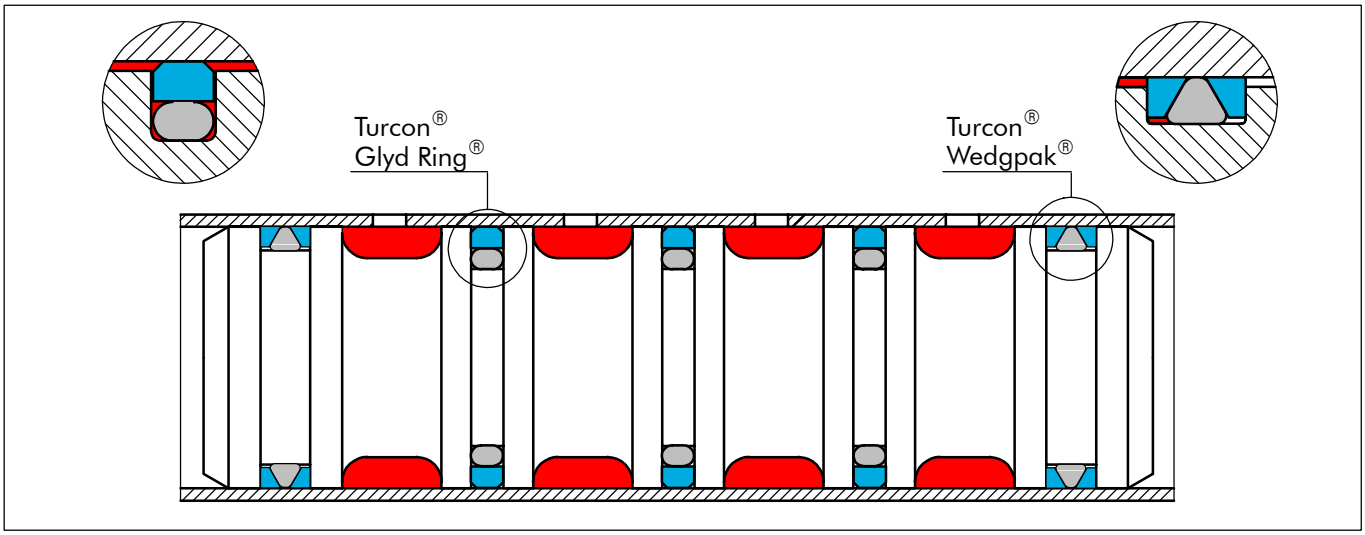


Figure 19 Spool Valve Sealing Systems. Application Example: IPTN

Brakes

Brake pistons equipped with a spring energized Turcon® Variseal®H to take pressure and temperature variation, combined with the tight and efficient Turcon®Excluder®DC, Series E, have proven to be very reliable. The advantage of using Variseal® (spring energized Turcon® jackets) instead of elastomer contact or energized seals is that brake systems often exceed the temperature capability of the elastomer. Spring energized seals can go from -100°C/-148°F to +260°C/500°F, and metallic springs address most fluid compatility problems.

The Spring Liner protects the brake housing from wear and abrasion from the spring.

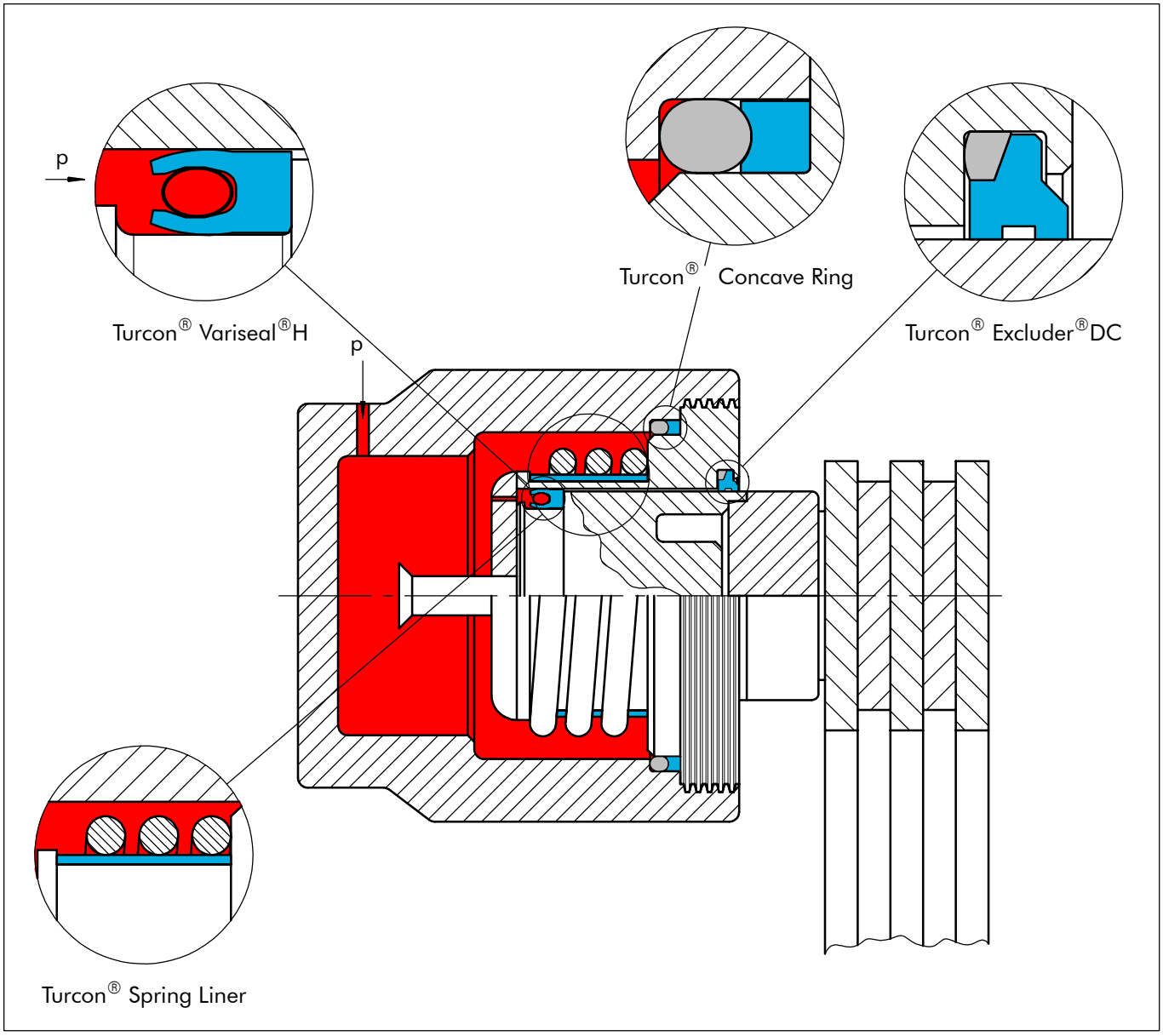


Figure 20 Brake Sealing System. Application Example: F-16 A/B

Turcon® Seal Materials

Turcon® materials are carefully formulated proprietary blends and are based on premium-grade PTFE fluoropolymer resins. Fillers are added that improve seal material properties. Fillers improve wear extrusion, resistance and high-temperature properties of Turcon®. The key features of Turcon® seal materials are as follows:

Low Friction

Turcon® materials exhibit the lowest coefficient of friction of any known solid, as low as 0.04 unlubricated on polished steel. The friction values obtained under lubricated conditions will be smaller. A unique property is the very low static coefficient of friction of Turcon® which results in extremely low breakout friction. Turcon® materials do not adhere to their mating surfaces, therefore eliminating any worries about stick-slip in dynamic applications.

Chemical Compatibility

Turcon® materials are chemically inert in essentially all industrial chemicals and solvents, even at elevated temperatures and pressures. A single Turcon® material can handle an extremely wide range of solvents, acids, or other corrosive media.

Temperature Range

Turcon® materials can operate at service temperatures from -196°C /320°F up to 260°C /500°F, (even further under special conditions) but it is necessary to limit other working conditions, such as speed and pressure, when the temperature reaches the limit.

Temperature Cycling

In elastomeric seals, temperature cycling causes material degradation leading to compression-set of the elastomer. Turcon® material properties, however, are not altered by cycling temperatures. Turcon® also does not contain plasticizers or any other ingredients which could degrade at temperatures below 300°C (572°F).

High Surface Speed

Turcon® materials generate far less heat than other materials, such as elastomer, polyurethane, etc. In general, surface speed can go up to 15 m/s, depending upon seal design and working conditions. Speed exceeding 20 m/s has been achieved under special conditions.

Aging

Turcon® properties do not significantly change over time. Turcon® does not age and will not embrittle or degrade when exposed to severe-weathering conditions of heat, light, water, salt spray, etc. This is useful when seals might sit idle for years and still be required to perform with complete reliability.

Resilience

Turcon® materials may experience "cold flow" or creep under continued thermal or mechanical stress because they do not have the resilience of elastomers. Consequently, Turcon® materials require an external-loading device such as a metal spring or an elastomer. This is required to provide the radial force which compensates for seal wear, cold flow, and the normal variations in gland dimensions due to tolerances or eccentricity.

Wear Resistance

Turcon® materials are formulated to enhance wear life at high speeds, pressures, and temperatures through the addition of fillers such as carbon fiber, glass fiber, molybdenum disulphide and others. Turcon® materials achieve wear values that exceed the demands of many difficult sealing environments.

Radiation

Turcon® is not recommended for an accumulated radiation dose above 7 x 10^2 Gy (7 x 10^4 rad). The large flourine molecules in the PTFE chain make good targets for radioactive particles. The molecular-chain structure is damaged by scissure when exposed to radiation, resulting in lowered tensile strength and eventual disintegration. In high-radiation service, other fluoropolymers such as EFTE and PCTFE or Zurcon® materials are recommended.

Polytetrafluoroethylene (PTFE) Properties

Since Turcon® materials are based on premium-grade PTFE resins, the general properties of PTFE may be of further interest. PTFE has excellent electric properties such as a low dielectric constant and a very high dieletric strength, even at elevated temperatures. PTFE will not sustain fire in pure oxygen. Virgin PTFE is physiologically inert.

The water absorption of PTFE is 0.01%. PTFE does not absorb fluid to a level worth mentioning other than fluorinated-cooling media (e.g. Freon). Fluorinated fluids can cause a reversible weight increase of approximately 5% accompanied by dimensional increases of approximately 1%.

Material Data

All Turcon® Materials are made of a high grade composition of Polytetrafluoroethylene (PTFE) resin and processed in an isostatic molding process.
The following list includes the standard Turcon® materials, but a large number of other materials are available and will be specified when required by the working conditions. The materials are tested at 23°C (73.4°F)

Table I Turcon® Materials

Material Code	Description and recommended use	Color	Tensile Strength		Elongation at break	Specific Gravity	Hardness
Turcon®			ASTM D 4894 [MPa]	ASTM D 4894 [psi]	ASTM D 4894 [%]	ASTM D 792 [g/cm^3]	ASTM D 2240 [Shore D]
T01	Virgin, exceeding MIL-R-8791 Profile: Clean system, low friction and pressure Surface: Steel and chrome	White to Off-white	42.3	6130	378	2.16	58
T05	Turcon®. Profile: All systems, low friction, medium lifetime and pressure Surface: Steel and chrome	Turquoise	39.2	5682	392	2.17	57
T10*	Additive: Carbon and graphite Profile: Dry system, poor lubrication. Large extrusion gap Surface: Steel, chrome	Black	21.9	3180	183	2.05	64
T19	Additive: Mineral fibers and MoS_2 Profile: High pressure and long wear life Surface: Steel, chrome and ceramic	Gray	24.2	3506	226	2.30	63
T25	Additive: Glass fibers and MoS_2 Profile: Rotary application Surface: Hardened steel, chrome and ceramic	Gray	31.5	4562	286	2.23	59
T29	Additive: Carbon fibers high filled Profile: Long wearlife and large extrusion gap Surface: Steel and chrome	Gray	22.1	3208	217	2.01	61
T40	Additive: Carbon fibers medium filled Profile: Long wearlife Surface: Aluminum, Steel and chrome	Gray	24.7	3579	241	2.06	60
T47	Additive: Bronze medium filled Profile: Bearing and Slydring® Surface: Steel and chrome	Light to dark brown	27.6	4000	250	3.09	60
T49	Additive: Bronze medium filled acid treated Profile: Extrusion resistant Surface: Hardened steel and chrome	Gray	27.6	4000	250	3.10	63
T99	Additive: MoS_2 Profile: Low friction, medium pressure, long seal life Surface: Steel, chrome and anodized aluminum	Gray	37.2	5385	347	2.22	58

Note ! The values in Table I are nominals, intended for engineering reference only. These values are not to be used as a specification requirement. Specification values are available upon request.

* Turcon® T11, used in North America is equivalent to Turcon® T10.

Table II Zurcon® Materials

Material Code	Description	Color	Tensile Strength		Elongation at break	Specific Gravity	Hardness
			ASTM D 638		ASTM D 638	ASTM D 792	ASTM D 785
Zurcon®			[MPa]	[psi]	[%]	[g/cm^3]	[Shore R]
Z48	Proprietary Polyester Leaktight performance Steel and chrome (Formerly Zurcon® 448)	Uniform black	44.1	6.400	550	1.20	-
Z60	Polyamide and MoS_2 Spec. T-Seal and corner reinforcement Steel and chrome (Formerly HiMod® 60)	Gray	82.7	12.000	50	1.16	120
Zurcon®			**ASTM D 1457** [MPa]	**ASTM D 1457** [psi]	**ASTM D 1457** [%]	**ASTM D 621** (Deformation @ 2.000 psi 73°F/24 hrs)	**ASTM D 785** [M Scale]
Z43	High modulus thermo plastics + PTFE + Carbon Bearing, Stakbak® and corner reinforcement Steel, chrome and ceramic (Formerly HiMod® 552)	Uniform black	81.0	11.750	25	0.08%	95

Note: The testing of tensile properties are based on the microtensile specimen per ASTM D 1457/D 4894, pulled at 2 inches per minute with an initial jaw separation at 0.875 ± .005 inches. Tensile properties are determined in accordance with the procedures described in ASTM D 638.

Note ! The values in Table II are nominals, intended for engineering references only. These values are not to be used as a specification requirement. Specified values can only be obtained from each batch.

Turel® Elastomer Materials

Many of the Shamban seal designs are composite seals with an elastomer element as an integral part of the seal. For this reason it is very important that we are in control of such important seal design parameters as elastomer swell, shrinkage during molding, compression set, compatibility and tolerances.

Through extensive testing in our own test laboratory we make sure that our materials are manufactured to our specifications. A number of the materials have also been approved for a QPL as part of a US Government support program.

Selection of elastomer material for a hydraulic fluid is a critical issue since the elastomer materials are more sensitive to fluids than other materials. Chemical reactions and physical behavior can be very damaging if the wrong material is selected.

Even though the specifications ensure compatability, different behaviors can result due to the number and types of additives used in the oil. It may be necessary to conduct a soak test at elevated temperature in order to verify the performance for critical applications. Contact your Shamban sales engineer for assistance.

Following points are important when designing the seal system:

Chemical Compatibility

Compability with the most common oil types can be found in Table IV, page 16. For other medias please contact your Shamban sales engineer. See also note in section below.

Nitrile MIL-P-83461 versus MIL-P-25732C

Due to the chemical composition of the nitriles, it is very important to separate and use them where the functional behaviors are optimized.

	Compression Set (Static)	Wearlife (Dynamic)
MIL-P-83461 (peroxide cured)	+	-
MIL-P-25732C (sulphur cured)	-	+

This indicates that dynamic elastomer contact seal should be MIL-P-25732C in order to optimize seal life requirement.

Temperature Range

Most Turel® materials can be used in MIL-G-5514F type II systems (-54°C to +135°C / -65°F to -275°F). The low temperature dynamic cycling limits vary according to elastomer type.

Shamban offers other Turel® elastomer compounds which expand this temperature range. Please refer to Table III on page 15. The use of spring energized Variseal® can expand the temperature range even further.

Temperature Cycling

The effect of temperature cycling on elastomeric seals results in compression set which means that the elastomer material loses its elasticity over time. For Turel® materials, this effect is kept to an acceptable minimum if they are within the indicated temperatures.

Cold Temperatures

Elastomer materials contract approximately 10 times more than steel in cold environments. The material becomes stiffer, loses its flexibility and when passing the lower limit it reaches the glass transition stage whereby it becomes extremely brittle. Physical properties will recover when temperatures go up again. (Increased squeeze can improve the performance.)

Hot Temperatures

Elastomer materials soften and loose its physical properties when passing the upper temperature limit. Physical properties will not recover and it will take a permanent compression set. (Compression set varies with elastomer type).

Surface Speed

The speed of the dynamic surface in contact with an elastomer contact seal should be kept below 3 m/s (9.8 ft/s) to avoid damage to the elastomer.

Aging

The maximum recommended storage time is shown in Table III. This is only valid if the elastomer is stored under controlled conditions in light and airtight packaging.

Table III Turel® Elastomer Materials

Material Code		Base Polymer	Temperature Range °C (°F)	Hardness (Shore A)	Fluid	Reference specification	Recommended shelf life
New	Old						
NK	**BAK**	Nitrile (NBR)	-54°C to +135°C (-65°F to +275°F)	75	MIL-H-5606	AMS-P-25732 (on QPL)	10 years
NE	**BAE**	Nitrile (NBR)	-54°C to +135°C (-65°F to +275°F)	75	MIL-H-83282	AMS-P-83461 (on QPL)	10 years
NG	**G**	Nitrile (NBR)	-54°C to +135°C (-65°F to +275°F)	75	MIL-H-5606 MIL-H-83282	AMS-P-25732	10 years
EH	**H**	Ethylene Propylene (EP)	-54°C to +149°C (-65°F to +300°F)	80	Phosphate Ester	NAS 1613 rev. 2 class 1	10 years
EP	**EP**	Ethylene Propylene (EP)	-54°C to +149°C (-65°F to +300°F)	80	Phosphate Ester	NAS 1613 rev. 4 (on QPL)	10 years
FT	**T**	Fluorocarbon (FKM)	-34°C to +260°C (-30°F to +500°F)	80	MIL-L-7808 MIL-L-23699	AMS-R-83485[1)]	20 years
FL	**FAL**	Fluorocarbon (FKM)	-23°C to +204°C (-10°F to +400°F)	90	MIL-L-7808 MIL-L-23699	AMS-7259	20 years
FK	**FAK**	Fluorocarbon (FKM)	-23°C to +204°C (-10°F to +400°F)	75	MIL-L-7808 MIL-L-23699	AMS-7276	20 years
LF	**F**	Fluorosilicone (FVMQ)	-73°C to +177°C (-100°F to +350°F)	70	Jet fuel	AMS-R-25988[1)]	10 years
LA	**LEA**	Fluorosilicone (FVMQ)	-57°C to +177°C (-70°F to +350°F)	80	Jet fuel	AMS-R-25988[1)]	10 years

1) Meets physical property requirements of applicable specification.
Testing to the specification on a lot-by-lot basis available on request at additional cost.
Other materials available upon request. Contact your Shamban sales engineer.

Aerospace Hydraulic Fluids

Table IV Common Oil Types

Specification	Trade name	Temperature Range	Type	Most Compatible Elastomer
MIL-H-5606 (Nato code H-515)	Red oil	-54°C to +135°C -65°F to +275°F	Petroleum based hydraulic oil. Primary military fluid.	NBR, Sulphur cured, FKM, FVMQ
MIL-H-83282C (Nato code H-537)	Synth. Red oil	-40°C to +205°C -40°F to +401°F	Synthetic hydrocarbon based hydraulic oil. The fluid has improved fire resistance (fire propagation) and shear stability, but reduced low temperature capability.	NBR, peroxide cured, FKM, FVMQ
MIL-PRF-87257 (Nato code H-538)	Synth. Red oil	-54°C to +135°C -65°F to +275°F	Synthetic hydrocarbon based hydraulic oil. Similar to above but improved cold temperature capability	NBR, FKM, FVMQ
AS 1241A-Cl1 AS 1241A-Cl2	Phosphate Ester	-54°C to +135°C -65°F to +275°F	Phosphate Ester fluid. No fire propagation. Cl1 is low density fluid, Cl2 is high density.	EPDM
MIL-L-7808	Engine lub. oil	Nominal -54°C to +150°C -65°F to +300°F	Synthetic oil-ester based lubricant oil (Organic acid ester based)	FKM
MIL-L-23699C	Engine lub. oil	Nominal -40°C to +204°C -40°F to +400°F	Synthetic based lubricant oil (Organic acid ester based)	FKM

Viscosities of Typical Fluids vs. Temperature

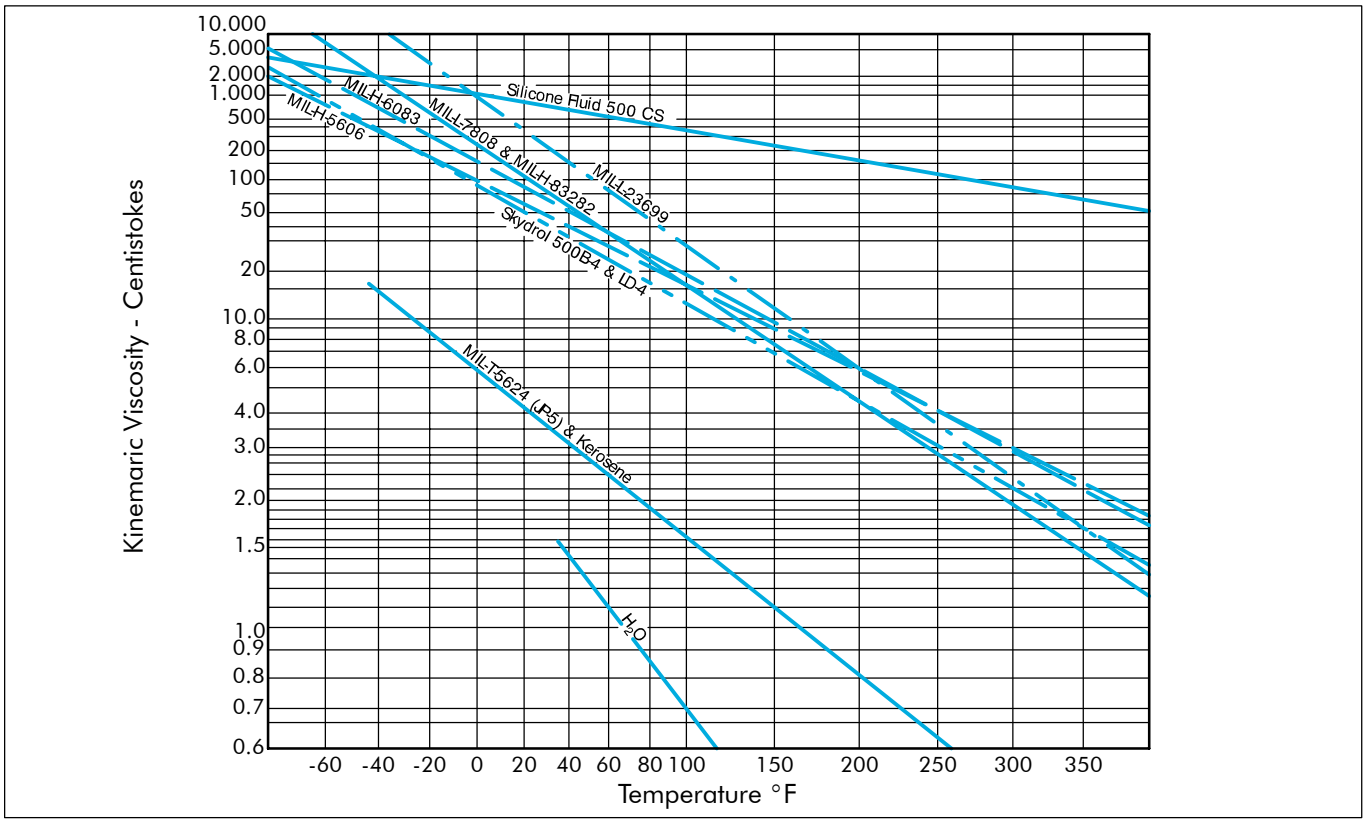


Figure 21

Surface Finish (Recommendations)

Surface Finish Recommendations

Current industry standards for surface finish range from 0.2-0.4 µm Ra (8-16 µin) per Mil-G-5514 to 0.25-0.50 µm Ra (10-20 µin) for general applications. Past industry experience suggested that surfaces smoother than 0.2 µm Ra (8 µin) did not allow for ample lubrication of seals, while surfaces rougher than 0.4-0.5 µm Ra (16-20 µin) prematurely wore seals, resulting in short life. With the surface measuring and finishing equipment available today, surface finishes smoother than the current standards have shown to be suitable and can actually improve overall seal performance.

Investigations into surface finish measurement equipment and capabilities, along with finishing methods, have resulted in functional seal testing being performed to determine and verify surface finish recommendations for improved seal performance. The following recommendations are a guide to defining the proper surface finish for dynamic sealing applications:

Ra	=	0.1 - 0.2 µm	(4 - 8 µin)
Rz	=	1.0 µm maximum	(40 µin)
Rp	=	0.6 µm maximum	(24 µin)
tp (Mr)	=	50-70% @ depth p = .25Rz relative to a ref. line c = 5% tp	

These general recommendations apply to all types of sealing surface finishes including plated or coated surfaces and bare, hardened metal surfaces.

Additionally, the surface profile should have a"plateaued" appearance as the illustration of Figure 29 shows. A surface with a high concentration and magnitude of peaks has been shown to cause excessive seal wear. A surface relatively void of peaks but including valleys for lubrication retention is more suitable for sealing applications.

Direction or "Lay" of Finish

Each of the many different methods used to obtain a specific surface finish - turning, grinding honing, ballizing, polishing, etc. - produces a characteristic direction or "lay" to the surface. This factor alone can have an effect on sealing performance and wear patterns in certain applications. To obtain the best seal performance, avoid finishing methods which promote the formation of leak-paths in your application. For example, avoid a strongly axial lay in a reciprocating rod-seal application, or a definite spiral pattern on the shaft in a rotary application. Consult your Shamban sales engineer for further information.

Mating Surface Hardness

The hardness of a mating surface affects seal performance in several ways. A harder material improves wear life by resisting the tendency of seals to damage the mating-surface finish. If the mating material is too soft, the seal will burnish or damage the surface. Harder mating surfaces also allow the user to specify certain tougher, longer-lasting Turcon® seal materials (such as Carbon fiber filled T29) which would not be recommended on softer hardware surfaces. Harder mating surfaces have a tendency to lower the running friction of a seal.

A seal will polish its mating surface, especially if it is a softer metal. For example, a reciprocating rod made of stainless steel with a hardness of 28 to 30 Rockwell C and a finish of Ra 0.6 µm will generally be polished by the seal to a finish of Ra 0.3 µm or better over a short time. Seal friction and wear will then decrease accordingly. Materials that are harder than 44 Rockwell C do not polish as easily. The abrasive nature of a rough finish can cause excessive seal wear during the early burn-in period. Therefore, the harder the mating surface, the more important it is to start with a smooth finish.

Substrates

In most applications an unplated, uncoated shaft is more than adequate. Typical mating-surface materials are listed in the Table IX, page 26 and Table X, page 27. These materials (and others not listed) can also act as substrates for platings or coatings to achieve higher hardness values. An important property to consider in such cases is the ability of the substrate to support the plating. For example, when a high-pressure load is exerted on a seal running against a hard-chrome plating supported by a soft substrate (such as 300 series stainless steel) the plating may peel or crack and then abrade the seal. A better substrate would be stainless steel Type 440C (hardened to 44 Rockwell C) or an alloy steel such as 4340 in the fully-hardened condition.

Platings and Coatings

Seal designs run well against unplated surfaces at moderate speeds and pressures. In high-speed rotary or high-pressure reciprocating service, harder surfaces are preferred. Several examples of platings and coatings (not a complete list) are given on page 27.

For further advice on platings and coatings, please consult your Shamban sales engineer.

Seal Material

Seal material selection affects mating-surface hardness requirements. When an application requires the longest possible wear life under moderate to severe conditions, the seal material should be one of the harder, highly-filled Turcon® blends. For example, Turcon® T29 is very wear-resistant but contains carbon fibers that can abrade soft mating surfaces. These materials should only be run against materials with hardness values of 45 to 70+ Rockwell C.

Supporting Test Data

Functional dynamic seal testing was conducted under different evaluation programs that were designed to study surface finish effects on seal performance. Various types of surfaces (coatings) were evaluated throughout these tests. Not all of the tests were performed utilizing the same conditions or test seals. Some of the test results and observed trends relative to surface finish effects on seal performance are reported here as supporting data.

Functional seal testing utilizing commercially available induction-hardened, chrome-plated (IHCP) piston rod material meeting the 0.2-0.4 µm Ra finish requirement has typically shown much variation in seal performance results. Analyzing test results, the test parameters, equipment and methods concluded that the variations were most likely due to differences in the surface textures of the test rods.

Further testing using IHCP rods finished to the extremes of the 0.2-0.4 Ra requirement confirmed this suspicion. A test matrix was conducted whereby four combinations of finishes were evaluated: (Ra in µm)

- 0.2 Ra ground
- 0.2 Ra ground, polished
- 0.4 Ra ground
- 0.4 Ra ground, polished

The results of this study were somewhat surprising and uncovered some effects that surface finish can have on seal performance. In general, the polished surfaces performed better with respect to seal leakage and wear, which was expected. But the polished 0.4 Ra surfaces allowed better seal performance than the 0.2 Ra ground; this result revealed the need for more in-depth studies of the effects of surface texture and type. Not only was the 0.2-0.4 µm roughness average finish callout inadequate, but the type of finish (ground only vs. ground and polished) was also significant to seal performance.

A test program was conducted to evaluate proposed improvements to a standard industrial sealing system for a reciprocating application. A comparison of different surface finishes was part of this study. The test rods were not plated; an alloy steel hardened to Rc 36-40 was the test rod material. For one of the tests, a maximum Rp value (peak height) was set for the test rod in addition to the Ra callout. The wear of the primary seal element was measured after 1 million cycles. The seal that ran on the more tightly-controlled surface finish showed a significant advantage with respect to wear as Figure 22 illustrates. Leakage performance was identical between the two tests.

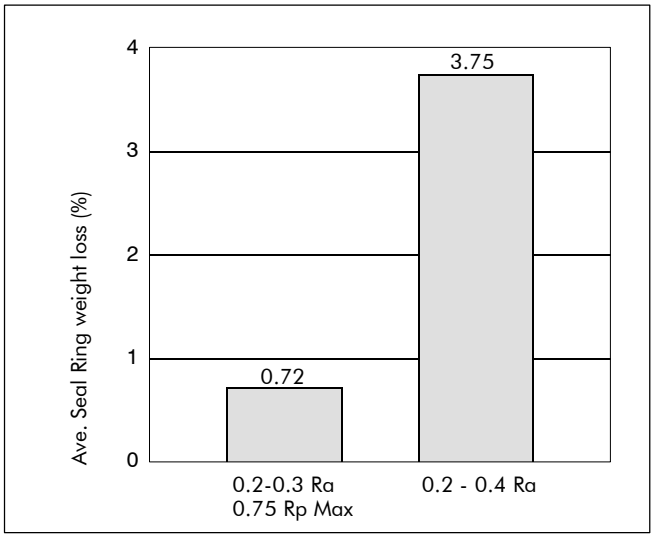


Figure 22 Seal Wear Comparison

A seal performance evaluation was conducted comparing standard hard-chrome plate to electroless nickel and tungsten carbide coatings. These coatings were applied to a base material of C1045 steel, induction hardened to 40-50 Rc. Both PTFE-contact (slipper seal) and elastomer-contact seals were evaluated under the following test conditions: (Ra in µm)

Pressure : 3000 psi constant

Stroke : 3 inches

Stroke Rate : 1 Hz

Fluid : Mil-H-83282

Duration : 300.000 cycles
(TTD 1.8 million inches)

Temperature: 121°C (250 °F)

Test rods were prepared according to the following descriptions:

0.15-0.30 Ra standard hard-chrome

0.15-0.30 Ra standard electroless nickel

0.05-0.10 Ra superfinished electroless nickel

0.05-0.10 Ra superfinished tungsten carbide

Leakage and wear were the two performance characteristics measured for all seals tested. Figure 23 shows average leakage data for the Turcon®-contact seal tests. Figure 24 shows average seal ring wear data for the Turcon®-contact seal tests.

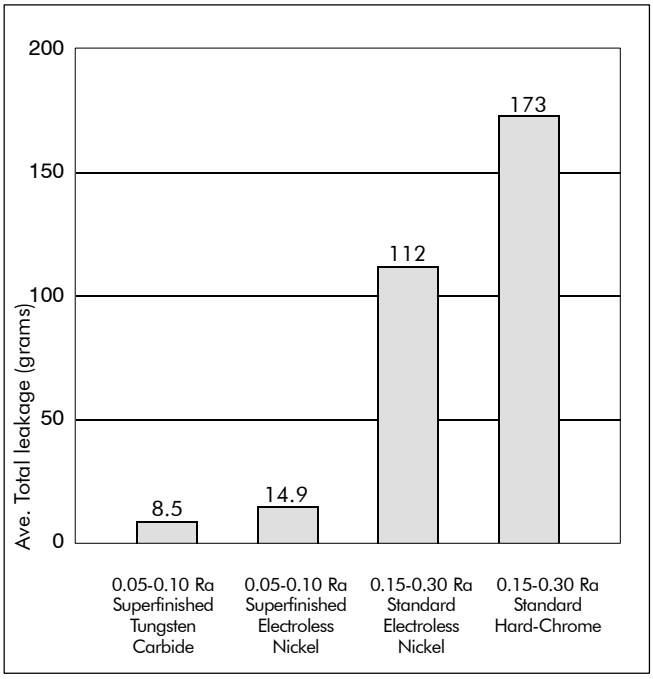


Figure 23 Turcon®-contact Seal Leakage

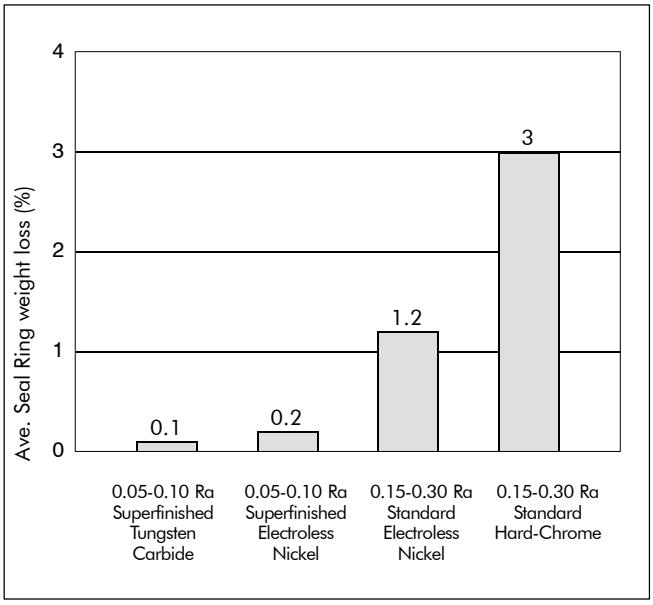


Figure 24 Turcon®-contact Seal Wear

As can be seen from the graphs, significant improvements in Turcon®-contact (slipper) seal performance can be gained through the use of advanced coatings and surface finish specifications.

Figures 25 and 26 show the leakage and wear results of the elastomer-contact seal tests.

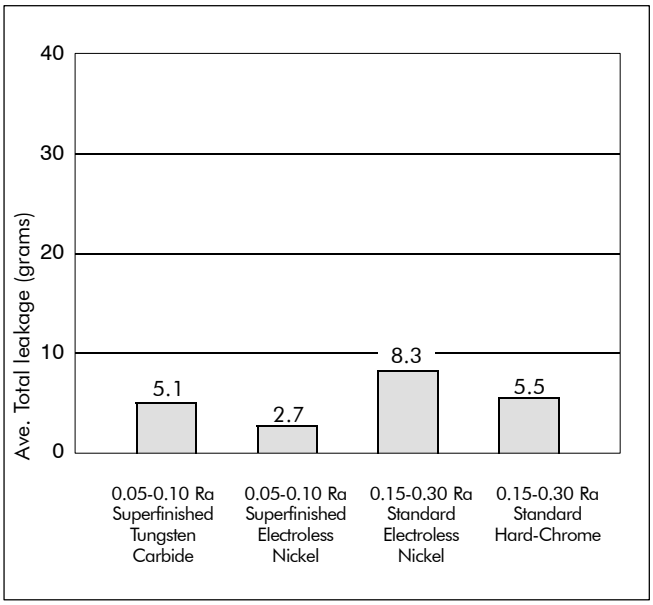


Figure 25 Elastomer-contact Seal Leakage

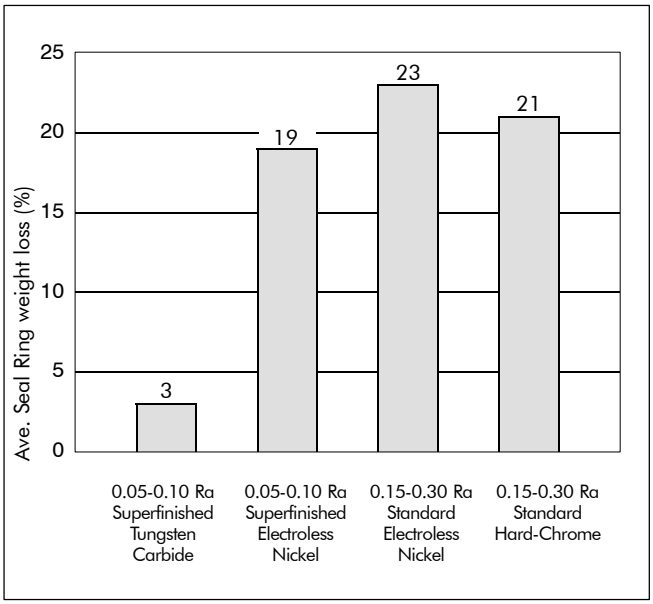


Figure 26 Elastomer-contact Seal Wear

In comparison to the Turcon®-contact seal performance data, the elastomer-contact seal performance gains are not as significant. This is mostly attributed to basic seal configuration and functional differences between the two types of seals.

Aluminum is occasionally used for cylinder barrels where weight is a major concern or the application is relatively light duty, as in pneumatics. For increased corrosion protection and wear resistance, aluminum alloys are usually hard-anodized. An evaluation was performed where hard-anodized aluminum was compared to tungsten carbide coated aluminum. Both Turcon®-contact and elastomer contact seals were tested to the following parameters:

Pressure : 3000 psi constant

Stroke : 3 inches

Stroke Rate : 1 Hz

Fluid : Mil-H-83282

Duration : 300.00 cycles
(1.8 million inches)

Temperature: 121°C (250 °F)

Leakage and wear were measured for all test samples. Figure 27 shows average leakage data; Figure 28 shows average seal ring wear data.

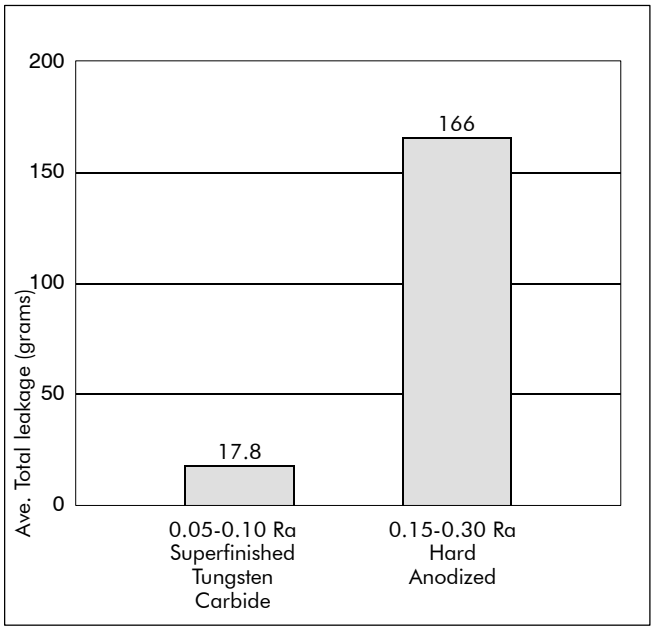


Figure 27 Turcon®-contact Seal Leakage

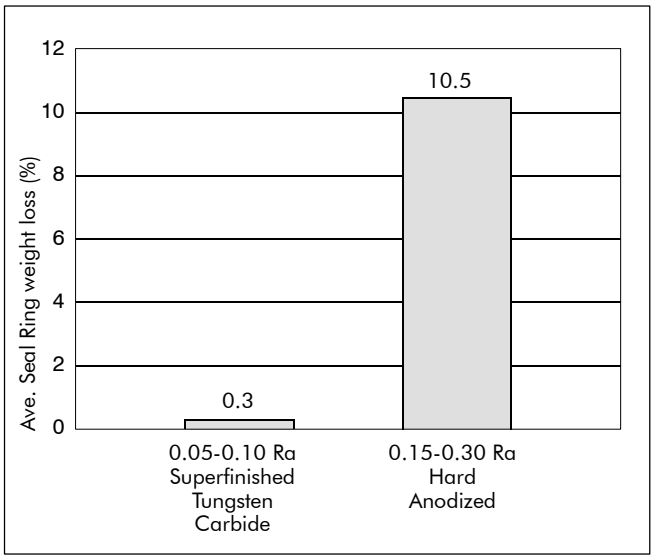


Figure 28 Turcon®-contact Seal Wear

Again, significant improvements in seal performance were observed between the different surfaces.

Throughout these supporting data, seal performance gains were demonstrated through the use of surface finish technology and advanced coatings. The exact contributions from either the coatings or actual surface finish improvements to the enhanced seal performances were not quantified. Regardless, significant performance gains, especially in the case of the Turcon®-contact seals, were shown as a result of improved surface quality.

Conclusion

Surface finish quality is directly related to dynamic seal performance. Properly defining, measuring and controlling surface finish quality is critical to the functional reliability and service life of a seal. Ra alone is not an adequate description of a sealing surface, however, care must be taken to prevent over-specifying surface finish requirements.

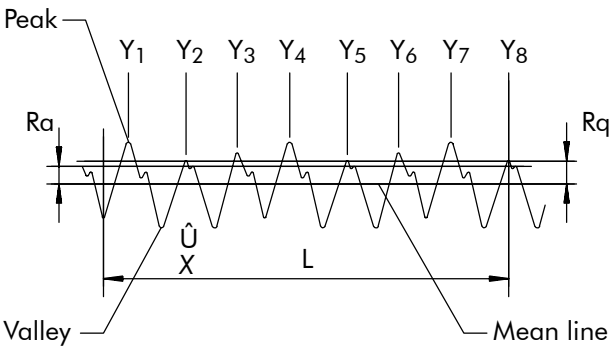
Many different types of surfaces are suitable for sealing applications as well as methods and equipment used to obtain satisfactory surface finishes. Advanced coatings and finishes, typically investigated as replacements to chrome plating, have demonstrated good performance gains with respect to dynamic sealing in hydraulic applications.

Surface Finish (Measurement Methods)

R_a - Arithmetic Average Roughness

Roughness averages are the most commonly used parameters because they provide a simple value for accept/reject decisions. Arithmetic average roughness, or R_a, is the arithmetic average height of roughness-component irregularities (peak heights and valleys) from the mean line, measured within the sampling length, L. See figure 29.

The measurements are taken as the fine point of the stylus on a profilometer which traverses the sampling length on the surface being measured.



$$Ra = \frac{1}{L}\int_0^L |y(x)|dx$$

$$Rq = \sqrt{\frac{1}{L}\int_0^L Y^2(x)dx}^{\,n}$$

Y = individual measured peak height

Figure 29 Surface Finish - R_a Versus R_q

R_q - Geometric Average Roughness

R_q is the current term for what was formerly called root-mean-square or RMS. R_q is more sensitive to occasional highs and lows, making it a valuable complement to R_a. R_q is the geometric average height of roughness-component irregularities from the mean line measured within the sampling length, L. Compare to R_a in Table V.

The main difference in the two scales is that R_q amplifies occasional high or low readings, while R_a simply averages them. For a given surface, therefore, the Rq value will be higher than the Ra value (by approximately 11%). That is, a surface finish that measures R_q 0.5 µm is equivalent to approximately R_a 0.45 µm.

Table V Surface Finish Conversion Table

R_a, AA, CLA		R_q or RMS	German-Swiss Norm[1]
English (µin.)	**Metric** (µm)	**English** (µin.)	
0.9	0.02	**1.0**	
1.0	0.03	1.1	**N1**
1.8	0.05	**2.0**	
2.0	0.05	2.2	**N2**
3.6	0.09	**4.0**	
4.0	0.10	4.4	**N3**
5.4	0.14	**6.0**	
7.2	0.18	**8.0**	
8.0	0.20	8.9	**N4**
10.8	0.28	**12.0**	
14.4	0.37	**16.0**	
16.0	0.41	17.8	**N5**
28.8	0.73	**32.0**	
32.0	0.81	35.5	**N6**
56.8	1.44	**63.0**	
63.0	1.60	69.9	**N7**

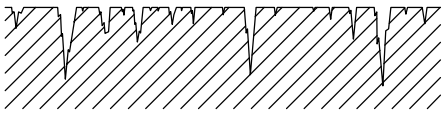
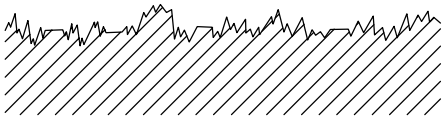
R_a : Arithmeric average roughness
AA : Arithmeric average
CLA : Center Line Average
R_q : Geometric average roughness
RMS : Root-mean-square

[1] The German-Swiss Norm is a series of roughness-grade numbers used to avoid confusion with numerical values of other types.

Improved Measurement Methods

The R_a measurement does not give a true picture of the real surface profile. The finish process plays a very important role in the outcome. In particular, the open profile "Peak Structure" can seriously affect seal performance, as its jagged structure can cut and nick the seal surface. On the other hand the closed profile form "valley structure", gives improved seal performance, because the valleys retain fluid and lubricate the running seal surface. Please see Table VI.

Table VI R_a Comparison

Surface Profile	R_a
	0.2
	0.2

Even with identical R_a values, the resulting seal performance will be very different.

An improved surface measurement method is described in the new ISO 13565-1 / -2 / -3, including the peak, valley and material ratios as described below.

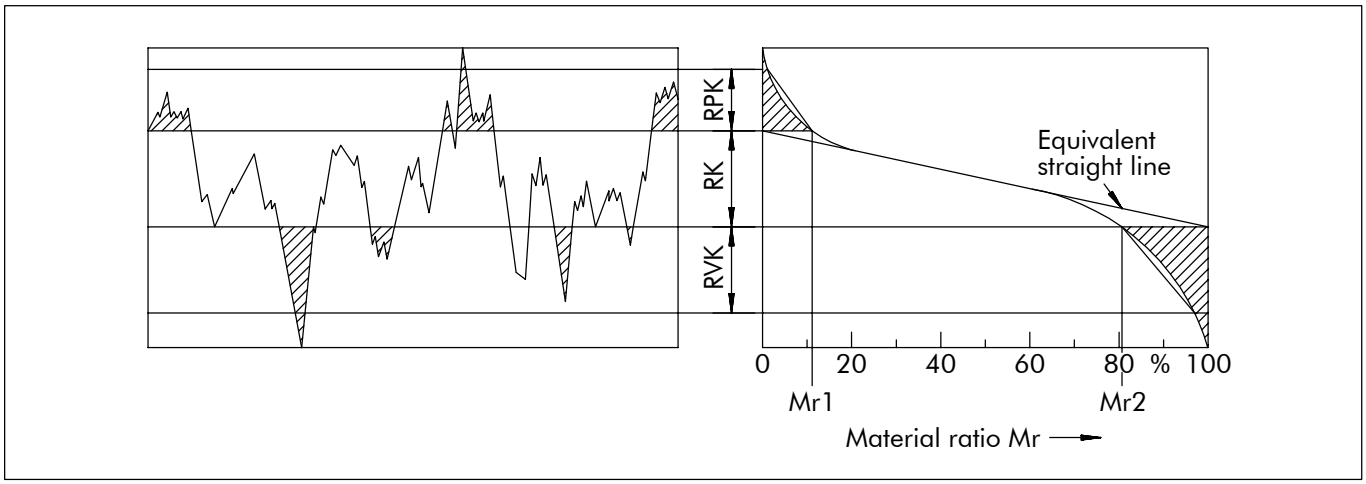


Figure 30 Abbot Curve

R_k (Core Roughness)
The core roughness depth is the depth of the roughness core profile.

M_r (Material Ratio)

M_{r1} in %
The material portion M_{r1} is determined by the intersecting line which separates the protruding peaks from the roughness core profile.

M_{r2} in %
The material portion M_{r2} is determined by the intersecting line which separates the valleys from the roughness core profile.

R_{pk} (Reduced peak height)
The reduced peak height R_{pk} is the average height of the protruding peaks above the roughness core profile.

R_{vk} (Reduced valley depth)
The reduced valley depth R_{vk} is the average depth of the profile valleys projecting through the roughness core profile.

The harder the material the more important it is to reduce the peak height R_{pk}. If mating surface is ceramic, the R_{pk} value must be down to 0.05 µm because the hard peaks will cut into the seal surface.

Other surface parameters are skewnesss and kurtosis, which give a more detailed picture of the surface. For explanation see Figure 31 below.

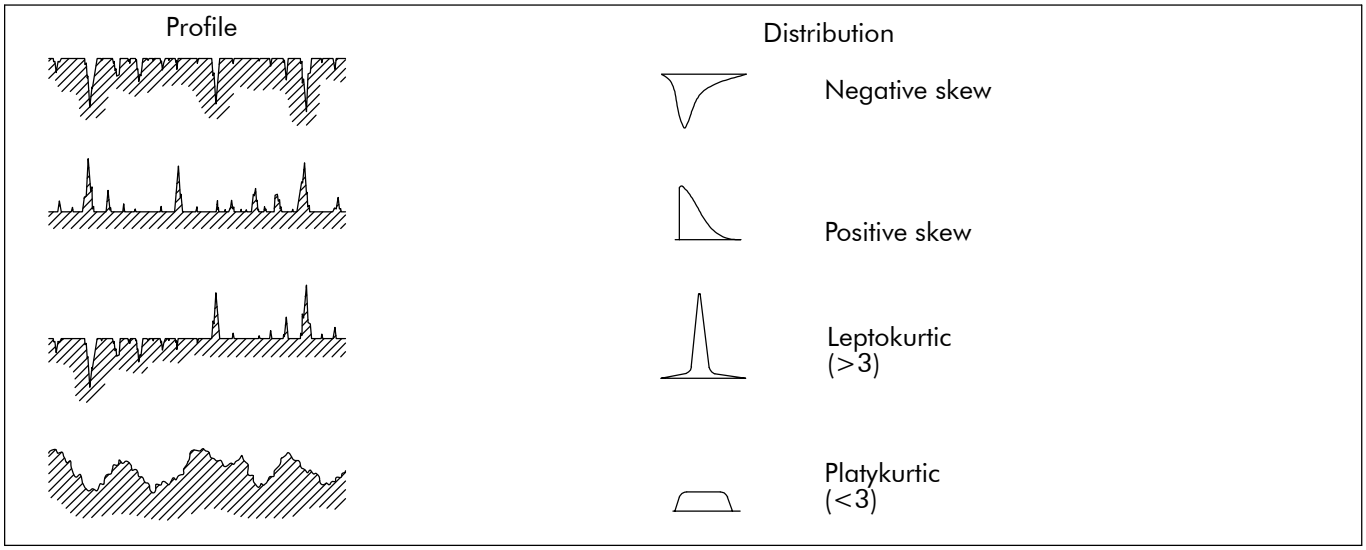


Figure 31 Surface Measurement Visualized

The optimum view of the surface structure is a 3-dimensional computerized picture showing not only peak, core and valley, but also direction of ridges and channels in the surface structure. Such pictures can be very valuable in evaluating seal performance. This method of measurement will expose widely varying surface profiles dependent upon base materials, platings or coatings, and the process used to produce the surface.

Table VII Properties of Surface Structure

Parameter	Unworn (μm)	Worn (μm)
S_a	0.11	0.21
S_{pk}	0.09	0.11
S_k	0.25	0.37
S_{vk}	0.40	0.98

Value measured in this dimension is called S instead of R, e.g. S_a is equivalent to R_a.

This method requires a sophisticated filter technique and software program that can convert the mathematical rounding. This technique is not readily available in industry, but is available at some universities and technical institutes.

3-dimensional surface texture characteristics are denoted by "S". 2-dimensional surface texture characteristics are denoted by "R". E.g. S_a is the 3-D equivalent to R_a

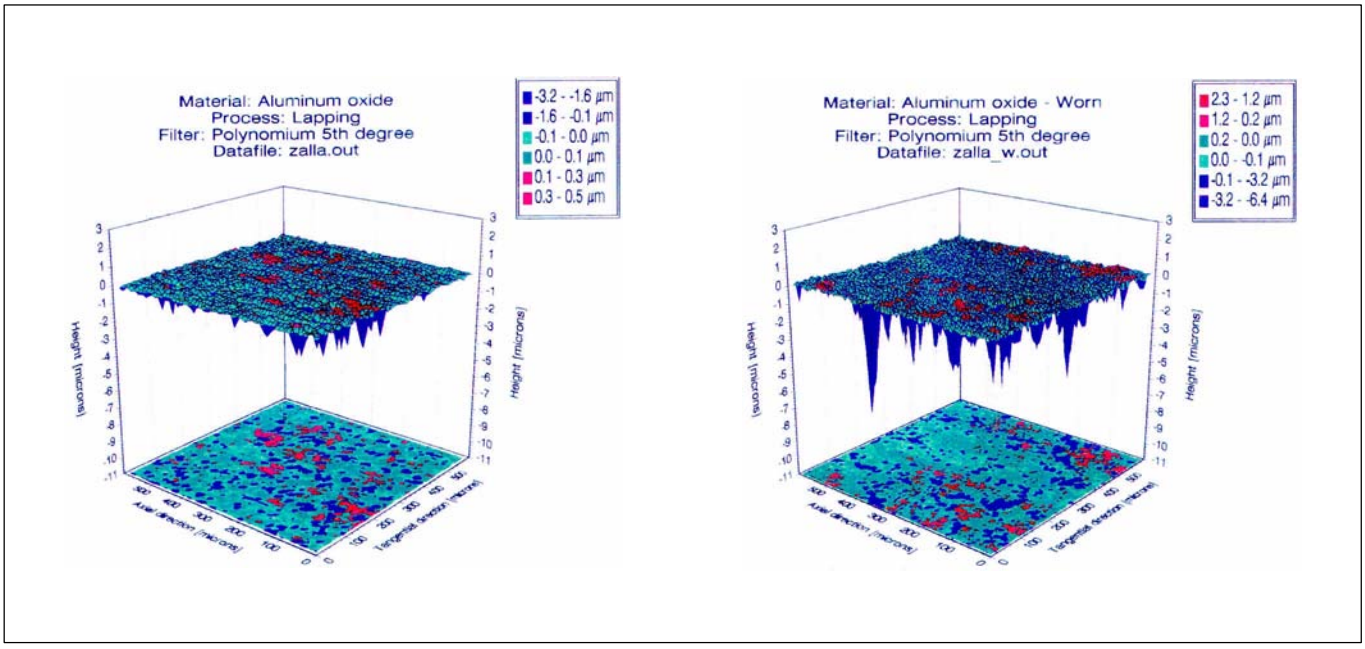


Figure 32 Surface Structure

Hardware Specifications

Table VIII Comparative Hardness Scales for Steel

Rockwell C	Brinell Number		Rockwell		Rockwell 15-N	Tensile Strength (kpsi)
	Standard ball	Tungsten ball	A	D		
68			85.6	76.9	93.2	
67			85.0	76.1	92.9	
66			84.5	75.4	92.5	
65		719	83.9	74.5	92.2	
64		722	83.4	73.8	91.8	
63		705	82.8	73.0	91.4	
62		688	82.3	72.2	91.1	
61		670	81.8	71.5	90.7	
60		654	81.2	70.7	90.2	
59		634	80.7	69.9	89.8	311
58		615	80.1	69.2	89.3	301
57		595	79.6	68.5	88.9	292
56		577	79.0	67.7	88.3	283
55		560	78.5	66.9	87.9	274
54		543	78.0	66.1	87.4	266
53		525	77.4	65.4	86.9	257
52	500	512	76.8	64.6	86.4	245
51	487	496	76.3	63.8	85.9	239
50	475	481	75.9	63.1	85.5	233
49	464	469	75.2	62.1	85.0	227
48	451	455	74.7	61.4	84.5	221
47	442	443	74.1	60.8	83.9	217
46	432	432	73.6	60.0	83.5	212
45	421	421	73.1	59.2	83.0	206
44	409	409	72.5	58.5	82.5	200
43	400	400	72.0	57.7	82.0	196
42	390	390	71.5	56.9	81.5	191
41	381	381	70.9	56.2	80.9	187
40	371	371	70.4	55.4	80.4	182
39	362	362	69.9	54.6	79.9	177
38	353	353	69.4	53.8	79.4	173
37	344	344	68.9	53.1	78.8	169
36	336	336	68.4	52.3	78.3	165
35	327	327	67.9	51.5	77.7	160
34	319	319	67.4	50.8	77.2	156
33	311	311	66.8	50.0	76.6	152
32	301	301	66.3	49.2	76.1	147
31	294	294	65.8	48.4	75.6	144
30	286	286	65.3	47.7	75.0	140
29	279	279	64.7	47.0	74.5	137
28	271	271	64.3	46.1	73.9	133
27	264	264	63.8	45.2	73.3	129
26	258	258	63.3	44.6	72.8	126
25	253	253	62.8	43.8	72.2	123
24	247	247	62.4	43.1	71.6	121
23	243	243	62.0	42.1	71.0	119
22	237	237	61.5	41.6	70.5	116
21	231	231	61.0	40.9	69.9	113
20	226	226	60.5	40.1	69.4	111

Relationship between hardness and tensile strength

The approximate relationship between the hardness of a metal and its tensile strength is shown by the following formula in which B = Brinell hardness number.

Tensile strength = B x 515 (for Brinell numbers up to 175)
Tensile strength = B x 490 (for Brinell numbers over 175)

These formulas give the tensile strength in pounds per square inch and apply only to steels. This relationship between hardness and tensile strength does not apply to nonferrous metals with the possible exception of certain aluminum alloys.

Dynamic Alignment

Proper alignment of dynamic mating surfaces is an important factor in improving seal performance. A well aligned shaft and housing assembly will last longer, leak less, and operate more reliably at higher speeds and pressures. There are three types of misalignment which should be avoided during the hardware-design phase.

Angular Displacement

When the axis of a rod or piston moves at an angle away from the true centerline, a condition called "angular displacement" exists. It affects sealing integrity by loading the seal unevenly and puts undue stress on the elastomer/spring. The seal wears more rapidly and may fail before its maximum wear life. Although this condition is often detected in the static condition, it is essential to measure it dynamically as well and correct any misalignment that is found.

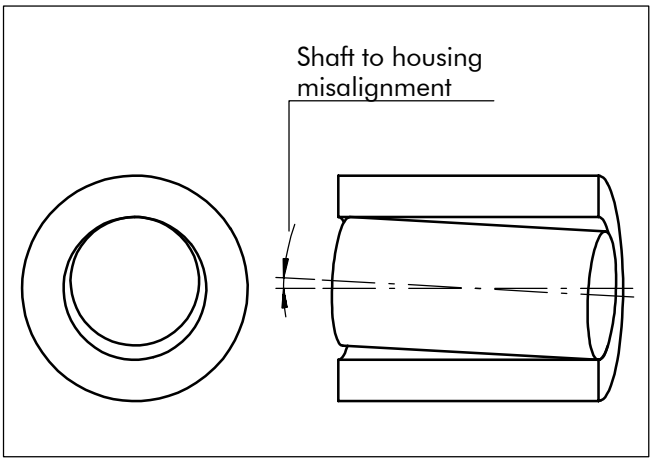


Figure 33 Angular Displacement

Eccentricity

In rotary service, when the shaft rotates about its own axis but is offset from the centerline of the housing, a condition of eccentric misalignment exists. In reciprocating service, the condition occurs when a rod or piston moves parallel to its own centerline but is offset from the true centerline of the housing or bore. In this situation the seal is stressed more heavily on one side, resulting in excess wear, and insufficiently loaded on the opposite side causing leakage. When examining the used seal, it may show damage on one side only. There may also be a visible difference in wear rates on opposite sides of the seal.

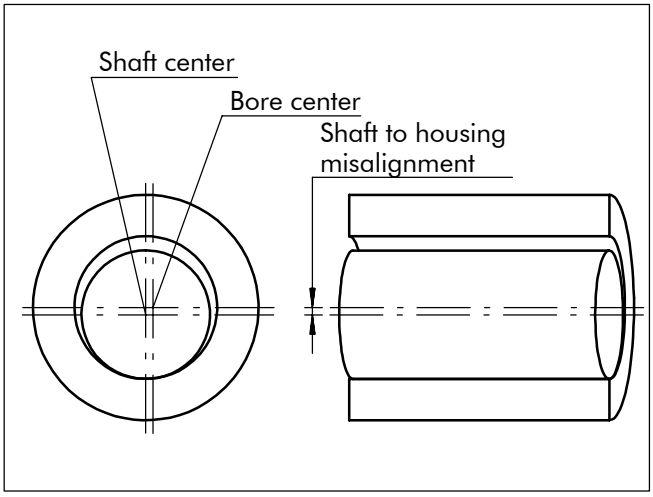


Figure 34 Eccentricity

Shaft Runout

Shaft runout occurs when a shaft is rotating about its own centerline which is offset from the true centerline of the housing. The shaft centerline is not stable in one place as in eccentric misalignment, but is itself moving around the true centerline of the housing, resulting in a "wobbling" effect. This condition stresses the seal around all points on its diameter. Shaft runout is measured with a dial indicator and is expressed in "thousandths of an inch" TIR (Total Indicator Reading). Runout causes a seal to wear prematurely but with more of an even wear pattern than that of "eccentric misalignment". It is often a contributor to early leakage since a potential leak-path is continuously formed as the "high point" of the shaft passes each point on the sealing contact surface.

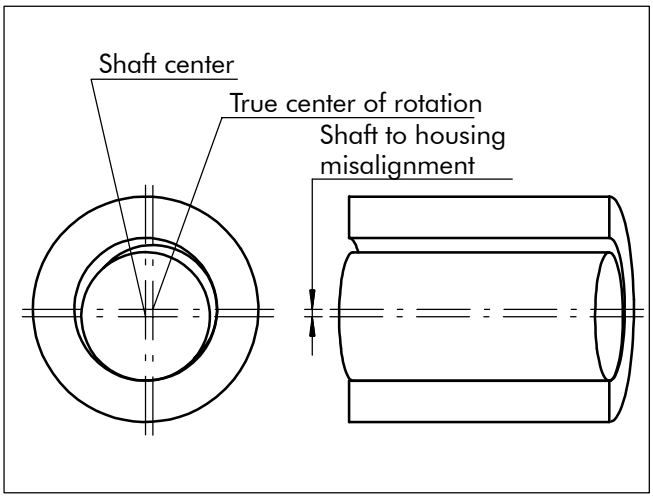


Figure 35 Shaft Runout

Excessive Runout

The amount of shaft runout in a hardware design can range from "minimal" (has no significant effect on seal performance) to "moderate" (less-than-optimum wear life) to "excessive" (causing an unacceptable early failure). The amount that is considered "excessive" can vary from one application to another depending on shaft speed, fluid media, and the limits specified by the design engineer concerning leakage rates and wear life. It also depends on how much runout a particular seal design can handle. Some seal designs can handle more runout than others.

Consult your Shamban sales engineer for further data on high-runout applications.

Table IX Typical Shaft Materials Used in Contact with Seals

Material		Typical Hardness, RC		Applications
		Annealed	Hardened	
Stainless Steel	17-4 PH	35	44	General-purpose with moderate corrosion resistance; a hardenable material for moderate-wear applications.
	Type 303	-	20*	Free-machining, very soft, for low speeds and pressures, with moderate corrosion resistance.
	Type 304	-	28*	Soft material with moderate corrosion resistance for use at low speeds and pressures.
	Type 316	-	28*	Soft material with excellent corrosion resistance for use at low speeds and pressures.
	Type 440C	22	44	Heat-treated material is hardest of all stainless steels; for higher speeds and pressures, but lower corrosion resistance than 300 series stainless steel.
Carbon Steel	SAE 1045	19	58	Good mechanical properties with higher strength than other low-carbon steels. Use in noncorrosive media only.
Alloy Steel	4140	10	50	General-purpose applications in noncorrosive media, for moderate speeds and pressures.
	4340	13	50	General service with better mechanical properties than Alloy 4140.
Tool Steel	D-2	-	62	High hardness and wear-resistance but limited corrosion resistance, for high speeds at moderate pressures.
Soft Metals	Hard-anodized aluminum 6061-T6	-	70+	Hard-anodized aluminum makes an excellent low-friction bore surface for reciprocating piston-seal applications. Not recommended for rotary service.
	Bronze	40 Rockwell B	85 Rockwell B	Light-duty service in slow speeds, low pressures, where friction and corrosion are not concerns.
	Mild Steel	150 Brinell	-	Light-duty service in noncorrosive media only.
Non-metallics	Ceramic	70		For high wear resistance at high pressures or high speeds, and for low friction against Turcon® seals due to lubrication-film-retention properties
	Sapphire	9 Mohs scale		Very hard, chemically inert material with ability to obtain flame polished finish less than Ra 0.05 µm.

The information supplied above is intended only as a guide. We strongly recommend that you test the selected material in the actual application before production use.

*) Series 300 stainless steel cannot be hardened by heat treatment. Values shown are for 30% cold-worked material.

Table X Properties of Typical Platings

Coating Type		MIL Spec.	Hardness RC	Nominal Thickness	Comments
Chrome Plating	**Hard Chrome**	QQC 320B Class 2E	65	0.02-0.13	Wearresistant for light duty. Not recommended for fast rotary or corrosive applications.
	Thin-dense Chrome	MIL-C-23422C Class 2	70	0.005-0.015	Higher wear resistance and lower friction than conventional chrome in light to moderate speeds.
Electroless Nickel Plating	**Nickel, as-deposited**	MIL-C-22074B	48-52	0.013-0.038	Excellent for corrosive applications in light to moderate speeds and pressures.
	Nickel, fully-hardened	MIL-C-26074B	58-70	0.013-0.038	Harder but more abrasive than as-deposited nickel. Not recommended for high-speed rotary.
Plasma Spray Coating	**Chromium Oxide**	See note 2	71	0.013-0.038	Recommended when wear life is the primary concern. Not recommended for high-shock loads.
	Aluminum Oxide	MIL-P-83348[3]	60-69	0.013-0.038	Lower-cost, less wear-resistant but greater ductility than chromium oxide coatings.
HVOF[1]	**Tungsten Carbide**	MIL-P-83348[2]	67-74	dependant upon application	High wear resistance, with higher bonding strength, for high speed and pressure combinations.
Anodizing	**Hard-anodized Aluminum**	MIL-A-8625C Type III	Over 70	0.05-0.25	Excellent bore material in piston-seal applications, as a lower friction mating surface than bare aluminum

The above information is intended only as a guide. Testing of the selected material in actual service conditions is recommended to determine the suitability of a plating or coating for a specific application.

[1]) HVOF = High Velocity Oxygen Fuel, a coating system using high-pressure, high-velocity spray guns (rocket guns) to improve coating density, hardness, and bond strength.

[2]) The MIL-Spec. is noted for reference only. Plasma-spray and HVOF coatings are typically produced using industry standards developed by certain companies. Those standards normally meet or exceed the requirements of the military specifications noted above.

Finite Element Analysis (FEA)

FEA is a technique by which a complex geometry, such as a sealing element, is divided into small, simply shaped entities. Using results from simple test methods designed to provide a reasonable measure of the properties of the seal in the end application, you can construct elementary equations relating the material properties and the complex loads of the behavior of the entire complex geometry. These results can then be verified using either traditional test methods or simple test methods designed to isolate the behavior of one feature of the seal assembly.

With FEA, the seal designer can screen new materials and designs of the computer rapidly, and limit the number of designs nessesary to be fully tested. This screening speeds the development cycle. Some additional benefits include quickly predicting the performance of a design in a variety of application conditions, providing input between the seal and the hardware conditions, and uncovering portions of the seal material/seal design interaction.

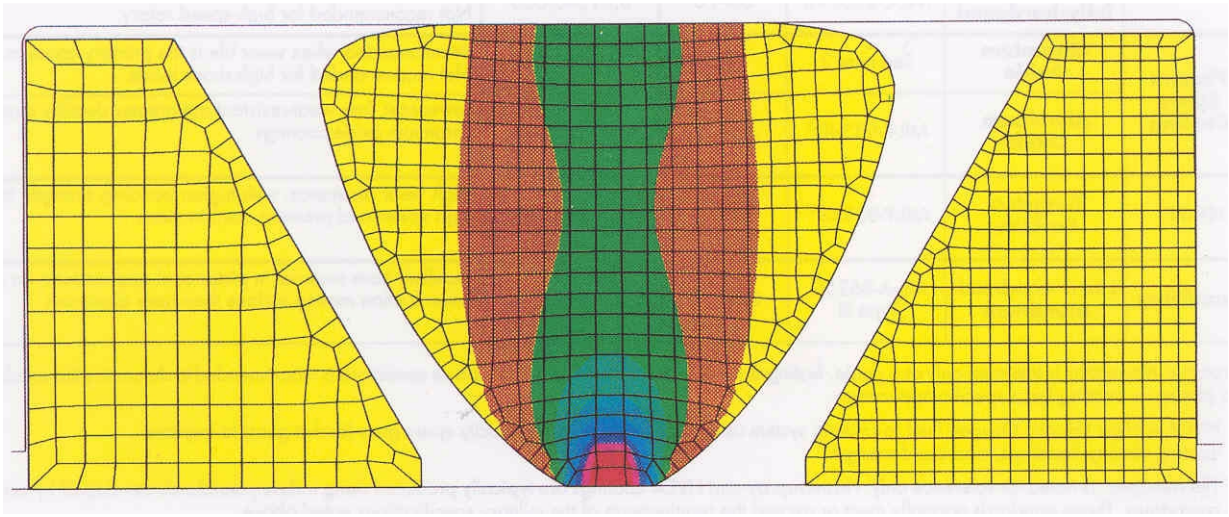


Figure 36 Featuring Wedgpak® in Unpressurized State

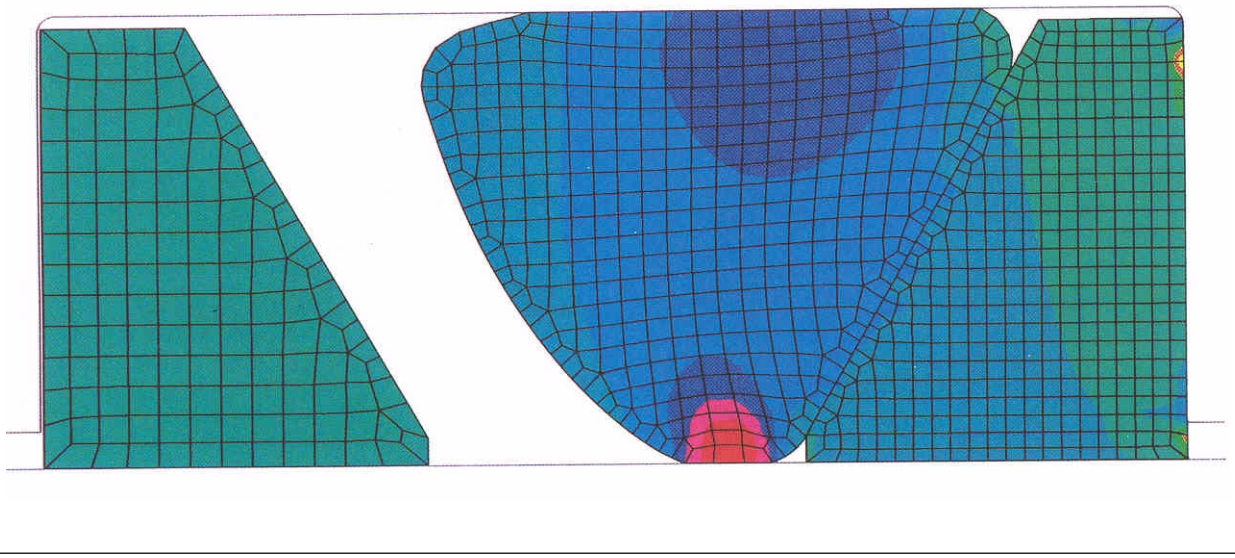


Figure 37 Featuring Wedgpak® in Pressurized State

Seal Quick Reference Guide

Sealing elements have a decisive influence on the design, function, and service life of hydraulic and pneumatic cylinders and systems.

Leakage control, friction control, resistance to wear and extrusion, chemical resistance, resistance to high and low temperature extremes, compact form, and ease of installation are demanded in order to meet the industry requirements for a functional sealing solution.

The significance of the performance parameters and their limits determines the requirements of the sealing application. Shamban has developed a unique and complete range of seals to meet the challenging demands of aerospace applications. Using optimized geometries, proven designs, and innovative materials, Shamban offers aerospace customers a wide range of sealing systems.

To select the most appropriate seal type and material, it is necessary to first define all the desired functional parameters. Table XI on pages 30 - 35 can be used to make an initial selection of seals and materials according to the specific requirements of each application.

The second column of Table XI contains the number of the page on which further general information can be found, including specific design and installation instructions on the particular seal type and materials (or material combinations with multi-element seals, e.g. Plus Seal®II).

The quality of the mating surface is explained in the section "Surface Finish", pages 17 - 23. Because surface texture has such a decisive influence on the functionality, reliability and service life of the seal system, it is important that these values are understood and applied.

Please do not hesitate to contact our Application Engineering Department to request further information and assistance on specific applications and to answer technical questions.

Note on Ordering

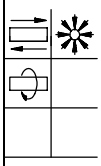
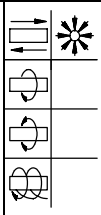
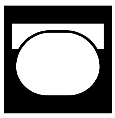
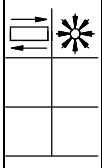
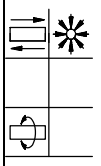
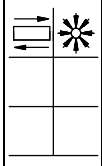
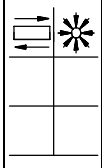
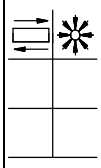
The multi-element seal assemblies presented in this catalog are supplied as complete sets. The assembly includes the seal and proprietary elastomer energizing element, such as the Plus Seal®II which contains a Turel® elastomer and Turcon® cap seal.

Older seal designs not represented in this catalog naturally continue to be available. For all new applications, we recommend you use the seal types and preferred sizes listed here.

Other combinations of Turcon® materials and special designs can be developed and supplied for unique applications. All intermediate sizes up to 3000 mm (10 ft.) diameter are available, providing there is sufficient demand. Sizes over 3000 mm (10 ft.) are available for some seal designs.

The sizes contained in the catalog are considered standard sizes. For non-standard sizes that include proprietary elastomer design, a share of the mold cost may be charged to the Customer if there is only a limited demand for the size.

Table XI Selection Criteria for Aerospace Seals **(To be continued. See next page ➔)**

Seal	Page	Features	Application				
			Gland	Move-ment	Pressure Direction	Piston	Rod
Turcon® VL Seal® 	44	High performance unidirectional rod seal -Low friction -Leaktight	MIL-G-5514F AS4716		S	No	Yes
Turcon® Plus Seal®II 	50	High performance slipper seal -Low constant friction -Resistance to wear and extrusion optimized -Easy installation -Recommended for high frequencies	MIL-G-5514F AS4716		D	Yes	Yes
Turcon® Double Delta®II 	54	The original slipper seal design -No stick-slip -Cost effective -Can be made to suit any O-Ring size.	MIL-G-5514F AS4716		D	Yes	Yes
Turcon® Wedgpak® 	56	Symmetrical seal with zero leakage -Low friction -Excellent extrusion and wear resistance -Preferred elastomer contact dynamic seal	MIL-G-5514F AS4716		D	Yes	Yes
Turcon® Hatseal®II 	59	Combined slipper and elastomer contact seal. -Zero leakage at low pressure -High pressure capability -Built-in sealing redundancy	One and two Back-up Ring groove width MIL-G-5514F (except 000 series) AS4716		S	No	Yes
Turcon® T-Seal 	62	Excellent static seal -Geometry prevents spiraling/rolling of seal during installation and use	MIL-G-5514F AS4716		D	Yes	Yes
Turcon® AQ-Seal®5 	65	-Excellent sealability between gas and oil -Low friction and leaktight	MIL-G-5514F (only 300 and 400 series) AS4716		D	Yes	No

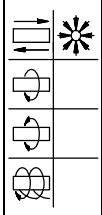
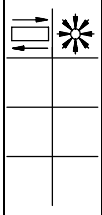
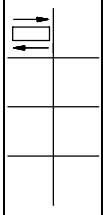
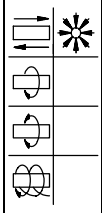
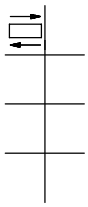
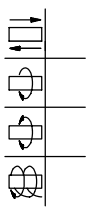
KEY TO MOVEMENT: Reciprocating = Rotary = Oscillating = Helix = Static =

KEY TO PRESSURE DIRECTION: Single acting (Unidirectional) = S Double acting (Bidirectional) = D

Application			Description	Seal
Speed Limit	**Temperature Range *)**	**Pressure **)**		
15.0 m/s 49.2 ft/s	-54 to +200°C -65 to +390°F	5000 psi 35 MPa	The VL Seal® has been developed over the past few years as a new generation unidirectional Rod seal. The design has taken the latest empirical and theoretical experience into account in order to optimise performance, friction, leakage and service life. This has been achieved through in-house testing and qualified in customer applications. The back-pumping effect allows the seal to relieve pressure trapped between tandem seals or between seals and double-acting scrapers.	Turcon® VL Seal® 
15.0 m/s 49.2 ft/s	-54 to +200°C -65 to +390°F	5000 psi 35 MPa	This superior slipper seal design has a contoured seal cap, formed to match the lemon shaped elastomer ring. The special elastomer allows more room for cap thickness, extended service life and activates the cap equally over the width, thereby reducing the friction. The cap can be provided with grooves in order to reduce friction even further.	Turcon® Plus Seal® II 
15.0 m/s 49.2 ft/s	-54 to +200°C -65 to +390°F	5000 psi 35 MPa	This is the original slipper seal that has a delta shaped cap activated by an O-Ring. This seal type has a good reputation for low friction and good leakage control in many dynamic applications.	Turcon® Double Delta® II 
3.0 m/s 9.8 ft/s	-54 to +200°C -65 to +390°F	5000 psi 35 MPa	A triangular shaped elastomer part, protected against extrusion, rolling and spiraling by two delta rings. The minimized elastomer footprint on the dynamic surface ensures an excellent leakage control, and is an improvement over seals with broader elastomer contact as the tendency to adhere to sealing surface is greatly reduced. The seal is "foolproof".	Turcon® Wedgpak® 
3.0 m/s 9.8 ft/s	-54 to +200°C -65 to +390°F	5000 psi 35 MPa	The best sealing characteristics of an elastomer contact seal and a slipper seal are combined in the Hatseal® II. The minimized elastomer footprint reduces friction and extends service life, while it maintains leakage control and dynamic performance at low pressure. The platform provides excellent extrusion resistance in peak pressure conditions.	Turcon® Hatseal® II 
1.0 m/s 3.3 ft/s	-54 to +200°C -65 to +390°F	5000 psi 35 MPa	T-Seal is primarily recommended for static application, has good leakage control and is prevented from rolling/spiraling in the gland at installation due to its unique shape.	Turcon® T-Seal 
3.0 m/s 9.8 ft/s	-54 to +200°C -65 to +390°F	5000 psi 35 MPa	This unique seal design was developed from the original Turcon® AQ-Seal®, but with an enlarged cap, allowing for a centrally positioned groove for a QUAD-RING® seal. This seal type has excellent leakage control of an elastomer contact seal, but at the same time, a very low friction and long service life, because the QUAD-RING® seal is energized by the design squeeze and not by the system pressure. AQ-Seal® 5 is especially designed to separate fluids and gases in dynamic applications.	Turcon® AQ-Seal® 5 

*) Temperature range is dependent upon material selection. **)Pressure is dependent upon material and gap dimension. Avoid combining extreme limits

(To be continued. See next page ➔)

Seal	Page	Features	Application				
			Gland	Move-ment	Pressure Direction	Piston	Rod
Turcon® Variseal® 	68	Spring energized seal -Chemical resistance optimal -Wide temperature range -Several spring designs available -Unlimited shelf life	MIL-G-5514F AS4716 (Groove may have to be split for installation)		S	Yes	Yes
Turcon® Back-up Ring 	79	-Spiral -Solid -Scarf-cut -Stakbak® design	MIL-G-5514F AS4716		D	Yes	Yes
Turcon® Dual Piston Ring 	82	-Spring energized seal -Low friction -Metallic expander -Wide temperature range -Controlled leakage -Saves space by using narrow grooves -Low hysteresis -Unlimited shelf life	B + S gland standard to MIL-G-5514F AS4716 bore sizes		D	Yes	No
Turcon® Glyd Ring® 	85	Optimum slipper seal -Low friction -Long service life -Saves space by using narrow grooves	B + S gland standard to MIL-G-5514F AS 4716 bore and rod sizes		D	Yes	Yes
Turcon® Stepseal®K 	91	Excellent primary seal -High pressure capability -Pressure relieving effect	B + S gland standard to MIL-G-5514F AS4716 bore and rod sizes		S	Yes	Yes
Turcon® Roto Glyd Ring® 	98	Rotary seal -Low speed -High pressure	ISO 7425/1		D	Yes	Yes

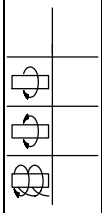
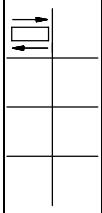
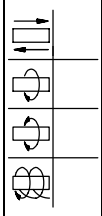
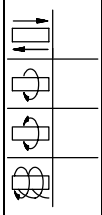
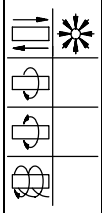
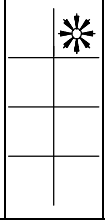
KEY TO MOVEMENT: Reciprocating =  Rotary =  Oscillating =  Helix =  Static = 

KEY TO PRESSURE DIRECTION: Single acting (Unidirectional) = S Double acting (Bidirectional) = D

Application			Description	Seal
Speed Limit	**Temperature Range *)**	**Pressure **)**		
15.0 m/s 49.2 ft/s	-273 to +260°C -459.67 to +500°F	5000 psi 35 MPa	Turcon® Variseal® is a single acting slipper seal activated with a metal spring, which is normally used in conditions of to extreme temperature, aggressive chemical media and long storage life. At the same time, it still features all the advances of the slipper seal as to low friction, no stick-slip, good leakage control and long service life.	Turcon® Variseal® 
-	-70 to +200°C -94 to +390°F	8000 psi 55 MPa	All standards and sizes available in virgin as well as filled PTFE compounds. The patented Stakbak® design allows extended temperature and pressure ranges.	Turcon® Back-up Ring 
15.0 m/s 49.2 ft/s	-70 to +260°C -94 to +500°F	5000 psi 35 MPa	Dual Piston Ring is energized by a stainless steel wave shaped spring. The characteristics of the seal are very low friction, long service life and a controlled leakage over the rings. Dual piston rings can be supplied with various spring types, depending upon application.	Turcon® Dual Piston Ring 
15.0 m/s 49.2 ft/s	-54 to +200°C -65 to +390°F	5000 psi 35 MPa	An all-around seal for hydraulics and pneumatics. Turcon® Glyd Ring® combines the experience from years of field test and laboratory research into highly efficient and reliable low friction seals for both high and low pressure systems widely used in industrial applications. A special advantage is the possibility of decreasing groove width in for example, spool valves.	Turcon® Glyd Ring® 
15.0 m/s 49.2 ft/s	-54 to +200°C -65 to +390°F	5000 psi 35 MPa	Turcon® Stepseal®K consists of a patented step cap, activated by an O-Ring. This is a further development of the slipper seal for the previously inactive cap now has an active back-pumping effect, when used with a secondary seal. This avoids pressure build-up during long strokes. Widely used in industrial applications, the Stepseal®K is now also available to the aerospace industry.	Turcon® Stepseal®K 
2.0 m/s 6.5 ft/s	-54 to +200°C -65 to +390°F	3000 psi 21 MPa	The Turcon® Roto Glyd Ring® is designed with chamfers, notches and radial grooves. The seal has no interference fit, but is energized via an O-Ring. High pressure and low speed are the main features.	Turcon® Roto Glyd Ring® 

*) Temperature range is dependent upon material selection. **)Pressure is dependent upon material and gap dimension. Avoid combining extreme limits

(To be continued. See next page ➔)

Seal	Page	Features	Application				
			Gland	move-ment	Double Acting	Piston	Rod
Turcon® Varilip® 	100	Rotary seal -Low friction -Dry run capability -Chemical resistance optimal -Outperforms traditional Oil seals	Gland to suit application		S	No	Yes
Footseal II 	103	-Fits BACS11AA	BACS11AA Gland		S	No	Yes
Turcon® Excluder® DC 	107	-Optimum scraping effect -Dual lip for optimized effect -Vented version available	B + S standard to MS33675		S	No	Yes
Turcon® Variseal® Scraper 	111	Spring energized scraper -Wide temperature range -Chemical resistance optimal -Hi-Clean option	MIL-G-5514F AS4716 (Groove may have to be split for installation)		S	Yes	Yes
Turcite® Slydring® Luytex® Slydring® 	114	-High load bearing capability -Very wear resistant -No rod scoring -Protection of the seals	Gland to suit application		D	Yes	Yes
Turcon® Wedgpak® Face Seal 	118	Flange seal -Absorbing pulsing and vibration -Internal and external version -Easy installation	Face Gland		S	External	Internal

KEY TO MOVEMENT: Reciprocating = Rotary = Oscillating = Helix = Static =

KEY TO PRESSURE DIRECTION: Single acting (Unidirectional) = S Double acting (Bidirectional) = D

Application			Description	Seal
Speed Limit	**Temperature Range *)**	**Pressure **)**		
20.0 m/s 65.6 ft/s	-60 to +200°C -76 to +390°F	290 psi 2 MPa	Varilip® has a metal or plastic casing incorporating one, two or three seal lips in the same or reversed direction, depending upon the chosen design. Designed for fast rotating shafts, Varilip® characteristics are long service life with minimal friction combined with very good leakage control.	Turcon® Varilip® 
15.0 m/s 49.2 ft/s	-54 to +200°C -65 to +390°F	6500 psi 45 MPa	Footseal II is an O-Ring activated slipper seal designed to fit the BACS11AA gland standard. The Footseal II is an improvement over the original Footseal design.	Footseal II 
15.0 m/s 49.2 ft/s	-54 to +200°C -65 to +390°F	-	Turcon® Excluder® is a solid ring with dual scraper lip contact, activated by an O-Ring, gives the best performance for an Excluder® device. The primary lip will prevent dust and ice from penetrating the system during the in-stroke of the rod while the secondary lip will stop the oil film from going out of the system during the out-stroke.	Turcon® Excluder®DC 
15.0 m/s 49.2 ft/s	-70 to +260°C -94 to +500°F	-	Turcon® Variseal® Scraper is a spring energized slipper seal with optimized scraping angle. Variseal® Scraper is designed for systems with extreme working temperature, high speeds, and agressive media.	Turcon® Variseal® Scraper 
(depending upon material choice)	-60 to +260°C -76 to +500°F	(3625-50 000 psi) 25 - 345 N/mm^2 Depending on material	Wear rings made from polymeric materials offer many advantages over metallic bearings. Among these are: Low friction, long wear life, easy replacement and low cost.	Turcite® Slydring® Luytex® Slydring® 
-	-54 to +200°C -65 to +390°F	5000 psi 35 MPa	Turcon® Wedgpak® Face Seal is a flange version of the standard Wedgpak®. Elastomer ring provides leaktightness, even with pulsing and vibration, whereas the Turcon® ring protects against extrusion.	Turcon® Wedgpak® Face Seal 

*) Temperature range is dependent upon material selection. **)Pressure is dependent upon material and gap dimension. Avoid combining extreme limits

Hardware Dimensions per MIL-G-5514F and AS4716, Bore

If You use AS4716 hardware dimensions, please contact Your Shamban Sales Engineer for recommendation.

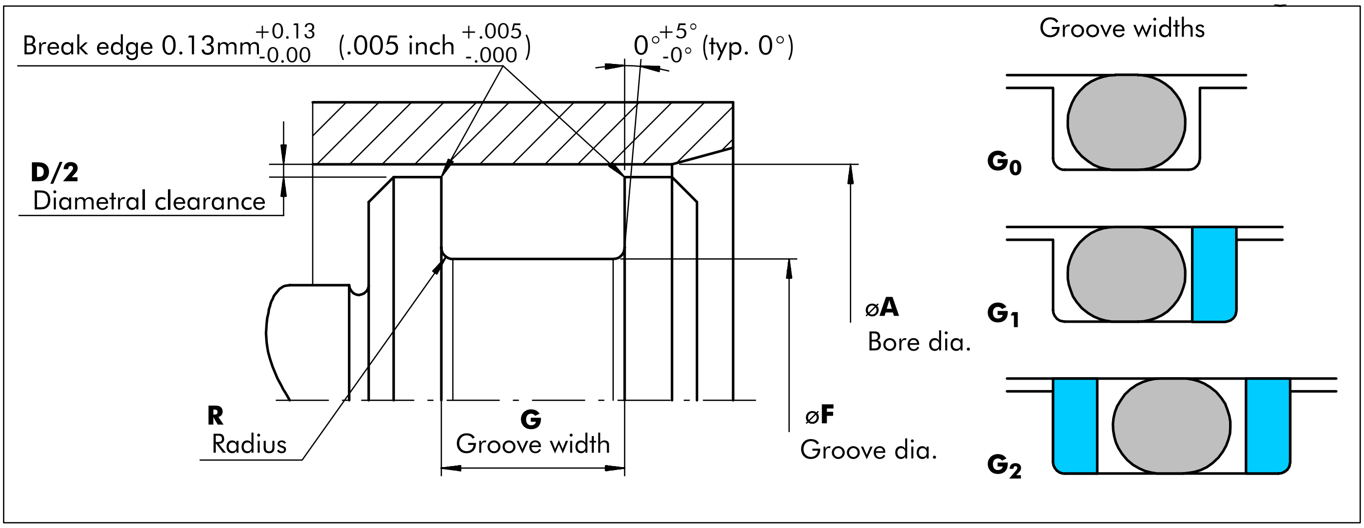


Figure 38 Installation Drawing

Table XII Groove Dimensions, Bore

	Bore Sizes per MIL-G-5514F														Changes acc. to AS4716	
	Inch							mm							Inch	mm
Dash No	øA Bore Dia.	øF Groove Dia.	D Diam. Clearance Max.	R Rad.	Groove Width +0.010/-0.000 G0	G1	G2	øA Bore Dia.	øF Groove Dia.	D Diam. Clearance Max.	R Rad.	Groove Width +0.25/-0.00 G0	G1	G2	øF Groove Dia.	øF Groove Dia.
	+0.001 -0.000	+0.000 -0.001						+0.025 -0.000	+0.000 -0.025						+0.000 -0.001	+0.000 -0.025
004	0.190	0.076						4.83	1.93							
005	0.221	0.108						5.61	2.74							
006	0.235	0.123						5.97	3.12							
007	0.266	0.154						6.76	3.91							
008	0.297	0.185	0.004					7.54	4.70	0.10					0.189	4.80
009	0.329	0.217						8.36	5.51						0.220	5.59
010	0.360	0.248						9.14	6.30						0.250	6.35
011	0.422	0.310						10.72	7.87						0.312	7.92
012	0.485	0.373						12.32	9.47						0.375	9.53
	+0.002 -0.000	+0.000 -0.002						+0.050 -0.000	+0.000 -0.050						+0.000 -0.002	+0.000 -0.050
013	0.550	0.438						13.97	11.13						0.441	11.20
014	0.613	0.501		.015				15.57	12.73		0.38				0.504	12.80
015	0.675	0.563			.094	.149	.207	17.15	14.30			2.39	3.78	5.26	0.566	14.38
016	0.738	0.626		.005				18.75	15.90		0.13				0.629	15.98
017	0.800	0.688						20.32	17.48						0.691	17.55
018	0.863	0.751						21.92	19.08						0.753	19.13
019	0.925	0.813						23.50	20.65						0.815	20.70
020	0.991	0.879	0.005					25.17	22.33	0.13					0.881	22.38
021	1.053	0.941						26.75	23.90						0.943	23.95
022	1.116	1.004						28.35	25.50						1.006	25.55
023	1.178	1.066						29.92	27.08						1.068	27.13
024	1.241	1.129						31.52	28.68						1.131	28.73
025	1.303	1.191						33.10	30.25						1.193	30.30
026	1.366	1.254						34.70	31.85						1.256	31.90
027	1.428	1.316						36.27	33.43						1.318	33.48
028	1.491	1.379						37.87	35.03						1.381	35.08

Recommended for static applications only. (grey: dash nos. 013–028)

Metric sizes. (blue)

Dash No	Bore Sizes per MIL-G-5514F														Changes acc. to AS4716	
	Inch							mm							Inch	mm
	øA Bore Dia.	**øF** Groove Dia.	**D** Diam. Clearance Max.	**R** Rad.	**Groove Width** +0.010/-0.000			**øA** Bore Dia.	**øF** Groove Dia.	**D** Diam. Clearance Max.	**R** Rad.	**Groove Width** +0.25/-0.00			**øF** Groove Dia.	**øF** Groove Dia.
					G_0	G_1	G_2					G_0	G_1	G_2		
	+0.002 -0.000	+0.000 -0.002						+0.050 -0.000	+0.000 -0.050						+0.000 -0.001	+0.000 -0.025
110	0.550	0.372						13.97	9.45						0.379	9.63
111	0.613	0.435						15.57	11.05						0.441	11.20
112	0.675	0.497						17.15	12.62						0.502	12.75
113	0.738	0.560						18.75	14.22						0.565	14.35
114	0.800	0.622						20.32	15.80						0.627	15.93
115	0.863	0.685						21.92	17.40						0.689	17.50
116	0.925	0.747						23.50	18.97						0.751	19.08
117	0.991	0.813						25.17	20.65						0.817	20.75
118	1.053	0.875						26.75	22.23						0.879	22.33
119	1.116	0.938	0.005					28.35	23.83	0.13					0.942	23.93
120	1.178	1.000						29.92	25.40						1.003	25.48
121	1.241	1.063						31.52	27.00						1.066	27.08
122	1.303	1.125						33.10	28.58						1.128	28.65
123	1.366	1.188						34.70	30.18						1.191	30.25
124	1.428	1.250						36.27	31.75						1.253	31.83
125	1.491	1.313						37.87	33.35						1.316	33.43
126	1.553	1.375						39.45	34.93						1.378	35.00
127	1.616	1.438						41.05	36.53						1.441	36.60
128	1.678	1.500						42.62	38.10						1.503	38.18
129	1.741	1.563						44.22	39.70						1.566	39.78
	+0.002 -0.000	+0.000 -0.002						+0.050 -0.000	+0.000 -0.050						+0.000 -0.002	+0.000 -0.050
130	1.805	1.627						45.85	41.33						1.631	41.43
131	1.867	1.689						47.42	42.90						1.693	43.00
132	1.930	1.752						49.02	44.50						1.756	44.60
133	1.992	1.814						50.60	46.08						1.818	46.18
134	2.055	1.877	0.006	.015 | .005	.141	.183	.245	52.20	47.68	0.15	0.38 | 0.13	3.58	4.65	6.22	1.881	47.78
135	2.118	1.940						53.80	49.28						1.944	49.38
136	2.180	2.002						55.37	50.85						2.006	50.95
137	2.243	2.065						56.97	52.45						2.069	52.55
138	2.305	2.127						58.55	54.03						2.131	54.13
139	2.368	2.190						60.15	55.63						2.194	55.73
140	2.430	2.252						61.72	57.20						2.256	57.30
141	2.493	2.315						63.32	58.80						2.319	58.90
142	2.555	2.377						64.90	60.38						2.381	60.48
143	2.618	2.440						66.50	61.98						2.444	62.08
144	2.680	2.502						68.07	63.55						2.506	63.65
145	2.743	2.565	0.007					69.67	65.15	0.18					2.569	65.25
146	2.805	2.627						71.25	66.73						2.631	66.83
147	2.868	2.690						72.85	68.33						2.694	68.43
148	2.930	2.752						74.42	69.90						2.756	70.00
149	2.993	2.815						76.02	71.50						2.819	71.60
210	0.991	0.748						25.17	19.00						0.750	19.05
211	1.053	0.810						26.75	20.57						0.812	20.63
212	1.116	0.873						28.35	22.17						0.874	22.20
213	1.178	0.935						29.92	23.75						0.936	23.77
214	1.241	0.998						31.52	25.35						0.999	25.37
215	1.303	1.060	0.005	.025 | .010	.188	.235	.304	33.10	26.92	0.13	0.64 | 0.25	4.78	5.97	7.72	1.064	27.03
216	1.366	1.123						34.70	28.52						1.124	28.55
217	1.428	1.185						36.27	30.10						1.186	30.12
218	1.491	1.248						37.87	31.70						1.249	31.72
219	1.553	1.310						39.45	33.27						1.311	33.30

Recommended for static applications only.

Metric sizes.

Dash No	Bore Sizes per MIL-G-5514F														Changes acc. to AS4716	
	Inch							mm							Inch	mm
	øA Bore Dia.	øF Groove Dia.	D Diam. Clearance Max.	R Rad.	Groove Width +0.010/-0.000			øA Bore Dia.	øF Groove Dia.	D Diam. Clearance Max.	R Rad.	Groove Width +0.25/-0.00			øF Groove Dia.	øF Groove Dia.
					G_0	G_1	G_2					G_0	G_1	G_2		
	+0.002 -0.000	+0.000 -0.002						+0.050 -0.000	+0.000 -0.050						+0.000 -0.002	+0.000 -0.050
220	1.616	1.373						41.05	34.87						1.374	34.90
221	1.678	1.435	0.005					42.62	36.45	0.13					1.436	36.47
222	1.741	1.498						44.22	38.05						1.499	38.07
223	1.867	1.624						47.42	41.25						1.625	41.28
224	1.992	1.749						50.60	44.42						1.750	44.45
225	2.118	1.875	0.006					53.80	47.63	0.15					1.876	47.65
226	2.243	2.000						56.97	50.80						2.001	50.83
227	2.368	2.125						60.15	53.98						2.126	54.00
228	2.493	2.250						63.32	57.15						2.251	57.18
229	2.618	2.375						66.50	60.33						2.376	60.35
230	2.743	2.500						69.67	63.50						2.501	63.53
231	2.868	2.625						72.85	66.68						2.626	66.70
232	2.993	2.750						76.02	69.85						2.751	69.88
233	3.118	2.875						79.20	73.03						2.876	73.05
234	3.243	3.000		.025				82.37	76.20		0.64				3.001	76.23
235	3.368	3.125	0.007	|	.188	.235	.304	85.55	79.38	0.18	|	4.78	5.97	7.72	3.126	79.40
236	3.493	3.250		.010				88.72	82.55		0.25				3.251	82.58
237	3.618	3.375						91.90	85.73						3.376	85.75
238	3.743	3.500						95.07	88.93						3.501	88.93
239	3.868	3.625						98.25	92.10						3.626	92.10
240	3.993	3.750						101.42	95.28						3.751	95.28
241	4.118	3.875						104.60	98.45						3.876	98.45
242	4.243	4.000						107.77	101.63						4.001	101.63
243	4.368	4.125						110.95	104.80						4.126	104.80
244	4.493	4.250						114.12	107.98						4.251	107.98
245	4.618	4.375	0.008					117.30	111.15	0.20					4.376	111.15
246	4.743	4.500						120.47	114.33						4.501	114.33
247	4.868	4.625						123.65	117.50						4.626	117.50
325	1.867	1.495						47.42	37.97							
326	1.992	1.620						50.60	41.15							
327	2.118	1.746	0.006					53.80	44.35	0.15						
328	2.243	1.871						56.97	47.52							
329	2.368	1.996						60.15	50.70							
330	2.493	2.121						63.32	53.87							
331	2.618	2.246						66.50	57.05							
332	2.743	2.371						69.67	60.22							
333	2.868	2.496						72.85	63.40							
334	2.993	2.621						76.02	66.57							
335	3.118	2.746						79.20	69.75							
336	3.243	2.871						82.37	72.92							
337	3.368	2.996		.035				85.55	76.10		0.89					
338	3.493	3.121	0.007	|	.281	.334	.424	88.72	79.27	0.18	|	7.14	8.48	10.77		
339	3.618	3.246		.020				91.90	82.45		0.51					
340	3.743	3.371						95.07	85.62							
341	3.868	3.496						98.25	88.80							
342	3.993	3.621						101.42	91.97							
343	4.118	3.746						104.60	95.15							
344	4.243	3.871						107.77	98.32							
345	4.368	3.996						110.95	101.50							
346	4.493	4.121						114.12	104.67							
347	4.618	4.246	0.008					117.30	107.85	0.20						
348	4.743	4.371						120.47	111.02							
349	4.868	4.496						123.65	114.20							

Recommended for static applications only.

Metric sizes.

Dash No	Bore Sizes per MIL-G-5514F													Changes acc. to AS4716	
	Inch							mm						Inch	mm
	øA Bore Dia.	**øF** Groove Dia.	**D** Diam. Clearance Max.	**R** Rad.	**Groove Width** +0.010/-0.000 G_0	G_1	G_2	**øA** Bore Dia.	**øF** Groove Dia.	**D** Diam. Clearance Max.	**R** Rad.	**Groove Width** +0.25/-0.00 G_0	G_1	G_2	**øF** Groove Dia.	**øF** Groove Dia.
	+0.003 -0.000	+0.000 -0.003						+0.076 -0.000	+0.000 -0.076							
425	4.974	4.497						126.34	114.22							
426	5.099	4.622						129.51	117.40							
427	5.224	4.747						132.69	120.57							
428	5.349	4.872						135.86	123.75							
429	5.474	4.997						139.04	126.92							
430	5.599	5.122						142.21	130.10							
431	5.724	5.247						145.39	133.27							
432	5.849	5.372						148.56	136.45							
433	5.974	5.497						151.74	139.62							
434	6.099	5.622	0.009		.375	.475	.579	154.91	142.80	0.23		9.53	12.07	14.71		
435	6.224	5.747						158.09	145.97							
436	6.349	5.872						161.26	149.15							
437	6.474	5.997						164.44	152.32							
438	6.724	6.247						170.79	158.67							
439	6.974	6.497						177.14	165.02							
440	7.224	6.747						183.49	171.37							
441	7.474	6.997						189.84	177.72							
442	7.724	7.247						196.19	184.07							
443	7.974	7.497						202.54	190.42							
444	8.224	7.747						208.89	196.77							
445	8.474	7.997						215.24	203.12							
446	8.974	8.497	0.010					227.94	215.82	0.25						
	+0.004 -0.000	+0.000 -0.004						+0.100 -0.000	+0.000 -0.100							
447	9.474	8.997						240.64	228.52							
448	9.974	9.497						253.34	241.22							
449	10.474	9.997						266.04	253.92							
450	10.974	10.497						278.74	266.62							
451	11.474	10.997						291.44	279.32							
452	11.974	11.497		.035				304.14	292.02		0.89					
453	12.474	11.997	0.009	|	.375	.475	.579	316.84	304.72	0.23	|	9.53	12.07	14.71		
454	12.974	12.497		.020				329.54	317.42		0.51					
455	13.474	12.997						342.24	330.12							
456	13.974	13.497						354.94	342.82							
457	14.474	13.997						367.64	355.52							
458	14.974	14.497						380.34	368.22							
459	15.474	14.997						393.04	380.92							
460	15.974	15.497						405.74	393.62							

Recommended for static applications only. Metric sizes.

The above dimensions are for reference only, Shamban cannot be held responsible for printing errors etc.

600 Series (3/8") cross section AS4832 recommended for diameters above -442.

Table XIII Overview of MIL-G-5514F Groove sizes

Series	000		100		200		300		400	
Gland Depth	0.056	1.42	0.089	2.26	0.122	3.09	0.186	4.72	0.239	6.06
Gland Width Zero BUR *)	0.094	2.39	0.141	3.58	0.188	4.78	0.281	7.14	0.375	9.53
Gland Width One BUR *)	0.149	3.78	0.183	4.65	0.235	5.97	0.334	8.48	0.475	12.07
Gland Width Two BUR *)	0.207	5.26	0.245	6.22	0.304	7.72	0.424	10.77	0.579	14.71

Metric sizes. *) BUR = Back-up ring AS4716 has variation in groove depth and width. See spec. for detail

■ Hardware Dimensions per MIL-G-5514F and AS4716, Rod

If You use AS4716 hardware dimensions, please contact Your Shamban Sales Engineer for recommendation.

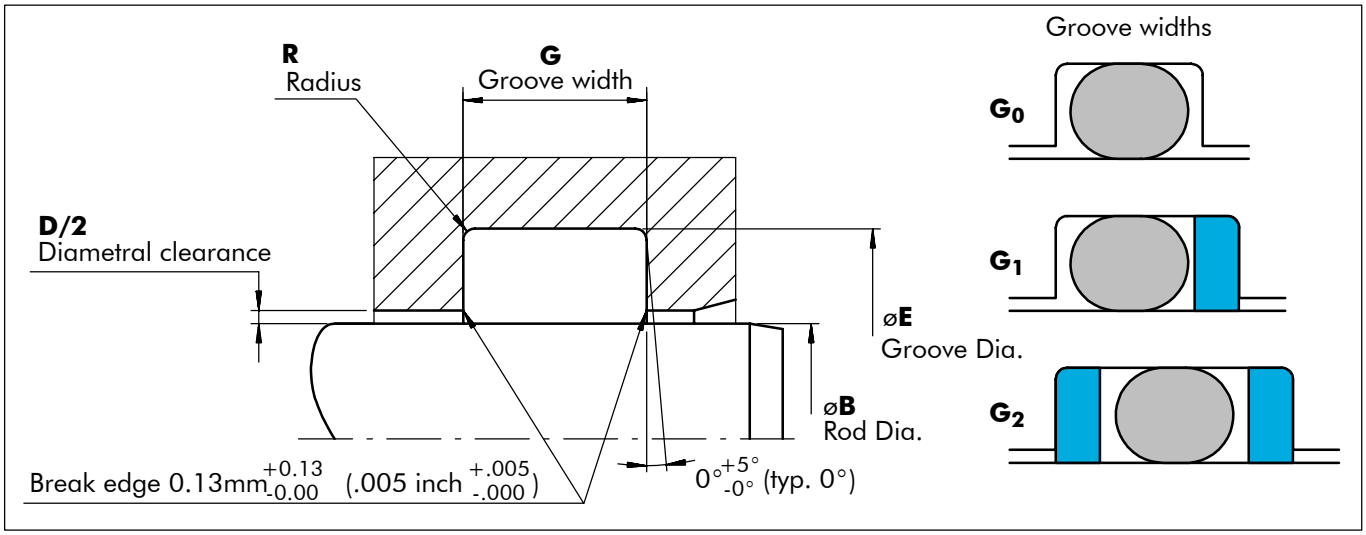


Figure 39 Installation Drawing

Table XIV Groove Dimensions, Rod

	Rod Sizes per MIL-G-5514F														Changes acc. to AS4716	
	Inch							mm							Inch	mm
Dash No	øB Rod Dia.	øE Groove Dia.	D Diam. Clearance Max.	R Rad.	Groove Width +0.010/-0.000 G0	G1	G2	øB Rod Dia.	øE Groove Dia.	D Diam. Clearance Max.	R Rad.	Groove Width +0.25/-0.00 G0	G1	G2	øE Groove Dia.	øE Groove Dia.
	+0.000 -0.001	+0.001 -0.000						+0.000 -0.025	+0.025 -0.000						+0.001 -0.000	+0.025 -0.000
004	0.076	0.190						1.93	4.83							
005	0.108	0.221						2.74	5.61							
006	0.123	0.235						3.12	5.97							
007	0.154	0.266						3.91	6.76							
			0.004							0.10						
008	0.185	0.297						4.70	7.54						0.294	7.47
009	0.217	0.329						5.51	8.36						0.327	8.31
010	0.248	0.360						6.30	9.14						0.359	9.12
011	0.310	0.422						7.87	10.72						0.421	10.69
012	0.373	0.485						9.47	12.32						0.484	12.29
	+0.000 -0.002	+0.002 -0.000						+0.00 -0.05	+0.05 -0.00						+0.002 -0.000	+0.05 -0.00
013	0.435	0.547						11.05	13.89						0.545	13.84
014	0.498	0.610		.015				12.65	15.49		0.38				0.608	15.44
015	0.560	0.672		|	.094	.149	.207	14.22	17.07		|	2.39	3.78	5.26	0.670	17.02
016	0.623	0.735		.005				15.82	18.67		0.13				0.733	18.62
017	0.685	0.797						17.40	20.24						0.795	20.19
018	0.748	0.860						19.00	21.84						0.858	21.79
019	0.810	0.922						20.57	23.42						0.920	23.37
020	0.873	0.985	0.005					22.17	25.02	0.13					0.983	24.97
021	0.935	1.047						23.75	26.59						1.045	26.54
022	0.998	1.110						25.35	28.19						1.108	28.14
023	1.060	1.172						26.92	29.77						1.170	29.72
024	1.123	1.235						28.52	31.37						1.233	31.32
025	1.185	1.297						30.10	32.94						1.295	32.89
026	1.248	1.360						31.70	34.54						1.358	34.49
027	1.310	1.422						33.27	36.12						1.420	36.07
028	1.373	1.485						34.87	37.72						1.483	37.67

Recommended for static applications only. Metric sizes.

	Rod Sizes per MIL-G-5514F														Changes acc. to AS4716	
	Inch							mm							Inch	mm
Dash No	øB Rod Dia.	øE Groove Dia.	D Diam. Clearance Max.	R Rad.	Groove Width +0.010/-0.000			øB Rod Dia.	øE Groove Dia.	D Diam. Clearance Max.	R Rad.	Groove Width +0.25/-0.00			øE Groove Dia.	øE Groove Dia.
					G_0	G_1	G_2					G_0	G_1	G_2		
	+0.000 -0.002	+0.002 -0.000						+0.00 -0.05	+0.05 -0.00						+0.002 -0.000	+0.05 -0.00
110	0.373	0.551						9.47	14.00						0.546	13.87
111	0.435	0.613						11.05	15.57						0.609	15.47
112	0.498	0.676						12.65	17.17						0.672	17.07
113	0.560	0.738						14.22	18.75						0.734	18.64
114	0.623	0.801						15.82	20.35						0.797	20.24
115	0.685	0.863						17.40	21.92						0.859	21.82
116	0.748	0.926						19.00	23.52						0.923	23.44
117	0.810	0.988						20.57	25.10						0.985	25.02
118	0.873	1.051	0.005					22.17	26.70	0.13					1.048	26.62
119	0.935	1.113						23.75	28.27						1.110	28.19
120	0.998	1.176						25.35	29.87						1.173	29.79
121	1.060	1.238						26.92	31.45						1.235	31.37
122	1.123	1.301						28.52	33.05						1.298	32.97
123	1.185	1.363						30.10	34.62						1.360	34.54
124	1.248	1.426						31.70	36.22						1.423	36.14
125	1.310	1.488						33.27	37.80						1.485	37.72
126	1.373	1.551						34.87	39.40						1.548	39.32
127	1.435	1.613		.015 | .005				36.45	40.97		0.38 | 0.13				1.610	40.89
128	1.498	1.676	0.006		.141	.183	.245	38.05	42.57	0.15		3.58	4.65	6.22	1.673	42.49
129	1.560	1.738						39.62	44.15						1.735	44.07
130	1.623	1.801						41.22	45.75						1.798	45.67
131	1.685	1.863						42.80	47.32						1.860	47.24
132	1.748	1.926						44.40	48.92						1.923	48.84
133	1.810	1.988						45.97	50.50						1.984	50.39
134	1.873	2.051						47.57	52.10						2.047	51.99
135	1.936	2.114						49.17	53.70						2.110	53.59
136	1.998	2.176						50.75	55.27						2.172	55.17
137	2.061	2.239	0.007					52.35	56.87	0.18					2.235	56.77
138	2.123	2.301						53.92	58.45						2.297	58.34
139	2.186	2.364						55.52	60.05						2.360	59.94
140	2.248	2.426						57.10	61.62						2.422	61.52
141	2.311	2.489						58.70	63.22						2.485	63.12
142	2.373	2.551						60.27	64.80						2.547	64.69
143	2.436	2.614						61.87	66.40						2.610	66.29
144	2.498	2.676						63.45	67.97						2.672	67.87
145	2.561	2.739						65.05	69.57						2.735	69.47
146	2.623	2.801						66.62	71.15						2.797	71.04
147	2.686	2.864						68.22	72.75						2.860	72.64
148	2.748	2.926						69.80	74.32						2.922	74.22
149	2.811	2.989						71.40	75.92						2.985	75.82
210	0.748	0.991						19.00	25.17						0.989	25.12
211	0.810	1.053						20.57	26.75						1.051	26.70
212	0.873	1.116						22.17	28.35						1.115	28.32
213	0.935	1.178						23.75	29.92						1.177	29.90
214	0.998	1.241						25.35	31.52						1.240	31.50
215	1.060	1.303		.025 | .010				26.92	33.10		0.64 | 0.25				1.302	33.07
216	1.123	1.366	0.005		.188	.235	.304	28.52	34.70	0.13		4.78	5.97	7.72	1.365	34.67
217	1.185	1.428						30.10	36.27						1.427	36.25
218	1.248	1.491						31.70	37.87						1.490	37.85
219	1.310	1.553						33.27	39.45						1.552	39.42
220	1.373	1.616						34.87	41.05						1.615	41.02
221	1.435	1.678						36.45	42.62						1.677	42.60
222	1.498	1.741						38.05	44.22						1.740	44.20

Recommended for static applications only.

Metric sizes.

	Rod Sizes per MIL-G-5514F														Changes acc. to AS4716	
	Inch							mm							Inch	mm
Dash No	**øB** Rod Dia.	**øE** Groove Dia.	**D** Diam. Clearance Max.	**R** Rad.	**Groove Width** +0.010/-0.000 G_0	G_1	G_2	**øB** Rod Dia.	**øE** Groove Dia.	**D** Diam. Clearance Max.	**R** Rad.	**Groove Width** +0.25/-0.00 G_0	G_1	G_2	**øE** Groove Dia.	**øE** Groove Dia.
	+0.000 -0.002	+0.002 -0.000						+0.00 -0.05	+0.05 -0.00						+0.000 -0.000	+0.050 -0.000
223 224	1.623 1.748	1.866 1.991	0.006					41.22 44.40	47.40 50.57	0.15					1.865 1.990	47.37 50.55
225 226 227 228 229	1.873 1.998 2.123 2.248 2.373	2.116 2.241 2.366 2.491 2.616						47.57 50.75 53.92 57.10 60.27	53.75 56.92 60.10 63.27 66.45						2.115 2.240 2.365 2.490 2.615	53.72 56.90 60.07 63.25 66.42
230 231 232 233 234	2.498 2.623 2.748 2.873 2.997	2.741 2.866 2.991 3.116 3.240	0.007	.025 | .010	.188	.235	.304	63.45 66.62 69.80 72.97 76.12	69.62 72.80 75.97 79.15 82.30	0.18	0.64 | 0.25	4.78	5.97	7.72	2.740 2.865 2.990 3.115 3.239	69.60 72.77 75.95 79.12 82.27
235 236 237 238 239	3.122 3.247 3.372 3.497 3.622	3.365 3.490 3.615 3.740 3.865						79.30 82.47 85.65 88.82 92.00	85.47 88.65 91.82 95.00 98.17						3.364 3.489 3.614 3.739 3.864	85.45 88.62 91.80 94.97 98.15
240 241 242 243 244	3.747 3.872 3.997 4.122 4.247	3.990 4.115 4.240 4.365 4.490						95.17 98.35 101.52 104.70 107.87	101.35 104.52 107.70 110.87 114.05						3.989 4.114 4.239 4.364 4.489	101.32 104.50 107.67 110.85 114.02
245	4.372	4.615						111.05	117.22						4.614	117.20
246 247	4.497 4.622	4.740 4.864	0.008					114.22 117.40	120.40 123.57	0.20					4.739 4.864	120.37 123.55
325 326 327	1.498 1.623 1.748	1.870 1.995 2.120	0.006					38.05 41.22 44.40	47.50 50.67 53.85	0.15						
328 329 330 331 332	1.873 1.998 2.123 2.248 2.373	2.245 2.370 2.495 2.620 2.745						47.57 50.75 53.92 57.10 60.27	57.02 60.20 63.37 66.55 69.72							
333 334 335 336 337	2.498 2.623 2.748 2.873 2.997	2.870 2.995 3.120 3.245 3.369	0.007	.035 | .020	.281	.334	.424	63.45 66.62 69.80 72.97 76.12	72.90 76.07 79.25 82.42 85.57	0.18	0.89 | 0.51	7.14	8.48	10.77		
338 339 340 341 342	3.122 3.247 3.372 3.497 3.662	3.494 3.619 3.744 3.869 3.994						79.30 82.47 85.65 88.82 92.00	88.75 91.92 95.10 98.27 101.45							
343 344 345	3.747 3.872 3.997	4.119 4.244 4.369						95.17 98.35 101.52	104.62 107.80 110.97							
346 347 348 349	4.122 4.247 4.372 4.497	4.494 4.619 4.744 4.869	0.008					104.70 107.87 111.05 114.22	114.15 117.32 120.50 123.67	0.20						

Recommended for static applications only.

Metric sizes.

	Rod Sizes per MIL-G-5514F														Changes acc. to AS4716	
	Inch							mm							Inch	mm
Dash No	øB Rod Dia.	øE Groove Dia.	D Diam. Clearance Max.	R Rad.	Groove Width +0.010/-0.000 G_0	G_1	G_2	øB Rod Dia.	øE Groove Dia.	D Diam. Clearance Max.	R Rad.	Groove Width +0.25/-0.00 G_0	G_1	G_2	øE Groove Dia.	øE Groove Dia.
	+0.000 -0.003	+0.003 -0.000						+0.000 -0.076	+0.076 -0.000							
425	4.497	4.974						114.22	126.34							
426	4.622	5.099						117.40	129.51							
427	4.747	5.224						120.57	132.69							
428	4.872	5.349						123.75	135.86							
429	4.997	5.474						126.92	139.04							
430	5.122	5.599						130.10	142.21							
431	5.247	5.724						133.27	145.39							
432	5.372	5.849	0.009					136.45	148.56	0.23						
433	5.497	5.974						139.62	151.74							
434	5.622	6.099						142.80	154.91							
435	5.747	6.224						145.97	158.09							
436	5.872	6.349						149.15	161.26							
437	5.997	6.474						152.32	164.44							
438	6.247	6.724						158.67	170.79							
439	6.497	6.974						165.02	177.14							
440	6.747	7.224						171.37	183.49							
441	6.997	7.474						177.72	189.84		0.89					
442	7.247	7.724		.035	.375	.475	.579	184.07	196.19		|	9.53	12.07	14.71		
443	7.497	7.974		| .020				190.42	202.54		0.51					
444	7.747	8.224						196.77	208.89							
445	7.997	8.474						203.12	215.24							
446	8.497	8.974						215.82	227.94							
	+0.000 -0.004	+0.004 -0.000						+0.000 -0.100	+0.100 -0.000							
447	8.997	9.474						228.52	240.64							
448	9.497	9.974	0.010					241.22	253.34	0.25						
449	9.997	10.474						253.92	266.04							
450	10.497	10.974						266.62	278.74							
451	10.997	11.474						279.32	291.44							
452	11.497	11.974						292.02	304.14							
453	11.997	12.474						304.72	316.84							
454	12.497	12.974						317.42	329.54							
455	12.997	13.474						330.12	342.24							
456	13.497	13.974						342.82	354.94							
457	13.997	14.474						355.52	367.64							
458	14.497	14.974						368.22	380.34							
459	14.997	15.474						380.92	393.04							
460	15.497	15.974						393.62	405.74							

Recommended for static applications only. Metric sizes.

The above dimensions are for reference only, Shamban cannot be held responsible for printing errors etc.

600 Series (3/8") cross section AS4832 recommended for diameters above -442.

Table XV Overview of MIL-G-5514F Groove sizes

Series	000		100		200		300		400	
Gland Depth	0.056	1.42	0.089	2.26	0.122	3.09	0.186	4.72	0.239	6.06
Gland Width Zero BUR *)	0.094	2.39	0.141	3.58	0.188	4.78	0.281	7.14	0.375	9.53
Gland Width One BUR *)	0.149	3.78	0.183	4.65	0.235	5.97	0.334	8.48	0.475	12.07
Gland Width Two BUR *)	0.207	5.26	0.245	6.22	0.304	7.72	0.424	10.77	0.579	14.71

Metric sizes. *) BUR = Back-up ring AS4716 has variation in groove depth and width. See spec. for detail

Turcon® VL Seal®*

Description

The Turcon® VL Seal® incorporates theoretical and empirical experience, in a new generation seal for the 21st century.

The VL Seal® has been developed over the past few years as a new generation unidirectional Rod seal. The design has taken the latest empirical and theoretical experience into account in order to optimise performance, friction, leakage and service life. This has been achieved through in-house testing and qualified in customer applications. See test section.

The back-pumping effect allows the seal to relieve pressure trapped between tandem seals or between seals and double-acting scrapers.

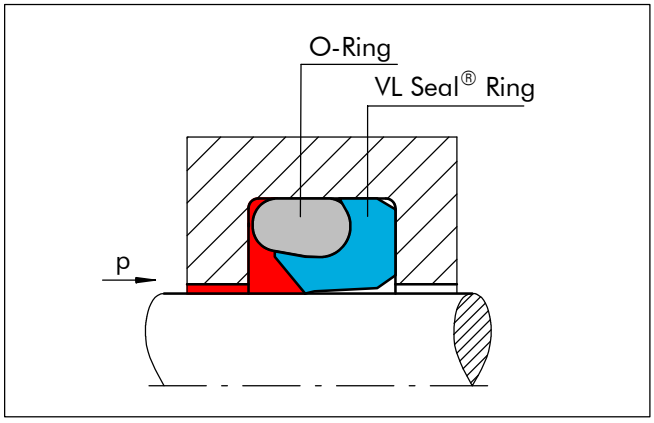


Figure 40 Turcon® VL Seal®

Method of Operation

The sealing mechanism of the Turcon® VL Seal® (Figure 40) is based on the hydrodynamic properties of the seal. The specially formed seal edge has a steep contact pressure gradient on the high pressure side and a shallow contact pressure gradient on the low pressure side. This ensures that the fluid film adhering to the piston rod is returned to the high pressure chamber on the return stroke of the rod. This prevents the micro-fluid layer, that is carried out of the high pressure chamber when the piston rod is extended, from causing leaks.

This return delivery property prevents the build-up of interstage pressure normally associated with tandem seal configurations (Figure 41). Interstage pressure depends on the system pressure speed, the stroke length and the groove design.

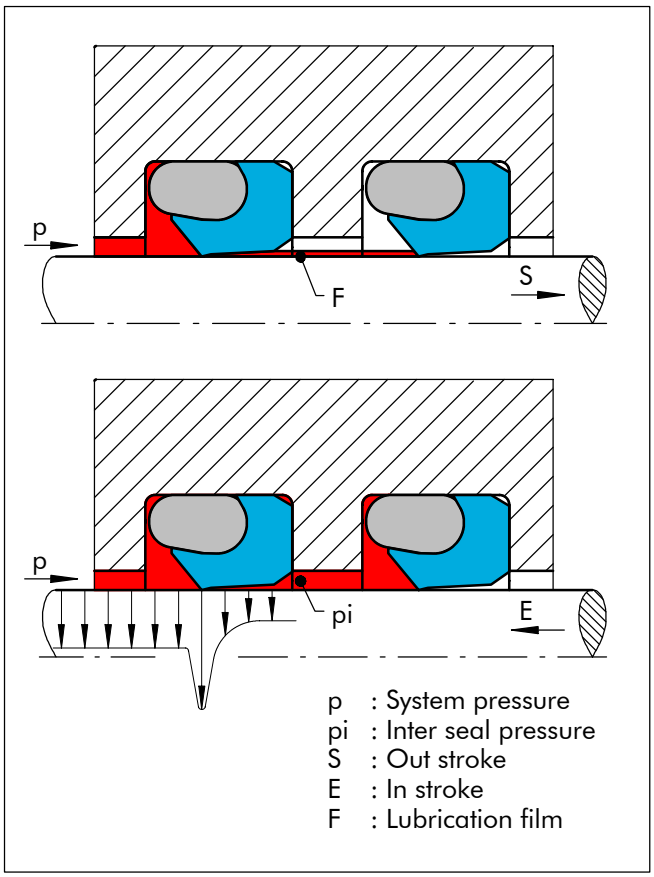


Figure 41 Pressure Distribution in Tandem Installation

Advantages

Compared with current rod seals, the following parameters have been improved:

- Seal gland: in accordance with MIL-G-5514 / AS4716. 0 b/u width (not available in 000 series).
- Tighter leakage control.
- Lower friction: (reduced contact area between seal and mating surface).
- Simplicity of design, using standard size O-Ring.
- Featuring the Turcon® Stepseal® back pumping effect.
- The seal geometry prevents seal roll at low or shuffling pressure.
- Recommended surface finish max. Ra 0.2 µm / 8 µinch.

* Patent pending.
(US Patent No. 6,497,415)

Technical Data

Operating pressure: 35 MPa (5000 psi)

Speed:	up to 15.0 m/s (49.2 ft/s) with reciprocating movements
Temperature range:	-54°C to +200°C (-65°F to +390°F) (depending on elastomer material)
Clearance:	As per MIL-G-5514F/AS4716
Media:	Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), Phosphate Ester, water and others, depending on the elastomer material (see Table IV, page 16)

Avoid combining extreme limits.

Materials

See Table I, page 12 and Table III, page 15.

Series

The VL Seal® follows the series as described in MIL-G-5514F. We recommend that the guidelines for static and dynamic sizes be followed to ensure a good service life for the seal.

For further information on the VL Seal® in a non-standard diameter size, please contact your Shamban sales engineer.

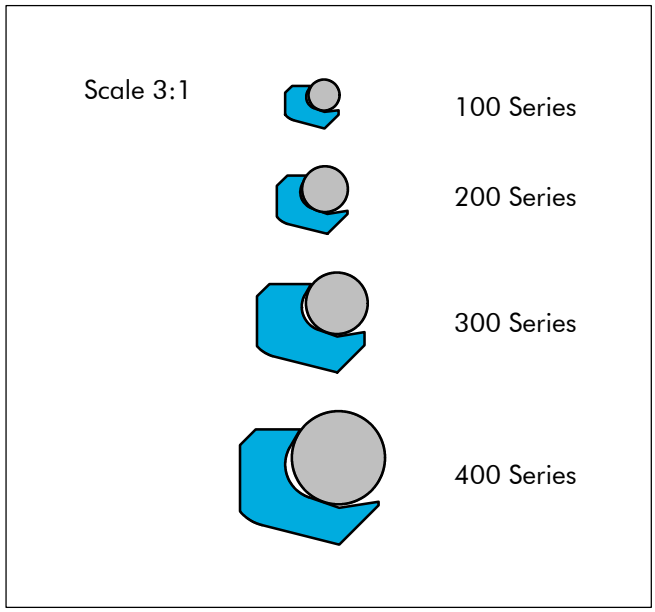


Figure 42 Relationship Between the Profile Cross-Section

Ordering Example

VL Seal® rod, with Notch.
Series No. REL 2 from Table XVI

Dash No: 220

Material: Turcon®: T05, see Table I, page 12

Order No. REL 2 N M220 A T05

- REL — Series No.
- 2 — Cross section*
- N — 0=No Notch (standard)** N=Notch
- M220 — MIL-G-5514F/AS4716 size
- A — Seal part includes Certificate of conformance. (C.C.)
- T05 — Turcon® material code

* 1=100 Series 4=400 Series
2=200 Series
3=300 Series

** Notching is recommended for service with high frequency pulsating pressure, where pressure can be built in the downstream upper corner. The notch will act as a draining channel.

Ordering Example

VL Seal® rod, metric sizes.
Series No. REL 2 from Table XVI

Rod dia.: 30.0 mm

Material: Turcon®: T05, see Table I, page 12

Order No. REL 2 0 0300 A T05

- REL — Series No.
- 2 — Cross section*
- 0 — 0=No Notch (standard)** N=Notch
- 0300 — Rod diameter in mm x 10
- A — Seal part includes Certificate of conformance. (C.C.)
- T05 — Turcon® material code

Note: O-Ring must be ordered seperately. Contact your Shamban sales engineer for dash-sizes.

Table XVI Installation Dimensions

Series	Standard Range	Extended Range	Radial Clearance			O-Ring Cross-Section
			1500 psi	3000 psi	5000 psi	
REL 1	-110 to -149	6 to 100mm 0.236"-3.937"	0.40mm 0.016"	0.25mm 0.010"	0.15mm 0.006"	1.78mm 0.070"
REL 2	-210 to -247	10 to 200mm 0.394"-7.874"	0.40mm 0.016"	0.25mm 0.010"	0.20mm 0.008"	2.62mm 0.103"
REL 3	-325 to -349	20 to 400mm .787"-15.748"	0.50mm 0.020"	0.30mm 0.012"	0.20mm 0.008"	3.53mm 0.139"
REL 4	-425 to -460	35 to 999mm 1.387"-39.330"	0.60mm 0.024"	0.35mm 0.014"	0.25mm 0.010"	5.33mm 0.210"

Only available in "0" Back-up groove width but can be used in 1 and 2 Back-up grooves using Spacer Rings. Not available in 000 Series.

The seal is designed for MIL-G5514F/AS4716 groove geometries, but higher clearances can be accommodated according to service conditions.

The seal is designed for 0 b/u groove width, but installation may be faciliated by the use of a 1 b/u groove width and filling the groove with a back-up ring, as a spacer.

Seals for 1 & 2 back-up ring groove widths can be used with solid b/u-rings (a scarfcut is only recommended for small diameters < 25 mm / 1 inch) to ease installation. Special back-up rings can be designed and supplied for unique application requirements.

The standard range can be installed in closed groove b/u down to 20 mm (-211) 0 b/u. Smaller diameters down to 16 mm (-114) can be installed for 1 or 2 b/u groove width. Back-up ring to be installed afterwards.

Test Data

Internal Test Report

Test fluid:	MIL-H-83282
Pressure:	0-3000 psi cyclic (0-207 bar)
Stroke:	76 mm (3 inches)
Rate:	1 Hz
Temp.:	121°C (250°F)
Rod size:	-214, IHCP R2 0.1-0.2 µm (4-8 µinch)

Single Seal:	**250 000 cycles**
Average wear:	-0.20 %
Average leakage:	0

Tandem Seal:	**500 000 cycles**
Average wear:	Primary: -0.42 % Secondary: -0.11 %
Average leakage:	0.11 g ~ 3 drops. (total)
Material:	Turcon® T19

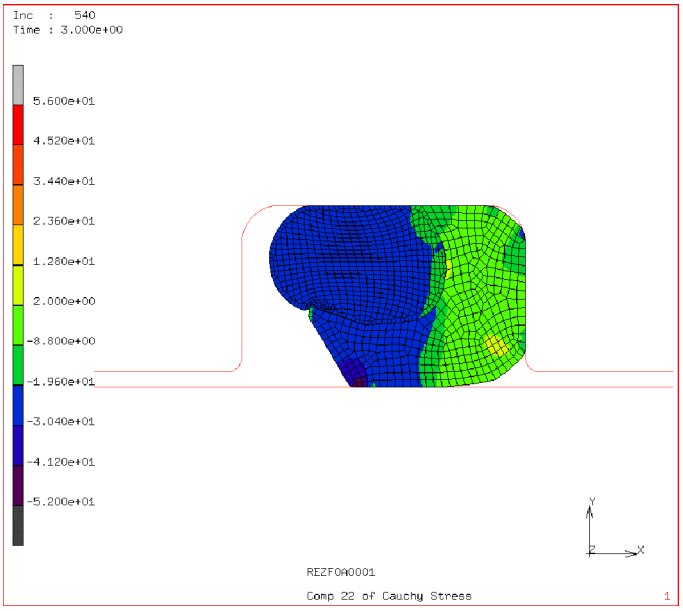


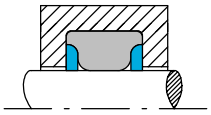
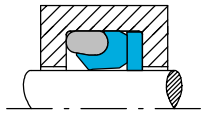
Figure 43 Internal Test Report

Customer Test Report

Working Condition

Rod size:	-114 (15.82 mm) hard-chrome
Pressure:	2320 psi (160 bar)
Fluid:	Phosphate Ester
Rate:	5 Hz max.
Requirement:	Zero leakage with friction below 10 daN (2.2 lb)
Temp.:	Ambient

Table XVII Test Results

Seal Type	8,000 hours	10,200 hours	10,800 hours	16,000 hours
Turcon® T Seal 	40 drops	400 drops	800 drops Test stopped	-
Turcon® VL Seal® 	3 drops	4 drops	5 drops	40 drops

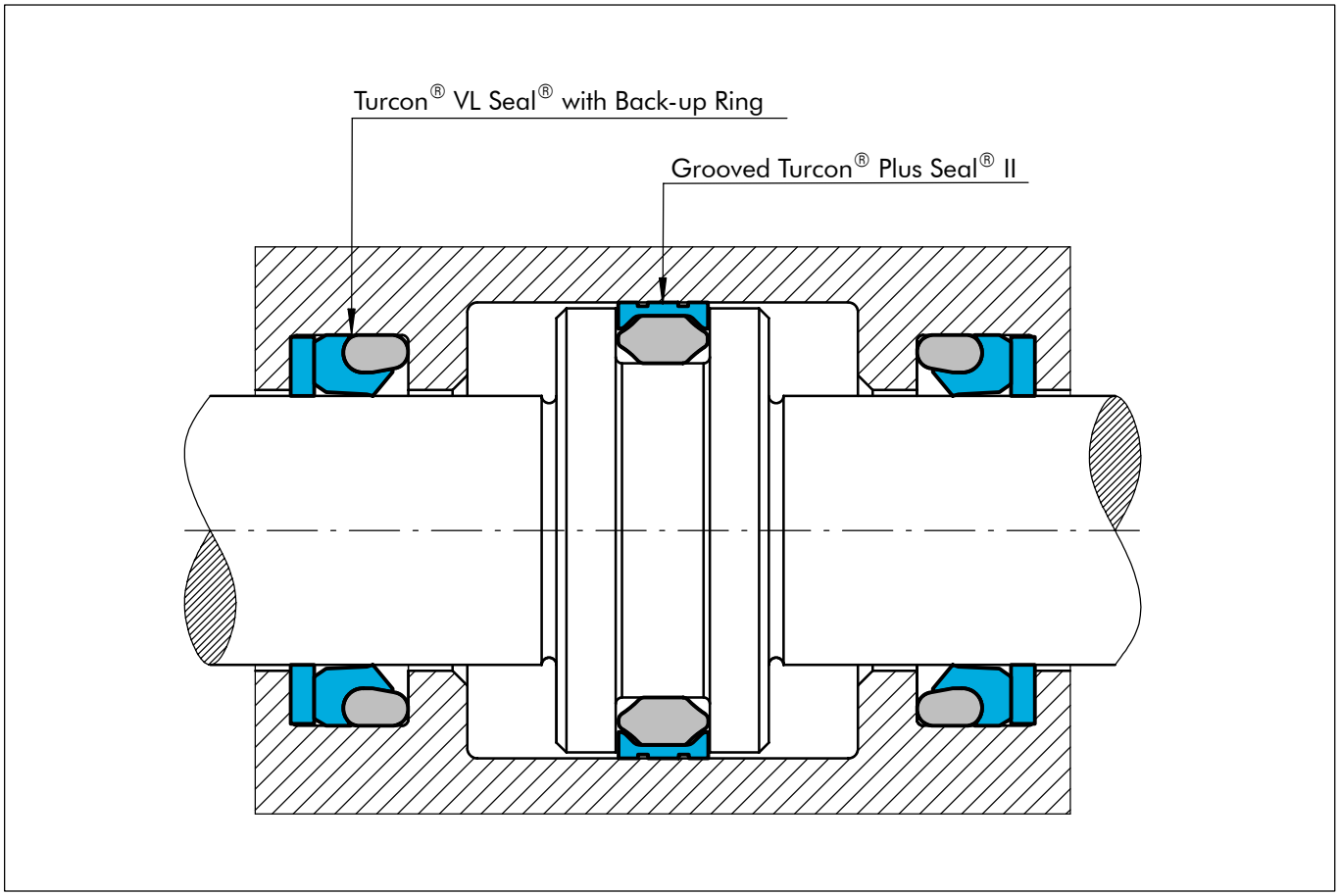


Figure 44 Installation

Problem

Low service life, with original equipment. Hard chrome.

Solution

New design with tungsten carbide rod and sealing system from Shamban.

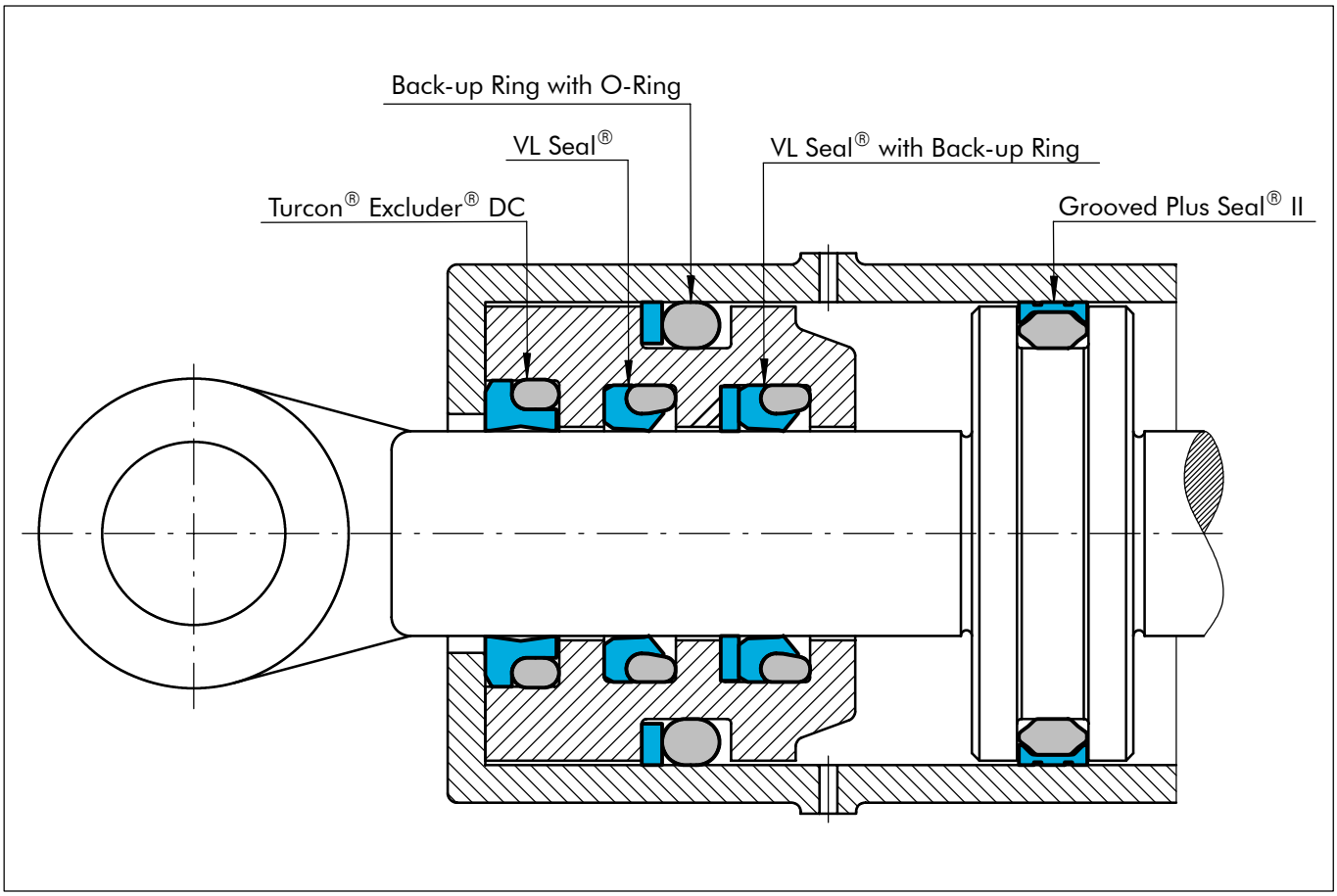


Figure 45 Primary Flight Control

Requirement

Tandem rod seal, with pressure relieving feature.

High frequency up to 10 Hz.

Long service life with exeptional leak-free performance (30 000 flight hours).

Solution

Shamban tandem VL Seal® with excellent performance on tungsten carbide rod.

Turcon® Plus Seal®II

Description

The Turcon® Plus Seal®II, with a long, successful history, is an evolutionary improvement of the Double Delta®. It is fully interchangeable with the Double Delta®II in most applications.

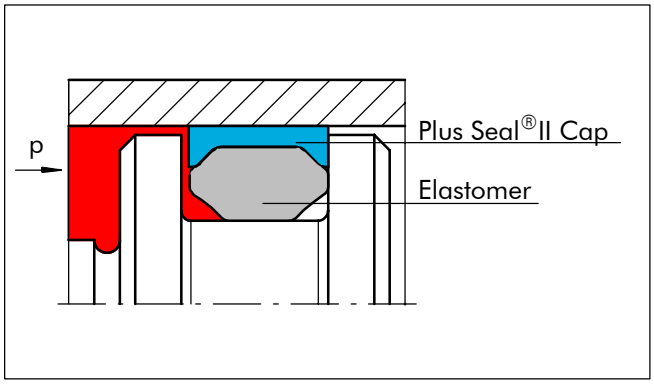


Figure 46 Turcon® Plus Seal®II

Method of Operation

The sealing effect of the Plus Seal®II comes from the slight interference of the seal cap with the rod or bore combined with the preload from the compressed elastomer. As the pressure increases, the system pressure joins forces with the elastomer and increases the loading of the seal cap significantly.

The substitution of the proprietary lemon shaped elastomer under the Plus Seal®II cap instead of a traditional O-Ring allows the cap to be thicker for increased wear life. The new elastomer element also activates the seal cap over a wider area providing a lower unit loading.

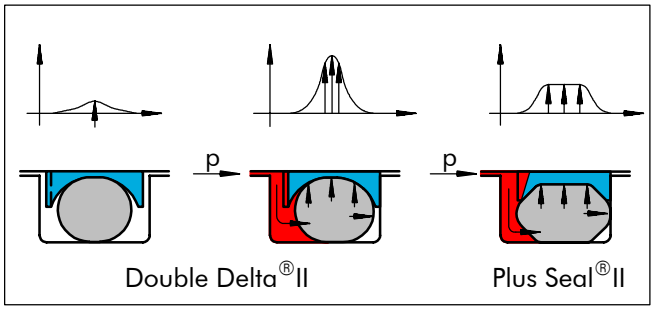


Figure 47 Pressure Distribution

The Plus Seal®II elastomer is carefully profiled to fit inside the cap and supports the corners to prevent them from sinking away from the sealing surface. This reduces the oil film under the seal to an absolute minimum.

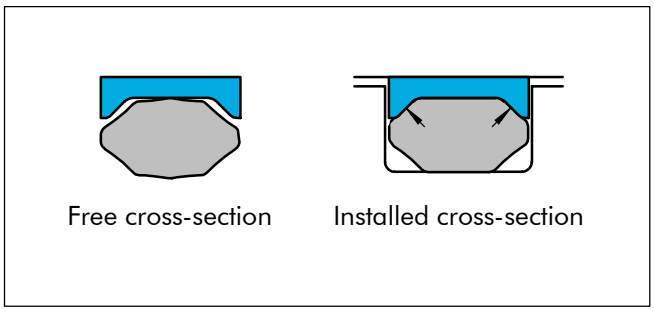


Figure 48 Turcon® Plus Seal®II Cross-Section

By choosing the grooved version, a further decrease in the film thickness can be achieved. The grooves increase the number of pressure peaks that the oil film must pass under. Another advantage of the grooved seal is that the grooves serve as an oil reservoir when the seal is static. When the seal starts to move, the oil film is quickly re-established under the sliding surface to lubricate the seal. This is especially important in applications where the stroke is shorter than the seal width and it provides a general improvement in wear life. Ask for Shamban test report R1069.

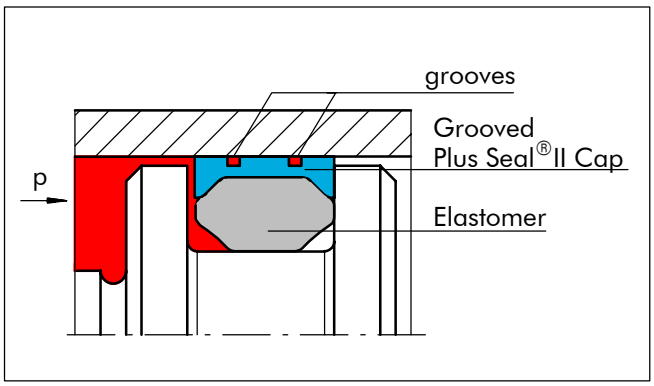


Figure 49 Turcon® Grooved Plus Seal®II

The zero back-up width of the seal is generally preferred even if a wider groove is available in smaller diameters. The extra space in a wider groove is used more efficiently when filled with back-up rings. This increases the seal life without notably changing the friction.

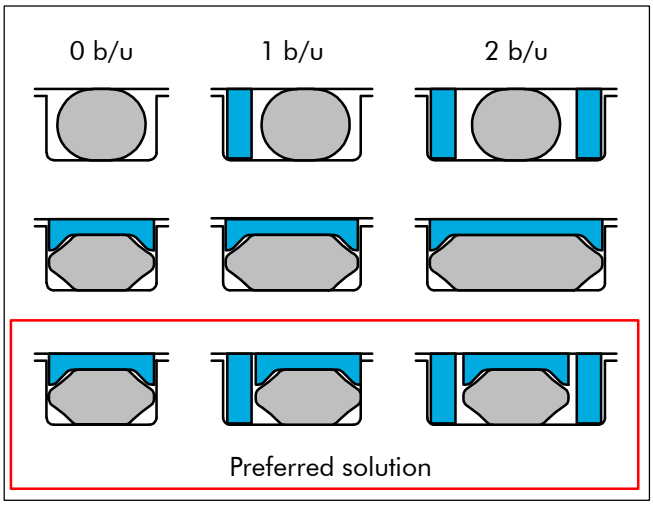


Figure 50 Use of Back-up Rings (BUR) with Plus Seal®II

Where the Plus Seal®II is subjected to pressure from both sides alternately, it should always be equipped with sidewall notches, which allow the pressure to properly activate the elastomer (Fig. 51). The Plus Seal®II for piston use is equipped with notches as standard whereas the rod version must be specified with notches if they are deemed necessary.

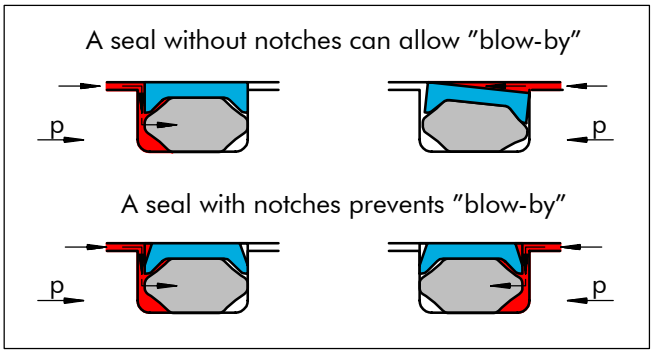


Figure 51 Plus Seal®II with Notches

Using a seal without notches may allow "blow-by", which is a situation where the pressure shoots over the top of the Plus Seal®II cap and forces the seal down into the groove. See also SAE document AIR 1243.

Advantages

- Good static and dynamic sealing effect
- High abrasion resistance
- Long life
- Low friction, high efficiency
- Stick-slip free starting
- No vulcanization even during long static periods
- Easy installation - foolproof
- Available for all MIL-G-5514F/AS4716 sizes.

Technical Data

Operating pressure:	35 MPa (5000 psi) (up to 70 MPa (10 000 psi) with Stakbaks®).
Speed:	up to 15.0 m/s (49.2 ft/s) with reciprocating movements
Temperature range:	-54°C to +200°C (-65°F to +390°F) (depending on elastomer material)
Clearance:	As per MIL-G-5514F/AS4716, larger with Stakbaks®
Media:	Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), Phosphate Ester, water and others, depending on the elastomer material (see Table IV, page 16)

Avoid combining extreme limits.

Materials

See Table I, page 12 and Table III, page 15.

Series

The Plus Seal®II follows the series as described in MIL-G-5514F/AS4716. We recommend that the guidelines for static and dynamic sizes be followed to ensure a good service life for the seal.

For further information on the Plus Seal®II in a non-standard diameter size, please contact your Shamban sales engineer.

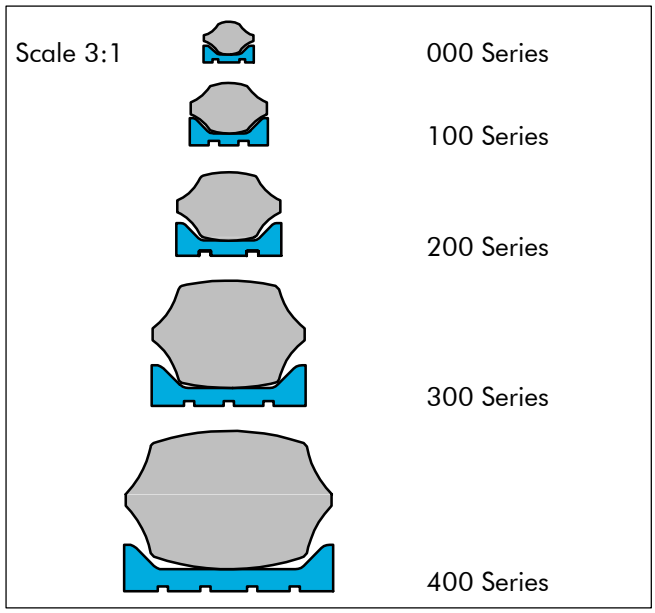


Figure 52 Relationship Between the Profile Cross-Section

Back-up Rings (BUR) for Plus Seal®II

The following Back-up Rings are especially designed for use with the Plus Seal®II. The same BUR is used for both rod and bore.

For installation in closed grooves with rod/piston diameter smaller than 18 mm (3/4 inch), we recommend cut Back-up Rings.

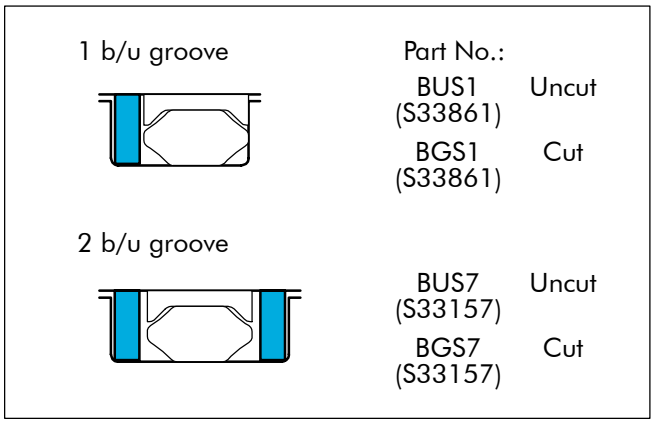


Figure 53 Plus Seal®II with Back-up Rings

For pressures above 35 MPa (5000 psi), we recommend using one or two Stakbak® Back-up Rings with the Plus Seal®II.

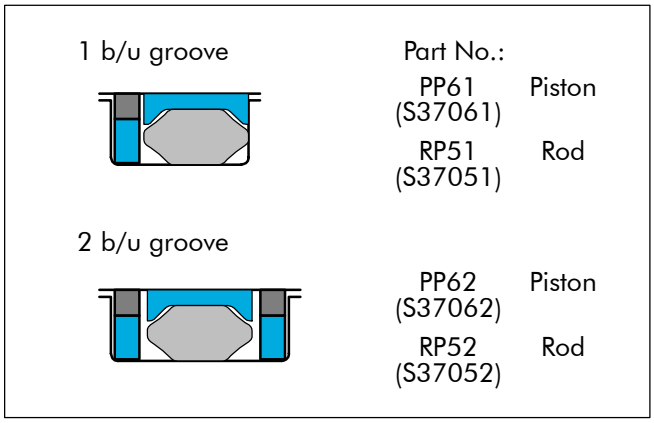


Figure 54 Plus Seal®II Set with Stakbaks®

The Stakbak® Back-up Ring for piston seals has a rigid HiMod® anti-extrusion outer ring bonded to a Turcon® inner ring. A wide range of tests at 55 MPa (8000 psi) shows that the Stakbak® efficiently protects the seal cap from extrusion and improves the lifetime of the seal at lower pressures.

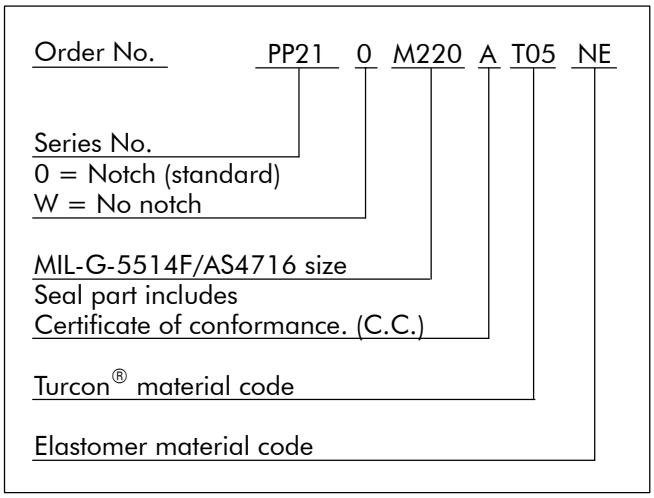
The use of Stakbak® Back-up Rings is recommended when the Plus Seal®II is used with increased diametral clearance, high pressure or temperature exceeding 135°C (275°F).

Ordering Example

Grooved Plus Seal®II piston, 1 b/u width, Notch.[1)]
Series No. PP21 from Table XVIII, page 53.

Dash No: 220

Material: Turcon®: T05, see Table I, page 12
Turel®: NE, see Table III, Page 15



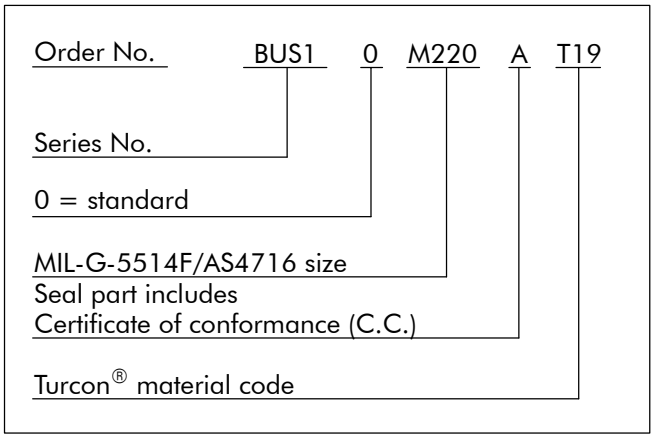
[1)] Please see note page 53

Ordering Example

Back-up Ring for a one back-up width groove, for use with Plus Seal® II
Series No. BUS1

Dash No: 220

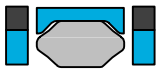
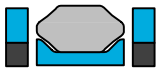
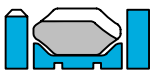
Material: T19



Please Note that Back-up Rings must be ordered separately!

This example is for ordering the Back-up Ring as shown in Fig. 53.

Table XVIII Turcon® Plus Seal®II Types

Seal Type	Groove Type: MIL-G-5514F / AS4716				Comments
	Width			Dia. Size Range Standard dash numbers	
	0 b/u	1 b/u	2 b/u		
Piston Plus Seal®II [1] 	PP50 (S34750)	PP81 (S34581)	PP82 (S34582)	004 to 460	Foolproof design. 0 b/u width Plus Seal®II with Back-up Ring recommended for low friction. Installable even in small closed grooves, but care must be taken.
Piston grooved Plus Seal®II [1] 	PP52 (S30852) [4] PP60 (S34760)	PP21 (S34721)	PP22 (S34722)	004 to 460	Grooves in surface cap increase wear life and leakage control. Friction is reduced due to the decreased surface area as well as better lubrication of the surface. Ask for Shamban test report R1069.
Rod Plus Seal®II [1] 	RP75 (S30775)	RP71 (S34571)	RP72 (S34572)	004 to 460	Foolproof design. 0 b/u width Plus Seal®II with Back-up Ring recommended for low friction. Installable even in small closed grooves, but care must be taken.
Rod grooved Plus Seal®II [1] 	RP55 (S30855)	RP11 (S34711)	RP12 (S34712)	004 to 460	Grooves in surface cap increase wear life and leakage control. Friction is reduced due to the decreased surface area as well as better lubrication of the surface. Ask for Shamban test report R1069.
Piston Plus Seal®II Stakbak® Set 	Not available	PP61 [2] (S37061)	PP62 (S37062)	020 to 460	For pressure above 35 MPa (5000 psi) For long service life. For high temperature protection of seal up to +260°C (500°F).1 b/u configuration incorporates only 1 BUR. Available also for size -020 to -028 and -118 to -149 even though this is static range! For more on Stakbaks®, see BUR section.
Rod Plus Seal®II Stakbak® Set 	Not available	RP51 [2] (S37051)	RP52 (S37052)	020 to 460	For pressure above 35 MPa (5000 psi) For long service life. For high temperature protection of seal up to +260°C (500°F).1 b/u configuration incorporates only 1 BUR. Available also for size -019 to -028 and -117 to -149 even though this is static range! For more on Stakbaks®, see BUR section.
Rod Plus Seal®PR Set 	Not available	RP81 [3] (S38671)	RP82 (S38672)	110 to 460	Pressure relieving Plus Seal®II, used as primary seal in tandem rod seal concept. Care must be taken for correct installation. 1 b/u width incorporate only upstream. Also available for piston applications.

1) Notching Options: Piston seals are always delivered as standard with notch. To omit, change 5th character to "W". Ex. PP50W. Rod seals are always delivered as standard without notch. To include notch, change 5th character to "N". Ex. RP75N. Notches are not possible in 000 series, 0 b/u.

2) Supplied with back-up ring for the downstream side only.

3) Supplied with spacer ring for the upstream side only.

4) Used in North America.

Turcon® Double Delta®II

Description

The Turcon® Double Delta®II is the original seal design that was developed to improve the performance of the O-Ring and Back-up Rings that were used in the MIL-G-5514F/AS4716 and older versions of that standard.

The Turcon® Double Delta®II represents a balance between the cap thickness and the squeeze of the O-Ring within the MIL-standard groove.

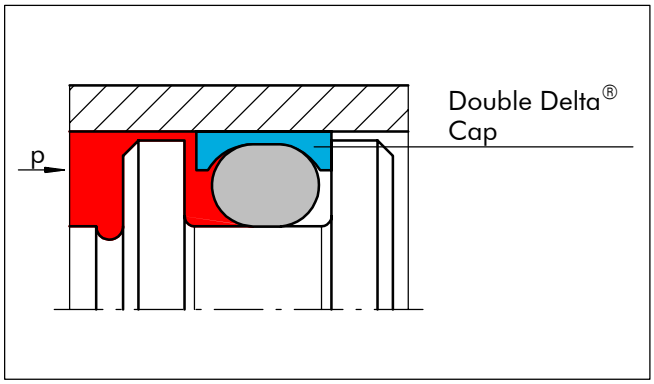


Figure 55 Turcon® Double Delta®II

Method of Operation

The O-Ring preloads the seal cap in the thin, flexible middle section and provides good leakage control even at low pressures.

In addition to the O-Ring preload, when the system pressure is added the oil film under the seal is further reduced. Double Delta®II will always allow an oil film to be dragged across the sealing surface. This oil film is necessary to ensure a long service life for the Double Delta®.

For use of notches and grooves, please see the section Plus Seal®II, pages 50 - 53.

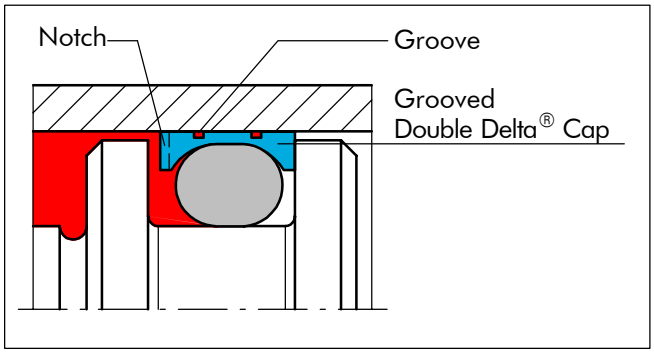


Figure 56 Grooved Double Delta®II with Notch

Advantages

- Good static sealing effect
- Low friction, high efficiency
- Stick-slip-free starting
- No adhesion to hardware even during long static periods
- Available for all MIL-G-5514F/AS4716 sizes.
- Can be made for all O-Ring sizes.

Technical Data

Operating pressure: 35 MPa (5000 psi)

Speed: 15.0 m/s (49,2 ft/s)

Temperature range: -54°C to +200°C
(-65°F to +390°F)
(depending on elastomer material)

Clearance: As per MIL-G-5514F/AS4716

Media: Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), Phosphate Ester, water and others, depending on the elastomer material (see Table IV, page 16)

Materials

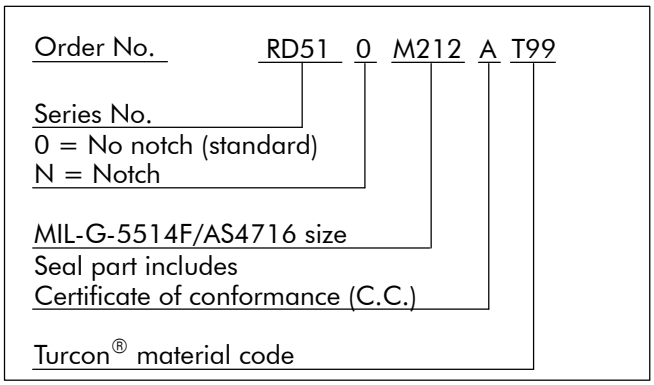
See Table I, page 12 and Table III, page 15.

Ordering Example

Grooved Double Delta®II for rod, 1 b/u width, Series No. RD51 from Table XIX, page 55

Dash No: 212

Material: T99



Note: O-Ring must be ordered separately. Sizes follow dash number.

Series

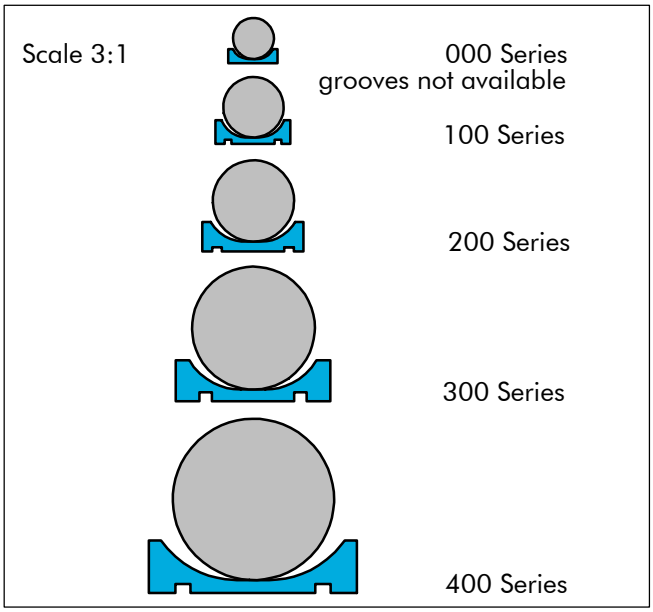


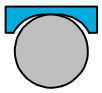
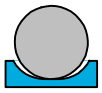
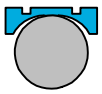
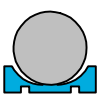
Figure 57 Relationship between the Profile Cross-Section

The Double Delta®II follows the series as laid out in MIL-G-5514F/AS4716. We recommend that the guidelines for static and dynamic sizes be followed to ensure a good service life for the seal.

The Double Delta®II is also available for the (British Std.) B.S.4518 O-Ring grooves.

For further information on the Double Delta® II in non-standard size, please contact your Shamban sales engineer.

Table XIX Turcon® Double Delta®II Types

Seal Type	Groove Type: MIL-G-5514F/ AS4716				Comments
	Width			Dia. Size Range Standard dash numbers	
	0 b/u	1 b/u	2 b/u (2)		
Piston Double Delta®II (1) 	PD60 (S30660)	PD61 (S30661)	PD62 (S30662)	Standard dash sizes	Foolproof design. Zero back-up width version preferred. Cost-effective solution.
Rod Double Delta®II (1) 	RD50 (S30650)	RD51 (S30651)	RD52 (S30652)	Standard dash sizes	Foolproof design. Zero back-up width version preferred. Cost-effective solution.
Piston grooved Double Delta®II (1) 	PD80 (S32860)	PD81 (S32861)	PD82 (S32862)	Standard dash sizes	Grooves in the surface of the cap increase wear life and leakage control. For 000 serie grooves only available in 2 b/u width.
Rod grooved Double Delta®II (1) 	RD80 (S32850)	RD81 (S32851)	RD82 (S32852)	Standard dash sizes	Grooves in the surface of the cap increase wear life and leakage control. For 000 serie grooves only available in 2 b/u width.

(1) Option Notches: Piston seals are always delivered as standard with notch. To omit, change 5th character to "W". Ex. PD60W. Rod seals are always delivered as standard without notch. To include notch, change 5th character to "N". Ex. RD81N. Notches are not available in 100 series, 0 + 1 b/u for grooved version.

(2) Seal width: For 2 b/u groove width, 0 or 1 b/u Double Delta® II recommended with Back-up Rings.

Turcon® Wedgpak®

Description

The Turcon® Wedgpak® consists of a proprietary triangular elastomer supported by two Delta shaped Back-up Rings that prevent the elastomer from spiraling or rolling under severe working conditions.

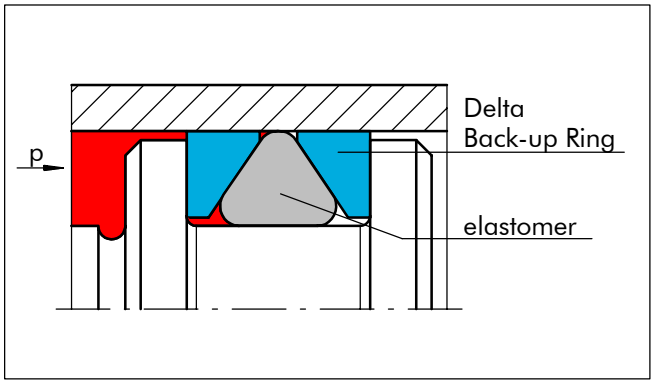


Figure 58 Turcon® Wedgpak®

Method of Operation

The small elastomer contact area of the Wedgpak® design results in a slipper seal-like performance with low static and dynamic friction. At the same time, the elastomer wipes the surface efficiently providing excellent leakage control. The Wedgpak® Back-up Rings provide support and extrusion protection for the elastomer.

Originally designed as a static seal, the Wedgpak® has now proved to be an excellent seal for dynamic applications typically demanded in flight control actuators. The Wedgpak® is also used in gas/oil separators both at high and low pressures.

For further information on Wedgpak® dynamic performance, please contact your Shamban sales engineer and ask for Test Report R1059.

Advantages

- Excellent static and dynamic sealing effect
- Low friction, high efficiency
- Available for all MIL-G-5514F/AS4716 sizes
- Foolproof installation

Technical Data

Operating pressure:	35 MPa (5000 psi)
Speed:	3.0 m/s (9.8 ft/s)
Temperature range:	-54°C to +200°C (-65°F to +390°F) (depending on elastomer material)
Clearance:	As per MIL-G-5514F/AS4716
Media:	Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), Phosphate Ester, water and others, depending on the elastomer material (see Table IV, page 16)

Materials

See Table I, page 12 and Table III, page 15.

Series

The Wedgpak® follows the series as described in MIL-G-5514F/AS4716. We recommend that the guidelines for static and dynamic sizes be followed to ensure a good service life for the seal.

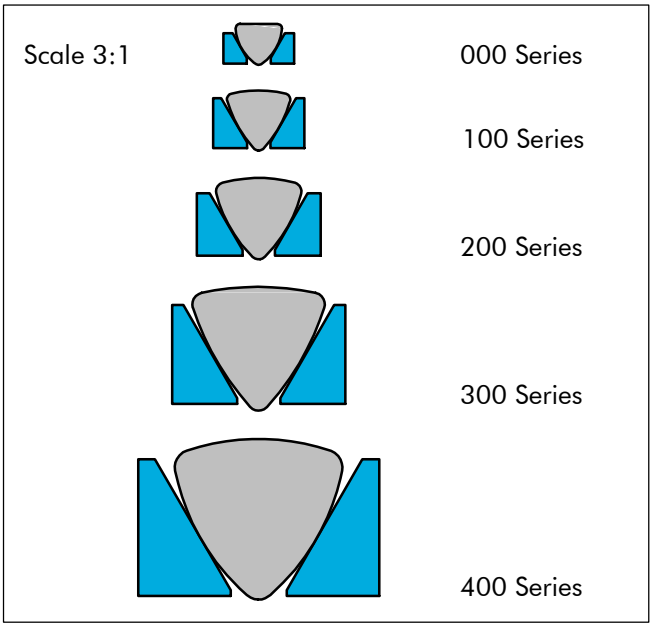


Figure 59 Relationship between the Profile Cross-Section for one Back-up Groove Width

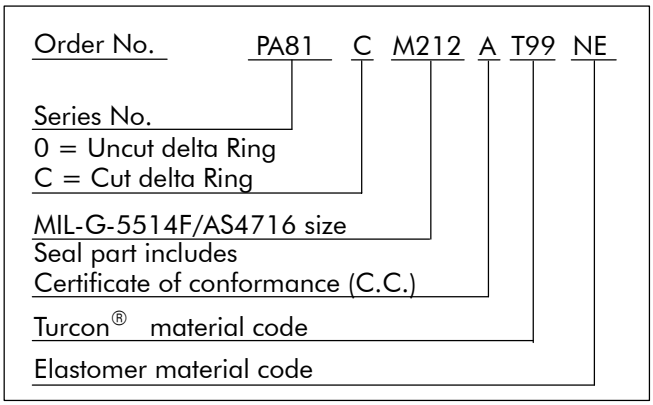
Table XX Wedgpak® Types

Seal Type	Groove Type: MIL-G-5514F/ AS4716				Comments
	Width			Dia. Size Range Standard dash size	
	0 b/u	1 b/u	2 b/u		
Piston Wedgpak® 	PA80 (S34780)	PA81 (S34781) preferred	PA82 (S34782) preferred	004 to 460	Foolproof design. Excellent static and dynamic leakage control. Cut Back-up Rings are not recommended or available by standard part number for the following dash sizes: 0 b/u: Greater than -019, -131, -230 and -341 1 b/u: Greater than -028, -142, -235, -349 and -440 2 b/u: Greater than -028, -149, -244, -349 and -447
Rod Wedgpak® 	RA70 (S34770)	RA71 (S34771) preferred	RA72 (S34772) preferred	004 to 460	Foolproof design. Excellent static and dynamic leakage control. Cut Back-up Rings are not recommended or available by standard part number for the following dash sizes: 0 b/u: Greater than -020, -132, -230 and -342 1 b/u: Greater than -028, -142, -236, -349 and -440 2 b/u: Greater than -028, -149, -244, -349 and -447
Piston Wedgpak®EP 	N.A.	PA1 (S38621)	PA2 (S38622)	004 to 460	For pressure > 35 MPa (5000 psi) and increased extrusion gap. Cut Back-up Rings are not recommended or available by standard part number for the following dash sizes: 0 b/u: Greater than -019, -131, -230 and -341 1 b/u: Greater than -028, -142, -235, -349 and -440 2 b/u: Greater than -028, -149, -244, -349 and -447
Rod Wedgpak®EP 	N.A.	RA1 (S38611)	RA2 (S38612)	004 to 460	For pressure > 35 MPa (5000 psi) and increased extrusion gap. Cut Back-up Rings are not recommended or available by standard part number for the following dash sizes: 0 b/u: Greater than -020, -132, -230 and -342 1 b/u: Greater than -028, -142, -236, -349 and -440 2 b/u: Greater than -028, -149, -244, -349 and -447

Ordering Example

Wedgpak® for piston, 1 b/u width,
Series No. PA81 from Table XX

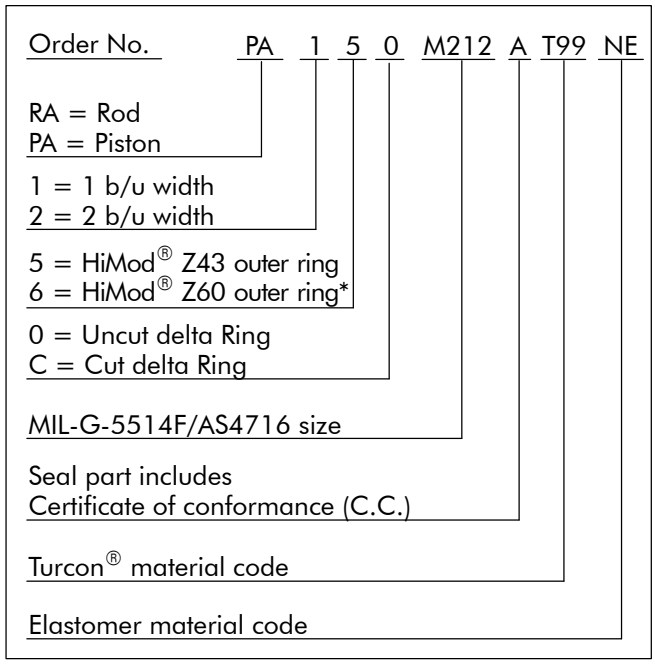
Dash No: 212
Material: T99 (standard recommendation)
see Table I, Page 12



Note! For small installation in closed grooves with rod/piston diameter smaller than 18 mm (3/4 inch), we recommend cut Back-up Rings. This is specified by adding "C" in the 5th character of the part no.
Example: PA81**C**M212AT99NE.
(EP extrusion rings are always delivered with cut.)

Ordering Example

For the Wedgpak®EP we have the following options:



*) **Note!** Other Compounds are available for the outer ring. Contact your Shamban sales engineer.

Case Story

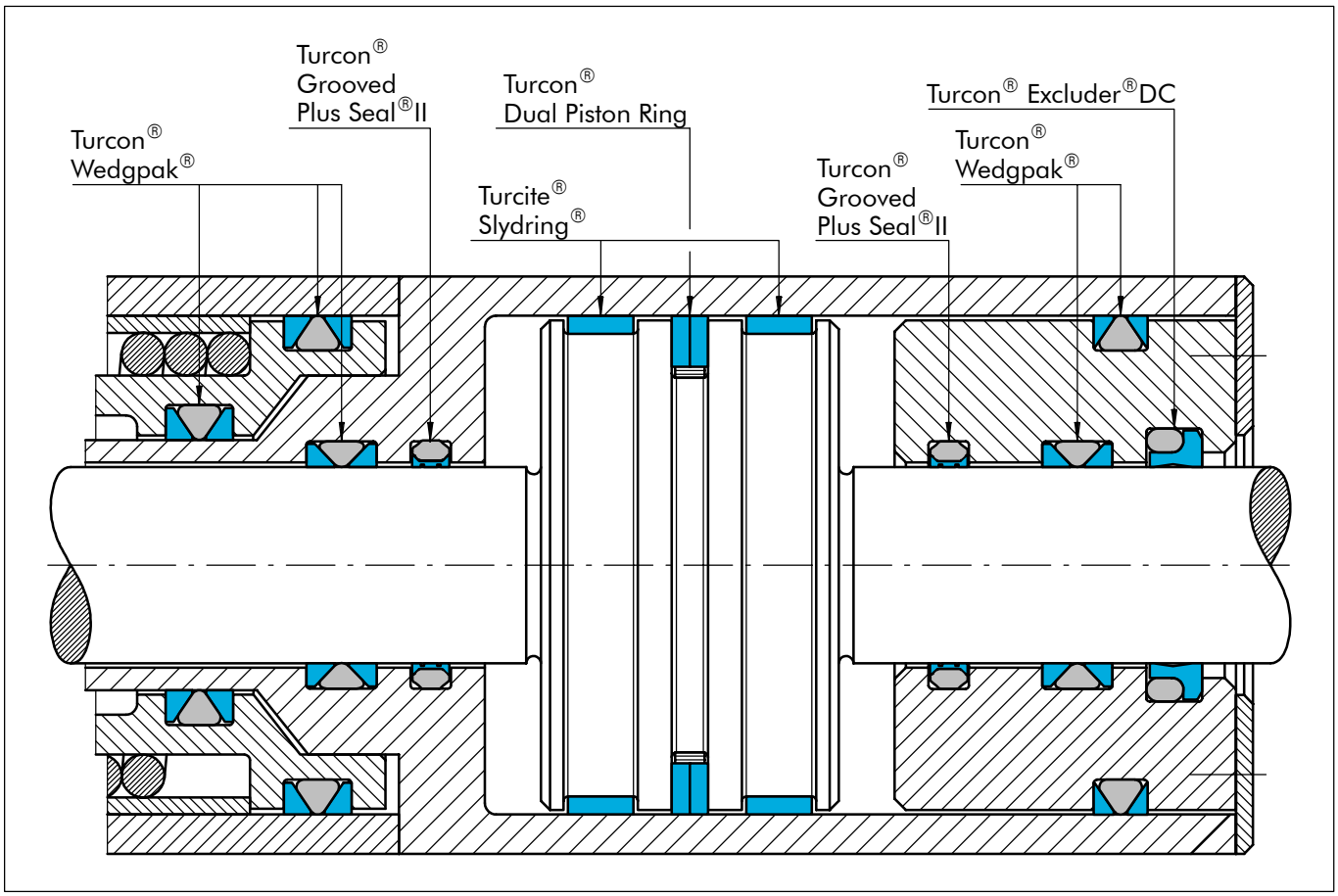


Figure 60 Main Rotor Damper, Helicopter

Problem

Low service life with original equipment.

Solution

New design with tungsten carbide rod and sealing system from Shamban.

Conditions on coated rod

Pressure:	Max.30 bar (435 psi)
Speed:	400 mm/sec.
Temperature:	-54°C - +135°C (-65°F - +275°F)
Media:	MIL-H-5606
Frequency:	6 Hz

Other Application Successes

- ADCAPPS fuel pump swashplate
- A330/A340, B747, L1011, DC10 Engine driven hydraulic pumps
- C17 OBIGGS constant speed motor
- V22 swashplate actuator
- RJ hydraulic pump
- B757/ B767 ram air turbine
- C130 gun elevation actuator
- B727 brake valve
- Space shuttle payload damper
- CH-53 nose landing gear strut
- A310 control drive shaft
- MD-80 nose gear retract actuator

Turcon® Hatseal®II

Description

The Turcon® Hatseal®II is one of the original high performance seals Shamban developed for the aircraft industry. It combines the advantages of the elastomer contact seal with those of the slipper seal.

The Hatseal®II was designed for demanding aerospace applications and is operating successfully in both military and commercial hydraulic components. The Hatseal®II combines the low leakage advantages of an elastomer contact seal and the long life characteristics of Turcon® contact seals.

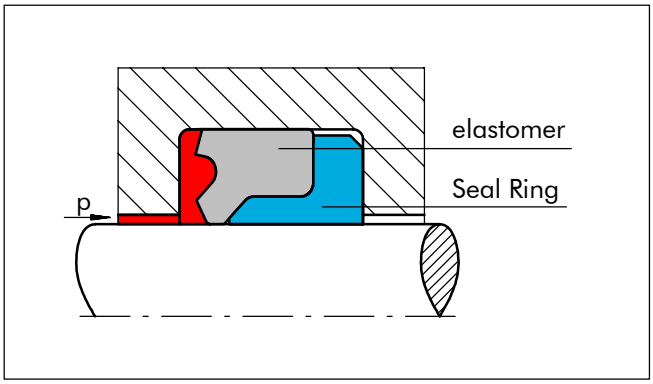


Figure 61 Turcon® Hatseal®II

Method of Operation

The Hatseal®II can be divided into 3 zones each with a specific function, (Figure 62).

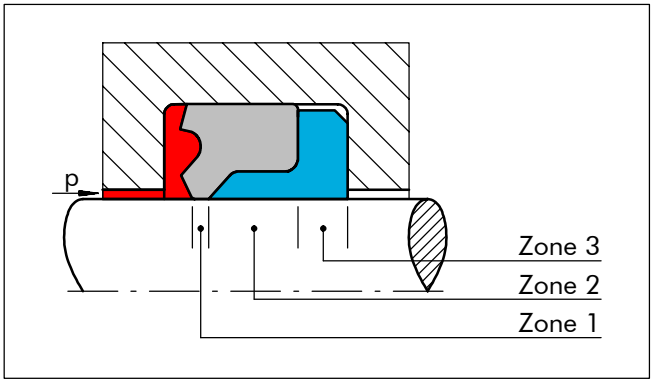


Figure 62 Hatseal®II, 3 Zone Specific Function

Zone 1 Elastomer contact area

The elastomer has a small but well-defined contact area where the oil film on the rod is reduced almost to zero. Due to the minimal elastomer contact, the friction of the seal is low. This ensures long life performance of the seal.

Zone 2 Slipper Seal area

In this area the Turcon® platform is energized by the main body of the elastomer to work like a slipper seal. This section will often run dry but since the Turcon® materials have very low coefficients of friction, this will not damage the seal. In the unlikely event of a damaged elastomer lip in Zone 1, the slipper seal part will continue to work and give a leakage performance like a slipper seal.

Zone 3 Back-up Ring area

The built-in Back-up Ring protects the seal from extrusion even at high operating pressures or speeds. For increased extrusion gaps and higher temperatures, a number of special versions have been developed (see Figure 67).

Advantages

- Built-in redundancy
- Zero leakage
- Stick-slip free operation
- High frequency applications

Technical Data

Operating pressure: 35 MPa (5000 psi)

Speed: 3.0 m/s (9.8 ft/s)

Temperature range: -54°C to +200°C
(-65°F to +390°F)
(depending on elastomer material)

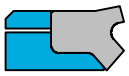
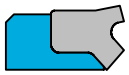
Clearance: As per MIL-G-5514F/AS4716, higher with corner reinforcement.

Media: Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), Phosphate Ester, water and others, depending on the elastomer material (see Table IV, page 16)

Materials

See Table I, page 12 and Table III, page 15.

Table XXI Turcon® Hatseal®II Types

Seal Type	Groove Type: Rod MIL-G-5514F/ AS4716			Comments
	Width		Dia. Size Range	
	1 b/u	2 b/u		
3 piece Hatseal®II 	RH31 (S34831)	RH32 (S34832)	-110 to -330	To be used for easier installation with rod diameters below 31.75 mm (1 1/4"). For dimensions below 20.0 mm (0.787") a split gland is recommended.
2 piece Hatseal®II 	RH51 (S34851)	RH52 (S34852)	-110 to -460	For dimensions below 31.75 mm (1 1/4") a split gland is recommended. Installation is made easier by heating up the Turcon® part.

Ordering Example

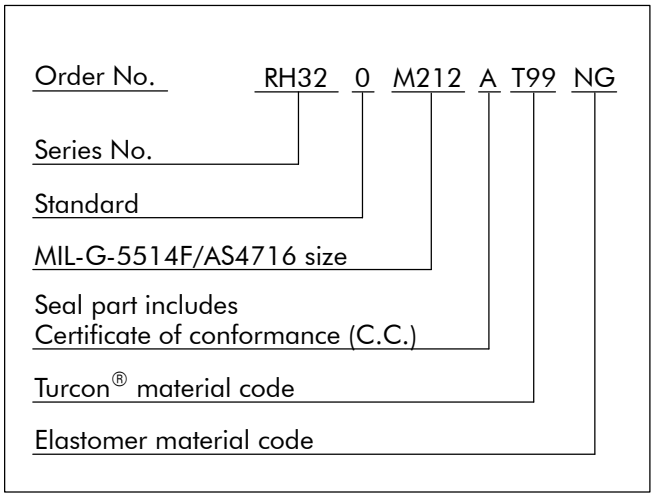
Hatseal®II, 2 b/u width, 3 pieces. Series No. RH32 from Table XXI

Dash No: 212

Material: T99 (standard recommendation)
see Table I, page 12

Notes:

The Hatseal®II can only be ordered in sizes from -110 and up. Only available in rod seal configurations. For similar performance on pistons seal, see the section on Wedgpak®.



Series

The Hatseal®II is designed to fit the MIL-G-5514F/AS4716 gland specification. We recommend that the guidelines for static and dynamic sizes be followed to ensure a good service life.

For further information on the Hatseal®II in non-standard sizes, please contact your Shamban sales engineer.

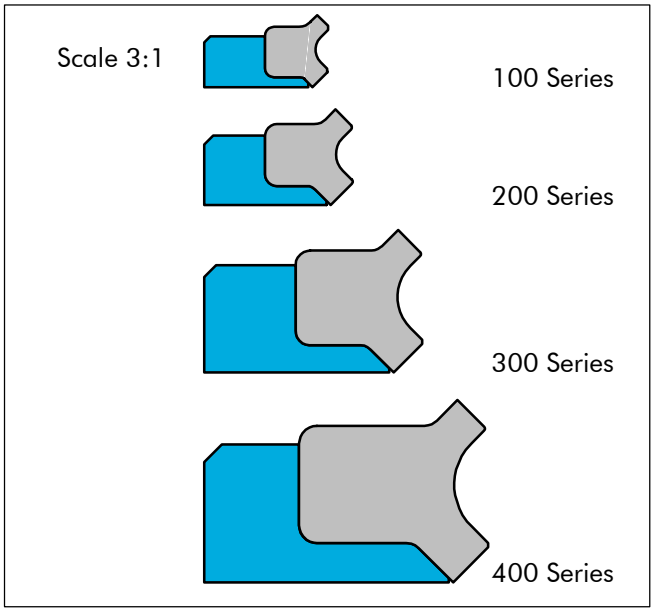


Figure 63 Relationship Between the Profile Cross-Section

Application Examples

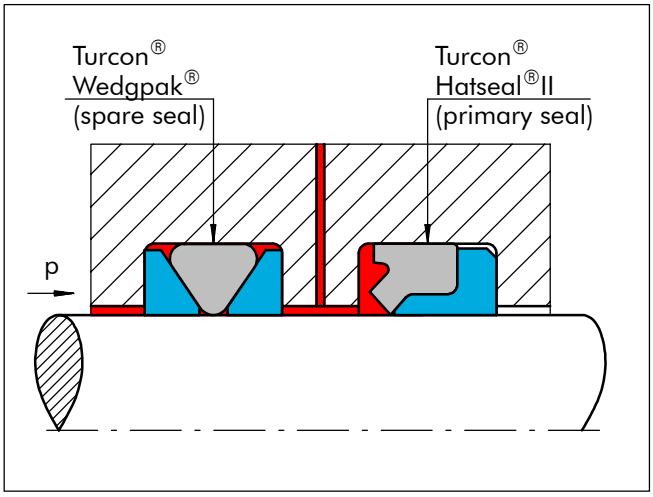


Figure 64 A320 Shock Absorber Hatseal®II

Hatseal®II installed as primary rod seal and with a Wedgpak® as spare seal. The seals are kept lubricated all the time and have shown remarkably long lifetimes.

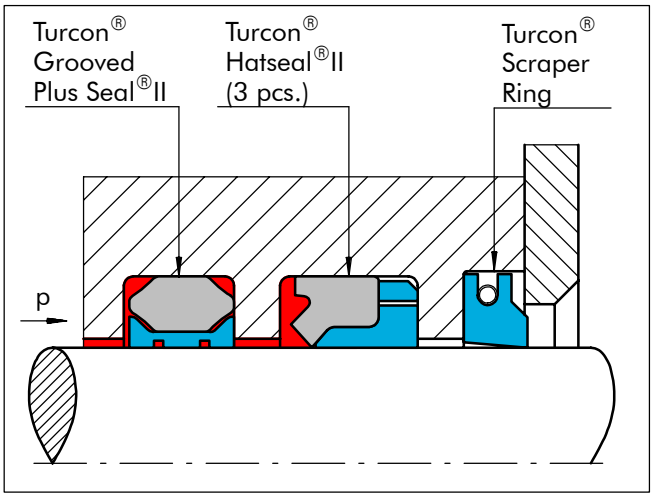


Figure 65 A320 Rudder Actuator Hatseal®II Grooved Plus Seal®II and Scraper

Hatseal®II installed as primary rod seal (single seal) to prevent leakage at both high and low pressure as well as temperature. Qualification test: 5.5 mill. cycles.

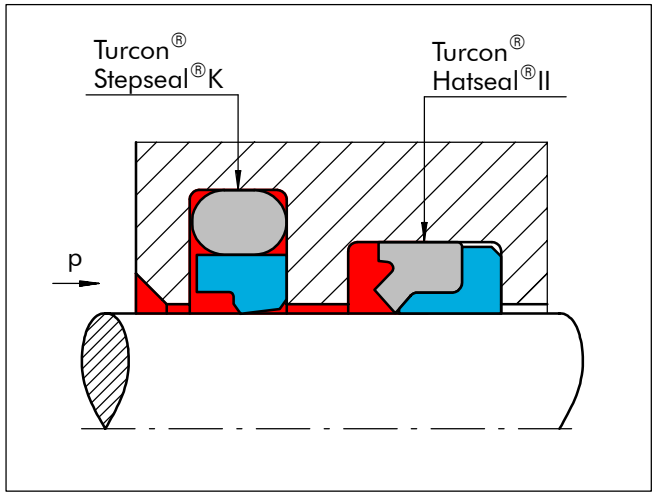


Figure 66 EH 101 Rotor Control Hatseal®II and Stepseal®K

Hatseal®II positioned as secondary rod seal to prevent leakage at low pressure. Primary seal takes the peak of the system pressure, thereby protecting the Hatseal®II. See page 8.

Alternative Hatseal®II Designs

Over the years, a number of special versions of the Hatseal®II have been designed to meet specific Customer demands such as large extrusion gap, or the ability to withstand hardware deflection under load. These designs are still available, but we recommend that they only be specified after a Shamban engineer has been consulted.

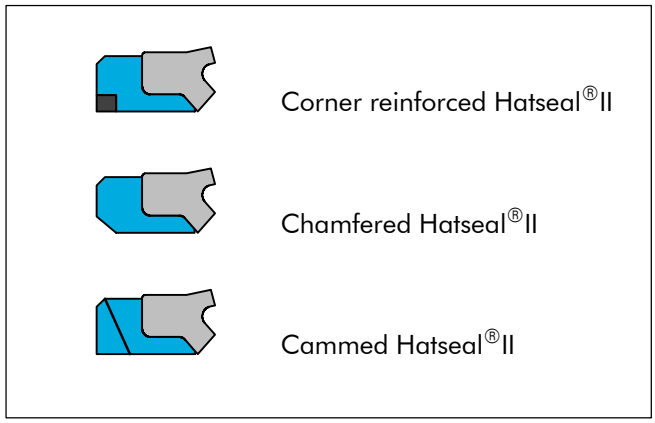


Figure 67 Alternative Hatseal®II Designs

Turcon® T-Seal

Description

The Turcon® T-Seal consists of a T-shaped elastomeric sealing element supported by a Turcon® Back-up Ring on both sides.

The T-Seal is available for zero, one and two Back-up Ring widths and all sizes of rod and piston glands as per MIL-G-5514F/AS4716.

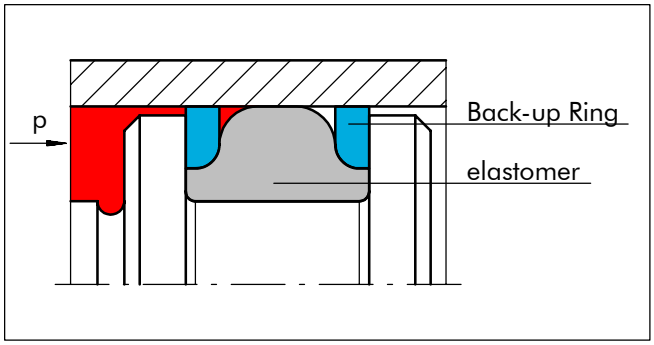


Figure 68 Turcon® T-Seal

Method of Operation

The T-Seal utilizes an optimally designed elastomer component to maximize leakage control while offering excellent extrusion protection in a symmetric design.

The large elastomer footprint makes the T-Seal a good static seal. The one and two Back-up Ring widths offer especially good protection against extrusion.

Although the T-Seal is satisfactory in light duty dynamic applications, the Wedgpak® design is preferred for more demanding dynamic applications. Ask for test report R1059.

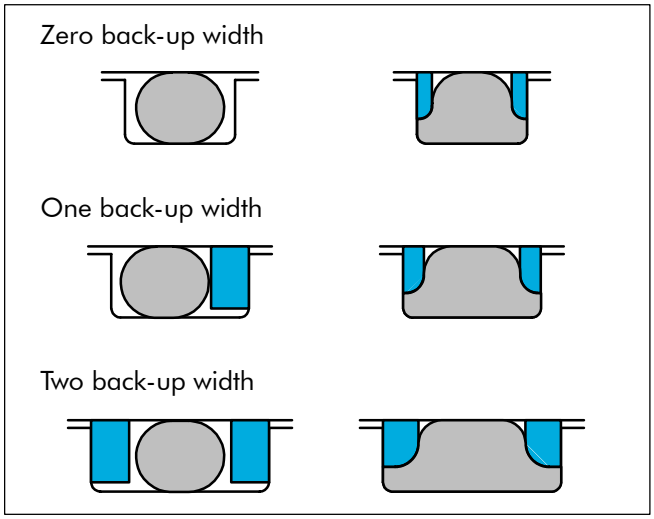


Figure 69 Comparison Between T-Seal and O-Ring with Back-up Rings

Advantages

- Good static sealing effect
- Cost-effective
- Available for all sizes of MIL-G-5514F/AS4716
- Approved for a large number of National Stock Numbers
- Provides bi-directional sealing

Technical Data

Operating pressure:	35 MPa (5000 psi) static 21 MPa (3000 psi) dynamic
Speed:	1 m/s (3.3ft/s)
Temperature range:	-54°C to +200°C (-65°F to +390°F) (depending on elastomer material)
Clearance:	As per MIL-G-5514F/AS4716
Media:	Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), Phosphate Ester, water and others, depending on the elastomer material (see Table IV, page 16)

Materials

See Table I, page 12 and Table III, page 15.

Series

The T-Seal follows the series as described in MIL-G-5514F/AS4716. We recommend that the guidelines for static and dynamic sizes be followed to ensure a good service life for the seal.

For more information on the T-Seal in non-standard sizes, please contact your Shamban sales engineer.

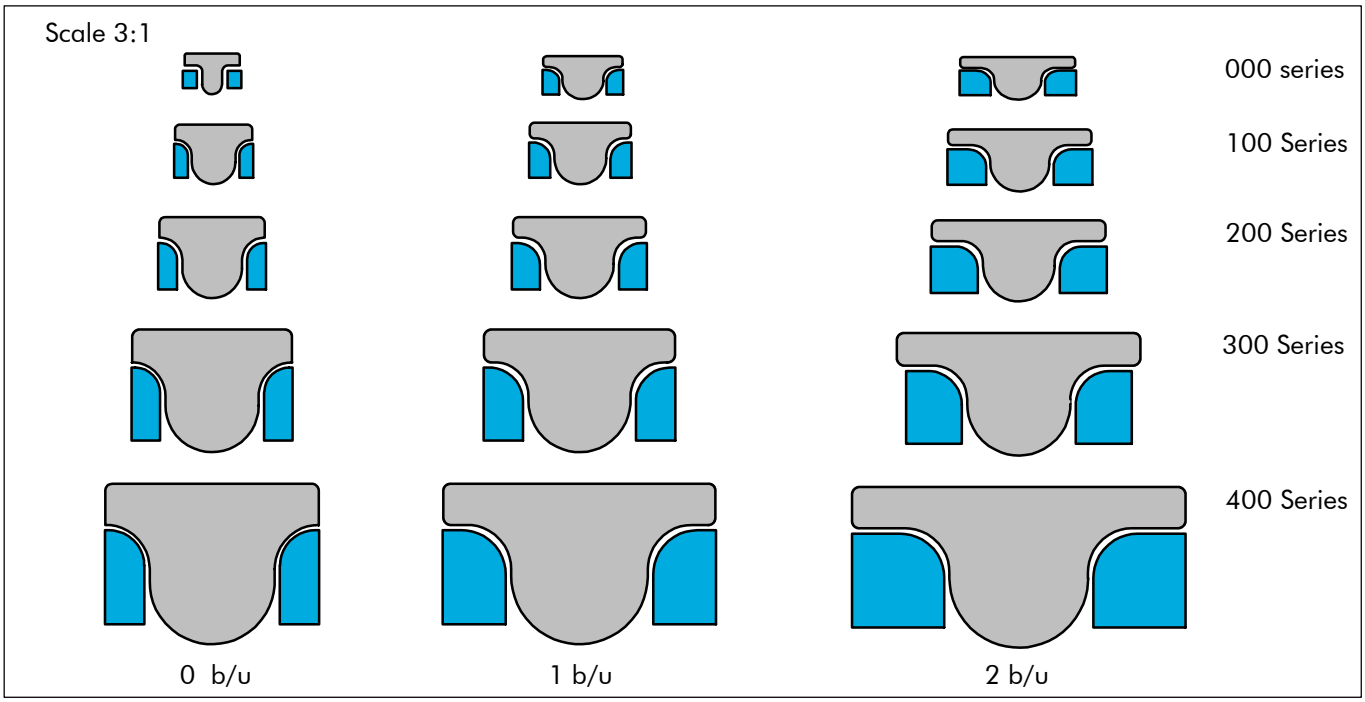
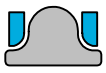
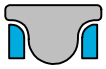


Figure 70 Relationship Between the Profile Cross-Sections

Table XXII T-Seal Types

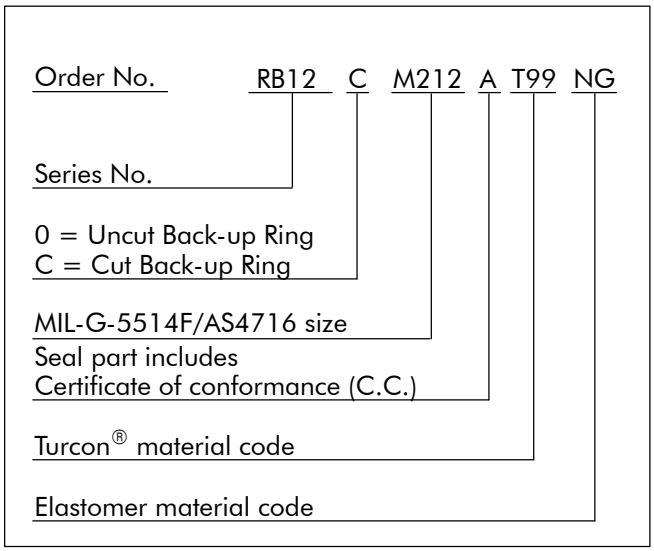
Seal Type	Groove Type: MIL-G-5514F/ AS4716				Comments
	Width			Dia. Size Range Standard dash size	
	0 b/u	1 b/u	2 b/u		
Piston T-Seal 	PB20 (S38420)	PB21 (S38421)	PB22 (S38422)	006 to 460	Good static sealing effect. Wedgpak® preferred for all dynamic applications.
Rod T-Seal 	RB10 (S38410)	RB11 (338411)	RB12 (S38412)	005 to 460	Good static sealing effect. Wedgpak® preferred for all dynamic applications.

Ordering Example

T-Seal 2 b/u width,
Series No. RB12 from Table XXII, page 63

Dash No: 210

Material: T99, see Table I, page 12



Note! For small installation in closed grooves with rod/piston diameter smaller than 18 mm (3/4 inch), we recommend cut Back-up Rings. This is specified by adding "C" in the 5th character of the part no.
Example: PB21**C**M212AT99NG.

T-Seal References

- F/A-18 - NLG shock strut
- F/A-18 - Nose wheel steering actuator
- F/A-18 - Horizontal stabilizer actuator
- F-16 - MLG strut
- F-16 - Integrated servoactuator
- F-16 - Rudder actuator
- F-15 - Ratio changer actuator
- F-15 - Yaw ratio controller
- UH60 - Tail rotor actuator
- B737/B757 - Main and nose landing gear

Turcon® AQ-Seal®5* (For use in MIL-Standard Grooves)

Description

The Turcon® AQ-Seal®5 is a patented development of the proven standard AQ-Seal®.

The AQ-Seal®5 is a double-acting piston seal designed for reciprocating or helical movements.

The AQ-Seal®5 is comprised of a dynamic sealing element in Turcon® with a limited footprint elastomeric QUAD-RING®1) Seal inset centrally into its sealing face. The seal ring is energized by two elastomeric O-Rings.

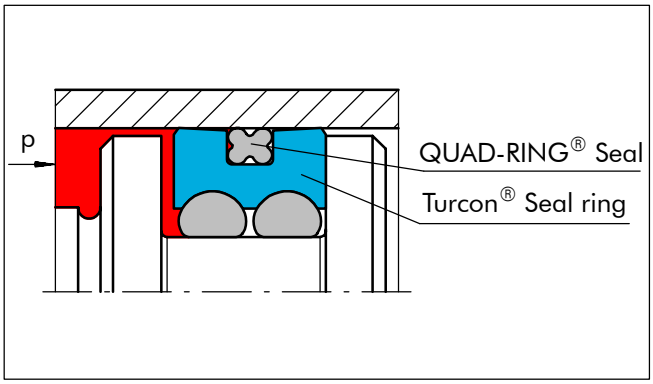


Figure 71 Turcon® AQ-Seal®5

Method of Operation

The AQ-Seal®5 combines the benefits of a low-friction Turcon® slipper seal with the high sealing characteristics of an elastomeric seal by incorporating a limited foot print QUAD-RING® Seal in the dynamic sealing face. This optimizes leakage control while minimizing friction.

The unique characteristics of the AQ-Seal®5 are the special seal profile with a defined seal edge and the use of two O-Rings as energizing elements to optimize the pressure profile.

Diametral Clearance

The AQ-Seal®5 can be installed in MIL-G-5514 F/AS4716 (-300 and -400 sizes only) glands using the standard diametral clearance. If a larger clearance is needed or if the hardware deflects excessively during operation, the diametral clearance will increase. In this case we recommend the use of Slydring® bearing rings with the AQ-Seal®5. Please see section "Turcite® Slydring®/Luytex® Slydring®", page 114.

* Patent-No. EP 0 424 372

1) Reg. trade mark of Minnesota rubber

Advantages

- High sealing effect in applications requiring media separation, e.g. fluid/fluid or fluid/gas
- Double security through the combination of low-friction special materials with elastomer seals
- Low gas permeation rate
- Higher pressure application limit, higher sliding speed compared to the T-Seal
- Outstanding sliding properties, no stick-slip effect
- Designed for zero back-up ring width groove

Technical Data

Operating pressure: 35 MPa (5000 psi)

Speed:	up to 3.0 m/s (9.8 ft/s) with reciprocating movements
Temperature range:	-54°C to +200°C (-65°F to +390°F) (depending on elastomer material)
Clearance:	As per MIL-G-5514F/AS4716, higher with Stakbaks®
Media:	For all common hydraulic fluids, including bio-oils and gases (see Table IV, page 16)

Materials

See Table I, page 12 and Table III, page 15.

Series

The AQ-Seal®5 follows the 300 and 400 Series described in the MIL-G-5514F/AS4716.

For more information on the AQ-Seal®5 in non-standard sizes, please contact your Shamban sales engineer.

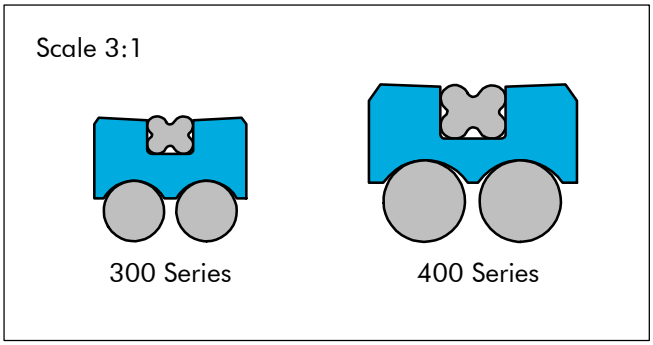


Figure 72 Relationship Between the Profile Cross-Section

Application Example

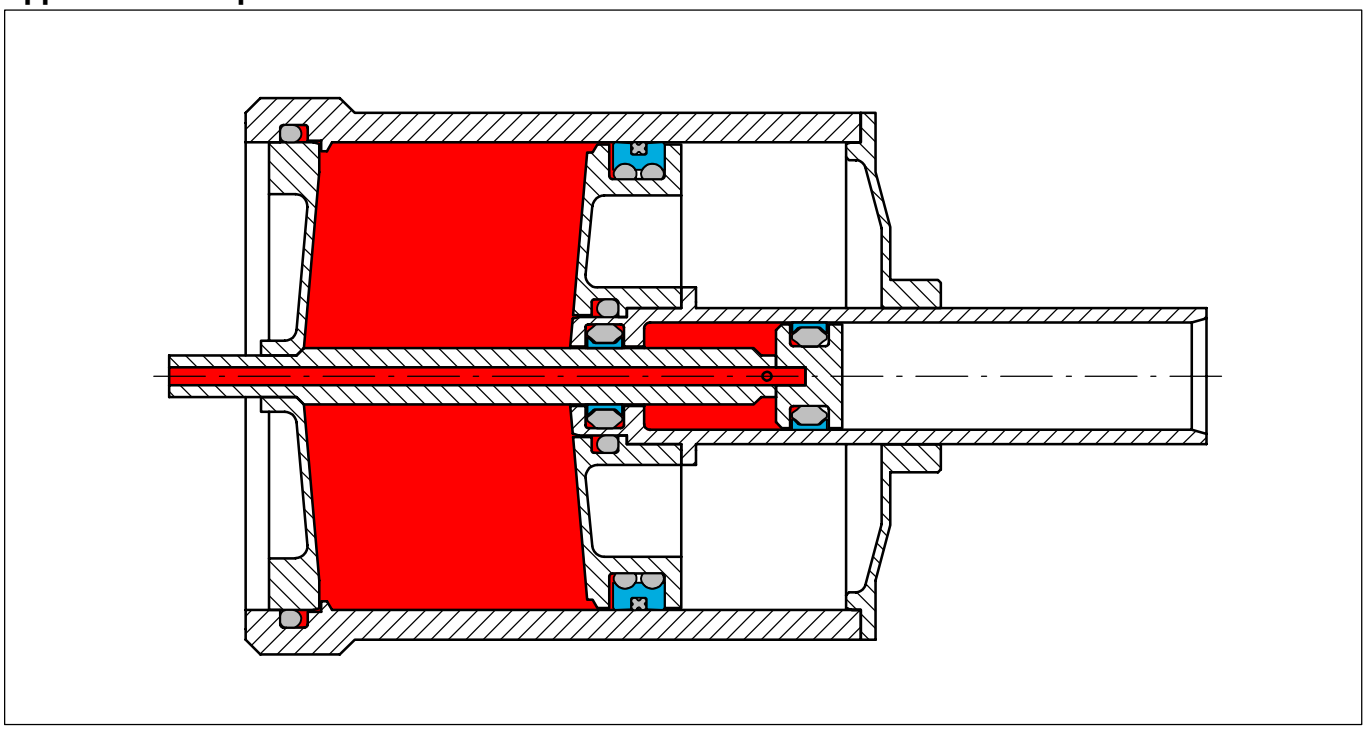


Figure 73 Bootstrap Reservoir with Turcon® AQ-Seal®5

Case Story

The AQ-Seal®5 is used in the Jetstream 31 propeller pitch adjuster mechanism with the following working conditions:

Temperature:	-50°C to +120°C (-58°F to +248°F)
Pressure:	0.35 MPa to 5.5 MPa (50 to 800 psi)
Fluid:	MIL-L-23699C
Service life:	7500 hours

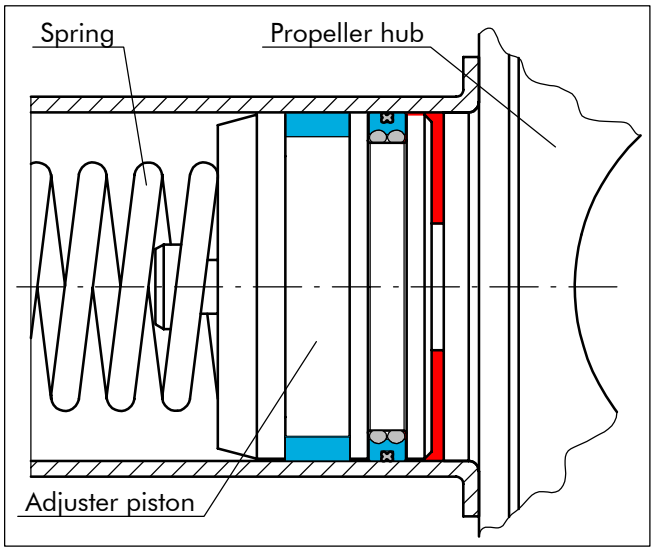


Figure 74 Jetstream 31 Propellers
(by courtesy of Dowty Aerospace Propellers)

Ordering Example

AQ-Seal®5,
Series No. PQ20 (Old Series No. S38620)

Dash No: 330

Material: T99 (standard), see Table I, Page 12

Order No. PQ20 0 M330 A T99 NG

- PQ20 — Series No.
- 0 — Standard
- M330 — MIL-G-5514F/AS4716 size
- A — Seal part includes Certificate of conformance (C.C.)
- T99 — Turcon® material code
- NG — Elastomer material code for QUAD-RING®

Note: O-Ring must be ordered seperately. Sizes can be found in Table XXIII, page 67.

Installation AQ-Seal®5, Series No. PQ20 (Old Series No. S38620)

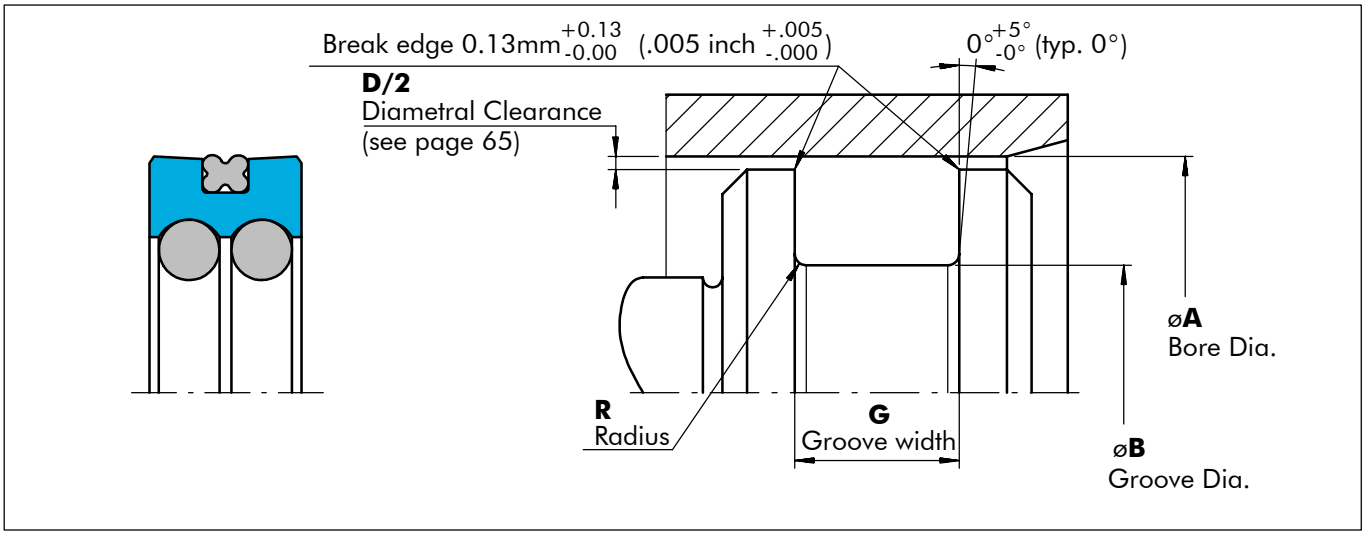


Figure 75 Installation Drawing

Table XXIII Groove Dimensions

Dash No	øA Bore Dia. Inch +0.002 -0.000	øA Bore Dia. mm +0.05 -0.00	øB Groove Dia. Inch +0.000 -0.002	øB Groove Dia. mm +0.00 -0.05	G Inch / mm	R Inch / mm	O-Ring Dash No AS 568 A	QUAD-RING® Dash No AS 568 A
325	1.867	47.42	1.495	37.97			128	031
326	1.992	50.60	1.620	41.15			130	032
327	2.118	53.80	1.746	44.35			132	033
328	2.243	56.97	1.871	47.52			133	034
329	2.368	60.15	1.996	50.70			135	035
330	2.493	63.32	2.121	53.87			137	036
331	2.618	66.50	2.246	57.05			139	037
332	2.743	69.67	2.371	60.22			141	038
333	2.868	72.85	2.496	63.40			143	039
334	2.993	76.02	2.621	66.57	.281 | .291	.020 | .035	145	040
335	3.118	79.20	2.746	69.75			147	041
336	3.243	82.37	2.871	72.92			149	041
337	3.368	85.55	2.996	76.10			151	042
338	3.493	88.72	3.121	79.27	7.14 | 7.39	0.51 | 0.89	151	042
339	3.618	91.90	3.246	82.45			152	043
340	3.743	95.07	3.371	85.62			152	043
341	3.868	98.25	3.496	88.80			153	044
342	3.993	101.42	3.621	91.97			153	044
343	4.118	104.60	3.746	95.15			154	045
344	4.243	107.77	3.871	98.32			154	045
345	4.368	110.95	3.996	101.50			155	046
346	4.493	114.12	4.121	104.67			155	046
347	4.619	117.32	4.246	107.85			156	047
348	4.743	120.47	4.371	111.02			156	047
349	4.868	123.65	4.496	114.20			157	048
	+0.002 -0.000	+0.05 -0.00	+0.000 -0.002	+0.00 -0.05	.375 | .385			
425	4.974	126.34	4.497	114.22			245	158
426	5.099	129.51	4.622	117.40			246	158
427	5.224	132.69	4.747	120.57			247	159
428	5.349	135.86	4.872	123.75	9.53 | 9.78		248	159
429	5.474	139.04	4.997	126.92			249	160
430	5.599	142.21	5.122	130.10			250	160

Dash No	øA Bore Dia. Inch +0.002 -0.000	øA Bore Dia. mm +0.05 -0.00	øB Groove Dia. Inch +0.000 -0.002	øB Groove Dia. mm +0.00 -0.05	G Inch / mm	R Inch / mm	O-Ring Dash No AS 568 A	QUAD-RING® Dash No AS 568 A
431	5.724	145.39	5.247	133.27			251	161
432	5.849	148.56	5.372	136.45			252	161
433	5.974	151.74	5.497	139.62			253	162
434	6.099	154.91	5.622	142.80			254	162
435	6.224	158.09	5.747	145.97			255	163
436	6.349	161.26	5.872	149.15			256	163
437	6.474	164.44	5.997	152.32			257	164
438	6.724	170.79	6.247	158.67			259	165
439	6.974	177.14	6.497	165.02	.375 | .385	.020 | .035	259	166
440	7.224	183.49	6.747	171.37			260	167
441	7.474	189.84	6.997	177.72			261	168
442	7.724	196.19	7.247	184.07			262	169
443	7.974	202.54	7.497	190.42			263	170
444	8.224	208.89	7.747	196.77	9.53 | 9.78	0.51 | 0.89	264	171
445	8.474	215.24	7.997	203.12			265	172
446	8.974	227.94	8.497	215.82			267	174
	+0.002 -0.000	+0.05 -0.00	+0.000 -0.002	+0.00 -0.05				
447	9.474	240.64	8.997	228.52			269	176
448	9.974	253.34	9.497	241.22			271	178
449	10.474	266.04	9.997	253.92			273	179
450	10.974	278.74	10.497	266.62			275	180
451	11.474	291.44	10.997	279.32			276	181
452	11.974	304.14	11.497	292.02			277	182
453	12.474	316.84	11.997	304.72			278	183
454	12.974	329.54	12.497	317.42			278	184
455	13.474	342.24	12.997	330.12			279	185
456	13.974	354.94	13.497	342.82			279	186
457	14.474	367.64	13.997	355.52			280	187
458	14.974	380.34	14.497	368.22			280	188
459	15.474	393.04	14.997	380.92			281	189
460	15.974	405.74	15.497	393.62			281	190

Metric sizes.

■ Turcon® Variseal®

Design Concept

Variseal® is a spring-energized seal. The Variseal® performs reliably in a wide range of applications where conventional elastomeric seals fail due to chemical attack, extreme heat or cold, extrusion, friction or compression set. The basic Variseal® design has two elements:

1. A pressure-actuated, "U-shaped" jacket.
2. A metal spring.

The U-shaped jacket allows the system pressure to energize the sealing lips, forcing them against the mating hardware with higher load as the system pressure rises.

The Variseal® is machined to very close tolerances, using only premium-grade materials. Each design is available in imperial and metric dimensions. The standard size range includes diameters from 3 mm (0.12 in) to 2500*) mm (8 ft).

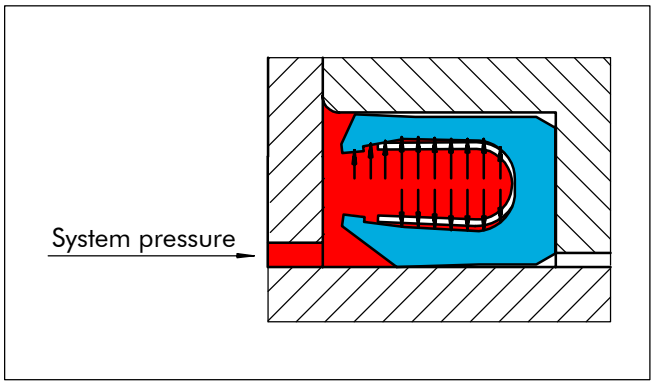


Figure 76 Turcon® Variseal® Energized by the System Pressure

Spring Load

The Variseal® is energized by a spring made from stainless steel, Hastelloy®, or Elgiloy®. The spring provides the load required for sealing when the system pressure is too low to fully actuate the lips. The spring also compensates for variations in gland tolerances and normal wear of the seal. As a seal loading device, a metal spring is more accurate for the control of friction than other devices, such as O-Rings.

See Spring Types, Table XXIV, page 70 for spring selection.

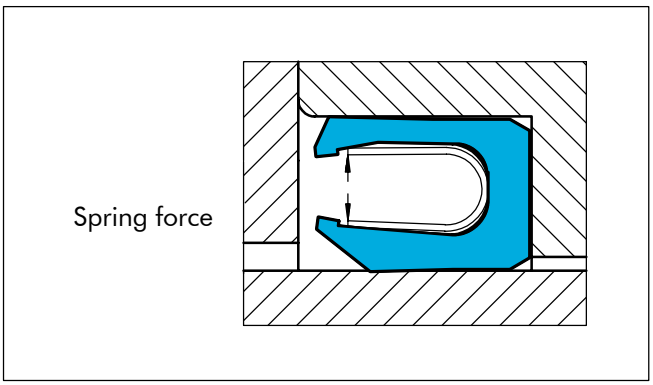


Figure 77 Spring Force

Jacket Material

Variseal® jackets are made from a variety of high-performance polymers. There are two categories of material available:

1. **Turcon®** Engineered-polymer compounds, based on low-friction Turcon® resins, are found in the majority of Variseal® applications.
2. **Zurcon®** Compounds have outstanding abrasion-resistance.

See Turcon® and Zurcon® Seal Materials, pages 12 and 13 for material selection.

High Performance

The unique design and material properties of the Variseal® provide design engineers with an assortment of solutions for difficult applications. Some of the outstanding capabilities of the Variseal® include:

- Very low friction.
- High speed service.
- Universal chemical compatibility.
- Cryogenic service to -273°C (-459.67°F).
- High-temperature service to +260°C (+500°F). Higher peak temperatures are possible.
- Permanent elasticity with immunity to aging, embrittlement and compression set.
- No lubrication required.

*) with extended size capability available.

Spring Types

A metal spring is incorporated in the design to provide elasticity to the seal. The spring makes the seal permanently elastic despite changes in operating temperature, pressure or chemicals. Each of the spring types found in the Variseal® has unique properties that affect seal performance. The two most important properties of the spring - besides the corrosion resistance of the metal - are its load value and deflection range. The spring load has influence on the sealing ability, friction, and wear rate of the seal. The deflection range determines the ability of the Variseal® to take up wear and compensate for variations in gland dimensions due to hardware tolerances or eccentricity.

V-Spring (Cantilever)

This spring, used in the Variseal®M types and the Roto Variseal®, operates as a set of "cantilever beams" extending from an arc at the bottom of the spring. The shape of the spring causes the load to be focused on the front edge of the sealing lip, contributing to the positive wiping action of the seal. A Cantilever-beam spring has a moderate load and deflection range.

Helical Spring

Helical spring, used in the Variseal®H types, has a much higher unit load and a shorter deflection range than the other spring types. It is therefore excellent for static applications or very slow speeds where friction and wear are not the primary concerns. The high spring load makes the Variseal®H suitable for applications with low temperatures. Under these conditions the 200 Series or larger is prefered.

Slantcoil® Spring

The patented Slantcoil® Spring, used in the Variseal®W, types consists of round wire formed into slanted coils. The coils load the seal radially.
The Slantcoil® Spring provides a unique spring-loading characteristic. The spring gives a relatively constant load over a wide deflection range. This allows more accurate control of friction during the working life of the seal.

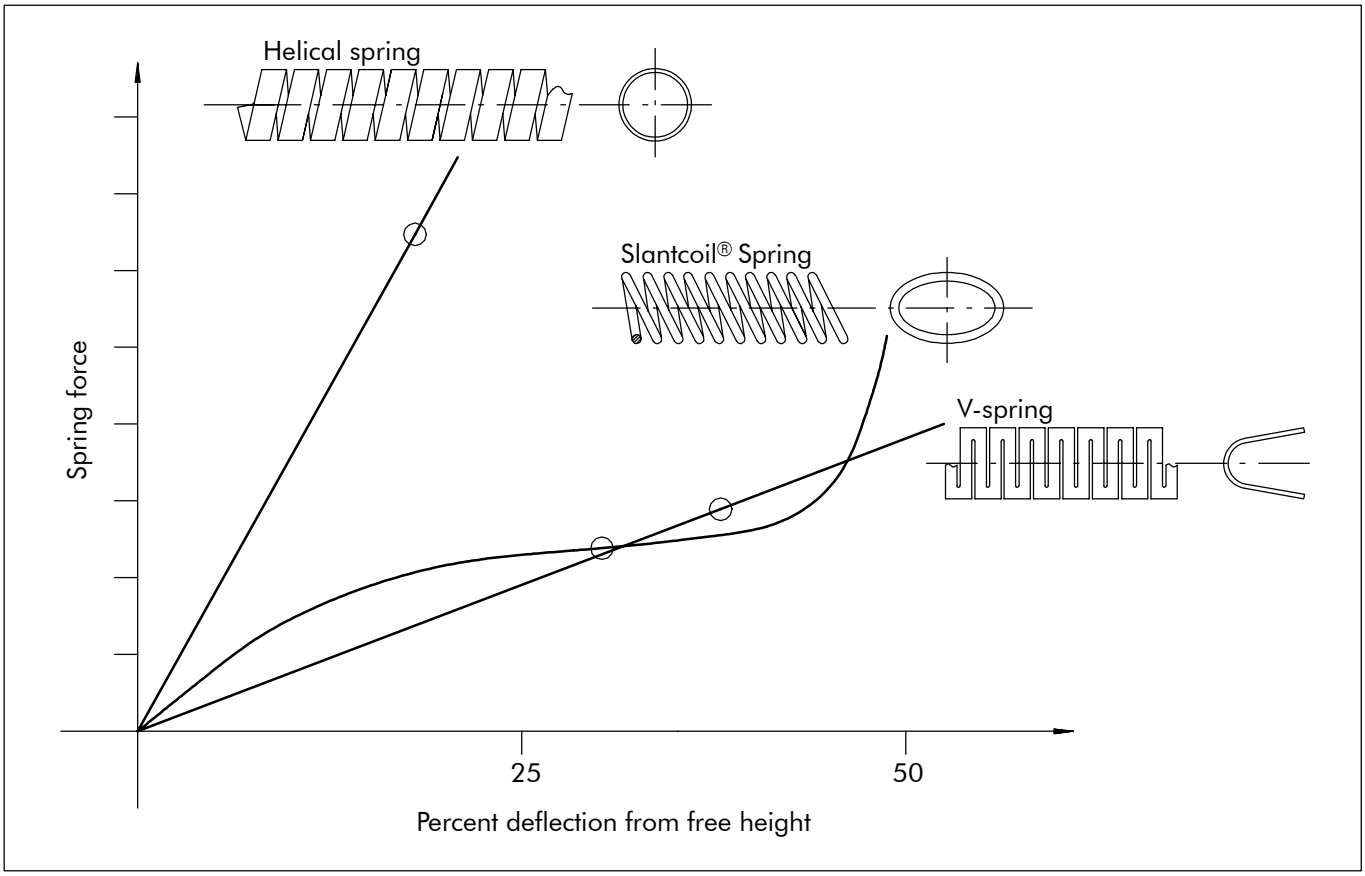


Figure 78 The Graph Represents a General Comparison of Load Curves for the Three Spring Types. The "O" Indicates the Load Point when Installed in the Gland.

The 3 standard spring types can be found in the following table:

Table XXIV Spring Material Selection Guide

Media	Spring Materials	Spring Code
For general use with: Oil Grease Air Water, Steam Solvents Food, Drugs Gas	**Stainless steel** DIN mat. No. 1.4310 (X12CrNi177) AISI 301	**S**
For use in corrosive media with: Acids Caustics Sea water	**Hastelloy® alloy C-276** Ni-Cr-Mo alloy DIN mat. No. 2.4819 UNS N10276	**H**
For petrochemical use with: Crude oil Sour gas	**Elgiloy® 1) 2)** Co-Ni alloy UNSR30003	**E**

1) NACE - approved

2) Not available as Slantcoil® spring

Hastelloy® is a registered Trade Mark of Cabot Corporation
Elgiloy® is a registered Trade Mark of Elgiloy Company

Special Turcon® Variseal®Hi-Clean

All Variseal® with V-shaped springs are available with the spring groove filled with silicone.
The silicone prevents entrapment of biological contaminants in the seal, making the seal easier to clean.

The Variseal®Hi-Clean is also used in applications working in dirty environment such as mud, slurry or sand where the silicone maintains the flexibility of the spring and seal lips by keeping media out of the spring groove.

Variseal®Hi-Clean is ordered by adding a (D) after the material code.

Example:
RVC200350AT40SD

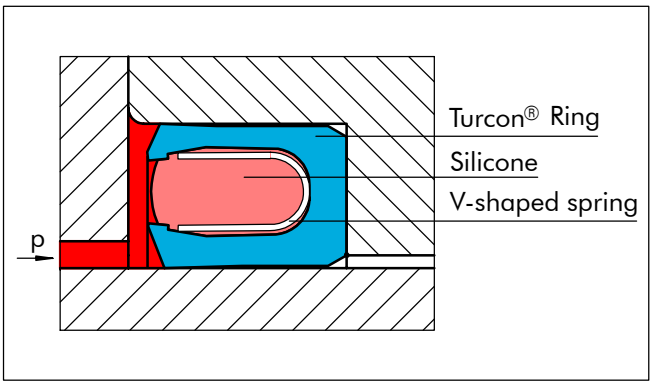
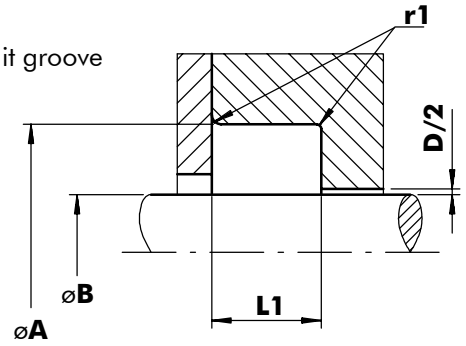


Figure 79 Turcon® Variseal®Hi-Clean

Installation Recommendations for Rod, MIL-G-5514F/AS4716 Sizes
Types M14, W14 and H14



For installation in stepped groove see page 76

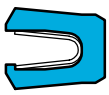
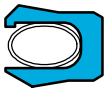
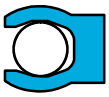
Type	M14	W14	H14
Cross section			
Series No.	RV93	RV95	RV91

Figure 80 Installation Drawing

Table XXV Groove Dimensions

Series	Rod Diameter øB h9		Groove Diameter[2]	Groove Width	Radius	Radial Clearance[3] D/2 max.			
	Standard Range	Extended[1] Range	øA H9	L_1 +.010	r_1	<2 MPa (300 psi)	<10 MPa (1500 psi)	<20 MPa (2900 psi)	<40 MPa (5800 psi)
000	.123 - 1.373	.123 - 3.997	øB + .112	.094	.010	.008	.004	.003	.002
100	.373 - 2.811	.185 - 5.497	øB + .178	.141	.015	.010	.006	.004	.003
200	.748 - 4.622	.248 - 8.997	øB + .244	.188	.015	.014	.008	.006	.003
300	1.498 - 4.497	.873 - 10.497	øB + .370	.281	.015	.020	.010	.008	.004
400	4.497 - 15.497	1.498 - 15.497	øB + .478	.375	.020	.024	.012	.010	.005

[1] Available on request
[2] By diameters larger than "Recommended Range": The tolerance on øB and øA is changed from h9/H9 to h8/H8
[3] For temperatures ≥ 80°C (176°F) we recommend reducing the radial clearance. At pressures **> 40 MPa (5800 psi)**: D/2 max. use H8/h8.
In both cases we recommend that you contact your local Shamban representative.

Ordering Example

Turcon® Variseal®H, Series RV91.
Rod diameter: øB = 1.623 (MIL-G-5514F-326)
Part No: RV910M326

Select the materials from Table I, page 12 and Table XXIV, page 70. The corresponding code numbers are appended to the Part No. Together these form the order number.

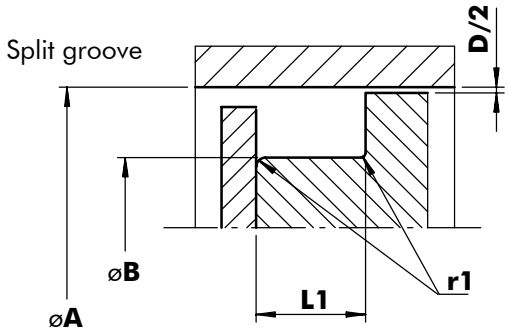
The order number for all intermediate sizes not shown in Table XXV can be determined following the example opposite.

Note that the series or cross section of the seal is automatically given by the sizes suitable for the selected dash number of MIL-G-5514F-326.

Order No. RV91 0 M326 A T40 S (D)

- RV91 — Series No.
- 0 — Standard
- M326 — MIL-G-5514F/AS4716 size
- A — Seal part includes Certificate of conformance (C.C.)
- T40 — Material Code - Turcon® Ring
- S — Material Code - spring
- (D) — Hi-Clean - option

Installation Recommendations for Bore, MIL-G-5514F/AS4716 Sizes
Types M14, W14 and H14



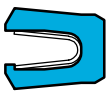
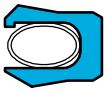
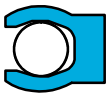
Type	M14	W14	H14
Cross section			
Series No.	PV93	PV95	PV91

Figure 81 Installation Drawing

Table XXVI Groove Dimensions

Series	Bore Diameter øA H9		Groove Diameter[2]	Groove Width	Radius	Radial Clearance[3] D/2 max.			
	Standard Range	Extended[1] Range	øB h9	L_1 +.010	r_1	<2 MPa (300 psi)	<10 MPa (1500 psi)	<20 MPa (2900 psi)	<40 MPa (5800 psi)
000	.235 - 1.491	.235 - 4.118	øA - .112	.094	.010	.008	.004	.003	.002
100	.550 - 2.993	.360 - 5.680	øA - .178	.141	.015	.010	.006	.004	.003
200	.991 - 4.868	.485 - 9.243	øA - .244	.188	.015	.014	.008	.006	.003
300	1.867 - 4.868	1.241 - 10.868	øA - .370	.281	.015	.020	.010	.008	.004
400	4.974 - 15.974	1.974 - 15.974	øA - .478	.375	.020	.024	.012	.010	.005

1) Available on request
2) By diameters larger than "Recommended Range": The tolerance on øA and øB is changed from h9/H9 to h8/H8
3) At pressures **> 40 MPa (5800 psi)**: D/2 max. use H8/h8. We recommend that you contact your local Shamban sales engineer.

Ordering Example

Turcon® Variseal®M, Series PV93.
Bore diameter: øA = 1.366 (MIL-G-5514F-216)
Part No: PV930M216

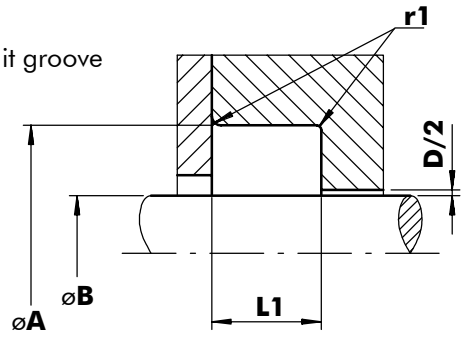
Select the materials from Table I, page 12 and Table XXIV, page 70. The corresponding code numbers are appended to the Part No. Together these form the order number.
The order number for all intermediate sizes not shown in Table XXVI can be determined following the example opposite.

Note that the series or cross section of the seal is automatically following the sizes suitable for the selected dash number of MIL-G-5514/AS4716.

Order No. PV93 0 M216 A T40 S (D)

- PV93 — Series No.
- 0 — Standard
- M216 — MIL-G-5514F/AS4716 size
- A — Seal part includes Certificate of conformance (C.C.)
- T40 — Material Code - Turcon® Ring
- S — Material Code - spring
- (D) — Hi-Clean - option

Installation Recommendations for Rod, Metric Sizes
Types M2, W and H



For installation in stepped groove see page 76

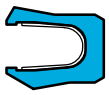
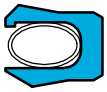
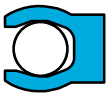
Type	M2	W	H
Cross section			
Series No.	RVA	RVW	RVE

Figure 82 Installation Drawing

Table XXVII Groove Dimensions

Series	Series No.			Rod Diameter øB h9		Groove Diameter	Groove Width	Radius	Radial Clearance[3] D/2 max.			
	M2	W	H	Standard Range	Extended[1] Range	øA H9	L_1 +0.2	r_1	<2 MPa (300 psi)	<10 MPa (1500 psi)	<21 MPa (3000 psi)	<40 MPa (5800 psi)
000	RVA0	RVW0	RVE0	3.0 - 9.9	3.0 - 40.0	øB + 2.9	2.4	0.4	0.20	0.10	0.08	0.05
100	RVA1	RVW1	RVE1	10.0 - 19.9	6.0 - 200.0[2]	øB + 4.5	3.6	0.4	0.25	0.15	0.10	0.07
200	RVA2	RVW2	RVE2	20.0 - 39.9	10.0 - 400.0[2]	øB + 6.2	4.8	0.6	0.35	0.20	0.15	0.08
300	RVA3	RVW3	RVE3	40.0 - 119.9	20.0 - 700.0[2]	øB + 9.4	7.1	0.8	0.50	0.25	0.20	0.10
400	RVA4	RVW4	RVE4	120.0 - 999.9	35.0 - 999.9[2]	øB + 12.2	9.5	0.8	0.60	0.30	0.25	0.12
500	-	-	RVE5	1000.0 - 2500.9	80.0 -2500.0[2]	øB + 19.0	15.0	0.8	0.90	0.50	0.40	0.20

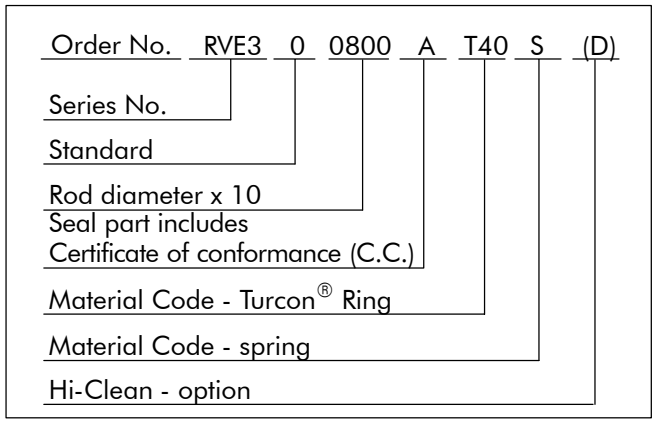
[1] Available on request
[2] By diameters larger than "Recommended Range": The tolerance on øB and øA is changed from h9/H9 to h8/H8
[3] For temperatures ≥ 80°C (176°F) we recommend reducing the radial clearance. At pressures **> 40 MPa (5800 psi)**: D/2 max. use H8/h8. In both cases we recommend that you contact your local Shamban representative.

Ordering Example

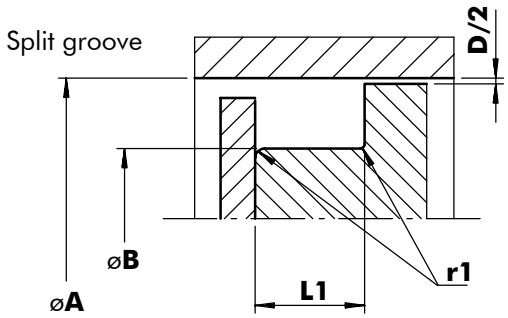
Turcon® Variseal®H, Series RVE3.
Rod diameter: øB = 80.0 mm (3.150 in)
Part No: RVE300800

Select the materials from Table I, page 12 and Table XXIV, page 70. The corresponding code numbers are appended to the Part No. Together these form the order number.

The order number for all intermediate sizes not shown in Table XXVII can be determined by following the example shown opposite here.



Installation Recommendations for Bore, Metric Sizes
Types M2, W and H



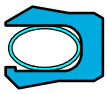
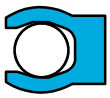
Type	M2	W	H
Cross section			
Series No.	PVA	PVW	PVE

Figure 83 Installation Drawing

Table XXVIII Groove Dimensions

Series	Series No.			Bore Diameter øA H9		Groove Dia.	Groove Width	Radius	Radial Clearance[3] D/2 max.*			
	M2	W	H	Recommended Range	Extended[1] Range	øB h9	L_1 +0.2	r_1	<2 MPa (300 psi)	<10 MPa (1500 psi)	<21 MPa (3000 psi)	<40 MPa (5800 psi)
000	PVA0	PVW0	PVE0	6.0 - 13.9	6.0 - 40.0	øA - 2.9	2.4	0.4	0.20	0.10	0.08	0.05
100	PVA1	PVW1	PVE1	14.0 - 24.9	10.0 -200.0[2]	øA - 4.5	3.6	0.4	0.25	0.15	0.10	0.07
200	PVA2	PVW2	PVE2	25.0 - 45.9	16.0 -400.0[2]	øA - 6.2	4.8	0.6	0.35	0.20	0.15	0.08
300	PVA3	PVW3	PVE3	46.0 -124.9	28.0 -700.0[2]	øA - 9.4	7.1	0.8	0.50	0.25	0.20	0.10
400	PVA4	PVW4	PVE4	125.0 -999.9	45.0 -999.9[2]	øA - 12.2	9.5	0.8	0.60	0.30	0.25	0.12
500	-	-	PVE5	1000.0 -2500.0	100.0 -2500.0[2]	øA - 19.0	15.0	0.8	0.90	0.50	0.40	0.20

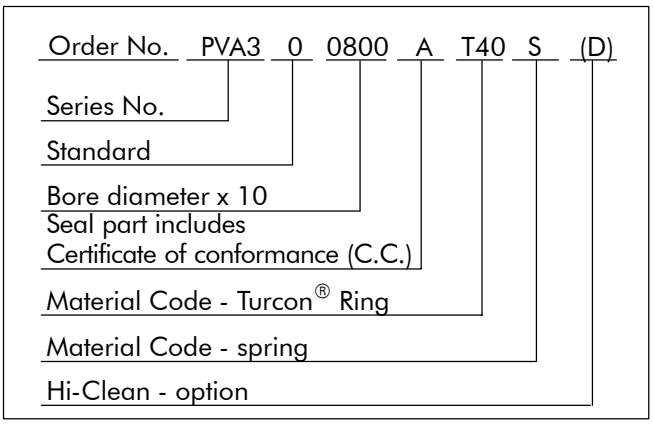
[1] Available on request
[2] By diameters larger than "Recommended Range":The tolerance on øA and øB is changed from h9/H9 to h8/H8

[3] For temperatures ≥ 80°C (176°F) we recommend reducing the radial clearance. At pressures **> 40 MPa (5800 psi)**: D/2 max. use H8/h8. In both cases we recommend that you contact your local Shamban representative.

Ordering Example

Turcon® Variseal®M2, Series PVA3.
Bore diameter: øA = 80.0 mm (3.150 in)
Part No: PVA300800

Select the materials from Table I, page 12 and Table XXIV, page 70. The corresponding code numbers are appended to the Part No. Together these form the order number.
The order number for all intermediate sizes not shown in Table XXVIII can be determined by following the example shown opposite here.



Installation in Closed Grooves

Installation in split or lipped grooves is recommended. Installation in closed grooves is possible for rod and bore diameters according to the following tables.

Rod Seals

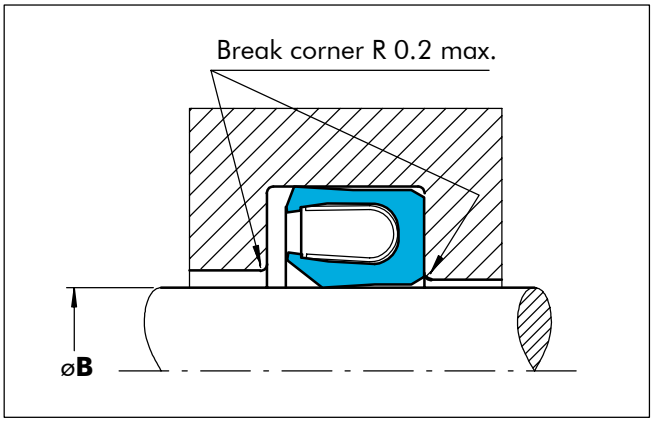


Figure 84 Installation in Closed Groove

Piston Seals

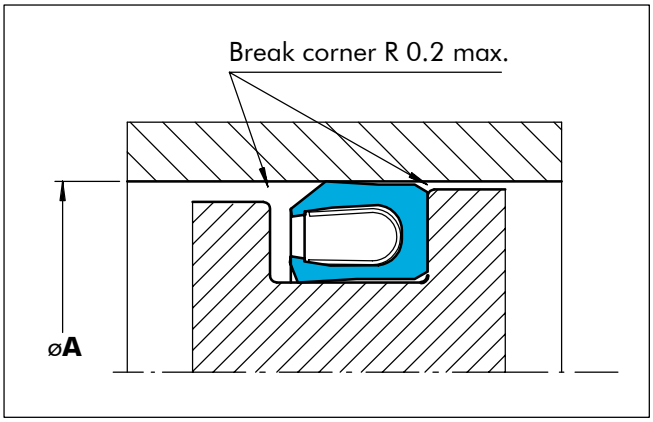


Figure 85 Installation in Closed Groove

Table XXIX Installation of Variseal®M Types into Closed Grooves

Series No. Rod Seals		øBmin.	øBmin.
		Inch	mm
000	RVA0	1.250	30.0
100	RVA1	2.750	70.0
200	RVA2	4.375	110.0
300	RVA3	11.750	300.0
400	RVA4	19.500	500.0

Table XXXI Installation of Variseal®M Types into Closed Grooves

Series No. Piston Seals		øAmin.	øAmin.
		Inch	mm
000	PVA0	1.375	35.0
100	PVA1	2.000	50.0
200	PVA2	2.750	70.0
300	PVA3	4.125	105.0
400	PVA4	5.500	140.0

Table XXX Installation of Variseal®H and Variseal®W Types into Closed Grooves

Series No. Rod Seals		øBmin.	øBmin.
		Inch	mm
000	RVE0 and RVW0	1.000	30.0
100	RVE1 and RVW1	2.500	70.0
200	RVE2 and RVW2	4.250	110.0
300	RVE3 and RVW3	9.000	230.0
400	RVE4 and RVW4	15.250	400.0
500	RVE5	27.560	700.0

Metric sizes.

Table XXXII Installation of Variseal®H and Variseal®W Types into Closed Grooves

Series No. Piston Seals		øAmin.	øAmin.
		Inch	mm
000	PVE0 and PVW0	.750	20.0
100	PVE1 and PVW1	1.125	35.0
200	PVE2 and PVW2	1.750	48.0
300	PVE3 and PVW3	2.375	75.0
400	PVE4 and PVW4	3.750	95.0
500	PVE5	11.800	300.0

Installation in Stepped Grooves

Rod Seals

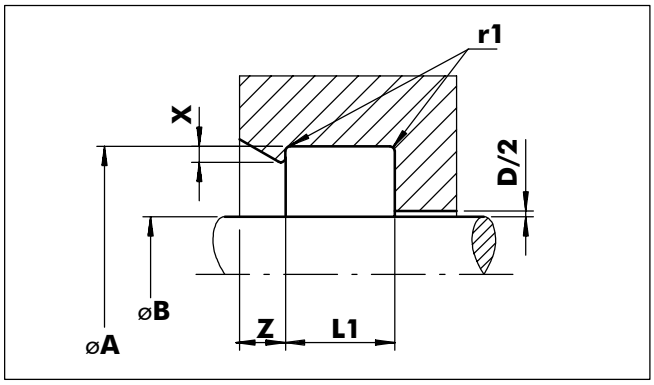


Figure 86 Stepped Grooves, Rod

Piston Seals

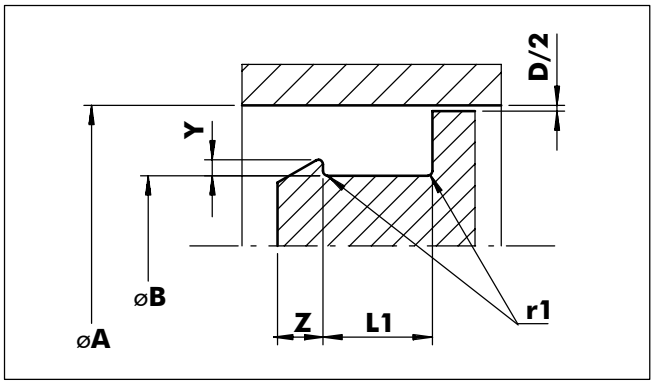


Figure 87 Stepped Grooves, Piston

Table XXXIII Groove Dimensions, Inch Sizes

Series	Lip X	Max. Radius	Min. Chamfer Z	Min. Seal ID
000	.008/.012	.005	.098	.250
100	.010/.015	.005	.138	.375
200	.015/.020	.007	.138	.750
300	.017/.023	.010	.177	1.000
400	.022/.028	.010	.295	2.000

Table XXXV Groove Dimensions, Inch Sizes

Series	Lip Y	Max. Radius	Min. Chamfer Z	Min. Seal ID
000	.008/.012	.005	.098	.375
100	.010/.015	.005	.138	.562
200	.015/.020	.007	.138	1.000
300	.017/.023	.010	.177	1.375
400	.022/.028	.010	.295	2.500

Table XXXIV Groove Dimensions, mm Sizes

Series	Rod Seal Types			Lip Height	Chamfer Length	Radius max.
	M2	W	H	X[1)]	Zmin	r1
000	RVA0	RVW0	RVE0	0.4	2.5	0.4
100	RVA1	RVW1	RVE1	0.6	3.5	0.4
200	RVA2	RVW2	RVE2	0.7	3.5	0.6
300	RVA3	RVW3	RVE3	0.8	4.5	0.8
400	RVA4	RVW4	RVE4	0.9	7.5	0.8
500	-	-	RVE5	1.5	7.5	0.8

[1)] X max = 0.02 x øB

Table XXXVI Groove Dimensions, mm Sizes

Series	Piston Seal Types			Lip Height	Chamfer Length	Radius max.
	M2	W	H	Y[1)]	Zmin	r1
000	PVA0	PVW0	PVE0	0.4	2.5	0.4
100	PVA1	PVW1	PVE1	0.6	3.5	0.4
200	PVA2	PVW2	PVE2	0.7	3.5	0.6
300	PVA3	PVW3	PVE3	0.8	4.5	0.8
400	PVA4	PVW4	PVE4	0.9	7.5	0.8
500	-	-	PVE5	1.5	7.5	0.8

[1)] Y max = 0.035 x øA

Note: The recommended dimensions for "Y", "X" and "Z" cannot always be achieved. Please contact your Shamban sales engineer.

Special Turcon® Variseal®

Turcon® Variseal® with extended heel

All Variseal® are available in extended heel versions to fit a one Back-up Ring groove.

The Variseal® with an extended heel is often used in high pressure applications, or when the extrusion gap is slightly larger than recommended.

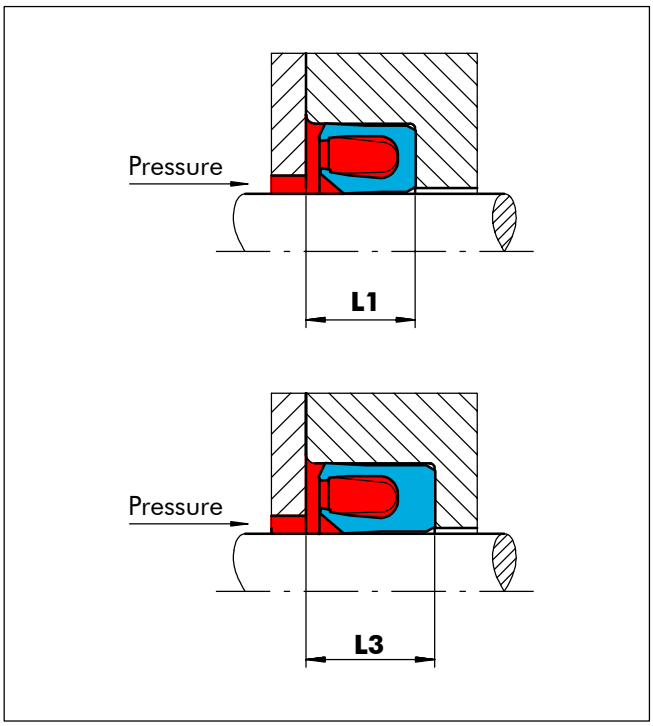


Figure 88 Standard Turcon® Variseal® and Turcon® Variseal® with Extended Heel

Table XXXVII Groove Width

Series No.	Groove Width	
	L1	L3
000	.094	.149
100	.141	.183
200	.188	.235
300	.281	.334
400	.375	.475

Groove width for standard (L1) and for 1 Back-up Ring groove (L3) according to MIL-G-5514F/AS4716.

It is possible to order Variseal® with extended heel by using the standard part number, but change the third character as shown in table XXXVIII.

Table XXXVIII Part Numbers

Variseal® Type	Standard Rod/Piston	Extended Heel Rod/Piston
Variseal® M2	RVA/PVA	RVB/PVB
Variseal® H	RVE/PVE	RVF/PVF
Variseal® W	RVW/PVW	RVX/PVX

Case Story

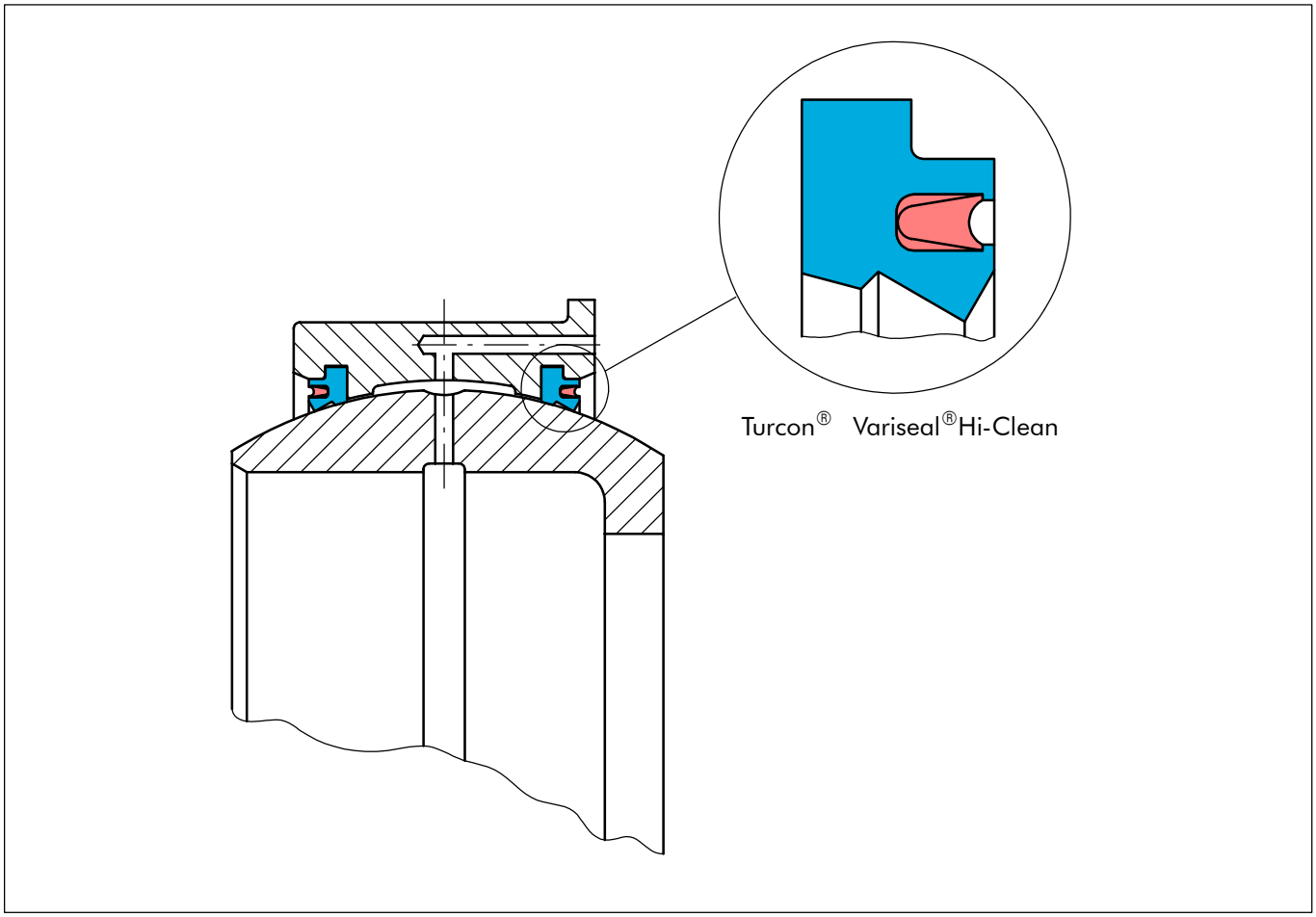


Figure 89 Wing Gear Aft Trunnion Bearing, Boeing 747

Problem

B747 operators have experienced migration of Boeing Scraper from the spherical bearing gland.

Boeing requested that Shamban provides improvement to existing scraper design.

Solution

Shamban Variseal®Hi-Clean.

Turcon® Variseal® Scraper easier to install than existing seal.

Notches allow grease to relieve if overpressured during servicing.

Scraper lip energized by cantilever spring.

Boeing approved Shamban as preferred scraper option.

Turcon® Back-up Ring (BUR)

Description

Shamban developed the Turcon® BUR as an improvement to the original leather rings. Military standards were set up for spiral ring type, scarfcut (single turn type) and solid ring (uncut type). The BUR is a rectangular size cross section ring, installed for seal extrusion protection.

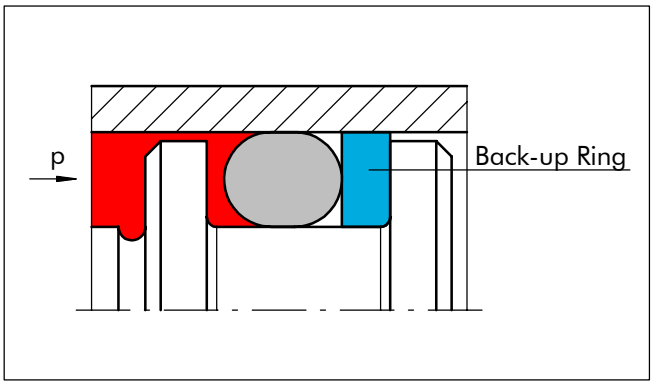


Figure 90 Turcon® Back-up Ring

Method of Operation

The BUR is installed between the O-Ring and the groove wall, separating the O-Ring from the clearance gap.

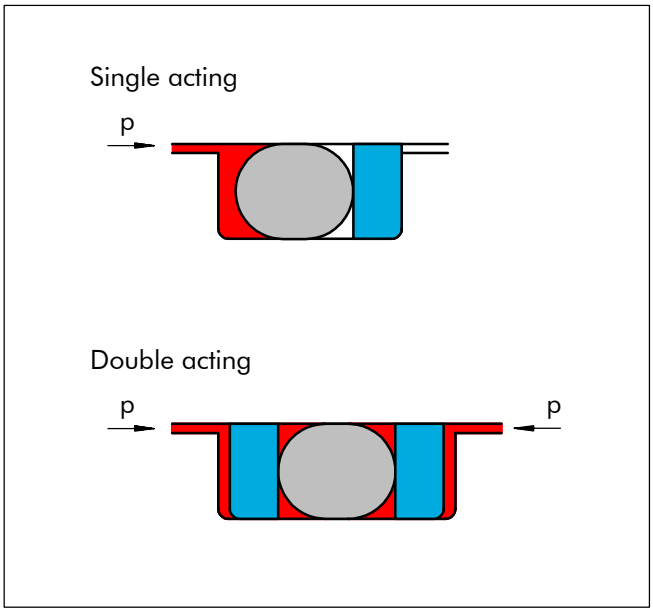


Figure 91 Single Acting Compared to Double Acting Sealing System

Advantages

- Extrusion protection
- Extending seal life
- Low cost

Technical Data

Operating pressure:	21 Mpa (3000 psi) Standard design (Turcon® T01) 35 MPa (5000 psi) Standard design Turcon® with fillers 55 MPa (8000 psi) special version (Stakbaks).
Speed:	15 m/s (49.2 ft/s)
Temperature range:	-70°C to +200°C (-94°F to +390°F)
Clearance:	As per MIL-G-5514F/AS4716
Media:	Practically all fluids, chemicals and gases

Materials

Standard material for Back-up Ring is Turcon® T01, Virgin PTFE. Back-up Rings are available in stronger materials in order to cope with specific applications, e.g. high pressure > 35 MPa (5000 psi).

Please contact your Shamban sales engineer for further information.

Series

The BUR follows the series described in MIL-G-5514F/ AS4716. We recommend that the guidelines for static and dynamic sizes be followed to ensure a good service life.

For further information on the Back-up Rings in non-standard diameter sizes, please contact your Shamban sales engineer.

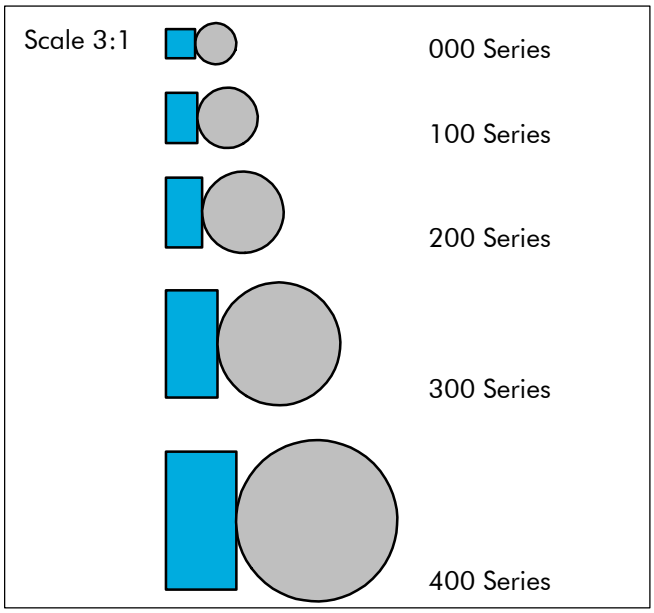


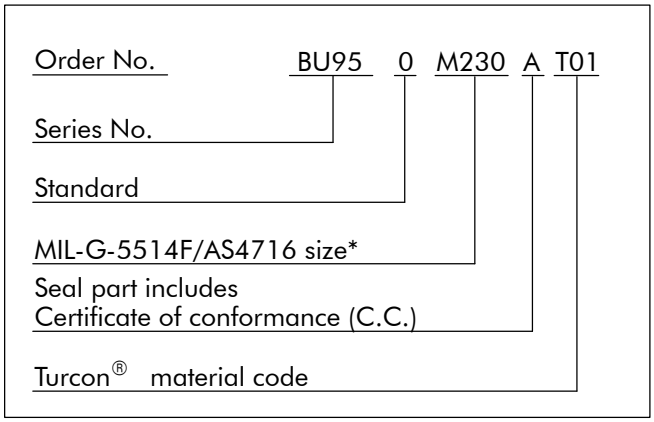
Figure 92 Relationship Between the Profile Cross-Section

Ordering Example

Back-up Ring, solid ring.
Series No. BU95 from Table XLI, page 81.

Dash No: 230

Material: T01 (standard)



Note: O-Ring must be ordered separately.

Regarding AS4716 Back-up rings, see page 81

Guidelines for gap, pressure and size

Back-up Rings must be used if the pressure in Tables XXXIX and XL are exceeded.

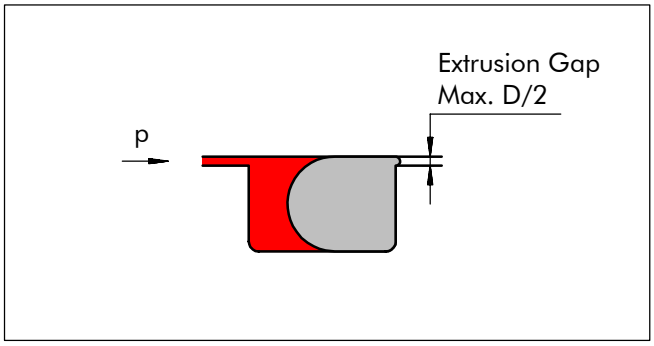


Figure 93 Extrusion Gap

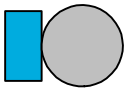
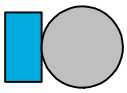
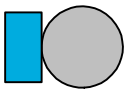
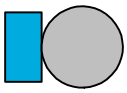
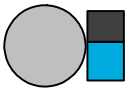
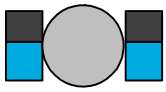
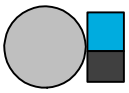
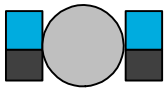
Table XXXIX Extrusion gap size D for 70 Shore Hardness

Series	O-Ring Cross section mm inch	Extrusion Gap D mm inch		
		3.5 MPa (500 psi)	7 MPa (1000 psi)	10.5 MPa (1500 psi)
000	1.78 0.070	0.15 0.006	0.10 0.004	0.05 0.002
100	2.62 0.103	0.18 0.007	0.13 0.005	0.08 0.003
200	3.53 0.139	0.20 0.008	0.15 0.006	0.10 0.004
300	5.33 0.210	0.25 0.010	0.18 0.007	0.13 0.005
400	7.00 0.276	0.30 0.012	0.20 0.008	0.15 0.006

Table XL Extrusion gap size D for 80 Shore Hardness

Series	O-Ring Cross section mm inch	Extrusion Gap D mm inch				
		3.5 MPa (500 psi)	7 MPa (1000 psi)	10.5 MPa (1500 psi)	14 MPa (2000 psi)	17.5 MPa (2500 psi)
000	1.78 0.070	0.20 0.008	0.15 0.006	0.10 0.004	0.05 0.002	0.03 0.001
100	2.62 0.103	0.25 0.010	0.18 0.007	0.13 0.005	0.08 0.003	0.04 0.002
200	3.53 0.139	0.30 0.012	0.20 0.008	0.15 0.006	0.10 0.004	0.05 0.002
300	5.33 0.210	0.35 0.014	0.25 0.010	0.18 0.007	0.13 0.005	0.06 0.002
400	7.00 0.276	0.40 0.016	0.30 0.012	0.20 0.008	0.15 0.006	0.07 0.003

Table XLI Turcon® Back-up Ring Types

Back-up Ring	Groove Type: MIL-G-5514F / AS4716			Comments
Type	Part No.	Gland Standard	Dia. Size Range Std. dash size	
Cut Back-up Ring 	BG91 (MIL-R-8791/1)	MIL-G-5514F/ AS4716 (ID/OD)	004 to 460	Former MS28774, now called MIL-R-8791/1 and for future AMS.
Uncut Back-up Ring 	BU95 (MS27595)	MIL-G-5514F/ AS4716 (ID/OD)	004 to 460	The MS27595 will have a future designation as AMS.
Cut Back-up Ring 	BG440G (S38544) BG450G (S38545)	AS4716 (ID) AS4716 (OD)	004 to 460	New gland standard AS 4716, designed to fit individual groove dimension. Note ID/OD differences.
Uncut Back-up Ring 	BU190G (S38619) BU180G (S38618)	AS4716 (ID) AS4716 (OD)	004 to 460	New gland standard AS 4716, designed to fit individual groove dimension. Note ID/OD differences.
Stakbak® (Static Seal, Piston) 	BG41 (S37241)	MIL-G-5514F/ AS4716	020 to 460	For greater extrusion resistance and increased gap. For use in 1 b/u gland
Stakbak® (Static Seal, Piston) 	BG61 (S37261) BG42 (S37242)	MIL-G-5514F/ AS4716	020 to 460	For greater extrusion resistance and increased gap. BG61: For 1 b/u groove width only BG42: For 2 b/u groove width only
Stakbak® (Static Seal, Rod) 	BG51 (S37251)	MIL-G-5514F/ AS4716	020 to 460	For greater extrusion resistance and increased gap. For use in 1 b/u gland
Stakbak® (Static Seal, Rod) 	BG71 (S37271) BG52 (S37252)	MIL-G-5514F AS4716	020 to 460	For greater extrusion resistance and increased gap. BG71: For 1 b/u groove width only BG52: For 2 b/u groove width only

Turcon® Dual Piston Ring

Description

The Dual Piston Ring Set consists of two Turcon® rings each with a step-cut. These rings are activated by a wave shaped stainless steel expander. On the inside of the Turcon® rings there is a small notch into which a tab on the spring fits. This prevents the rings from rotating relative to each other. When installed correctly the step-cuts of the two rings will be separated by 180°.

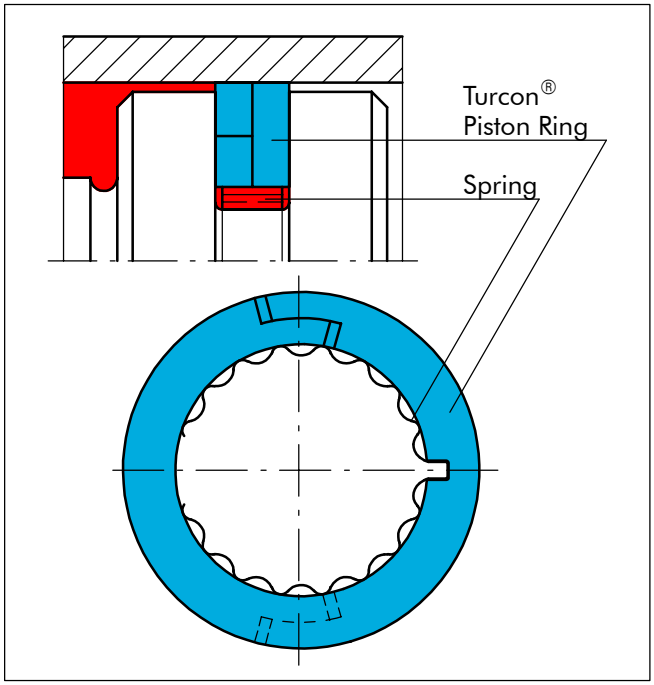


Figure 94 Turcon® Dual Piston Ring Set

Method of Operation

With zero or low system pressure, the two piston rings are kept in contact with the bore by the spring force. As the pressure increases it will act on the side and inner diameter of the rings forcing them up against the bore.

The tolerances on the groove width and the width of the rings are very tight which means that the Dual Piston Ring can be made to fit the groove closely. This results in a seal that reacts to pressure changes very quickly, a feature that is used to the full extent in modern fly-by-wire flight controls where minimum hysteresis is important.

The narrow seal design provides a low friction in comparison to seals in a MIL-G-5514F/AS4716 groove width. The use of metallic expanders allows for a broader temperature range and improves the chemical resistance of the assembly.

Advantages

- Very low friction
- Wide temperature range
- Narrow groove
- Controlled leakage
- Excellent chemical resistance
- Low hysteresis
- MIL-G-5514F/AS4716 diameters from -112 and up

Technical Data

Operating pressure:	35 MPa (5000 psi) standard design For higher pressures, special versions are available
Speed:	15.0 m/s (49.2 ft/s)
Temperature range:	-70°C to +260°C (-94°F to +500°F) Extended temp. capability with special Dual Piston Ring
Clearance:	See Table XLII, page 83
Media:	Practically all fluids, chemicals and gases (See Table IV, page 16)

Note: At high temperature and pressure, speed must be reduced. Consult your Shamban sales engineer.

Materials

See Table I, page 12 and Table III, page 15.
Turcon® T05 is standard material.

Materials, Spring

The standard spring material PH is 17-7 PH Stainless steel condition CH900. This will also be supplied if the spring code is omitted. Other available materials are:

CC	17-7 PH condition C
SS	301 per AMS 5519 full hard

Installation Turcon® Dual Piston Ring Set, Series No. PF52 (Old Series No. S32152)

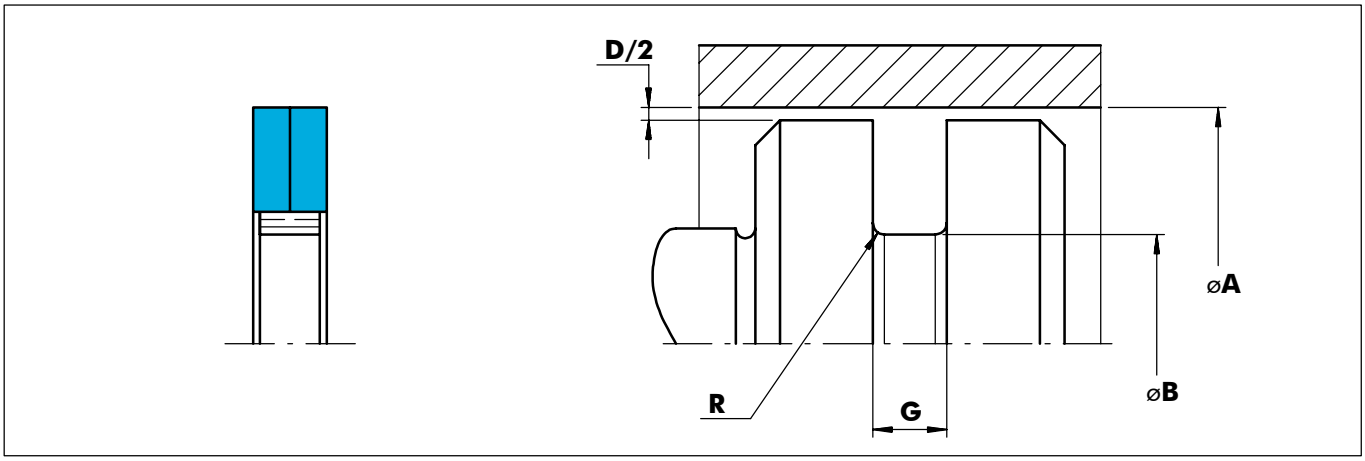


Figure 95 Installation Drawing

Table XLII Groove Dimensions

Dash No	øA Bore Dia. Inch +0.002 -0.000	øA Bore Dia. mm +0.05 -0.00	øB Groove Dia. Inch ±0.004	øB Groove Dia. mm ±0.10	G Inch / mm	R Inch / mm	D Max. Inch / mm
112	0.675	17.15	0.429	10.90			
113	0.738	18.75	0.428	10.87			
114	0.800	20.32	0.490	12.45			
115	0.863	21.92	0.553	14.05			
116	0.925	23.50	0.615	15.62			
210	0.991	25.17	0.681	17.30			
211	1.053	26.75	0.743	18.87			
212	1.116	28.35	0.806	20.47			
213	1.178	29.92	0.868	22.05			
214	1.241	31.52	0.931	23.65			
215	1.303	33.10	0.993	25.22			
216	1.366	34.70	1.056	26.82			
217	1.428	36.27	0.994	25.25			
218	1.491	37.87	1.057	26.85			
219	1.553	39.45	1.119	28.42			.005
220	1.616	41.05	1.182	30.02	.125 | .127	.010 | .020	0.13
221	1.678	42.62	1.244	31.60			
222	1.741	44.22	1.307	33.20			
325	1.867	47.42	1.433	36.40			
326	1.992	50.60	1.558	39.57			
327	2.118	53.80	1.684	42.77	3.18 | 3.23	0.25 | 0.50	
328	2.243	56.97	1.809	45.95			
329	2.368	60.15	1.934	49.12			
330	2.493	63.32	2.059	52.30			
331	2.618	66.50	2.184	55.47			
332	2.743	69.67	2.309	58.65			
333	2.868	72.85	2.434	61.82			
334	2.993	76.02	2.559	65.00			
335	3.118	79.20	2.684	68.17			.006
336	3.243	82.37	2.809	71.35			
337	3.368	85.55	2.934	74.52			
338	3.493	88.72	3.059	77.70			0.15
339	3.618	91.90	3.184	80.87			
340	3.743	95.07	3.309	84.05			

Dash No	øA Bore Dia. Inch +0.002 -0.000	øA Bore Dia. mm +0.05 -0.00	øB Groove Dia. Inch ±0.004	øB Groove Dia. mm ±0.10	G Inch / mm	R Inch / mm	D Max. Inch / mm
341	3.868	98.25	3.434	87.22			.006
342	3.993	101.42	3.559	90.40	.125 | .127	.010 | .020	0.15
343	4.118	104.60	3.558	90.37			.007
344	4.243	107.77	3.683	93.55			
345	4.368	110.95	3.808	96.72			
346	4.493	114.12	3.933	99.90	3.18 | 3.23	0.25 | 0.50	0.18
347	4.618	117.30	4.058	103.07			
348	4.743	120.47	4.183	106.25			
349	4.868	123.65	4.308	109.42			
	+0.003 -0.000	+0.076 -0.000	±0.004	±0.10			
425	4.974	126.34	4.414	112.12			
426	5.099	129.51	4.539	115.29			
427	5.224	132.69	4.664	118.47			
428	5.349	135.86	4.789	121.64			
429	5.474	139.04	4.914	124.82			
430	5.599	142.21	5.039	127.99			
431	5.724	145.39	5.164	131.17			
432	5.849	148.56	5.289	134.34			
433	5.974	151.74	5.414	137.52	.188 | .190	.010 | .020	
434	6.099	154.91	5.539	140.69			
435	6.224	158.09	5.664	143.87			.008
436	6.349	161.26	5.789	147.04			
437	6.474	164.44	5.914	150.22	4.78 | 4.83	0.25 | 0.50	0.20
438	6.724	170.79	6.164	156.57			
439	6.974	177.14	6.414	162.92			
440	7.224	183.49	6.664	169.27			
441	7.474	189.84	6.914	175.62			
442	7.724	196.19	7.164	181.67			
443	7.974	202.54	7.414	188.32			
444	8.224	208.89	7.664	194.67			
445	8.474	215.24	7.914	201.02			
446	8.974	227.94	8.414	213.72			
447	9.474	240.64	8.914	226.42			

Metric sizes.

Series

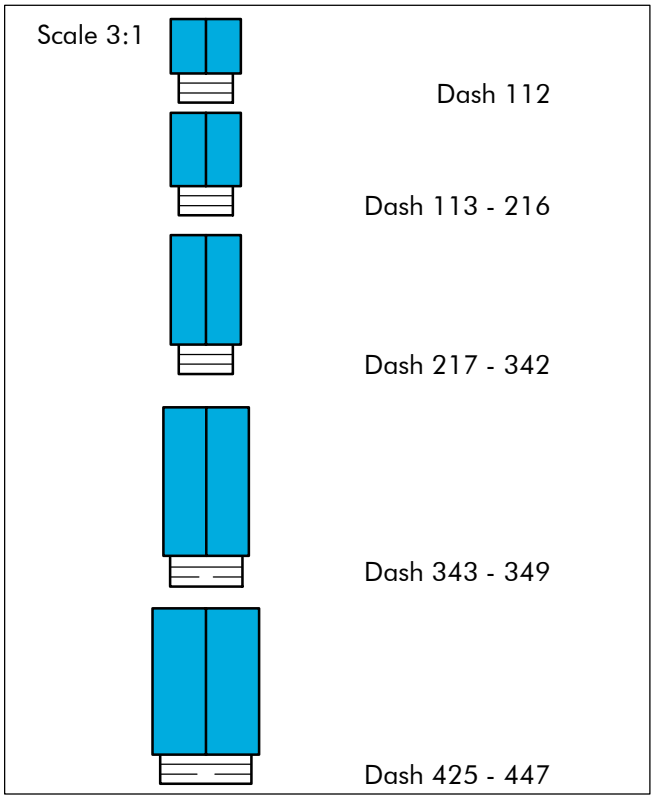


Figure 96 Relationship Between the Profile Cross-Section

Ordering Example

Dual Piston Ring Series No. PF52

Dash No: 214

Material: T05

Order No.	PF52	0	B	214	A	T05	S
	Series No.						
		0 = Standard K = a.r.t. (see note)					
			Groove standard				
				Dash No.			
					Seal part includes Certificate of conformance (C.C.)		
						Turcon® material code	
							Standard Expander material

Note! For demanding dynamic applications an insert can be added to the anti-rotation tab (a.r.t.) to provide greater strength. This option can be ordered by inserting a "K" in the 5th character of the part number.

Application Example

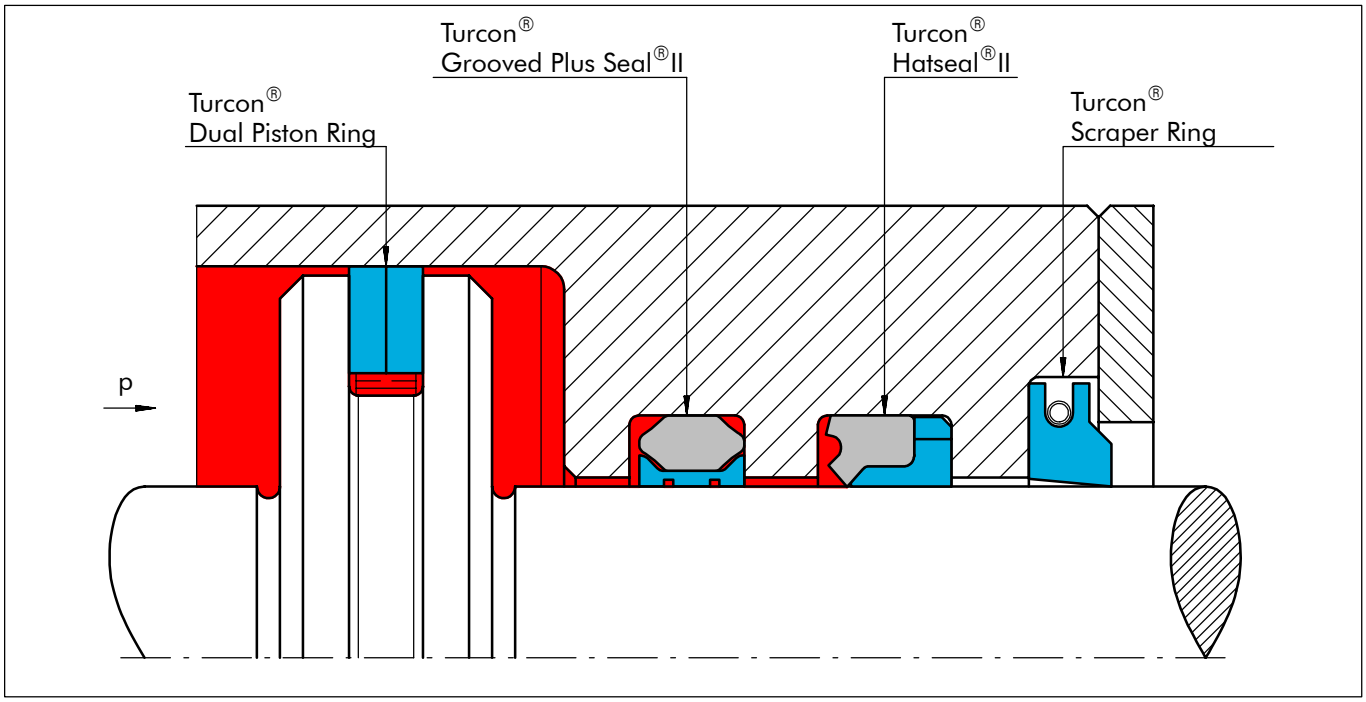


Figure 97 Rudder Actuator (Fly-By-Wire), Airbus A320

Turcon® Glyd Ring® for use with MIL-G-5514F/AS4716 Rod/Bore

Description

The Turcon® Glyd Ring® is a simple and reliable seal consisting of a Turcon® seal cap activated by an O-Ring.

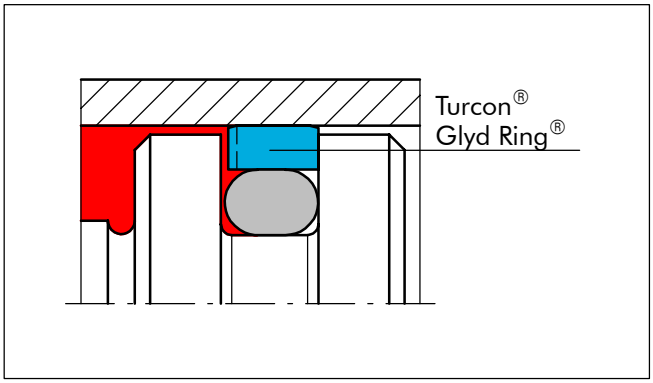


Figure 98 Turcon® Glyd Ring®

Method of Operation

A true slipper seal, the Glyd Ring® relies on the O-Ring energization to provide the sealing force at zero or low pressure. As the pressure increases the Glyd Ring® is energized by the hydraulic pressure and is force against the sealing surface.

The Glyd Ring® is made with a slight interference fit which ensures initial contact with the mating surface.

The geometry of the Glyd Ring® allows the formation of a lubricating hydro-dynamic oil film under the seal in reciprocating applications.

All piston versions of the Glyd Ring® are supplied with notches to prevent blow-by (see also Plus Seal®II, page 50). In the case of rod versions, notches are an option and must be specified in the part number. See page 86 "Option Notches".

Advantages

- Low friction
- Low cost
- Narrow groove
- Design flexibility - adaptable for almost all groove sizes
- Long service life
- High operational reliability
- Stick-slip free operation
- Easy installation
- Available for all diameters

Technical Data

Operating pressure:	35 MPa (5000 psi)
Speed:	up to 15 m/s (49.2 ft/s) with reciprocating movements
Temperature range:	-54°C to +200°C (-65°F to +390°F) (depending on elastomer material)
Clearance:	As indicated on the enclosed data sheets
Media:	Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), Phosphate ester, water and others, depending on the elastomer material (see Table IV, page 16)

Materials

See Table I, page 12 and Table III, page 15.

Series

The Glyd Ring® is designed to mate with standard MIL-G-5514F/AS4716 rod or bore sizes, however the groove dimensions are a Shamban design standard.

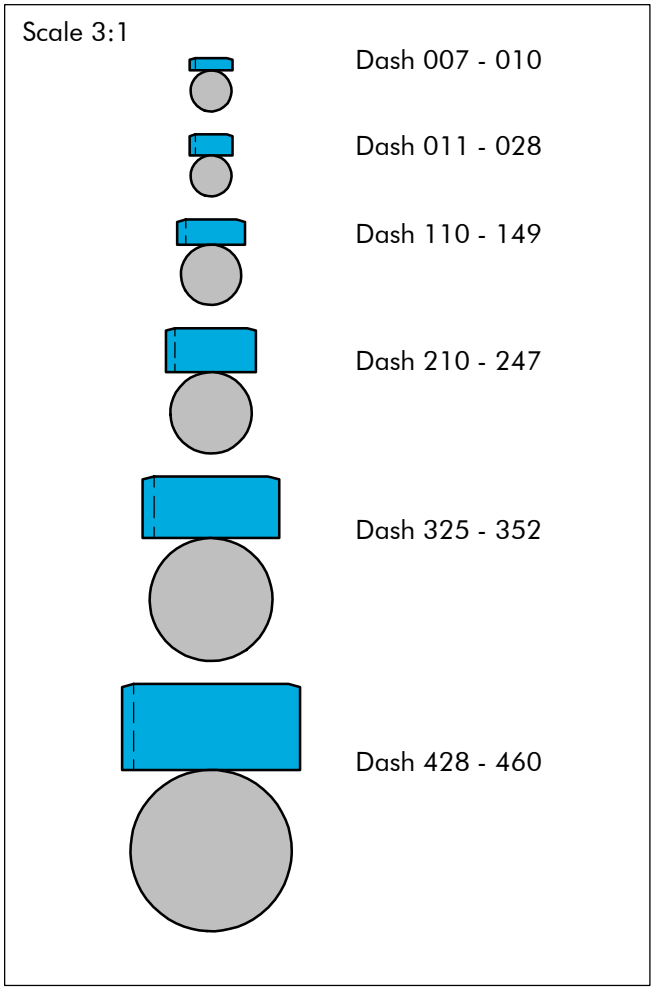


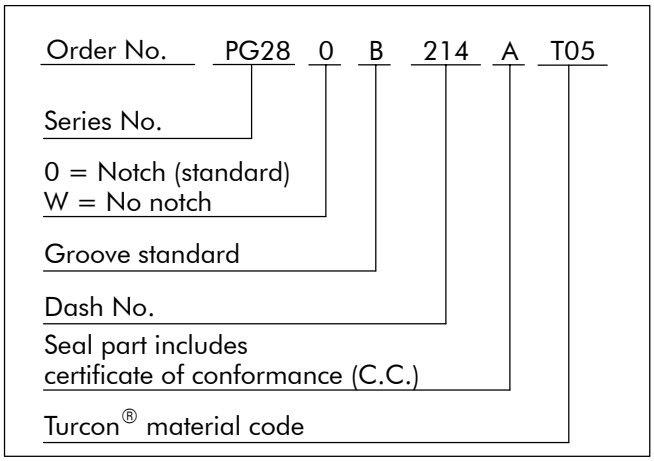
Figure 99 Relationship Between the Profile Cross-Section Series No. PG28 and RG27

Ordering Example

Turcon® Glyd Ring® Series No. PG28 with notch

Dash No: 214

Material: T05 (standard), see Table I, page 12.



Note: O-Rings are ordered separately. Sizes can be found in Table XLIII, page 87 and Table XLIV, page 89.

Option Notches: Piston seals are always delivered as standard with notch. To omit notch, change 5th character to "W". Ex. PG28**W**.
Rod seals are always delivered as standard without notch. To include notch, change 5th character to "N". Ex. RG27**N**

Application Example

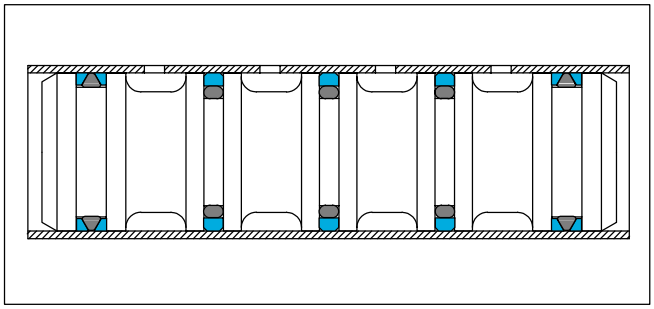


Figure 100 Typical Spool Valve

The Glyd Ring® offers space savings and easy assembly in spool valves.

Installation Turcon® Glyd Ring® Bore, Series No. PG28 (Old Series No. S32928)

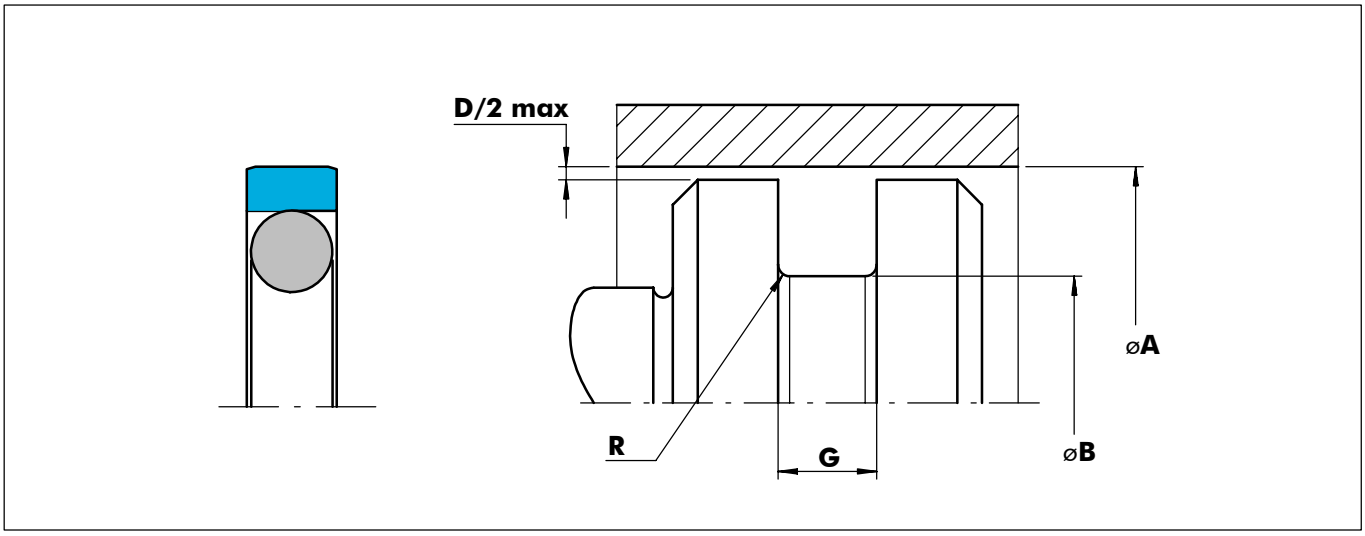


Figure 101 Installation Drawing

Table XLIII Groove Dimensions

Dash No	øA Bore Dia. Inch +0.001 -0.000	øA Bore Dia. mm +0.025 -0.000	øB Groove Dia. Inch +0.000 -0.001	øB Groove Dia. mm +0.000 -0.025	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
007	0.266	6.76	0.124	3.15	.081 | .086	.005 | .015	.004	006
008	0.297	7.54	0.155	3.94				007
009	0.329	8.36	0.187	4.75				008
010	0.360	9.14	0.218	5.54			0.10	009
011	0.422	10.72	0.248	6.30				010
012	0.485	12.32	0.311	7.90				011
	+0.002 -0.000	+0.05 -0.00	+0.000 -0.002	+0.00 -0.05				
013	0.550	13.97	0.376	9.55				012
014	0.613	15.57	0.439	11.15				013
015	0.675	17.15	0.501	12.73				014
016	0.738	18.75	0.564	14.33				015
017	0.800	20.32	0.626	15.90	2.06 | 2.19		.005	016
018	0.863	21.92	0.689	17.50				017
019	0.925	23.50	0.751	19.08		0.13 | 0.38	0.13	018
020	0.991	25.17	0.817	20.75				019
021	1.053	26.75	0.879	22.33				020
022	1.116	28.35	0.942	23.93				021
023	1.178	29.92	1.004	25.50				022
024	1.241	31.52	1.067	27.10				023
025	1.303	33.10	1.129	28.68				024
026	1.366	34.70	1.192	30.28				025
027	1.428	36.27	1.254	31.85				026
028	1.491	37.87	1.317	33.45				027
110	0.550	13.97	0.300	7.62	↓			109
111	0.613	15.57	0.363	9.22				110
112	0.675	17.15	0.425	10.80				111
113	0.738	18.75	0.488	12.40				112
114	0.800	20.32	0.550	13.97				113

Dash No	øA Bore Dia. Inch +0.002 -0.000	øA Bore Dia. mm +0.05 -0.00	øB Groove Dia. Inch +0.000 -0.002	øB Groove Dia. mm +0.00 -0.05	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
115	0.863	21.92	0.613	15.57				114
116	0.925	23.50	0.675	17.15				115
117	0.991	25.17	0.741	18.82				116
118	1.053	26.75	0.803	20.40				117
119	1.116	28.35	0.866	22.00				118
120	1.178	29.92	0.928	23.57				119
121	1.241	31.52	0.991	25.17				120
122	1.303	33.10	1.053	26.75				121
123	1.366	34.70	1.116	28.35				122
124	1.428	36.27	1.178	29.92				123
125	1.491	37.87	1.241	31.52				124
126	1.553	39.45	1.303	33.10				125
127	1.616	41.05	1.366	34.70	.126 | .131	.005 | .015		126
128	1.678	42.62	1.428	36.27				127
129	1.741	44.22	1.491	37.87			.005	128
130	1.805	45.85	1.555	39.50				129
131	1.867	47.42	1.617	41.07	3.20 | 3.33	0.13 | 0.38	0.13	130
132	1.930	49.02	1.680	42.67				131
133	1.992	50.60	1.742	44.45				132
134	2.055	52.20	1.805	45.85				133
135	2.118	53.80	1.868	47.45				134
136	2.180	55.37	1.930	49.02				135
137	2.243	56.97	1.993	50.62				136
138	2.305	58.55	2.055	52.20				137
139	2.368	60.15	2.118	53.80				138
140	2.430	61.72	2.180	55.37				139
141	2.493	63.32	2.243	56.97				140
142	2.555	64.90	2.305	58.55				141
143	2.618	66.50	2.368	60.15				142
144	2.680	68.07	2.430	61.72				143

Metric sizes.

Dash No	øA Bore Dia. Inch +0.002 -0.000	øA Bore Dia. mm +0.05 -0.00	øB Groove Dia. Inch +0.000 -0.002	øB Groove Dia. mm +0.00 -0.05	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
145	2.743	69.67	2.493	63.32				144
146	2.805	71.25	2.555	64.90				145
147	2.868	72.85	2.618	66.50	↑	↑	↑	146
148	2.930	74.42	2.680	68.07				147
149	2.993	76.02	2.743	69.67				148
210	0.991	25.17	0.617	15.67				208
211	1.053	26.75	0.679	17.25				209
212	1.116	28.35	0.742	18.85				210
213	1.178	29.92	0.804	20.42				211
214	1.241	31.52	0.867	22.02				212
215	1.303	33.10	0.929	23.60				213
216	1.366	34.70	0.992	25.20				214
217	1.428	36.27	1.054	26.77				215
218	1.491	37.87	1.117	28.37				216
219	1.553	39.45	1.179	29.95				217
220	1.616	41.05	1.242	31.55				218
221	1.678	42.62	1.304	33.12				219
222	1.741	44.22	1.367	34.72				220
223	1.867	47.42	1.493	37.92				222
224	1.992	50.60	1.618	41.10				223
225	2.118	53.80	1.744	44.30	.166 | .171	.010 | .025	.006	224
226	2.243	56.97	1.869	47.47				225
227	2.368	60.15	1.994	50.65				226
228	2.493	63.32	2.119	53.82				227
229	2.618	66.50	2.244	53.82				228
230	2.743	69.67	2.369	60.17	4.22 | 4.35	0.25 | 0.64	0.15	229
231	2.868	72.85	2.494	63.35				230
232	2.993	76.02	2.619	66.52				231
233	3.118	79.20	2.744	69.70				232
234	3.243	82.37	2.869	72.87				233
235	3.368	85.55	2.994	76.05				234
236	3.493	88.72	3.119	79.22				235
237	3.618	91.90	3.244	82.40				236
238	3.743	95.07	3.369	85.57				237
239	3.868	98.25	3.494	88.75				238
240	3.993	101.42	3.619	91.92				239
241	4.118	104.60	3.744	95.10				240
242	4.243	107.77	3.869	98.27				241
243	4.368	110.95	3.994	101.45				242
244	4.493	114.12	4.119	104.62				243
245	4.618	117.30	4.244	107.80				244
246	4.743	120.47	4.369	110.97				245
247	4.868	123.65	4.494	114.15				246
325	1.867	47.42	1.313	33.35				323
326	1.992	50.60	1.438	36.53				324
327	2.118	53.80	1.564	39.73				325
328	2.243	56.97	1.689	42.90	.247 | .252	.020 | .035	.007	326
329	2.368	60.15	1.814	46.08				327
330	2.493	63.32	1.939	49.25				328
331	2.618	66.50	2.064	52.43				329
332	2.743	69.67	2.189	55.60	6.27 | 6.40	0.50 | 0.73	0.18	330
333	2.868	72.85	2.314	58.78				331
334	2.993	76.02	2.439	61.95				332
335	3.118	79.20	2.564	65.13				333
336	3.243	82.37	2.689	68.30				334

Dash No	øA Bore Dia. Inch +0.002 -0.000	øA Bore Dia. mm +0.05 -0.00	øB Groove Dia. Inch +0.000 -0.002	øB Groove Dia. mm +0.00 -0.05	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
337	3.368	85.55	2.814	71.48				335
338	3.493	88.72	2.939	74.65				336
339	3.618	91.90	3.064	77.83				337
340	3.743	95.07	3.189	81.00				338
341	3.868	98.25	3.314	84.18				339
342	3.993	101.42	3.439	87.35	.247 | .252	.020 | .035	.007	340
343	4.118	104.60	3.564	90.53				341
344	4.243	107.77	3.689	93.70				342
345	4.368	110.95	3.814	96.88				343
346	4.493	114.12	3.939	100.05	6.27 | 6.40	0.50 | 0.73	0.18	344
347	4.618	117.30	4.064	103.23				345
348	4.743	120.47	4.189	106.40				346
349	4.868	123.65	4.314	109.58				347
	+0.003 -0.000	+0.076 -0.000	+0.000 -0.003	+0.000 -0.076				
350	4.974	126.34	4.420	112.27				348
351	5.099	129.51	4.545	115.44				349
352	5.224	132.69	4.670	118.62				350
428	5.349	135.86	4.599	116.81				425
429	5.474	139.04	4.724	119.99				426
430	5.599	142.21	4.849	123.16				427
431	5.724	145.39	4.974	126.34				428
432	5.849	148.56	5.099	129.51				429
433	5.974	151.74	5.224	132.69				430
434	6.099	154.91	5.349	135.86				431
435	6.224	158.09	5.474	139.04				432
436	6.349	161.26	5.599	142.21				433
437	6.474	164.44	5.724	145.39				434
438	6.724	170.79	5.974	151.74				436
439	6.974	177.14	6.224	158.09				437
440	7.224	183.49	6.474	164.44				438
441	7.474	189.84	6.724	170.79				439
442	7.724	196.19	6.974	177.14	.320 | .325	.020 | .035	.010	440
443	7.974	202.54	7.224	183.49				441
444	8.224	208.89	7.474	189.84				443
445	8.474	215.24	7.724	196.19				443
446	8.974	227.94	8.224	208.89	8.13 | 8.26	0.50 | 0.73	0.25	445
	+0.004 -0.000	+0.10 -0.00	+0.000 -0.003	+0.000 -0.076				
447	9.474	240.64	8.724	221.59				446
448	9.974	253.34	9.224	234.29				447
449	10.474	266.04	9.724	246.99				448
450	10.974	278.74	10.224	259.69				449
451	11.474	291.44	10.724	272.39				450
452	11.974	304.14	11.224	285.09				451
453	12.474	316.84	11.724	297.79				452
454	12.974	329.54	12.224	310.49				453
455	13.474	342.24	12.724	323.19				454
456	13.974	354.94	13.224	335.89				455
457	14.474	367.64	13.724	348.59				456
458	14.974	380.34	14.224	361.29				457
459	15.474	393.04	14.724	373.99				458
460	15.974	405.74	15.224	386.69				459

Metric sizes.

Installation Turcon® Glyd Ring® Rod, Series No. RG27 (Old Series No. S32927)

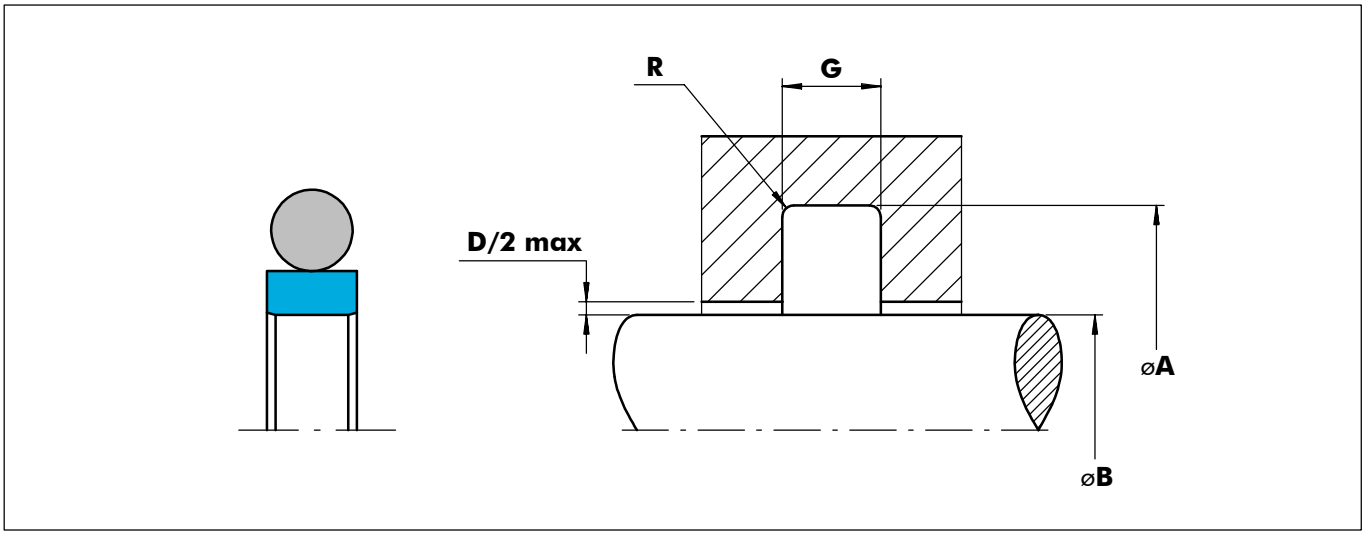


Figure 102 Installation Drawing

Table XLIV Groove Dimensions

Dash No	øB Rod Dia. Inch	øB Rod Dia. mm	øA Groove Dia. Inch	øA Groove Dia. mm	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
	+0.000 -0.001	+0.000 -0.025	+0.001 -0.000	+0.025 -0.000				
006	0.123	3.12	0.259	6.58				007
007	0.154	3.91	0.290	7.37				008
008	0.185	4.70	0.321	8.15			.004	009
009	0.217	5.51	0.353	8.97				010
010	0.248	6.30	0.422	10.72			0.10	011
011	0.310	7.87	0.484	12.29				012
012	0.373	9.47	0.547	13.89				013
	+0.000 -0.002	+0.00 -0.05	+0.002 -0.000	+0.05 -0.00				
013	0.435	11.05	0.609	15.47	.081 | .086	.005 | .015		014
014	0.498	12.65	0.672	17.07				015
015	0.560	14.22	0.734	18.64				016
016	0.623	15.82	0.797	20.24				017
017	0.685	17.40	0.859	21.82	2.06 | 2.19	0.13 | 0.38		018
018	0.748	19.00	0.922	23.42				019
019	0.810	20.57	0.984	24.99				020
020	0.873	22.17	1.047	26.59			.005	021
021	0.935	23.75	1.109	28.17				022
022	0.998	25.35	1.172	29.77				023
023	1.060	26.92	1.234	31.34			0.13	024
024	1.123	28.52	1.297	32.94				025
025	1.185	30.10	1.359	34.52				026
026	1.248	31.70	1.422	36.12				027
027	1.310	33.27	1.484	37.69				028
028	1.373	34.87	1.547	39.29				028
110	0.373	9.47	0.623	15.82	↓			111
111	0.435	11.05	0.685	17.40				112
112	0.498	12.65	0.748	19.00				113
113	0.560	14.22	0.810	20.57				114

Dash No	øB Rod Dia. Inch	øB Rod Dia. mm	øA Groove Dia. Inch	øA Groove Dia. mm	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
	+0.000 -0.002	+0.00 -0.05	+0.002 -0.000	+0.05 -0.00				
114	0.623	15.82	0.873	22.17				115
115	0.685	17.40	0.935	23.75				116
116	0.748	19.00	0.998	25.35				117
117	0.810	20.57	1.060	26.92				118
118	0.873	22.17	1.123	28.52				119
119	0.935	23.75	1.185	30.10				120
120	0.998	25.35	1.248	31.70				121
121	1.060	26.92	1.310	33.27				122
122	1.123	28.52	1.373	34.87				123
123	1.185	30.10	1.435	36.45				124
124	1.248	31.70	1.498	38.05				125
125	1.310	33.27	1.560	39.62	.126 | .131	.005 | .015	.005	126
126	1.373	34.87	1.623	41.22				127
127	1.435	36.45	1.685	42.80				128
128	1.498	38.05	1.748	44.40				129
129	1.560	39.62	1.810	45.97	3.20 | 3.33	0.13 | 0.38	0.13	130
130	1.623	41.22	1.873	47.57				131
131	1.685	42.80	1.935	49.15				132
132	1.748	44.40	1.998	50.75				133
133	1.810	45.97	2.060	52.32				134
134	1.873	47.57	2.123	53.92				135
135	1.930	49.17	2.186	55.52				136
136	1.998	50.75	2.248	57.10				137
137	2.061	52.35	2.311	58.70				138
138	2.123	53.92	2.373	60.27				139
139	2.186	55.52	2.436	61.87				140
140	2.248	57.10	2.498	63.45				141
141	2.311	58.70	2.561	65.05				142
142	2.373	60.27	2.623	66.62				143

Metric sizes.

Dash No	øB Rod Dia. Inch +0.000 -0.002	øB Rod Dia. mm +0.00 -0.05	øA Groove Dia. Inch +0.002 -0.000	øA Groove Dia. mm +0.05 -0.00	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
143	2.436	61.87	2.686	68.22				144
144	2.498	63.45	2.748	69.80				145
145	2.561	65.05	2.811	71.40	↑	↑	↑	146
146	2.623	66.62	2.873	72.97				147
147	2.686	68.22	2.936	74.57				148
148	2.748	69.80	2.998	76.15				149
149	2.811	71.40	3.061	77.75				150
210	0.748	19.00	1.122	28.50				212
211	0.810	20.57	1.184	30.07				213
212	0.873	22.17	1.247	31.67				214
213	0.935	23.75	1.309	33.25				215
214	0.998	25.35	1.372	34.85				216
215	1.060	26.92	1.434	36.42				217
216	1.123	28.52	1.497	38.02				218
217	1.185	30.10	1.559	39.60				219
218	1.248	31.70	1.622	41.20				220
219	1.310	33.27	1.684	42.77				221
220	1.373	34.87	1.747	44.37				222
221	1.435	36.45	1.809	45.95				222
222	1.498	38.05	1.872	47.55				223
223	1.623	41.22	1.997	50.72				224
224	1.748	44.40	2.122	53.90				225
225	1.873	47.57	2.247	57.07	.166	.010		226
226	1.998	50.75	2.372	60.25	|	|		227
227	2.123	53.92	2.497	63.42	.171	.025	.006	228
228	2.248	57.10	2.622	66.60				229
229	2.373	60.27	2.747	69.77				230
230	2.498	63.45	2.872	72.95	4.22	0.25	0.15	231
231	2.623	66.62	2.997	76.12	|	|		232
232	2.748	69.80	3.122	79.30	4.35	0.64		233
233	2.873	72.97	3.247	82.47				234
234	2.997	76.12	3.371	85.62				235
235	3.122	79.30	3.496	88.80				236
236	3.247	82.47	3.621	91.97				237
237	3.372	85.65	3.746	95.15				238
238	3.497	88.82	3.871	98.32				239
239	3.622	92.00	3.996	101.50				240
240	3.747	95.17	4.121	104.67				241
241	3.872	98.35	4.246	107.85				242
242	3.997	101.52	4.371	111.02				243
243	4.122	104.70	4.496	114.20				244
244	4.247	107.87	4.621	117.37				245
245	4.372	111.05	4.746	120.55				246
246	4.497	114.22	4.871	123.72				247
247	4.622	117.40	4.996	126.90				248
325	1.498	38.05	2.052	51.12				326
326	1.623	41.22	2.177	55.30	.247	.020		327
327	1.748	44.40	2.302	58.47	|	|		328
328	1.873	47.57	2.427	61.65	.252	.035	.007	329
329	1.998	50.75	2.552	64.82				330
330	2.123	53.92	2.677	68.00	6.27	0.50	0.18	331
331	2.248	57.10	2.802	71.17	|	|		332
332	2.373	60.27	2.927	74.35	6.40	0.73		333
333	2.498	63.45	3.052	77.52				334
334	2.623	66.62	3.177	80.70				335

Dash No	øB Rod Dia. Inch +0.000 -0.002	øB Rod Dia. mm +0.00 -0.05	øA Groove Dia. Inch +0.002 -0.000	øA Groove Dia. mm +0.05 -0.00	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
335	2.748	69.80	3.302	83.87				336
336	2.873	72.97	3.427	87.05				337
337	2.997	76.12	3.551	90.20				338
338	3.122	79.30	3.676	93.37				339
339	3.247	82.47	3.801	96.55				340
340	3.372	85.65	3.926	99.72	.247			341
341	3.497	88.82	4.051	102.90	|		.007	342
342	3.622	92.00	4.176	106.07	.252			343
343	3.747	95.17	4.301	109.25				344
344	3.872	98.35	4.426	112.42			0.18	345
345	3.997	101.52	4.551	115.60	6.27			346
346	4.122	104.70	4.676	118.77	|			347
347	4.247	107.87	4.801	121.95	6.40			348
348	4.372	111.05	4.926	125.12				349
349	4.497	114.22	5.051	128.30				350
	+0.000 -0.003	+0.000 -0.076	+0.003 -0.000	+0.076 -0.000				
425	4.497	114.22	5.247	133.27				427
426	4.622	117.40	5.372	136.45				428
427	4.747	120.57	5.497	139.62				429
428	4.872	123.75	5.622	142.80				430
429	4.997	126.92	5.747	145.97				431
430	5.122	130.10	5.872	149.15				432
431	5.247	133.27	5.997	152.32				433
432	5.372	136.45	6.122	155.50				434
433	5.497	139.62	6.247	158.67	.320	.020		435
434	5.622	142.80	6.372	161.85	|	|		436
435	5.747	145.97	6.497	165.02	.325	.035	.010	437
436	5.872	149.15	6.622	168.20				437
437	5.997	152.32	6.747	171.37	8.13	0.50	0.25	438
438	6.247	158.67	6.997	177.72	|	|		439
439	6.497	165.02	7.247	184.07	8.26	0.73		440
440	6.747	171.37	7.497	190.42				441
441	6.997	177.72	7.747	196.77				442
442	7.247	184.07	7.997	203.12				443
443	7.497	190.42	8.247	209.47				444
444	7.747	196.77	8.497	215.82				445
445	7.997	203.12	8.747	222.17				445
446	8.497	215.82	9.247	234.87				446
	+0.000 -0.003	+0.000 -0.076	+0.004 -0.000	+0.100 -0.000				
447	8.997	228.52	9.747	247.57				447
448	9.497	241.22	10.247	260.27				448
449	9.997	253.92	10.747	272.97				449
450	10.497	266.62	11.247	285.67				450
451	10.997	279.32	11.747	298.37				451
452	11.497	292.02	12.247	311.07				452
453	11.997	304.72	12.747	323.77				453
454	12.497	317.42	13.247	336.47				454
455	12.997	330.12	13.747	349.17				455
456	13.497	342.82	14.247	361.87				456
457	13.997	355.52	14.747	374.57				457
458	14.497	368.22	15.247	387.27				458
459	14.997	380.92	15.747	399.97				459
460	15.497	393.62	16.247	412.67				460

Metric sizes.

Turcon® Stepseal®K*
For use with MIL-Standard Rod/Bore

Description

The sealing of piston rods places the highest demands on operational safety and environmental protection in hydraulic engineering.

Rod sealing systems must exhibit no dynamic leakage to the atmosphere under all operating conditions and must be completely leak tight when the machine is in a static condition.

Furthermore, they should achieve a high degree of mechanical efficiency through low friction and be easy to install in small grooves. Costs and service life must meet the high expectations of the operator.

The piston rod seal, Turcon® Stepseal®K, developed by Shamban comes closest to satisfying these ideal demands. Already in use for several decades, this seal is still a technically outstanding seal element due to the continuous innovative development of the design and of the Turcon® materials.

With the introduction of the Stepseal®K it became possible to arrange several seals one behind the other, thus allowing tandem seal configurations to be created without any build-up of intermediate pressure.

The single-acting seal element is made of high-grade Turcon® materials with outstanding sliding and wear resistance properties. It is installed in grooves to Shamban standards using an O-Ring as the energizing element.

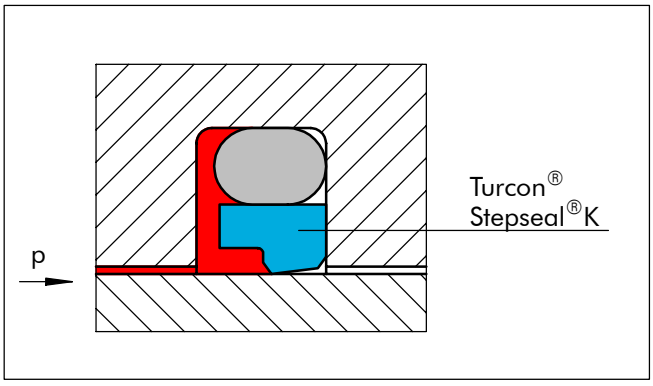


Figure 103 Turcon® Stepseal®K

Method of Operation

The sealing mechanism of the Stepseal®K (Figure 103) is based on the hydrodynamic properties of the seal. The specially formed seal edge has a steep contact pressure gradient on the high pressure side and a shallow contact pressure gradient on the low pressure side. This ensures that the fluid film adhering to the piston rod is returned to the high pressure chamber on the return stroke of the rod. This prevents the micro-fluid layer, that is carried out of the high pressure chamber when the piston rod is extended, from causing leaks.

This return delivery property prevents the build-up of interstage pressure normally associated with tandem seal configurations (Figure 104). Interstage pressure depends on the system pressure speed, the stroke length and the groove design.

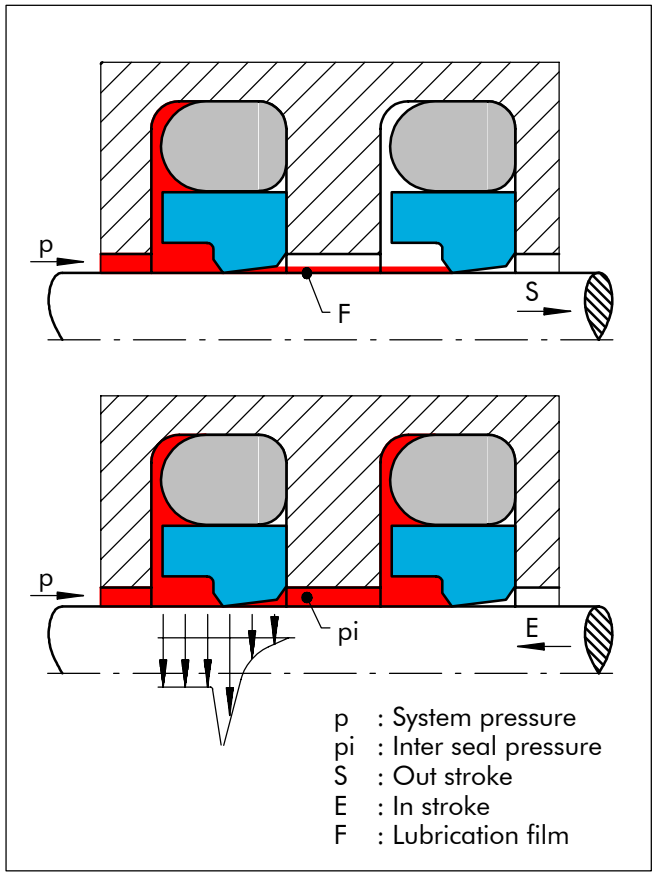


Figure 104 Pressure Distribution in Tandem Installation

* Patent-No. P 32 25 906

Design Instructions

In many applications, tandem unvented sealing systems are required. Figure 105 shows such a tandem configuration utilizing the Stepseal®K. The use of tandem Stepseal® increases functional reliability.

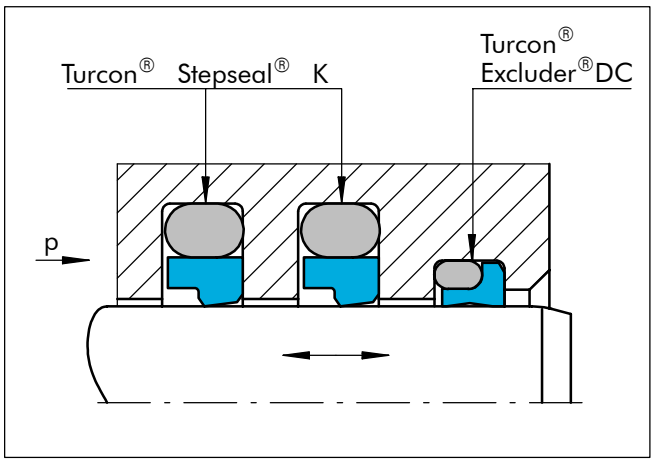


Figure 105 Turcon® Stepseal®K in Tandem Configuration

In this configuration it must be noted that a sufficiently large space is designed between the seals to take the hydraulic fluid, as shown in Figure 123, page 104.

Depending on the application and the operating conditions, the combination of different materials offers an improvement in the sealing efficiency and the service life of the system, e.g. in hydraulic cylinders subject to high loads and under rough operating conditions.

Stepseal® K elements should always be used in combination with a double acting scraper to provide an optimum sealing effect. The Excluder® DC is well suited for such applications. For further details, please see Excluder® and Scraper section on page 104.

Advantages

- High static and dynamic sealing effect
- Low friction, and high efficiency
- Stick-slip free operation
- High abrasion resistance, high operational reliability
- Simple groove design
- Wide range of application temperatures and high resistance to chemicals, depending on the choice of elastomer material
- Available for all diameters up to 3000 mm (10 ft.)

Technical Data

Operating pressure:	up to 35 MPa (5000 psi)
Speed:	up to 15 m/s (49.2 ft/s) with reciprocating movements, frequency up to 5 Hz
Temperature:	-54°C to +200°C (-65°F to +390°F) (depending on elastomer material)
Media:	Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), water and others, depending on the elastomer material (see Table IV, page 16)
Gap width:	The maximum permissible radial gap $D/2_{max}$ is shown in Table XLV and XLVI, pages 94 - 97, as a function of the operating pressure and functional diameter.

Materials

See Table I, page 12.

Series

The Stepseal®K is available in most MIL-G-5514F/ AS4716 bore or rod dimensions, and also for a number of non-MIL spec. grooves. Please consult your Shamban sales engineer for non-standard sizes.

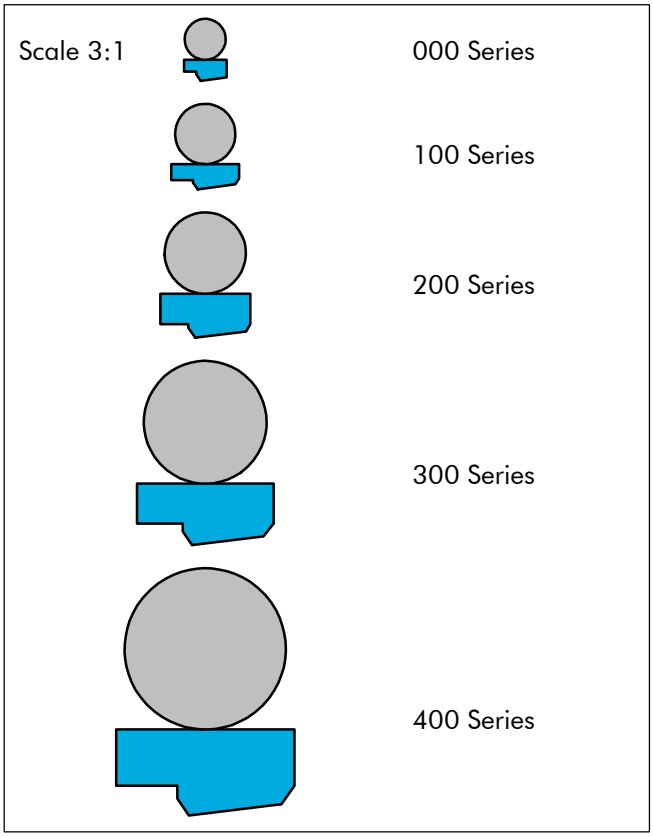


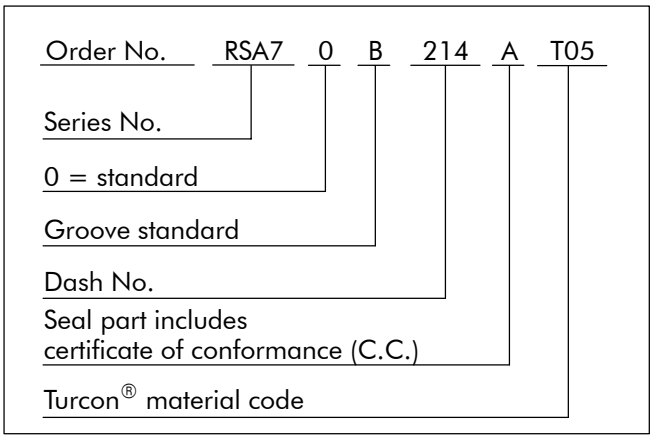
Figure 106 Relationship Between the Profile Cross-Sections

Ordering Example

Turcon® Stepseal®K,
Rod Seal, Series No. RSA7

Dash No: 214

Material: T05
see Table I, Page 12



Note: O-Rings must be ordered separately. Sizes can be found in Table XLV and Table XLVI, pages 94 - 97.

Case Story

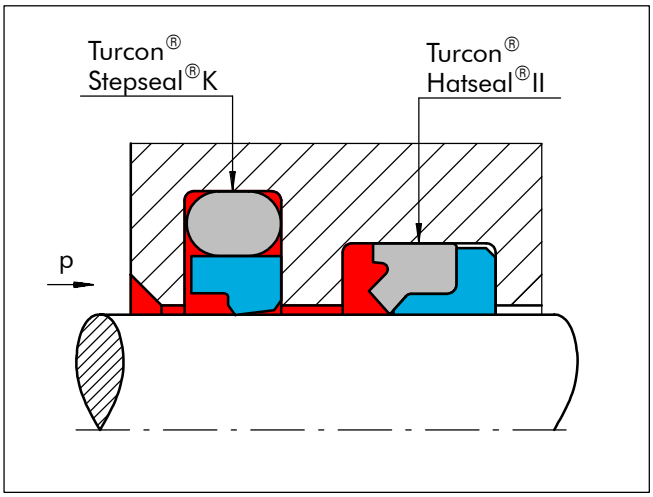


Figure 107 EH 101 Rotor Control Turcon® Hatseal®II and Turcon® Stepseal®K

Problem

Limited life resulting from pressure impulsing.

Solution

A sealing system combining the Stepseal®K and Hatseal®II has optimized seal life.

Installation Turcon® Stepseal®K Bore, Series No. PSA8 (Old Series No. S34768)

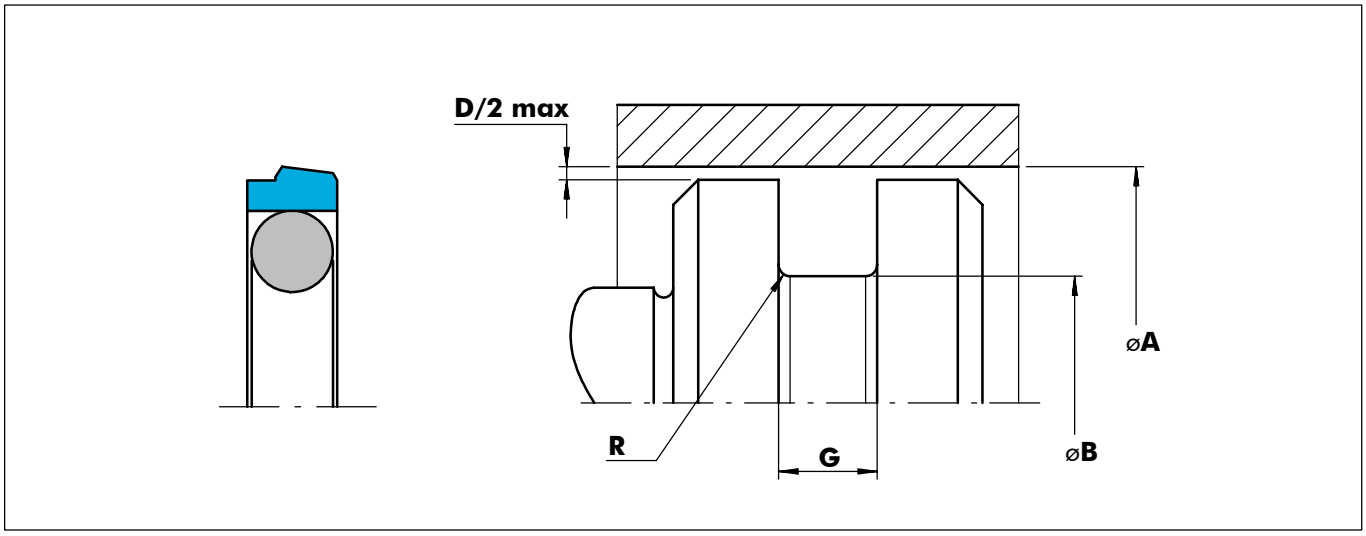


Figure 108 Installation Drawing

Table XLV Groove Dimensions

Dash No	øA Bore Dia. Inch	øA Bore Dia. mm	øB Groove Dia. Inch	øB Groove Dia. mm	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
	+0.001 -0.000	+0.025 -0.000	+0.000 -0.001	+0.000 -0.025				
011	0.422	10.72	0.248	6.30			.004	010
012	0.485	12.32	0.311	7.90			0.10	011
	+0.002 -0.000	+0.05 -0.00	+0.000 -0.002	+0.00 -0.05				
013	0.550	13.97	0.376	9.55				012
014	0.613	15.57	0.439	11.15				013
015	0.675	17.15	0.501	12.73	.081			014
016	0.738	18.75	0.564	14.33	|			015
017	0.800	20.32	0.626	15.90	.086			016
018	0.863	21.92	0.689	17.50				017
019	0.925	23.50	0.751	19.08				018
020	0.991	25.17	0.817	20.75	2.06	.005		019
021	1.053	26.75	0.879	22.33	|	|		020
022	1.116	28.35	0.942	23.93	2.19	.015		021
023	1.178	29.92	1.004	25.50			.005	022
024	1.241	31.52	1.067	27.10				023
025	1.303	33.10	1.129	28.68		0.13		024
026	1.366	34.70	1.192	30.28		|	0.13	025
027	1.428	36.27	1.254	31.85		0.38		026
028	1.491	37.87	1.317	33.45				027
110	0.550	13.97	0.300	7.62				109
111	0.613	15.57	0.363	9.22	.126			110
112	0.675	17.15	0.425	10.80	|			111
113	0.738	18.75	0.488	12.40	.131			112
114	0.800	20.32	0.550	13.97				113
115	0.863	21.92	0.613	15.57	3.20			114
116	0.925	23.50	0.675	17.15	|			115
117	0.991	25.17	0.741	18.82	3.33			116
118	1.053	26.75	0.803	20.40				117
119	1.116	28.35	0.866	22.00				118

Dash No	øA Bore Dia. Inch	øA Bore Dia. mm	øB Groove Dia. Inch	øB Groove Dia. mm	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
	+0.002 -0.000	+0.05 -0.00	+0.000 -0.002	+0.00 -0.05				
120	1.178	29.92	0.928	23.57				119
121	1.241	31.52	0.991	25.17				120
122	1.303	33.10	1.053	26.75				121
123	1.366	34.70	1.116	28.35			.005	122
124	1.428	36.27	1.178	29.92				123
125	1.491	37.87	1.241	31.52			0.13	124
126	1.553	39.45	1.303	33.10				125
127	1.616	41.05	1.366	34.70				126
128	1.678	42.62	1.428	36.27				127
129	1.741	44.22	1.491	37.87				128
130	1.805	45.85	1.555	39.50				129
131	1.867	47.42	1.617	41.07				130
132	1.930	49.02	1.680	42.67	.126	.005		131
133	1.992	50.60	1.742	44.45	|	|		132
134	2.055	52.20	1.805	45.85	.131	.015	.006	133
135	2.118	53.80	1.868	47.45				134
136	2.180	55.37	1.930	49.02	3.20	0.13		135
137	2.243	56.97	1.993	50.62	|	|	0.15	136
138	2.305	58.55	2.055	52.20	3.33	0.38		137
139	2.368	60.15	2.118	53.80				138
140	2.430	61.72	2.180	55.37				139
141	2.493	63.32	2.243	56.97				140
142	2.555	64.90	2.305	58.55				141
143	2.618	66.50	2.368	60.15				142
144	2.680	68.07	2.430	61.72			.007	143
145	2.743	69.67	2.493	63.32				144
146	2.805	71.25	2.555	64.90			0.18	145
147	2.868	72.85	2.618	66.50				146
148	2.930	74.42	2.680	68.07				147
149	2.993	76.02	2.743	69.67				148

Metric sizes.

Dash No	øA Bore Dia. Inch +0.002 -0.000	øA Bore Dia. mm +0.05 -0.00	øB Groove Dia. Inch +0.000 -0.002	øB Groove Dia. mm +0.00 -0.05	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
210	0.991	25.17	0.617	15.67				208
211	1.053	26.75	0.679	17.25				209
212	1.116	28.35	0.742	18.85				210
213	1.178	29.92	0.804	20.42				211
214	1.241	31.52	0.867	22.02				212
215	1.303	33.10	0.929	23.60			.005	213
216	1.366	34.70	0.992	25.20				214
217	1.428	36.27	1.054	26.77			0.13	215
218	1.491	37.87	1.117	28.37				216
219	1.553	39.45	1.179	29.95				217
220	1.616	41.05	1.242	31.55				218
221	1.678	42.62	1.304	33.12				219
222	1.741	44.22	1.367	34.72				220
223	1.867	47.42	1.493	37.92				222
224	1.992	50.60	1.618	41.10			.006	223
225	2.118	53.80	1.744	44.30				224
226	2.243	56.97	1.869	47.47	.166 | .171	.010 | .025	0.15	225
227	2.368	60.15	1.994	50.65				226
228	2.493	63.32	2.119	53.82				227
229	2.618	66.50	2.244	57.00				228
230	2.743	69.67	2.369	60.17	4.22 | 4.35	0.25 | 0.64		229
231	2.868	72.85	2.494	63.35				230
232	2.993	76.02	2.619	66.52				231
233	3.118	79.20	2.744	69.70				232
234	3.243	82.37	2.869	72.87			.007	233
235	3.368	85.55	2.994	76.05				234
236	3.493	88.72	3.119	79.22			0.18	235
237	3.618	91.90	3.244	82.40				236
238	3.743	95.07	3.369	85.57				237
239	3.868	98.25	3.494	88.75				238
240	3.993	101.42	3.619	91.92				239
241	4.118	104.60	3.744	95.10				240
242	4.243	107.77	3.869	98.27				241
243	4.368	110.95	3.994	101.45				242
244	4.493	114.12	4.119	104.62			.008	243
245	4.618	117.30	4.244	107.80				244
246	4.743	120.47	4.369	110.97			0.20	245
247	4.868	123.65	4.494	114.15				246
325	1.867	47.42	1.313	33.35			.006	323
326	1.992	50.60	1.438	36.53				324
327	2.118	53.80	1.564	39.73				325
328	2.243	56.97	1.689	42.90			0.15	326
329	2.368	60.15	1.814	46.08				327
330	2.493	63.32	1.939	49.25				328
331	2.618	66.50	2.064	52.43	.247 | .252	.020 | .035		329
332	2.743	69.67	2.189	55.60				330
333	2.868	72.85	2.314	58.78				331
334	2.993	76.02	2.439	61.95			.007	332
335	3.118	79.20	2.564	65.13	6.27 | 6.40	0.50 | 0.73		333
336	3.243	82.37	2.689	68.30			0.18	334
337	3.368	85.55	2.814	71.48				335
338	3.493	88.72	2.939	74.65				336
339	3.618	91.90	3.064	77.83				337
340	3.743	95.07	3.189	81.00				338

Dash No	øA Bore Dia. Inch +0.002 -0.000	øA Bore Dia. mm +0.05 -0.00	øB Groove Dia. Inch +0.000 -0.002	øB Groove Dia. mm +0.00 -0.05	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
341	3.868	98.25	3.314	84.18				339
342	3.993	101.42	3.439	87.35			.007	340
343	4.118	104.60	3.564	90.53				341
344	4.243	107.77	3.689	93.70			0.18	342
345	4.368	110.95	3.814	96.88	.247 | .252	.020 | .035		343
346	4.493	114.12	3.939	100.05				344
347	4.618	117.30	4.064	103.23				345
348	4.743	120.47	4.189	106.40				346
349	4.868	123.65	4.314	109.58	6.27 | 6.40	0.50 | 0.73	.008	347
	+0.003 -0.000	+0.076 -0.000	+0.000 -0.003	+0.000 -0.076			0.20	
350	4.974	126.34	4.420	112.27				348
351	5.099	129.51	4.545	115.44				349
352	5.224	132.69	4.670	118.62				350
428	5.349	135.86	4.599	116.81				425
429	5.474	139.04	4.724	119.99				426
430	5.599	142.21	4.849	123.16				427
431	5.724	145.39	4.974	126.34				428
432	5.849	148.56	5.099	129.51				429
433	5.974	151.74	5.224	132.69				430
434	6.099	154.91	5.349	135.86				431
435	6.224	158.09	5.474	139.04			.009	432
436	6.349	161.26	5.599	142.21				433
437	6.474	164.44	5.724	145.39				434
438	6.724	170.79	5.974	151.74			0.23	436
439	6.974	177.14	6.224	158.09				437
440	7.224	183.49	6.474	164.44				438
441	7.474	189.84	6.724	170.79				439
442	7.724	196.19	6.974	177.14				440
443	7.974	202.54	7.224	183.49				441
444	8.224	208.89	7.474	189.84	.320 | .325	.020 | .035		443
445	8.474	215.24	7.724	196.19				443
446	8.974	227.94	8.224	208.89			.010	445
					8.13 | 8.26	0.50 | 0.73	0.25	
	+0.004 -0.000	+0.10 -0.00	+0.000 -0.003	+0.000 -0.076				
447	9.474	240.64	8.724	221.59				446
448	9.974	253.34	9.224	234.29				447
449	10.474	266.04	9.724	246.99				448
450	10.974	278.74	10.224	259.69				449
451	11.474	291.44	10.724	272.39			.011	450
452	11.974	304.14	11.224	285.09				451
453	12.474	316.84	11.724	297.79				452
454	12.974	329.54	12.224	310.49			0.28	453
455	13.474	342.24	12.724	323.19				454
456	13.974	354.94	13.224	335.89				455
457	14.474	367.64	13.724	348.59				456
458	14.974	380.34	14.224	361.29				457
459	15.474	393.04	14.724	373.99				458
460	15.974	405.74	15.224	386.69				459

Metric sizes.

Installation Turcon® Stepseal®K Rod, Series No. RSA7 (Old Series No. S34767)

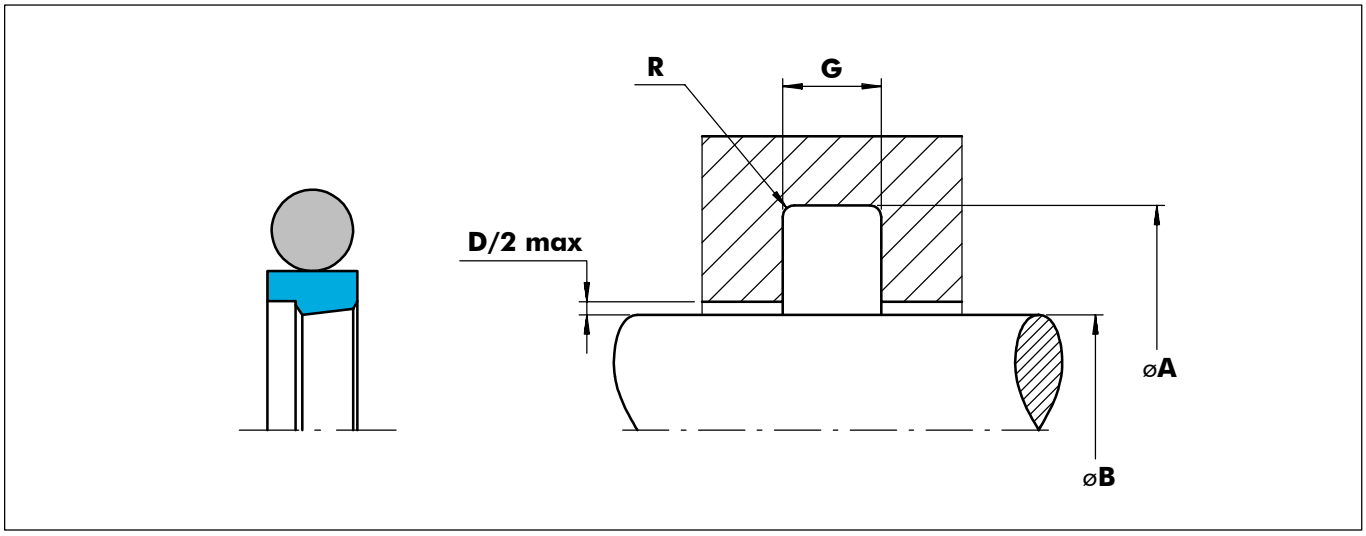


Figure 109 Installation Drawing

Table XLVI Groove Dimensions

Dash No	øB Rod Dia. Inch	øB Rod Dia. mm	øA Groove Dia. Inch	øA Groove Dia. mm	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
	+0.000 -0.001	+0.000 -0.025	+0.001 -0.000	+0.025 -0.000				
010	0.248	6.30	0.422	10.72			.004	011
011	0.310	7.87	0.484	12.29				012
012	0.373	9.47	0.547	13.89			0.10	013
	+0.000 -0.002	+0.00 -0.05	+0.002 -0.000	+0.05 -0.00				
013	0.435	11.05	0.609	15.47				014
014	0.498	12.65	0.672	17.07				015
015	0.560	14.22	0.734	18.64	.081 | .086			016
016	0.623	15.82	0.797	20.24				017
017	0.685	17.40	0.859	21.82				018
018	0.748	19.00	0.922	23.42				019
019	0.810	20.57	0.984	24.99	2.06 | 2.19	.005 | .015		020
020	0.873	22.17	1.047	26.59				021
021	0.935	23.75	1.109	28.17				022
022	0.998	25.35	1.172	29.77				023
023	1.060	26.92	1.234	31.34			.005	024
024	1.123	28.52	1.297	32.94		0.13 | 0.38		025
025	1.185	30.10	1.359	34.52			0.13	026
026	1.248	31.70	1.422	36.12				027
027	1.310	33.27	1.484	37.69				028
028	1.373	34.87	1.547	39.29				028
110	0.373	9.47	0.623	15.82				111
111	0.435	11.05	0.685	17.40	.126 | .131			112
112	0.498	12.65	0.748	19.00				113
113	0.560	14.22	0.810	20.57				114
114	0.623	15.82	0.873	22.17				115
115	0.685	17.40	0.935	23.75	3.20 | 3.33			116
116	0.748	19.00	0.998	25.35				117
117	0.810	20.52	1.060	26.92				118
118	0.873	22.17	1.123	28.52				119
119	0.935	23.75	1.185	30.10				120

Dash No	øB Rod Dia. Inch	øB Rod Dia. mm	øA Groove Dia. Inch	øA Groove Dia. mm	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
	+0.000 -0.002	+0.00 -0.05	+0.002 -0.000	+0.05 -0.00				
120	0.998	25.35	1.248	31.70				121
121	1.060	26.92	1.310	33.27				122
122	1.123	28.52	1.373	34.87			.005	123
123	1.185	30.10	1.435	36.45				124
124	1.248	31.70	1.498	38.05			0.13	125
125	1.310	33.27	1.560	39.62				126
126	1.373	34.87	1.623	41.22				127
127	1.435	36.45	1.685	42.80				128
128	1.498	38.05	1.748	44.40			.006	129
129	1.560	39.62	1.810	45.97				130
130	1.623	41.22	1.873	47.57			0.15	131
131	1.685	42.80	1.935	49.15				132
132	1.748	44.40	1.998	50.75	.126 | .131	.005 | .015		133
133	1.810	45.97	2.060	52.32				134
134	1.873	47.57	2.123	53.92				135
135	1.936	49.17	2.186	55.52				136
136	1.998	50.75	2.248	57.10	3.20 | 3.33	0.13 | 0.38		137
137	2.061	52.35	2.311	58.70				138
138	2.123	53.92	2.373	60.27				139
139	2.186	55.52	2.436	61.87				140
140	2.248	57.10	2.498	63.45			.007	141
141	2.311	58.70	2.561	65.05				142
142	2.373	60.27	2.623	66.62			0.18	143
143	2.436	61.87	2.686	68.22				144
144	2.498	63.45	2.748	69.80				145
145	2.561	65.05	2.811	71.40				146
146	2.623	66.62	2.873	72.97				147
147	2.686	68.22	2.936	74.57				148
148	2.748	69.80	2.998	76.15				149
149	2.811	71.40	3.061	77.75				150

Metric sizes.

Dash No	øB Rod Dia. Inch +0.000 -0.002	øB Rod Dia. mm +0.00 -0.05	øA Groove Dia. Inch +0.002 -0.000	øA Groove Dia. mm +0.05 -0.00	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
210	0.748	19.00	1.122	28.50				212
211	0.810	20.57	1.184	30.07				213
212	0.873	22.17	1.247	31.67				214
213	0.935	23.75	1.309	33.25				215
214	0.998	25.35	1.372	34.85				216
215	1.060	26.92	1.434	36.42			.005	217
216	1.123	28.52	1.497	38.02				218
217	1.185	30.10	1.559	39.60			0.13	219
218	1.248	31.70	1.622	41.20				220
219	1.310	33.27	1.684	42.77				221
220	1.373	34.87	1.747	44.37				222
221	1.435	36.45	1.809	45.95				222
222	1.498	38.05	1.872	47.55				223
223	1.623	41.22	1.997	50.72			.006	224
224	1.748	44.40	2.122	53.90			0.15	225
225	1.873	47.57	2.247	57.07	.166 | .171	.010 | .025		226
226	1.998	50.75	2.372	60.25	4.22 | 4.35	0.25 | 0.64		227
227	2.123	53.92	2.497	63.42				228
228	2.248	57.10	2.622	66.60				229
229	2.373	60.27	2.747	69.77				230
230	2.498	63.45	2.872	72.95				231
231	2.623	66.62	2.997	76.12				232
232	2.748	69.80	3.122	79.30				233
233	2.873	72.97	3.247	82.47				234
234	2.997	76.12	3.371	85.62			.007	235
235	3.122	79.30	3.496	88.80				236
236	3.247	82.47	3.621	91.97			0.18	237
237	3.372	85.65	3.746	95.15				238
238	3.497	88.82	3.871	98.32				239
239	3.622	92.00	3.996	101.50				240
240	3.747	95.17	4.121	104.67				241
241	3.872	98.35	4.246	107.85				242
242	3.997	101.52	4.371	111.02				243
243	4.122	104.70	4.496	114.20				244
244	4.247	107.87	4.621	117.37				245
245	4.372	111.05	4.746	120.55				246
246	4.497	114.22	4.871	123.72			.008	247
247	4.622	117.40	4.996	126.90			0.20	248
325	1.498	38.05	2.052	51.12			.006	326
326	1.623	41.22	2.177	55.30				327
327	1.748	44.40	2.302	58.47			0.15	328
328	1.873	47.57	2.427	61.65	.247 | .252	.020 | .035		329
329	1.998	50.75	2.552	64.82				330
330	2.123	53.92	2.677	68.00			.007	331
331	2.248	57.10	2.802	71.17	6.27 | 6.40	0.50 | 0.73		332
332	2.373	60.27	2.927	74.35				333
333	2.498	63.45	3.052	77.52			0.18	334
334	2.623	66.62	3.177	80.70				335
335	2.748	69.80	3.302	83.87				336
336	2.873	72.97	3.427	87.05				337

Dash No	øB Rod Dia. Inch +0.000 -0.002	øB Rod Dia. mm +0.00 -0.05	øA Groove Dia. Inch +0.002 -0.000	øA Groove Dia. mm +0.05 -0.00	G Inch / mm	R Inch / mm	D Inch / mm	O-Ring Dash No AS 568A
337	2.997	76.12	3.551	90.20				338
338	3.122	79.30	3.676	93.37				339
339	3.247	82.47	3.801	96.55				340
340	3.372	85.65	3.926	99.72	.247 | .252			341
341	3.497	88.82	4.051	102.90			.007	342
342	3.622	92.00	4.176	106.07				343
343	3.747	95.17	4.301	109.25			0.18	344
344	3.872	98.35	4.426	112.42	6.27 | 6.40			345
345	3.997	101.52	4.551	115.60				346
346	4.122	104.70	4.676	118.77				347
347	4.247	107.87	4.801	121.95				348
348	4.372	111.05	4.926	125.12				349
349	4.497	114.22	5.051	128.30				350
	+0.000 -0.003	+0.000 -0.076	+0.003 -0.000	+0.076 -0.000				
425	4.497	114.22	5.247	133.27				427
426	4.622	117.40	5.372	136.45				428
427	4.747	120.57	5.497	139.62				429
428	4.872	123.75	5.622	142.80				430
429	4.997	126.92	5.747	145.97			.009	431
430	5.122	130.10	5.872	149.15				432
431	5.247	133.27	5.997	152.32				433
432	5.372	136.45	6.122	155.50			0.23	434
433	5.497	139.62	6.247	158.67				435
434	5.622	142.80	6.372	161.85		.020 | .035		436
435	5.747	145.97	6.497	165.02				437
436	5.872	149.15	6.622	168.20				437
437	5.997	152.32	6.747	171.37				438
438	6.247	158.67	6.997	177.72		0.50 | 0.73		439
439	6.497	165.02	7.247	184.07				440
440	6.747	171.37	7.497	190.42	.320 | .325			441
441	6.997	177.72	7.747	196.77				442
442	7.247	184.07	7.997	203.12				443
443	7.497	190.42	8.247	209.47				444
444	7.747	196.77	8.497	215.82	8.13 | 8.26			445
445	7.997	203.12	8.747	222.17				445
446	8.497	215.82	9.247	234.87				446
	+0.000 -0.003	+0.000 -0.076	+0.004 -0.000	+0.100 -0.000				
447	8.997	228.52	9.747	247.57			.010	447
448	9.497	241.22	10.247	260.27				448
449	9.997	253.92	10.747	272.97			0.25	449
450	10.497	266.62	11.247	285.67				450
451	10.997	279.32	11.747	298.37				451
452	11.497	292.02	12.247	311.07				452
453	11.997	304.72	12.747	323.77				453
454	12.497	317.42	13.247	336.47				454
455	12.997	330.12	13.747	349.17				455
456	13.497	342.82	14.247	361.87				456
457	13.997	355.52	14.747	374.57				457
458	14.497	368.22	15.247	387.27				458
459	14.997	380.92	15.747	399.97				459
460	15.497	393.62	16.247	412.67				460

Metric sizes.

Turcon® Roto Glyd Ring®
For use with MIL-G-5514F/AS4716 Rod/Bore

Description

The Turcon® Roto Glyd Ring® is used to seal rods, axles, rotary swivel, steering units, with rotary, helical or oscillating movement.

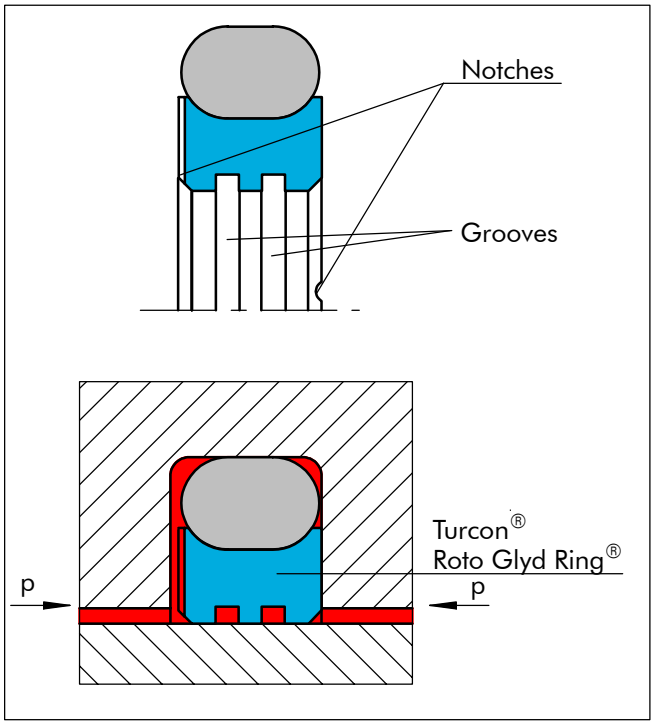


Figure 110 Turcon® Roto Glyd Ring®

The Roto Glyd Ring® consists of a seal ring of high-grade Turcon® material activated by an O-Ring as an elastic energizing element.

The contact surface profile of the seal ring is specifically designed for use under high pressures and at low sliding speeds.

Depending on the profile cross-section of the seal, the contact surface has one or two continuous machined grooves. These have the following functions:

- Improved seal efficiency by increasing the specific surface load pressure against the sealed surface.
- Formation of lubricant reservoir and reduction in friction.

In order to improve the pressure activation of the O-Ring, the Roto Glyd Ring® has notched end faces as standard.

The geometry which holds the O-Ring has a concave form. This increases the contact surface and prevents the seal from turning with the shaft.

Availability

A large number of sizes are available both for inch and metric sizes.

Please inquire about sizes and availability early in your design phase.

For ordering examples please consult the separate Turcon® Rotary Seals catalog or contact your Shamban sales engineer.

Application Limits

The maximum values for temperature, pressure and speed given in this catalog have an accumulative effect and thus cannot be used simultaneously.

Seal performance is influenced by such factors as fluid lubrication and the ability of the hardware to dissipate heat. Testing should be conducted to confirm performance.

Technical Data

Operating pressure:	up to 30 MPa (4350 psi)
Speed:	up to 2 m/s (6.37 ft/s) continuous
Temperature:	-54 °C to + 200 °C (-65°F to + 500 °F) (depending on O-Ring material)

Frictional Power

Guiding values for the frictional power can be determined from the graph below. They are shown as a function of the sliding speed and operating pressure for a shaft diameter of 50 mm with an oil temperature of 60° C (140° F). At higher temperatures, these application limits must be reduced.

Formular for other dia. : $p \simeq p_{50} \times (\frac{d}{50\ mm})$ [W]

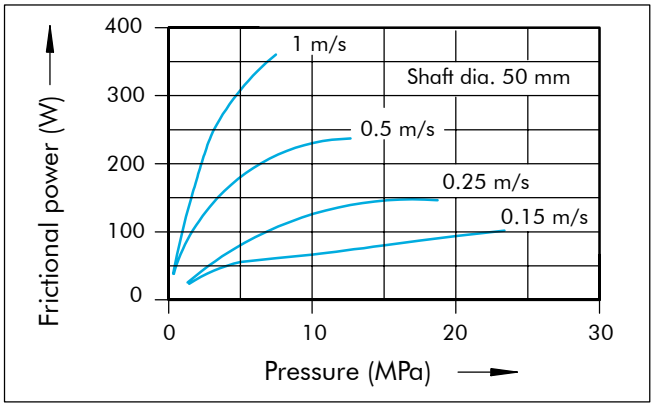


Figure 111 Friction for Turcon® Roto Glyd Ring®

Case Story

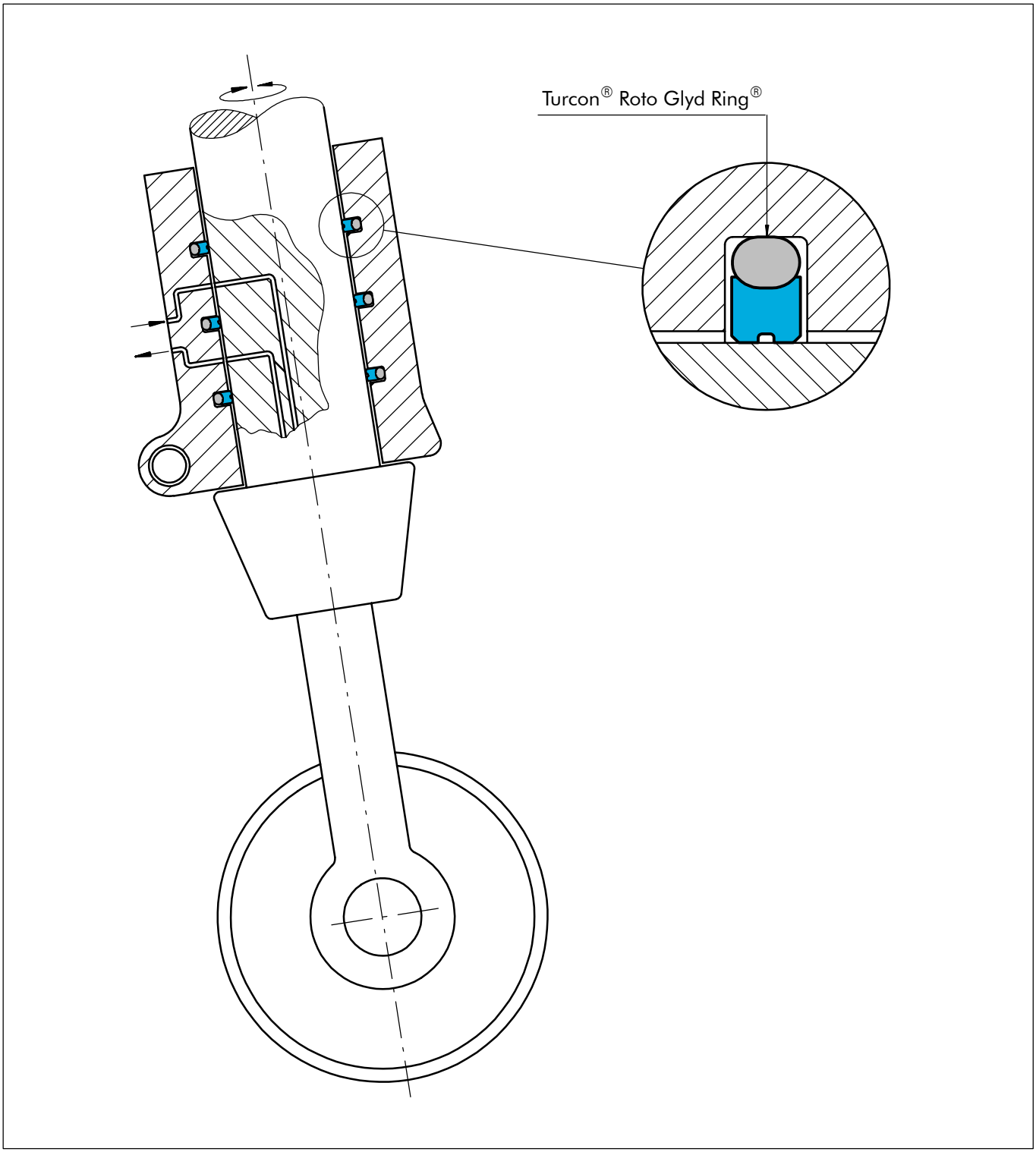


Figure 112 Nose Landing Gear

Problem

Friction and leakage control.

Solution

Turcon® Roto Glyd Ring®.

Turcon® Varilip®

Description

Due to their elastomer sealing lip, standard radial shaft seals have only a limited application range with respect to pressure, temperature, media and loads.

Varilip® shaft seals from Shamban extend this application range by using modern Turcon® materials developed specially for rotational applications.

The Varilip® is characterized in particular by their low friction, which reduces heat build-up and permits higher rotary speeds, and therefore longer life.

The Varilip® shaft seal is dimensionally interchangeable with the shaft seals to DIN 3760 and ISO 6194/1. Inch sizes are also available.

The minimal groove size required for Varilip® allows its use as a pressurized seal where the installation of a mechanical shaft seal would not be possible due to space envelope limits.

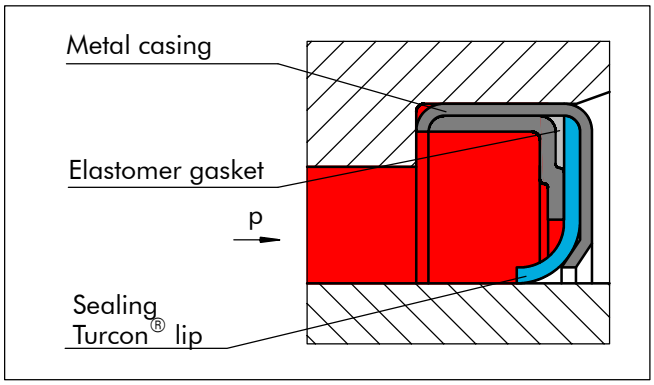


Figure 113 Turcon® Varilip®, Type A

Method of Operation

In contrast to conventional shaft seals, the Varilip® seal requires no metallic spring to energize the sealing lip.

As can be seen from Figure 113, dynamic sealing is affected by the radial load of the sealing lip against the shaft. Static sealing is affected by a press fit of the metallic casing in the housing bore, and by an elastomeric flat gasket between metallic housing and Turcon® sealing lip.

Technical Data

Operating pressure: up to 2 MPa (290 psi)

Speed:	40 m/s (131 ft/s)
Temperature range:	-60°C to +200°C (-76°F to +390°F)
Media:	Practically all fluids, chemicals and gases.

Application Limits

The limits for temperature, pressure and speed given in this catalog cannot be fully exploited at the same time.

Furthermore, the lubrication properties of the media, heat dissipation of the hardware, and the condition of the shaft surface, affects the application limits.

The following p x v values can be used as general guidelines:
For shaft diameter from 30 mm (1.2 in) to 170 mm (6.7 in):

up to	3	(MPa x m/s) with good lubrication
up to	1.5	(MPa x m/s) with poor lubrication
up to	10	(MPa x m/s) with very good cooling

For smaller shaft diameters, the values must be reduced.

Turcon® Varilip®, Type A

Type A (Fig. 114) is a one-lip seal suitable for use in standard applications up to p_{max} = 0.5 MPa (73 psi) where a radial shaft seal would be unable to withstand the temperature, friction, medium or poor lubrication. Type A allows high- speed shafts with peripheral speeds of up to 40 m/s (131 ft/s) to be sealed.

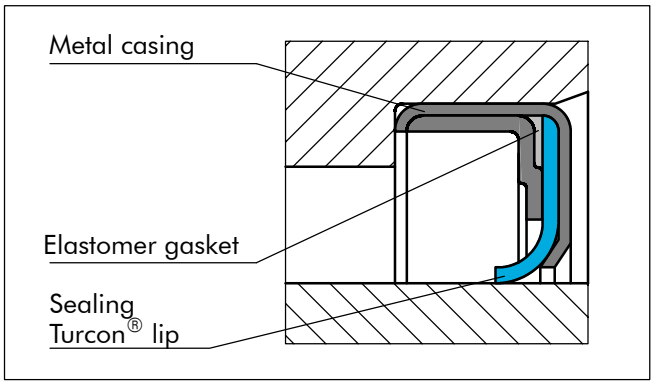


Figure 114 Turcon® Varilip®, Type A

Turcon® Varilip®, Type B

Type B (Fig. 115) is the preferred choice for applications requiring high leakage control or where contaminated media are to be sealed. This two-lip type offers greater safety than the Type A.

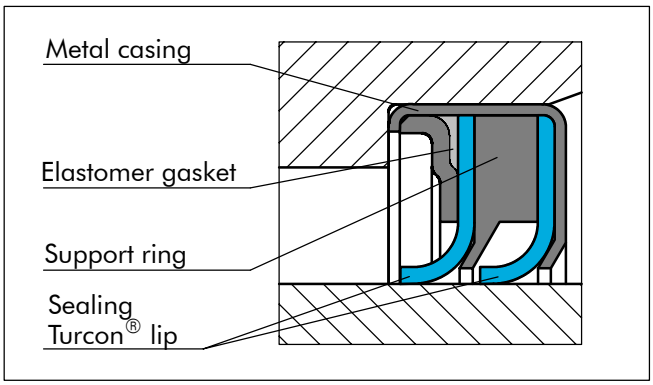


Figure 115 Turcon® Varilip®, Type B

Turcon® Varilip®, Type C

The Varilip® Type C can be used for applications involving higher pressures for which a simple elastomer radial shaft seal can no longer be considered. Due to a reinforcement of the sealing lip, pressures of up to 2 MPa (290 psi) are possible, e.g. as pump, shaft or rotor seals.

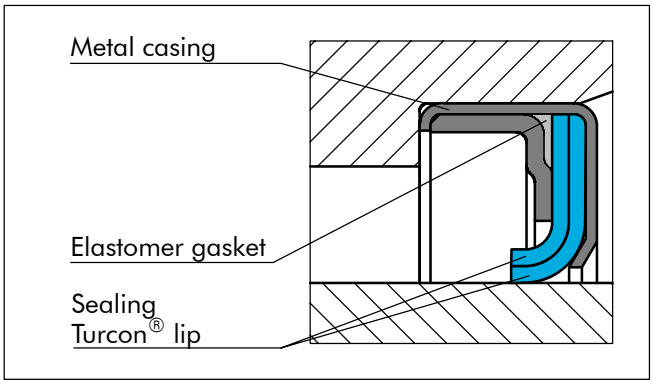


Figure 116 Turcon® Varilip®, Type C

Propeller drive for Zeppelin NT →

Working conditions:
Temperaure: -30°C to +120°C (-22°F to 250°F)
Pressure: Max. 5 bar
Speed: Max. 3.4 m/sec.

Solution

Shamban Turcon® Varilip®, Type D (special).

Turcon® Varilip®, Type D

While Types A to C can be used to seal against pressures from only one side, Type D can be subjected to pressure from both sides. Pressures of up to 0.1 MPa (14.5 psi) are permissible. The separation of two different media using a single seal is possible. The second lip can also take on the function of a wiper or dust lip. A grease packing between the sealing lips is recommended.

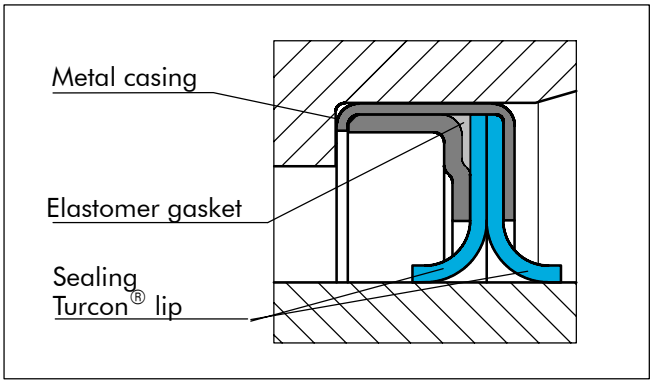


Figure 117 Turcon® Varilip®, Type D

Availability

A large number of sizes are available both for inch and metric sizes.

Please inquire about sizes and availability early in your design phase.

For ordering examples please consult the separate Varilip® catalog or contact your Shamban sales engineer.

Case Story

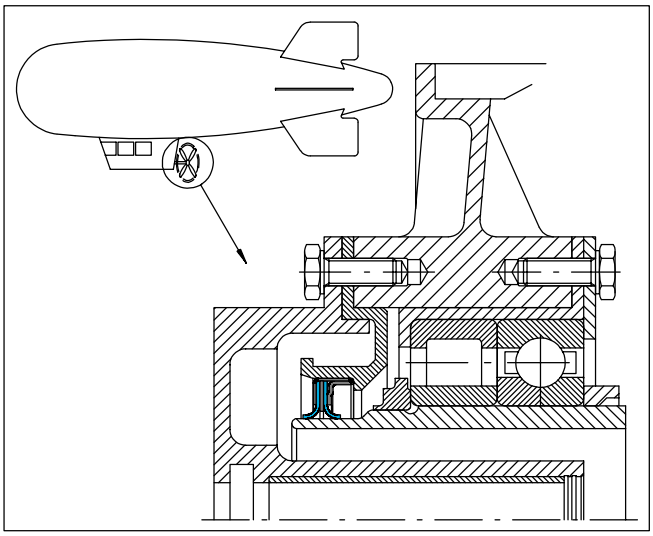


Figure 118 Propeller Drive for Zeppelin NT

Seals for Boeing Gland Standard BACS11AA

Description

The Boeing Footseal gland/seal specification BACS11AA was intended for use in hydraulic systems to provide maximum O-Ring life with minimum friction.

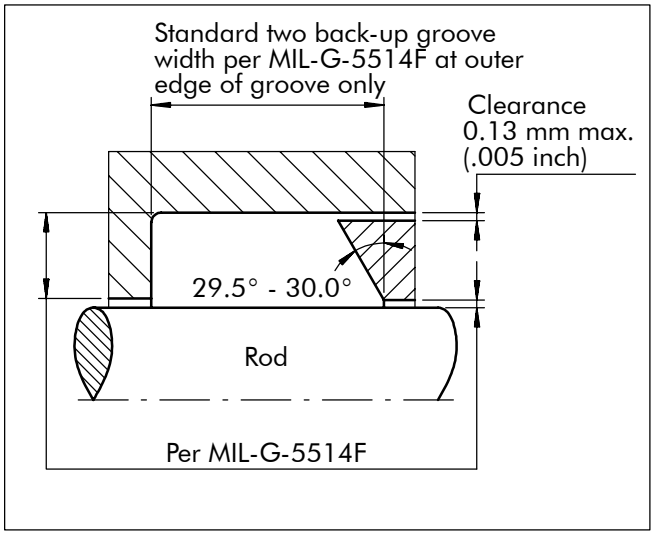


Figure 119 Groove Geometry

Application Example

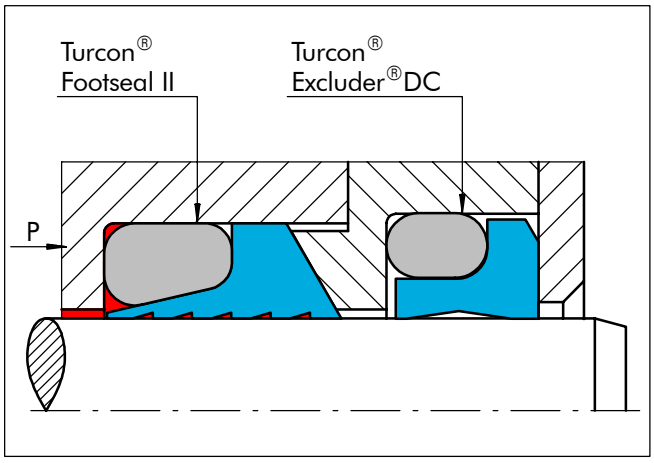


Figure 120 B777 Flight Controls

Alternative Seal Designs

The following Shamban seals are available in modified form to fit the BACS11AA gland:

Footseal II	Part no.	RF21	(S33121)
Plus Seal®II	Part no.	RP47	(S38647)
Wedgpak®	Part no.	RA49	(S38649)
Hatseal®II	Part no.	RH53	(S34853) *)

*) Only from 100 Series and up.

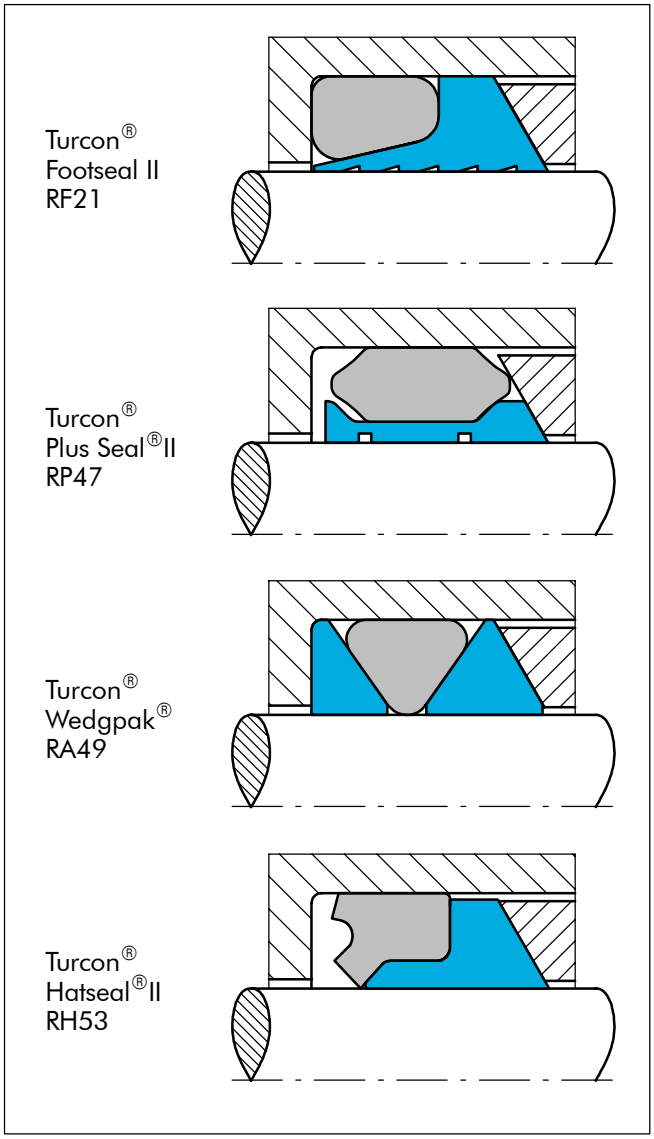


Figure 121 Alternative Seal Design

The alternative designs should only be used after consulting your Shamban sales engineer.

Footseal II *)

Description

The Footseal II rod seal was developed as an improvement to the original Footseal designed to fit the existing Boeing BACS11AA rod gland standard.

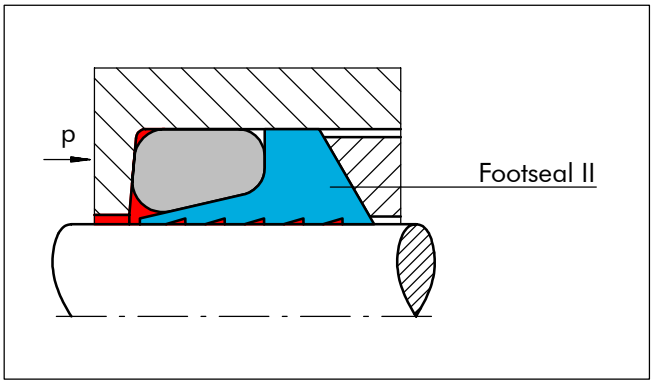


Figure 122 Footseal II

Method of Operation

Similar to other slipper seal designs, the Footseal II utilizes an O-Ring to preload the seal ring.

When the system pressure is increased, the oil film under the seal is further reduced. Improvements in the Footseal II result in increased low pressure leakage performance and longer life when compared to the standard Footseal.

The Footseal II also utilizes circumferential grooves to improve leakage performance and provide longer life sealing.

Advantages

- Good static sealing effect
- Low friction
- Fits BACS11AA gland standard

Technical Data

Operating pressure: 21 MPa (3000 psi)

Speed: 15.0 m/s (49.2 ft/s)

Temperature range: -54°C to +200°C
(-65°F to +390°F)
(depending on elastomer material)

Clearance: As per BACS11AA gland design

Media: Phosphate Ester,
Mineral oil-based hydraulic fluids,
Flame retardant hydraulic fluids,
Environmentally safe hydraulic fluids
and others, depending on the
elastomer material
(see Table IV, page 16)

Materials

See Table I, page 12 and Table III, page 15.

Series

The Footseal II follows the series as described in BACS11AA.

Ordering Example

Footseal II for BACS11AA gland, standard series, Series No. RF21

Dash No.: 214

Material: T99

Order No.	RF21	0	B	214	A	T99
Series No.						
Standard						
Groove Standard (Boeing)						
BACS11AA size						
Seal part includes Certificate of conformance (C.C.)						
Turcon® material code						

Note: O-Ring must be ordered seperately.

*) Shamban is the only authorized manufacturer of the Footseal II

Selection of the Scraper Element

Scraper is a general term applied to those configurations installed in hydraulic cylinders for the purpose of scraping contamination from rods, or excluding contamination from the hydraulic system. The term *scraper* is generally used in reference to those geometries that, although they provide a scraping function, do not prevent ingression of small particles into the system. Excluders, in addition to providing a scraping function, also minimize the ingression of small particles into the system, and act as a secondary seal.

It is important to consider the scraper selection as an element of a sealing system. Despite the proper selection of primary and secondary seals, if a scraper appropriate for the application is not selected, the resulting migration of contamination into a system can cause damage to wear rings, seals, and hardware components. Scrapers thus form part of a functional system, and therefore must be viewed in combination with seals.

In order to satisfy a variety of technical and economic demands, Shamban has developed a complete range of scrapers with optimized geometries made from high-quality materials.

An axial notch can be added to the inner scraping lip of a double-acting scraper thereby providing a path to vent any interstage pressure to the outside while still retaining the double-acting scraping effect. (See Fig. 128)

For systems with extreme working conditions, a spring energized scraper like the Variseal®M2S ensures a wide temperature range and optimal chemical resistance.

The final choice of scraper type and material must also take account of the detailed information on the individual scraper type elements.

Please do not hesitate to contact your sales engineer for further information on specific applications and special technical questions.

Note on Ordering

All multi-element standard seals in this catalog which contain a proprietary elastomer part such as the Plus Seal® are always supplied as complete seal sets. The supply includes the seal and matching elastomer energizing element.

O-Ring activated seals and scrapers are normally supplied without the elastomer in order to increase the flexibility of delivery and stocking.

Exceptions to the above may be determined with your local Shamban sales engineer to find the most suitable solution.

Older designs no longer contained in this catalog naturally continue to be available. For all new applications we recommend the use of the types and preferred sizes listed in this catalog.

Other combinations of Turcon® materials and special designs can be developed and supplied for special applications in intermediate sizes up to 3000 mm (10 ft) diameter, provided there is sufficient demand. Sizes over 3000 mm (10 ft) are available for specific designs.

Groove Distance

When installing scrapers in conjunction with rod seals where interstage pressure is a concern, we recommend the following positioning:

- Distance between seal groove and scraper groove L should exceed groove depth x
- Oil reservoir to collect the oil to be returned as shown in Figure 123.

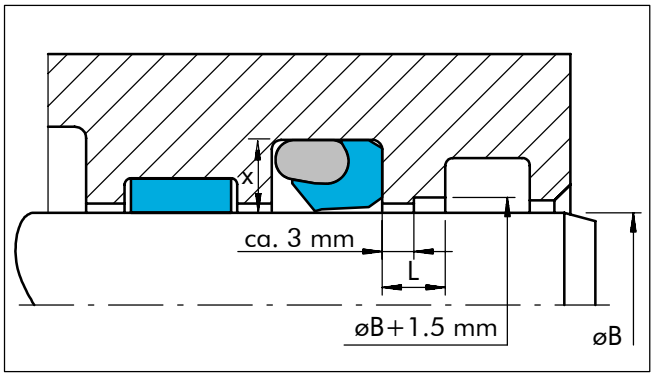


Figure 123 Recommendations for Groove Distance

Turcon® DC Scraper Ring

Description

The Turcon® DC Scraper Ring replaces the old S11065 Series designed for the MS33675 military gland standard. This design utilizes a dual scraping lip Turcon® element which is scarf cut and energized by a garter spring.

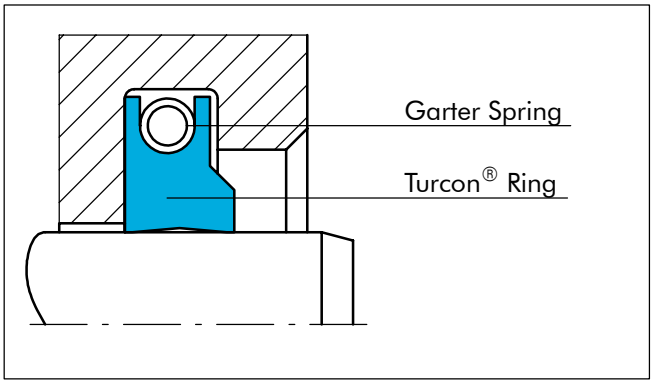


Figure 124 Turcon® DC-Scraper Ring

Method of Operation

This design provides a good scraping effect and also offers a much more improved stability under linear actuation than the old S11065 design. Two possible paths for the ingression of contamination exist with this design: Through the scarf cut in the Turcon® scraping element, and through the garter spring. This design should not be used in environments where severe contamination exists.

Advantages

- Fits the MS33675 groove + BACS34A
- Low friction
- Easy installation
- Can be installed in closed grooves
- Two scraping lips
- Good stability in the groove
- Excellent chemical resistance due to the stainless steel spring activation

Technical Data

Speed: 15 m/s (49.2 ft/s)
Temperature range: -200°C to +200°C (-328°F to +390°F)
Media: Practically all fluids, chemicals and gases

Materials

Turcon® T05 is standard. For other materials please see Table I, page 12.

Series

The sizes in Table XLVIII, Installation Dimensions, page 109 are the recommended standard sizes. Please consult your Shamban sales engineer.

Ordering Example

DC Scraper, standard series,
Series No. WM82

MS33675 Dash No: 012
Corresponding
MIL-G-5514F Dash No: 217

Material: T05 (standard), see Table I, Page 12

Order No.	WM82	0	S	012	A	T05
Series No.						
0 = No notch (standard)						
Groove Standard						
Dash No. (MS33675)						
Seal part includes Certificate of conformance (C.C.)						
Turcon® material code						

Ordering Example

Turcon® Excluder®DC, Series E, standard series, without axial notch, Series No. WE65, see page 106.

MS33675 Dash No: 017
Corresponding
MIL-G-5514F Dash No: 325

Material: T05 (standard), see Table I, Page 12

Order No.	WE65	0	S	017	A	T05
Series No.						
0 = No notch (standard)						
Groove Standard						
Dash No.(MS33675)						
Seal part includes Certificate of conformance (C.C.)						
Turcon® material code						

Note: O-Ring must be ordered seperately. Sizes can be found in Table XLVIII, page 109.

Turcon® Excluder®DC, Series E

Description

The Turcon® Excluder®DC, Series E consists of an uncut, dual scraping lip Turcon® element energized by a standard O-Ring. This design is offered as a retrofit to the MS33675 military gland standard which previously utilized a cut, spring energized scraper design.

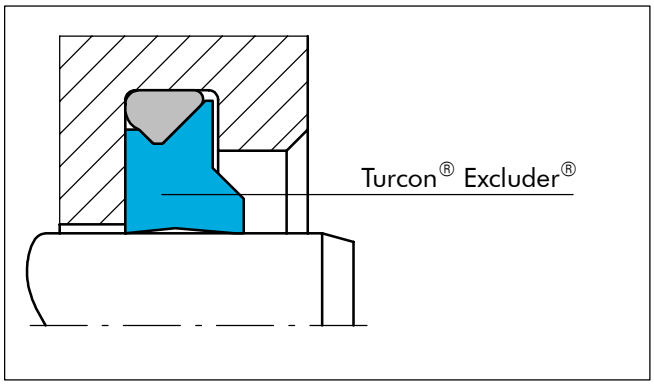


Figure 125 Turcon® Excluder®DC, Series E

Method of Operation

This design addresses the two contamination paths inherent in the DC Scraper Ring design. The scarf cut is eliminated, and the garter spring is replaced with an O-Ring. In effect, these two changes create a secondary sealing element. The outboard scraping lip minimizes the ingression of water and contaminates, and equally important, the inboard scraping lip will contain any fluid leakage that may pass the primary seal. This fluid will provide lubrication for the sealing system, reducing friction and extending the life of the sealing system.

Note, for diameters smaller than 25 mm (1 inch) a split groove is recommended.

Shamban offers other Excluder® designs that have better performance under the above mentioned conditions. For best performance results, the MS33675 gland standard is not recommended. Also see the section Excluder®DC, page 107.

Please contact your Shamban sales engineer for further information.

Advantages

- Fits the MS33675 groove
- Acts as a secondary seal
- Two scraping lips
- Good stability in the groove

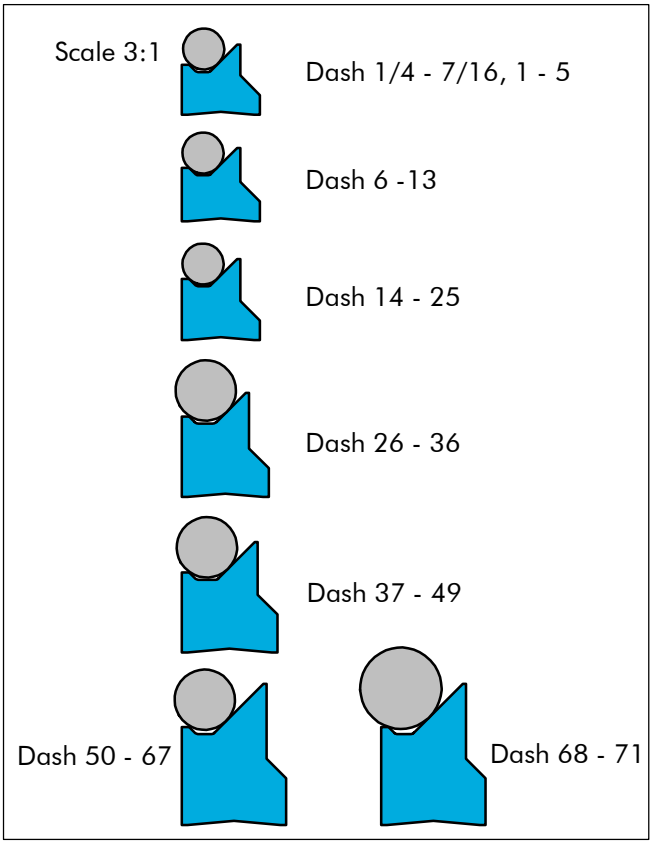


Figure 126 Relationship Between the Profile Cross-Sections

Technical Data

Speed:	15 m/s
Temperature range:	-54°C to +200°C (-65°F to +390°F) (depending on O-Ring material)
Media:	Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), Phosphate Ester, water and others, depending on the O-Ring material (see Tab. IV, page 16)

Materials

Turcon® T05 is standard. For other materials please see Table I, page 12.

Series

The sizes in Table XLVIII, Installation Dimensions, page 109 are the recommended standard sizes. Larger and smaller cross-sections are also available, please consult your Shamban sales engineer.

Turcon® Excluder®DC

Description

The design of the Turcon® Excluder®DC optimizes the device's ability to exclude contamination without the restrictions and limitations of the MS33675 gland dimensions. The gland has been altered to accommodate a larger cross section O-Ring for better activation of the scraping lips.

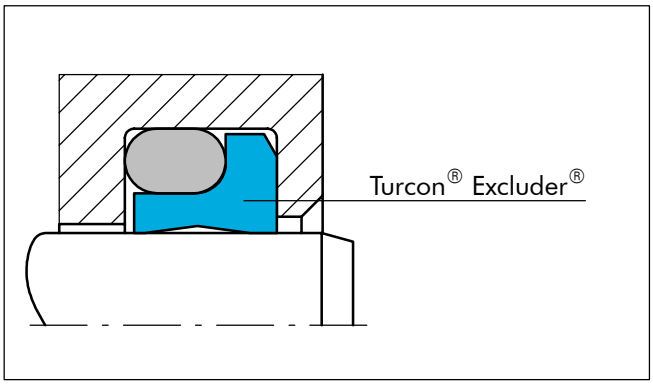


Figure 127 Turcon® Excluder®DC

Method of Operation

The wider groove, combined with a better support on the downstream side of the Excluder®DC, has resulted in a far more reliable exclusion device than those utilizing the MS33675 gland standard. These changes have led to widespread acceptance of the Excluder®DC as the state-of-the-art exclusion device for aerospace applications.

Due to the heavy cross-section of the Turcon® element on the downstream side, the Excluder®DC will accept a significant back-pressure without being extruded out of the groove. If high back-pressure is expected, we recommend use of the Excluder®DC with the axial notch.

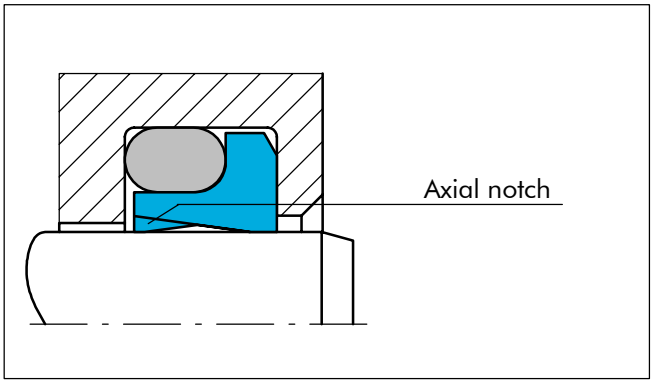


Figure 128 Axial Notch (see page 105)

Open/split grooves are recommended for diameters smaller than 35 mm (1.4 in).

Advantages

- Very efficient scraping lips
- Capable of scraping light ice covering rods
- Very stable and reliable design
- Acts as a secondary seal.

Technical Data

Speed: 15 m/s (49 ft/s)

Temperature range: -54°C to +260°C
(-65°F to +500°F)
(depending on O-Ring material)

Media: Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), Phosphate Ester, water and others, depending on the O-Ring material (see Table IV, page 16)

Materials

Turcon® T05 is standard. For other materials, please see Table I, page 12.

Design and Installation Recommendations

Scrapers and excluders can be installed either in split or in closed grooves, depending upon cross-section and rod diameter. See below for our recommendations:

Table XLVII Installation in Closed Grooves

MS33675	Size P/N	Rod
1/4	B100	open grooves recommended
5/16	B200	
3/8	B300	
7/16	B400	
001 - ∞	B001	closed grooves possible

Ordering Example

Turcon® Excluder®DC for MS33675, rod

Dash size.: 5/16

Part No.: WE250**B200**AT05NG

Series

The sizes in Table XLVIII, Installation Dimensions, page 109 are the recommended standard sizes. Larger and smaller cross sections are also available. Please consult your Shamban sales engineer. Please note that the Excluder® size follows the dash numbering system as per MS33675 and must be ordered with this dash No. and not the MIL-G-5514F/AS4716 dash No.

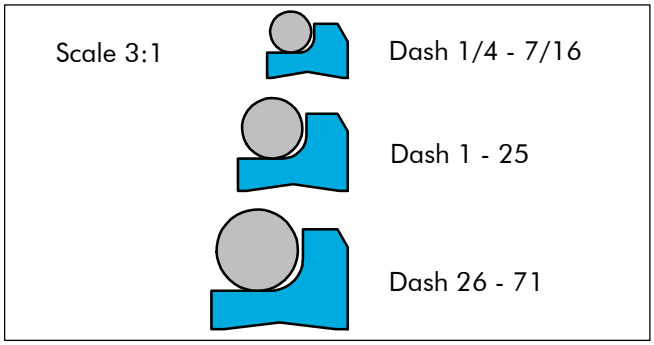


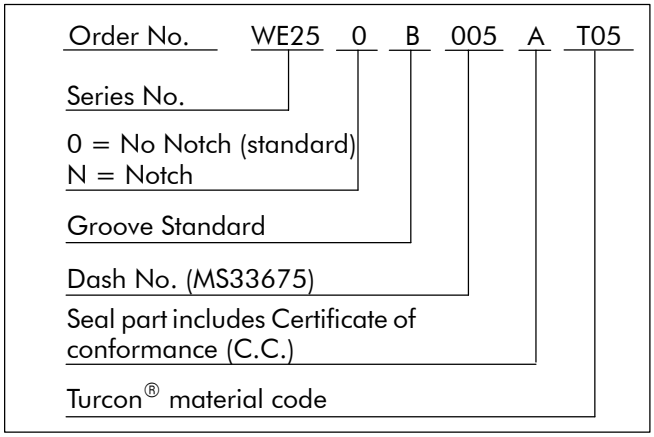
Figure 129 Relationship Between the Profile Cross-Sections

Ordering Example

Turcon® Excluder®DC, standard series, without axial notch, Series No. WE25

MS33675 Dash No: 005
Corresponding
MIL-G-5514F Dash No: 210

Material: T05 (standard), see Table I, Page 12

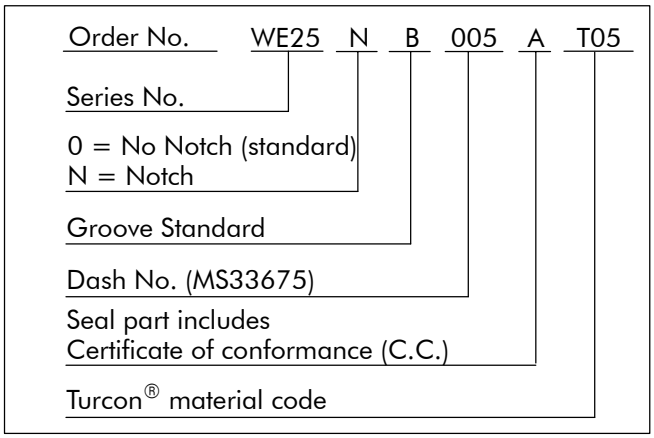


Ordering Example

Turcon® Excluder®DC, standard series, with axial notch Series No. WE25 from Table XLVIII, page 109

MS 33675 Dash No: 005
Corresponding
MIL-G-5514F Dash No: 210

Material: T05 (standard), see Table I, Page 12



DC Excluder, light series w, smaller cross section is available. Consult Your Shamban Sales Engineer.

Notes:

Turcon® T05 is the standard material for the Excluder®DC due to its flexible properties. Other materials may be chosen. For example Turcon® T42 is preferred to scrape sticky deposits off the rod.

For the WE25 series, both an over- and under-size Excluder®DC is available for hard and light working conditions. Please contact your Shamban sales engineer for details.

Please note that O-Rings must be ordered separately ! Sizes can be found in Table XLVIII, page 109. Without the O-Ring the Excluder®DC has unlimited shelf life.

Excluder® to fit larger and smaller grooves than mentioned in Table XLVIII are available upon request.

Installation Turcon® Excluder®DC, Series No. WE25 (Old Series No. S32925), Turcon® Excluder®DC, Series E, Series No. WE65 (Old Series No S33865) and Turcon® DC Scraper, Series No. WM82 (Old Series No. S34382)

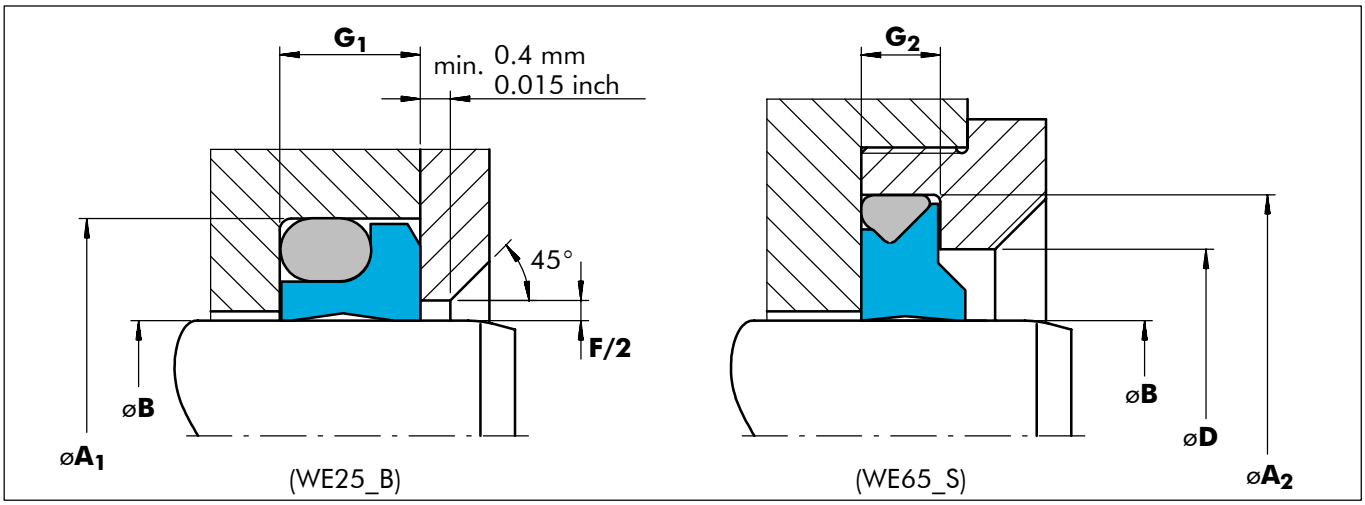


Figure 130 Installation Drawing

Table XLVIII Groove Dimensions

Rod Size	Rod Dia. øB		Shamban Size WE25					MS33675, WE65 and WM82					
MS-33675	Inch	mm	Groove Dia. øA1		Width G1	Dia. Cl. F (max)	O-Ring size AS 568A	Groove Dia. øA2		Dia. Clearance øD		Width G2	O-Ring size only WE65 AS 568A
			Inch	mm	Inch / mm	Inch / mm		Inch	mm	Inch	mm	Inch / mm	
	+0.000 -0.001	+0.00 -0.03	+0.002 -0.000	+0.05 -0.00	.144 +.005/-0 | 3.66 +0.13/-0	.042 | 1.07		+0.004 -0.000	+0.10 -0.00	+0.005 -0.000	+0.13 -0.00	.104 +.005/-0 | 2.64 +0.13/-0	
1/4	0.248	6.30	0.436	11.07			011	0.510	12.95	0.398	10.11		012
5/16	0.310	7.87	0.498	12.65			012	0.572	14.53	0.460	11.68		013
3/8	0.373	9.47	0.561	14.25			013	0.636	16.15	0.523	13.28		014
7/16	0.435	11.05	0.623	15.82			014	0.697	17.70	0.585	14.86		015
	+0.000 -0.002	+0.00 -0.05											
001	0.498	12.65	0.766	19.46			113	0.760	19.30	0.647	16.43		016
002	0.560	14.22	0.828	21.03			114	0.823	20.90	0.710	18.03		017
003	0.623	15.82	0.891	22.63			115	0.885	22.48	0.772	19.61		018
004	0.685	17.40	0.953	24.21			116	0.948	24.08	0.834	21.18		019
005	0.748	19.00	1.016	25.81	.195 +.005/-0 | 4.95 +0.13/-0		117	1.010	25.65	0.897	22.78		020
006	0.810	20.57	1.078	27.38			118	1.086	27.58	0.949	24.10		021
007	0.873	22.17	1.141	28.98			119	1.148	29.16	1.012	25.70		022
008	0.935	23.75	1.203	30.56			120	1.210	30.73	1.074	27.28		023
009	0.998	25.35	1.266	32.16			121	1.273	32.33	1.136	28.85		024
010	1.060	26.92	1.328	33.73			122	1.335	33.91	1.199	30.45		025
011	1.123	28.52	1.391	35.33			123	1.398	35.51	1.262	32.05		026
012	1.185	30.10	1.453	36.91			124	1.460	37.08	1.324	33.63		027
013	1.248	31.70	1.516	38.51			125	1.523	38.68	1.386	35.20		028
014	1.310	33.27	1.578	40.08			126	1.614	41.00	1.480	37.59		029
015	1.373	34.87	1.641	41.68			127	1.677	42.60	1.542	39.17		029
016	1.435	36.45	1.703	43.26			128	1.739	44.17	1.605	40.77		030
017	1.498	38.05	1.766	44.86			129	1.802	45.77	1.668	42.37		030
018	1.623	41.22	1.891	48.03			131	1.927	48.95	1.793	45.54		031
019	1.748	44.40	2.016	51.21			133	2.052	52.12	1.918	48.72		032

Metric sizes.

Rod Size	Rod Dia. øB		Shamban Size WE25					MS33675, WE65 and WM82					
MS33675	Inch	mm	Groove Dia. øA1		Width G1	Dia. Cl., F (max)	O-Ring size AS 568A	Groove Dia. øA2		Dia. Clearance øD		Width G2	O-Ring size only WE65 AS 568A
			Inch	mm	Inch / mm	Inch / mm		Inch	mm	Inch	mm	Inch / mm	
	+0.000 -0.002	+0.00 -0.05	+0.002 -0.000	+0.05 -0.00				+0.004 -0.000	+0.10 -0.00	+0.005 -0.000	+0.13 -0.00		
020	1.873	47.57	2.141	54.38	.195 +.005/-0 | 4.95 +0.13/-0		135	2.177	55.30	2.043	51.89	.104 +.005/-0 | 2.64 +0.13/-0	033
021	1.998	50.75	2.266	57.56			137	2.302	58.47	2.178	55.32		034
022	2.123	53.92	2.391	60.73			139	2.427	61.65	2.303	58.50		035
023	2.248	57.10	2.516	63.91			141	2.552	64.82	2.428	61.67		036
024	2.373	60.27	2.641	67.08			143	2.677	68.00	2.553	64.85		037
025	2.498	63.45	2.766	70.26			145	2.802	71.17	2.678	68.02		038
026	2.623	66.62	2.971	75.46			232	2.989	75.92	2.834	71.98		039
027	2.748	69.80	3.096	78.64			233	3.114	79.10	2.959	75.16		040
028	2.873	72.97	3.221	81.81			234	3.239	82.27	3.084	78.33		041
029	2.997	76.12	3.345	84.96			235	3.364	85.45	3.209	81.51		041
030	3.122	79.30	3.470	88.14			236	3.489	88.62	3.334	84.68	.119 +.005/-0 | 3.02 +0.13/-0	042
031	3.247	82.47	3.595	91.31			237	3.614	91.80	3.459	87.86		042
032	3.372	85.65	3.720	94.49			238	3.739	94.97	3.584	91.03		043
033	3.497	88.82	3.845	97.66			239	3.864	98.15	3.709	94.21		043
034	3.622	92.00	3.970	100.84			240	3.989	101.32	3.834	97.38		044
035	3.747	95.17	4.095	104.01			241	4.114	104.50	3.959	100.56		044
036	3.872	98.35	4.220	107.19			242	4.239	107.67	4.084	103.73		045
037	3.997	101.52	4.345	110.36			243	4.427	112.45	4.240	107.70		156
038	4.122	104.70	4.470	113.54			244	4.552	115.62	4.365	110.87		156
039	4.247	107.87	4.595	116.71			245	4.677	118.80	4.490	114.05		157
040	4.372	111.05	4.720	119.89			246	4.802	121.97	4.615	117.22		157
	+0.000 -0.003	+0.00 -0.08	+0.003 -0.000	+0.08 -0.00				+0.005 -0.000	+0.13 -0.00				
041	4.497	114.22	4.845	123.06	.240 +.005/-0 | 6.10 +0.13/-0	.042 | 1.07	247	4.927	125.15	4.740	120.40	.135 +.005/-0 | 3.43 +0.13/-0	158
042	4.622	117.40	4.970	126.24			248	5.052	128.32	4.865	123.57		158
043	4.747	120.57	5.095	129.41			249	5.177	131.50	4.990	126.75		159
044	4.872	123.75	5.220	132.59			250	5.302	134.67	5.115	129.92		159
045	4.997	126.92	5.345	135.76			251	5.427	137.85	5.240	133.10		160
046	5.122	130.10	5.470	138.94			252	5.552	141.02	5.365	136.27		160
047	5.247	133.27	5.595	142.11			253	5.677	144.20	5.490	139.45		161
048	5.372	136.45	5.720	145.29			254	5.802	147.37	5.615	142.62		161
049	5.497	139.62	5.845	148.46			255	5.927	150.55	5.740	145.80		162
050	5.622	142.80	5.970	151.64			256	6.114	155.30	5.896	149.76		162
051	5.747	145.97	6.095	154.81			257	6.239	158.47	6.022	152.96		163
052	5.872	149.15	6.220	157.99			258	6.364	161.65	6.146	156.11		163
053	5.997	152.32	6.345	161.16			258	6.489	164.82	6.272	159.31		164
054	6.247	158.67	6.595	167.51			259	6.739	171.17	6.522	165.66		165
055	6.497	165.02	6.845	173.86			260	6.989	177.52	6.772	172.01		166
056	6.747	171.37	7.095	180.21			261	7.239	183.87	7.022	178.36		167
057	6.997	177.72	7.345	186.56			262	7.489	190.22	7.272	184.71	.151 +.005/-0 | 3.84 +0.13/-0	168
058	7.247	184.07	7.595	192.91			263	7.739	196.57	7.522	191.82		169
059	7.497	190.42	7.845	199.26			264	7.989	202.92	7.772	197.41		170
060	7.747	196.77	8.095	205.61			265	8.239	209.27	8.022	203.76		171
			+0.005 -0.000	+0.13 -0.00									
061	7.997	203.12	8.345	211.96			266	8.489	215.62	8.272	210.11		172
062	8.497	215.82	8.845	224.66			268	8.989	228.32	8.772	222.81		174
063	8.997	228.52	9.345	237.36			270	9.489	241.02	9.272	235.51		176
064	9.497	241.22	9.845	250.06			272	9.989	253.72	9.772	248.21		178
065	9.997	253.92	10.345	262.76			274	10.489	266.42	10.272	260.91		
066	10.497	266.62	10.845	275.46			275	10.989	279.12	10.772	273.61		
067	10.997	279.32	11.345	288.16			276	11.489	291.82	11.272	286.31		
068	11.497	292.02	11.845	300.86			277	11.989	304.52	11.772	299.01	.166 +.005/-0 | 4.22 +0.13/-0	278
069	11.997	304.72	12.345	313.56			278	12.489	317.22	12.272	311.71		278
070	12.497	317.42	12.845	326.26			278	12.989	329.92	12.772	324.41		279
071	12.997	330.12	13.345	338.96			279	13.489	342.62	13.272	337.11		279

Metric sizes.

Turcon® Variseal®M2S Scraper

Description

The Turcon® Variseal®M2S is a single-acting seal/scraper consisting of a U-shaped seal jacket and a V-shaped corrosion resistant spring.

The most unique characteristic of the Variseal®M2S is the newly developed asymmetric seal profile, where the dynamic lip has an optimized heavy profile, and offers long service life and a good scraping effect, even in highly viscous media.

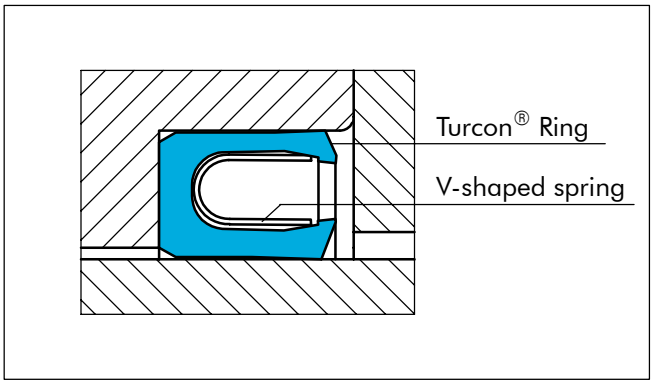


Figure 131 Turcon® Variseal®M2S

The Variseal®M2S can be sterilized and is available in a special Hi-Clean version where the spring cavity is filled with silicone to prevent contaminants from being entrapped in the seal. This design also works well in applications involving mud, slurries, ice, and prevents grit from packing into the seal cavity and inhibiting the spring action.

Variseal®M2S can be installed in grooves to MIL-G-5514F/ AS4716 and ISO 3771. The seal can only be installed to a limited extent in closed grooves. Installation instructions, see page 75. Utilize Table XXIX and Table XXXI.

Advantages

- Excellent scraping effect
- Reciprocating and turning movement
- Low friction characteristics for precise control
- High abrasion resistance and dimensional stability
- Can handle rapid changes in temperature
- Suitable for use in a variety of caustic media
- Can be sterilized
- Unlimited shelf life.

Technical Data

Speed:	Reciprocating up to 15 m/s (49.8 ft.) Turning up to 0.5 m/s (1.65 ft/s)
Temperature:	-70°C to +260°C (-94°F to +500°F) For specific applications at lower temperatures, please ask your Shamban sales engineer
Media:	Typically fluids with medium to high viscocity and media containing hard particles

Materials

For spring and material selection, see Table XXIV, page 70.

Installation Variseal®M2S Scraper, Series No. RVC, Rod

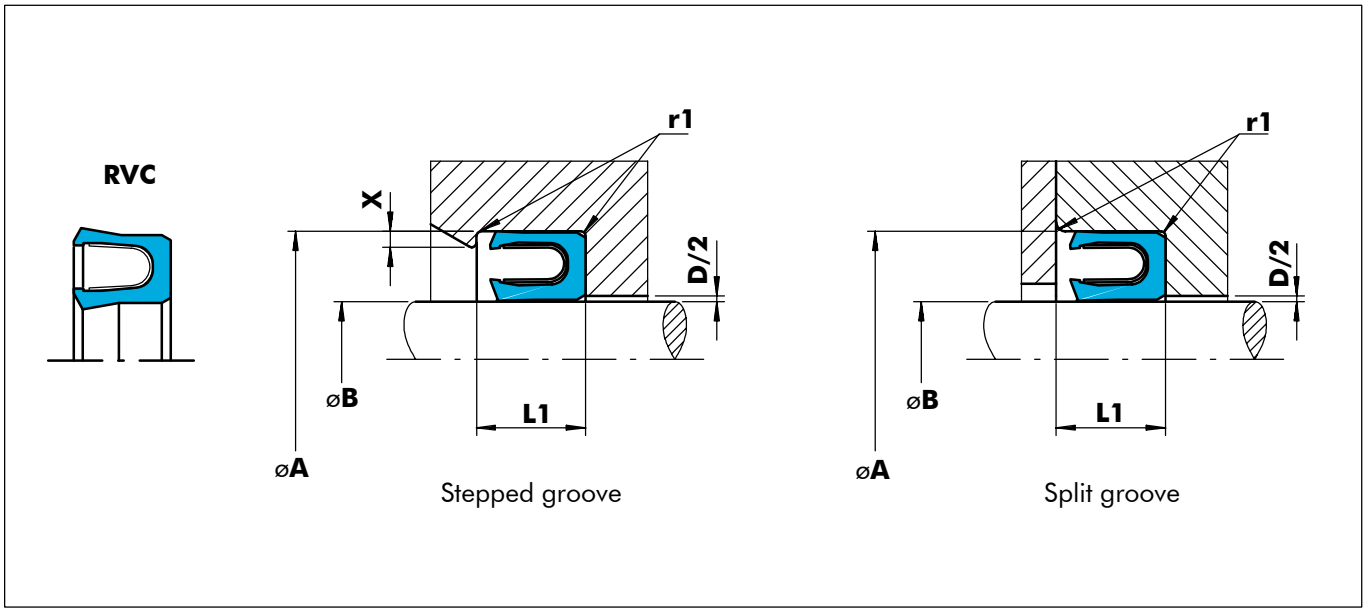


Figure 132 Installation Drawing

Table XLIX Groove Dimensions (metric)

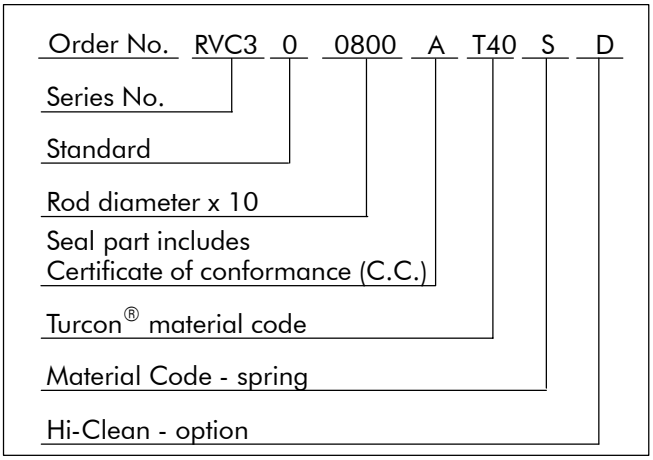
Series No.	Rod Diameter øB h9		Groove Diameter	Groove Width	Radius	Step[2] Height	Radial Clearance D/2 max.*			
	Recommended Range	Extended[1] Range	øA H9	L_1 +0.2	r_1	X	<2 MPa (300 psi)	<10 MPa (1500 psi)	<21 MPa (3000 psi)	<40 MPa (5800 psi)
RVC0	3.0 - 9.9	3.0 - 40.0	øB + 2.9	2.4	0.4	0.4	0.20	0.10	0.08	0.05
RVC1	10.0 - 19.9	6.0 - 200.0[3]	øB + 4.5	3.6	0.4	0.6	0.25	0.15	0.10	0.07
RVC2	20.0 - 39.9	10.0 - 400.0[3]	øB + 6.2	4.8	0.6	0.7	0.35	0.20	0.15	0.08
RVC3	40.0 - 119.9	20.0 - 700.0[3]	øB + 9.4	7.1	0.8	0.8	0.50	0.25	0.20	0.10
RVC4	120.0 - 999.9	35.0 - 999.9[3]	øB + 12.2	9.5	0.8	0.9	0.60	0.30	0.25	0.12

* At pressures **> 40 MPa**: D/2 max. use H8/f8
1) Available on request
2) Maximum X = 0.02 x øB
3) For diameters larger than "Recommended Range": the tolerance on øA is changed from H9 to H8. For pressure above 40 MPa (5000 psi), please contact your Shamban sales engineer.

Ordering Example

Turcon® Variseal®M2S, Series RVC3.
Rod diameter: øB = 80.0 mm
Part No: RVC300800

Select the materials from Table I, page 12 and Table XXIV, page 70. The corresponding code numbers are appended to the Part No. Together these form the order number.
The order number for all intermediate sizes not shown in Table XLIX can be determined by following the example opposite.



Installation Variseal®M2S Scraper, Series No. PVC, Bore

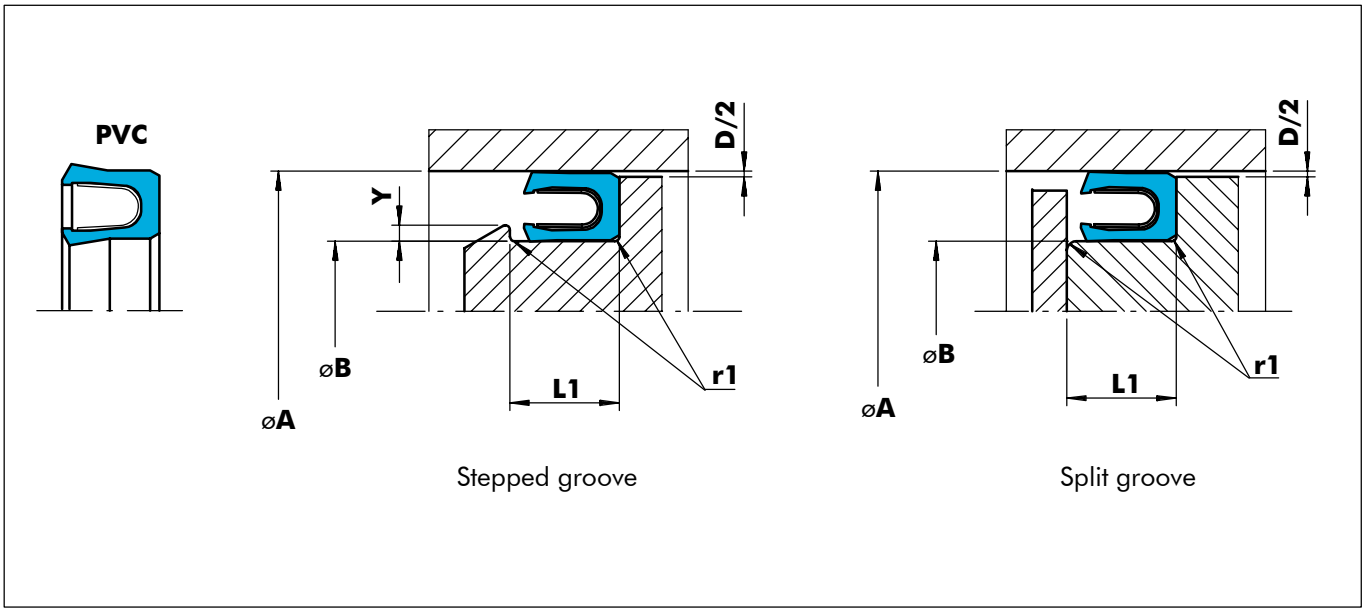


Figure 133 Installation Drawing

Table L Groove Dimensions (metric)

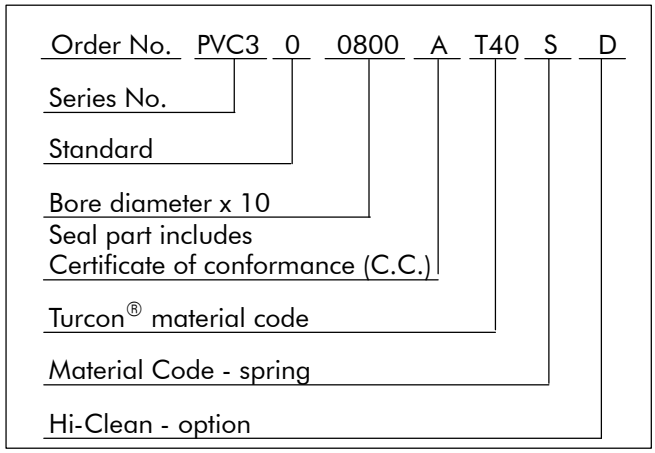
Series No.	Bore Diameter øA H9		Groove Diameter	Groove Width	Radius	Step2) Height	Radial Clearance D/2 max*			
	Recommended Range	Extended1) Range	øB h9	L_1 +0.2	r_1	Y	<2 MPa (300 psi)	<10 MPa (1500 psi)	<21 MPa (3000 psi)	<40 MPa (5800 psi)
PVC0	6.0 - 13.9	6.0 - 40.0	øA-2.9	2.4	0.4	0.4	0.20	0.10	0.08	0.05
PVC1	14.0 - 24.9	10.0 - 200.0[3]	øA-4.5	3.6	0.4	0.6	0.25	0.15	0.10	0.07
PVC2	25.0 - 45.9	16.0 - 400.0[3]	øA-6.2	4.8	0.6	0.7	0.35	0.20	0.15	0.08
PVC3	46.0 - 124.9	28.0 - 700.0[3]	øA-9.4	7.1	0.8	0.8	0.50	0.25	0.20	0.10
PVC4	125.0 - 999.9	45.0 - 999.9[3]	øA-12.2	9.5	0.8	0.9	0.60	0.30	0.25	0.12

*At pressures > **40 MPa** $D/2_{max}$ use H8/f8
1) Available on request.
2) Maximum Y = 0.035 x øA
3) For diameters larger than "Recommended Range": the tolerance on øB is changed from h9 to h8. For pressure above 40 MPa (5000 PSI), please contact your Shamban sales engineer.

Ordering example

Turcon® Variseal®M2S, Series PVC3.
Bore diameter: øA = 80.0 mm
Part No.: PVC300800

Select the materials from Table I, page 12 and Table XXIV, page 70. The corresponding code numbers are appended to the Part No. Together these form the order number.
For all intermediate sizes not shown in Table L, the Order No. can be determined from the example shown opposite.



Turcite® Slydring® / Luytex® Slydring®

The purpose of the rings is to guide the piston and rod of a working cylinder and to absorb the transverse forces which may occur. Metallic contact between the sliding parts of the cylinder must be prevented. Non-metallic Slydring® offer major benefits compared with the traditional metallic bearings:

- Cost efficient.
- High load bearing capacity.
- Eliminates local stress concentrations.
- Very wear-resistant, long service life.
- Eliminates galling.
- Good friction characteristics.
- Damping of mechanical vibrations.
- Protection of the seal against "dieseling".
- Eliminates hydrodynamic problems in the guide system.
- Easy installation.
- Low maintenance costs.

Designs

Three different types of Slydring® materials are available depending upon application demands:

- Highly wear-resistant, low friction, specially modified Turcite® materials for low to medium loads - Slydring®.
- Luytex® fabric composite materials for high loads and transverse forces - Slydring®.
- Zurcon®. High modulus thermoplastics for high loads, temperature with long service life.

Slydring® for Aerospace Applications

In the past, due to the imposed limitations of MIL-G-5514F/AS4716 and the minimum required clearance gaps necessary to minimize seal extrusion, Slydring® use has been limited. The use of Slydring® often requires larger clearance gaps.

With the trend toward higher hydraulic system pressures, resulting in higher sideloads, the use of Slydring® becomes necessary in order to protect primary seals and hardware.

Since no industry standard has been developed for Slydring®, we have a wide range of sizes available in preformed rings.

Slydring® are provided as cut rings with an angle cut as standard. For special applications, other cut types are available; consult your Shamban sales engineer.

Table LI Selection Criteria for Turcite® Slydring® / Luytex® Slydring®

Material	Filler	Technical Data		Application
Material Designation		Temperature C°/F°	Velocity m/s (ft/s)	
Turcon® T08	High filled bronze	-80 to +200 (-112 to +392)	15 (99)	Standard bearing for low to medium load
Turcon® T10 2)	Carbon / Graphite			
Turcon® T29	Carbon fiber			
Luytex® C380	Polyesther resin + PTFE	-60 to +130 (-76 to +266)	1 (3.3)	High sideload 1)
Zurcon® Z43	High modulus thermoplastic and PTFE + Carbon	-80 to +200 (-112 to +392)	15 (99)	High speed, temperature and pressure. Excellent for PFC

1) Consult your Shamban sales engineer prior to applying Luytex®.
2) Turcon® T11, used in North America is equivalent to Turcon® T10.

Installation Recommendations, Turcite® Slydring® / Luytex® Slydring® for Piston Series No. GP0 (Old Series No. S34545, S34546 and S34547)

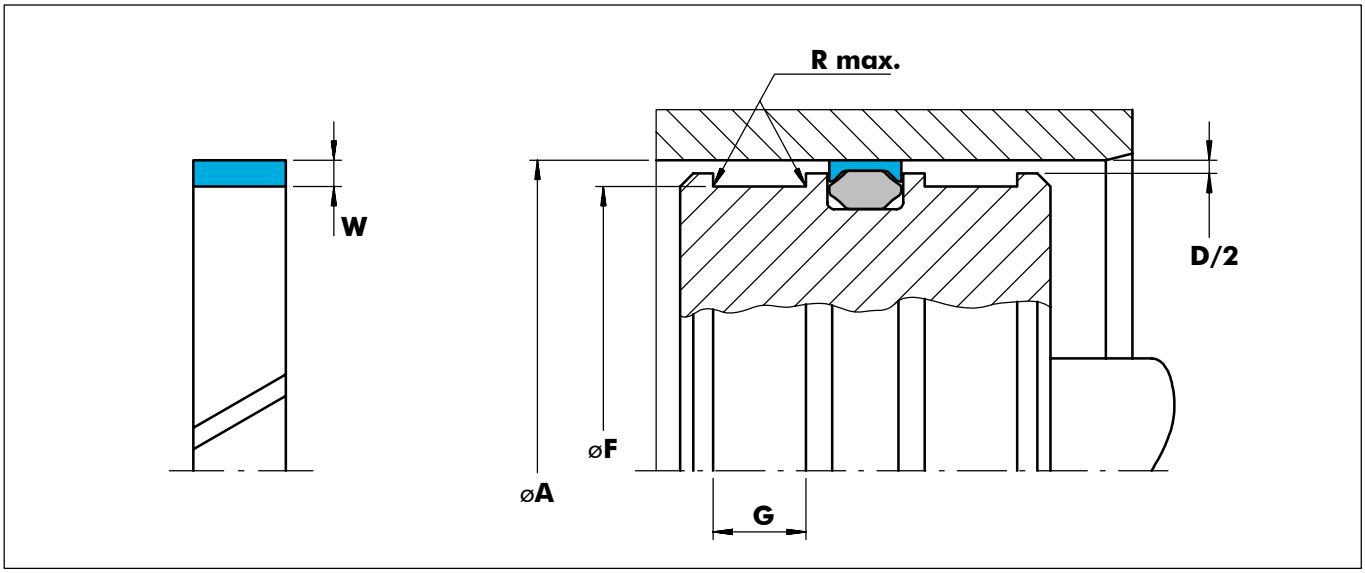


Figure 134 Installation Drawing

Table LII Groove Dimensions

Series No.	Bore Diameter		Groove Diameter		Groove Width		Radial Clearance	
	Inch	mm	Inch	mm	Inch	mm	Inch	mm
	øA	**øA**	**øF** h8	**øF** h8	**G** +0.010	**G** +0.25	**D/2max.**	**D/2max.**
GP02X	0.235 - 1.491	5.97 - 37.87	øA - 0.064	øA - 1.63	0.135	3.43	0.007	0.18
GP04X	0.235 - 1.491	5.97 - 37.87	øA - 0.064	øA - 1.63	0.260	6.60	0.007	0.18
GP06X	0.235 - 1.491	5.97 - 37.87	øA - 0.064	øA - 1.63	0.385	9.78	0.007	0.18
GP08X	0.235 - 1.491	5.97 - 37.87	øA - 0.064	øA - 1.63	0.510	12.95	0.007	0.18
GP02W	0.550 - 4.468	13.97 - 113.49	øA - 0.126	øA - 3.20	0.135	3.43	0.009	0.23
GP04W	0.550 - 4.468	13.97 - 113.49	øA - 0.126	øA - 3.20	0.260	6.60	0.009	0.23
GP06W	0.550 - 4.468	13.97 - 113.49	øA - 0.126	øA - 3.20	0.385	9.78	0.009	0.23
GP08W	0.550 - 4.468	13.97 - 113.49	øA - 0.126	øA - 3.20	0.510	12.95	0.009	0.23
GP02Y	2.993 - 10.474	76.02 - 266.04	øA - 0.188	øA - 4.78	0.135	3.43	0.011	0.28
GP04Y	2.993 - 10.474	76.02 - 266.04	øA - 0.188	øA - 4.78	0.260	6.60	0.011	0.28
GP06Y	2.993 - 10.474	76.02 - 266.04	øA - 0.188	øA - 4.78	0.385	9.78	0.011	0.28
GP08Y	2.993 - 10.474	76.02 - 266.04	øA - 0.188	øA - 4.78	0.510	12.95	0.011	0.28

Metric sizes.

Table LIII Recommended Radius for Groove Dia.

Bore Diameter		Rmax.	
Inch	mm	Inch	mm
< 9.842	< 250.0	0.008	0.2
> 9.842	> 250.0	0.015	0.4

Metric sizes.

Installation Recommendations, Turcite® Slydring® / Luytex® Slydring® for Rod Series No. GR0 (Old Series No. S34548, S34549 and S34550)

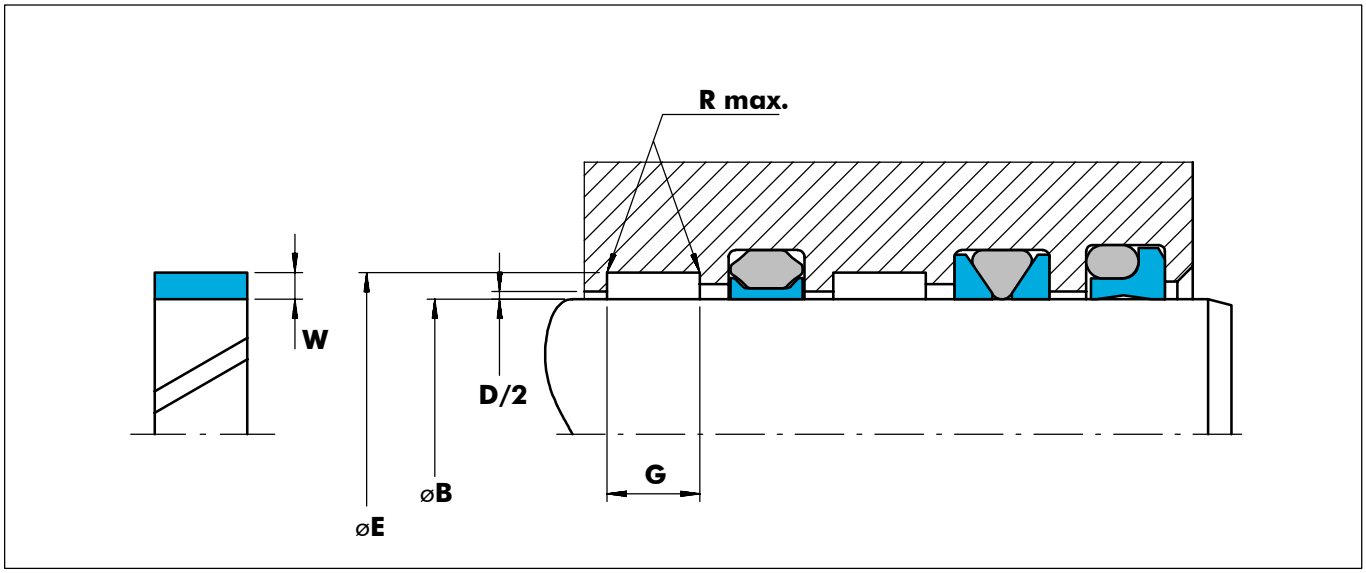


Figure 135 Installation Drawing

Table LIV Groove Dimensions

Series No.	Rod Diameter		Groove Diameter		Groove Width		Radial Clearance	
	Inch	mm	Inch	mm	Inch	mm	Inch	mm
	øB	**øB**	**øE** h8	**øE** h8	**G** +0.010	**G** +0.25	**D/2max.**	**D/2max.**
GR02X	0.123 - 1.498	3.12 - 38.05	øB + 0.064	øB + 1.63	0.135	3.43	0.007	0.18
GR04X	0.123 - 1.498	3.12 - 38.05	øB + 0.064	øB + 1.63	0.260	6.60	0.007	0.18
GR06X	0.123 - 1.498	3.12 - 38.05	øB + 0.064	øB + 1.63	0.385	9.78	0.007	0.18
GR08X	0.123 - 1.498	3.12 - 38.05	øB + 0.064	øB + 1.63	0.510	12.95	0.007	0.18
GR02W	0.373 - 4.497	9.47 - 114.22	øB + 0.126	øB + 3.20	0.135	3.43	0.009	0.23
GR04W	0.373 - 4.497	9.47 - 114.22	øB + 0.126	øB + 3.20	0.260	6.60	0.009	0.23
GR06W	0.373 - 4.497	9.47 - 114.22	øB + 0.126	øB + 3.20	0.385	9.78	0.009	0.23
GR08W	0.373 - 4.497	9.47 - 114.22	øB + 0.126	øB + 3.20	0.510	12.95	0.009	0.23
GR02Y	2.997 - 9.997	76.12 - 253.92	øB + 0.188	øB + 4.78	0.135	3.43	0.011	0.28
GR04Y	2.997 - 9.997	76.12 - 253.92	øB + 0.188	øB + 4.78	0.260	6.60	0.011	0.28
GR06Y	2.997 - 9.997	76.12 - 253.92	øB + 0.188	øB + 4.78	0.385	9.78	0.011	0.28
GR08Y	2.997 - 9.997	76.12 - 253.92	øB + 0.188	øB + 4.78	0.510	12.95	0.011	0.28

Metric sizes.

Table LV Recommended Radius for Groove Dia.

Bore Diameter		Rmax.	
Inch	mm	Inch	mm
< 9.842	< 250.0	0.008	0.2
> 9.842	> 250.0	0.015	0.4

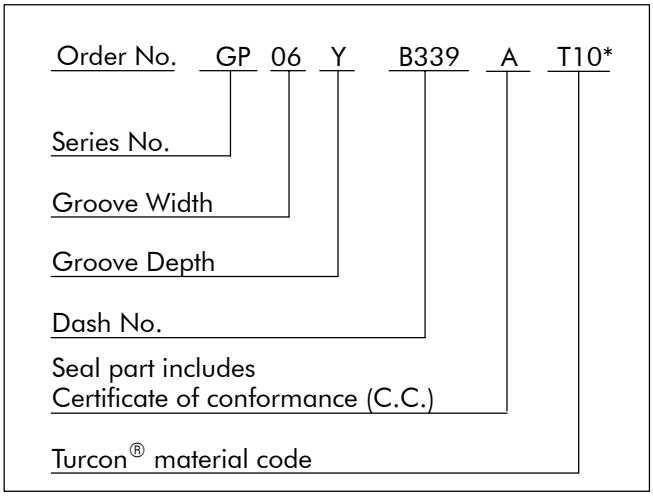
Metric sizes.

Ordering example - Piston

Slydring® for bore diameter A: 91.90 mm (3.618 inch)
Dash No. per MIL-G-5514F: -339
Series GP0 from Table LII, page 115

Groove width: 9.78 mm (0.385 inch)
Groove depth: 2.39 mm (0.094 inch)

Material: Turcon® T10
see Table I, page 12.



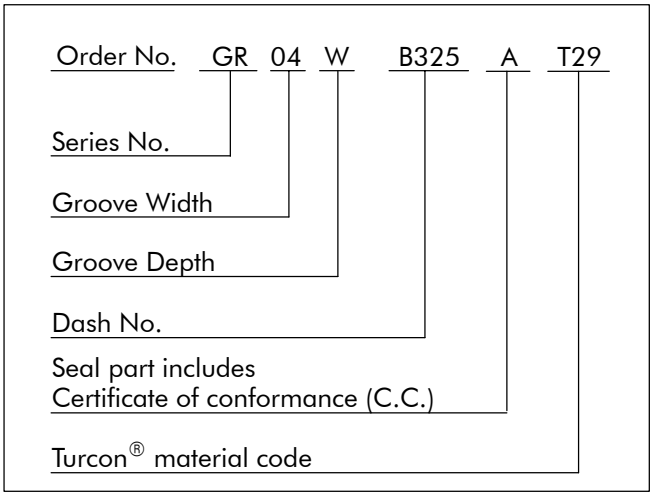
* Turcon® T11, used in North America is equivalent to Turcon® T10

Ordering example - Rod

Slydring® for rod diameter B: 38.05 mm (1.498 inch)
Dash No. per MIL-G-5514F: -325
Series GR0 from Table LIV, page 116

Groove width: 6.60 mm (0.260 inch)
Groove depth: 1.60 mm (0.063 inch)

Material: Turcon® T29
see Table I, page 12



Note: Slydring® in material Luytex® and Zurcon® will use special Part No. due to tolerance and temperature variations. For other sizes, (width/depth) and special Part No. consult your Shamban sales engineer.

Turcon® Wedgpak® Face Seal

Description

The Turcon® Wedgpak® Face Seal is an adaptation of the traditional Wedgpak® design to maximize performance in face seal applications. It utilizes a triangular shaped Turcon® delta ring energized by a uniquely shaped elastomer designed to maximize extrusion protection under abnormal clearance gap conditions.

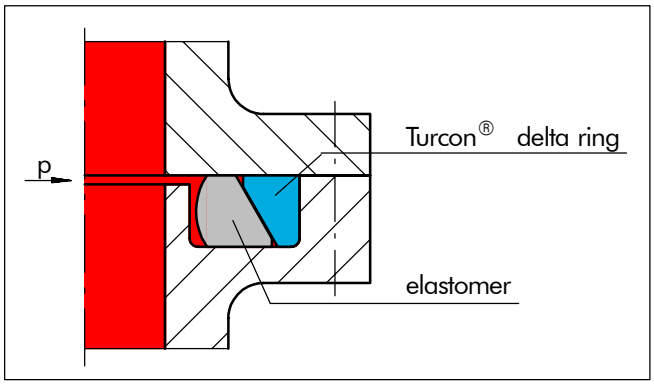


Figure 136 Turcon® Wedgpak® Face Seal

Method of Operation

It is typical for face seal applications to experience impulse pressures and therefore abnormally high "breathing" conditions in mating hardware. The Turcon® delta ring uses the full depth of the seal groove to optimize the amount of material available and maximize extrusion protection under worst case conditions. The special shaped geometry of the elastomer provides a preload under low pressure conditions, and constantly forces the Turcon® delta ring up against the clearance gap to prevent extrusion of the elastomer.

Advantages

- Excellent static sealing effect
- Good extrusion protection
- Easy installation

Technical Data

Operating pressure: 35 MPa (5000 psi)

Speed: Not applicable

Temperature range: -54°C to +200°C
(-65°F to +390°F)
(depending on elastomer material)

Clearance: Can exceed recommendations of MIL-G-5514F/AS4716 dependent upon the combination of pressures and clearance gaps

Media: Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), Phosphate Ester, water and others, depending on the elastomer material (see Table IV, page 16)

Materials

See Table I, page 12 and Table III, page 15.

Series

The Wedgpak® Face Seal follows the series as described in following pages. Special sizes are available upon request. Please contact your Shamban sales engineer.

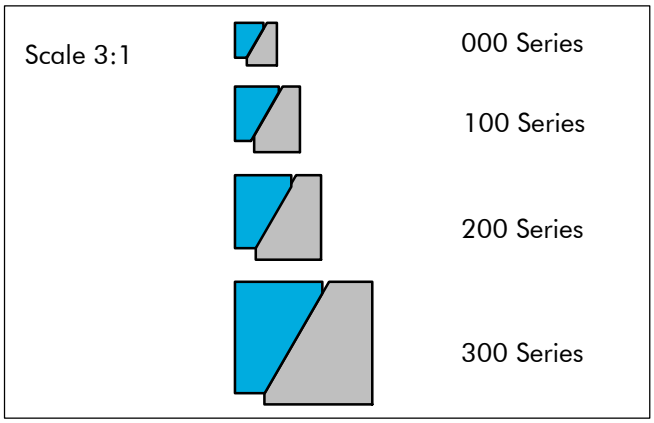


Figure 137 Relationship Between the Profile Cross-Section

Case Story

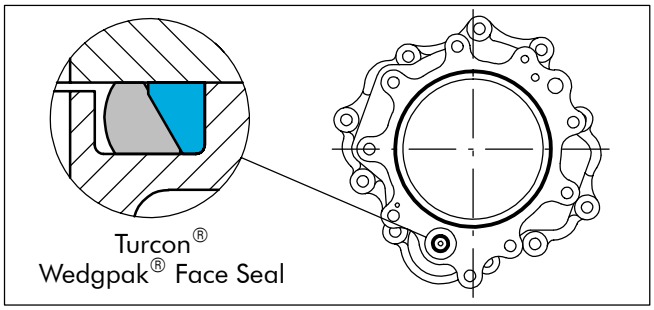


Figure 138 Engine Driven Hydraulic Pump Flange Seal Retrofit

Problem

Operators of wide bodied aircraft have experienced leakage of engine driven pumps, between adaptor block and housing.

Solution

Turcon® Wedgpak® Face Seal eliminated leakage failures.

Installation Turcon® Wedgpak® Face Seal, Series No. DW00 (Old Series No. S38000), Internal

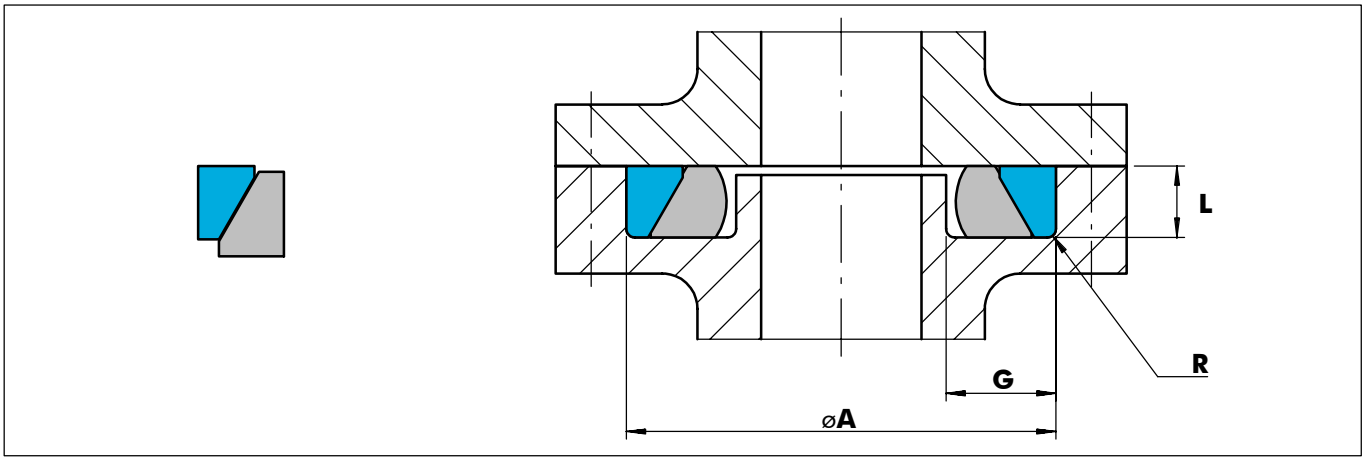


Figure 139 Installation Drawing

Table LVI Groove Dimensions

Dash No	øA Dia. Inch	øA Dia. mm	G Groove Width. Inch	G Groove Width. mm	L Groove Depth Inch	L Groove Depth mm	R Inch / mm
	+0.000 -0.005	+0.00 -0.13	+0.010 -0.000	+0.25 -0.00	±0.001	±0.03	
008	0.316	8.03	0.094	2.39	0.057	1.45	0.005 | 0.015
009	0.348	8.94					
010	0.379	9.63					
011	0.441	11.20					
012	0.504	12.80					
013	0.566	14.38					
014	0.629	15.98					
015	0.691	17.55					
016	0.754	19.15					
017	0.816	20.73					
018	0.879	22.33					
019	0.941	23.90					
020	1.004	25.50					
021	1.066	27.08					
022	1.129	28.68					
023	1.191	30.25					
024	1.254	31.85					
025	1.316	33.43					
026	1.379	35.03					
027	1.441	36.60					
028	1.504	38.20					
110	0.568	14.43	0.141	3.58	0.090	2.29	0.13 | 0.38
111	0.630	16.00					
112	0.693	17.60					
113	0.755	19.18					
114	0.818	20.78					
115	0.880	22.35					
116	0.943	23.95					
117	1.005	25.53					
118	1.068	27.13					
119	1.130	28.70					
120	1.193	30.30					

Dash No	øA Dia. Inch	øA Dia. mm	G Groove Width. Inch	G Groove Width. mm	L Groove Depth Inch	L Groove Depth mm	R Inch / mm
	+0.000 -0.005	+0.00 -0.13	+0.010 -0.000	+0.25 -0.00	±0.001	±0.03	
121	1.255	31.12	0.141	3.58	0.090	2.29	0.005 | 0.015
122	1.318	33.48					
123	1.380	35.05					
124	1.443	36.65					
125	1.505	38.23					
126	1.568	39.83					
127	1.630	41.40					
128	1.693	43.00					
129	1.755	44.58					
130	1.818	46.18					
131	1.880	47.75					
132	1.943	49.35					
133	2.005	50.83					
134	2.068	52.53					
135	2.131	54.13					
210	1.012	25.70	0.188	4.78	0.122	3.10	0.010 | 0.025
211	1.074	27.28					
212	1.137	28.88					
213	1.199	30.45					
214	1.262	32.05					
215	1.324	33.63					
216	1.387	35.23					
217	1.449	36.80					
218	1.512	38.40					
219	1.574	39.98					
220	1.637	41.58					
221	1.699	43.15					
222	1.762	44.75					
223	1.887	47.93					
224	2.012	51.10					
225	2.137	54.28					
226	2.262	57.45					

Metric sizes.

Dash No	⌀A Dia.		G Groove Width.		L Groove Depth		R
	Inch	mm	Inch	mm	Inch	mm	Inch / mm
	+0.000 -0.005	+0.00 -0.13	+0.010 -0.000	+0.25 -0.00	±0.001	±0.03	
227	2.387	60.63					
228	2.512	63.80					
229	2.637	66.98					
230	2.762	70.15					
231	2.887	73.33					
232	3.012	76.50					
233	3.137	79.68					
234	3.262	82.85					0.010 | 0.025
235	3.387	86.03					
236	3.512	89.20					
237	3.637	89.84	0.188	4.76	0.122	3.10	
238	3.762	95.55					0.25 | 0.63
239	3.887	98.73					
240	4.012	101.90					
241	4.137	105.08					
242	4.262	108.25					
243	4.387	111.43					
244	4.512	114.60					
245	4.637	117.78					
246	4.762	120.95					
247	4.887	124.13					
325	1.895	48.13					
326	2.020	51.31					
327	2.145	54.48					
328	2.270	57.66					
329	2.395	60.83					
330	2.520	64.01					
331	2.645	67.18					
332	2.770	70.36					
333	2.895	73.53					
334	3.020	76.71					0.020 | 0.035
335	3.145	79.88					
336	3.270	83.06					
337	3.395	86.23	0.281	7.14	0.187	4.75	
338	3.520	89.41					0.51 | 0.89
339	3.645	92.58					
340	3.770	95.76					
341	3.895	98.93					
342	4.020	102.11					
343	4.145	105.28					
344	4.270	108.46					
345	4.395	111.63					
346	4.520	114.81					
347	4.645	117.98					
348	4.770	121.16					
349	4.895	124.33					

Metric sizes.

Ordering Example

Wedgpak® Face Seal for internal use
Series No. DW00

Dash No: 115

Material: T29 EH

Order No. DW00 0 B 115 A T29 EH

- DW00 — Series No.
- 0 — 0 = Standard
- B — Groove standard
- 115 — Shamban gland specification
- A — Seal part includes Certificate of conformance (C.C.)
- T29 — Turcon® material code
- EH — Elastomer material code

Installation Turcon® Wedgpak® Face Seal, Series No. DW01 (Old Series No. S38001), External

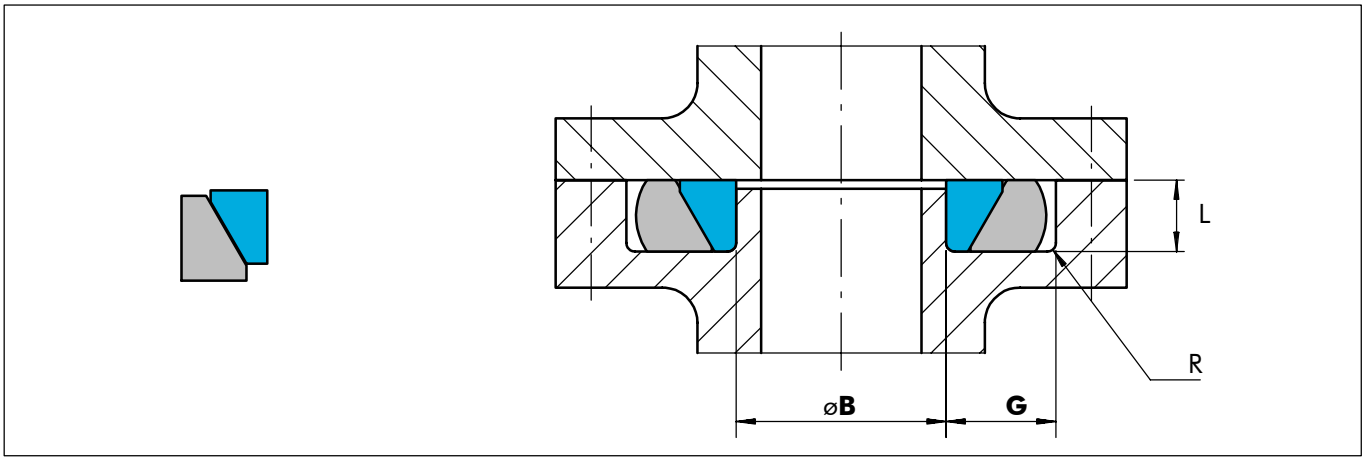


Figure 140 Installation Drawing

Table LVII Groove Dimensions

Dash No	øB Dia.		G Groove Width.		L Groove Depth		R
	Inch	mm	Inch	mm	Inch	mm	Inch / mm
	+0.000 -0.005	+0.00 -0.13	+0.010 -0.000	+0.25 -0.00	±0.001	±0.03	
008	0.176	4.47	0.094	2.39	0.057	1.45	0.005 | 0.015
009	0.208	5.28					
010	0.239	6.07					
011	0.301	7.65					
012	0.364	9.25					
013	0.426	10.82					
014	0.489	12.42					
015	0.551	14.00					
016	0.614	15.60					
017	0.676	17.17					
018	0.739	18.77					
019	0.801	20.35					
020	0.864	21.95					
021	0.926	23.52					
022	0.989	25.12					
023	1.051	26.70					
024	1.114	28.30					
025	1.176	29.87					
026	1.239	31.47					
027	1.301	33.05					
028	1.364	34.65					
110	0.362	9.19	0.141	3.58	0.090	2.29	0.13 | 0.38
111	0.424	10.77					
112	0.487	12.37					
113	0.549	13.94					
114	0.612	15.54					
115	0.674	17.12					
116	0.737	18.72					
117	0.799	20.29					
118	0.862	21.89					
119	0.924	23.47					
120	0.987	25.07					
121	1.049	26.64	0.141	3.58	0.090	2.29	0.005 | 0.015
122	1.112	28.24					
123	1.174	29.82					
124	1.237	31.42					
125	1.299	32.99					
126	1.362	34.59					
127	1.424	36.17					
128	1.487	37.77					
129	1.549	39.34					
130	1.612	40.94					
131	1.674	42.52					
132	1.737	44.12					
133	1.799	45.69					
134	1.862	47.29					
135	1.925	48.90					
210	0.734	18.64	0.188	4.76	0.122	3.10	0.010 | 0.025
211	0.796	20.22					
212	0.859	21.82					
213	0.921	23.39					
214	0.984	24.99					
215	1.046	26.57					
216	1.109	28.17					
217	1.171	29.74					
218	1.234	31.34					
219	1.296	32.92					
220	1.359	34.52					
221	1.421	36.09					
222	1.484	37.69					
223	1.609	40.87					
224	1.734	44.04					
225	1.859	47.22					
226	1.984	50.39					

Metric sizes.

Dash No	⌀B Dia.		G Groove Width.		L Groove Depth		R
	Inch	mm	Inch	mm	Inch	mm	Inch / mm
	+0.000 -0.005	+0.00 -0.13	+0.010 -0.000	+0.25 -0.00	±0.001	±0.03	
227	2.109	53.57					
228	2.234	56.74					
229	2.359	59.92					
230	2.484	63.09					
231	2.609	66.27					
232	2.734	69.44					
233	2.859	72.62					
234	2.984	75.79					0.010 | 0.025
235	3.109	78.97					
236	3.234	82.14					
237	3.359	85.32	0.188	4.76	0.122	3.10	
238	3.484	88.49					0.25 | 0.63
239	3.609	91.67					
240	3.734	94.84					
241	3.859	98.02					
242	3.984	101.19					
243	4.109	104.37					
244	4.234	107.54					
245	4.359	110.72					
246	4.484	113.89					
247	4.609	117.07					
325	1.475	37.47					
326	1.600	40.64					
327	1.725	43.82					
328	1.850	46.99					
329	1.975	50.17					
330	2.100	53.34					
331	2.225	56.52					
332	2.350	59.69					
333	2.475	62.87					
334	2.600	66.04					0.020 | 0.035
335	2.725	69.22					
336	2.850	72.39					
337	2.975	75.57	0.281	7.14	0.187	4.75	
338	3.100	78.74					0.51 | 0.89
339	3.225	81.92					
340	3.350	85.09					
341	3.475	88.27					
342	3.600	91.44					
343	3.725	94.62					
344	3.850	97.79					
345	3.975	100.97					
346	4.100	104.14					
347	4.225	107.32					
348	4.350	110.49					
349	4.475	113.67					

Metric sizes.

Ordering Example

Wedgpak® Face Seal for external use
Series No. DW01

Dash No: 236

Material: T05 NG

Order No. DW01 0 B 236 A T05 NG

- DW01 — Series No.
- 0 — 0 = Standard
- B — Groove standard
- 236 — Shamban gland specification
- A — Seal part includes Certificate of conformance (C.C.)
- T05 — Turcon® material code
- NG — Elastomer material code

Installation Instructions

General Comments

After choosing the right seal design, the second most important issue is to install the seal without damaging it.

The following hardware characteristics should be considered at an early hardware design stage in order to ensure damage free installation of seals.

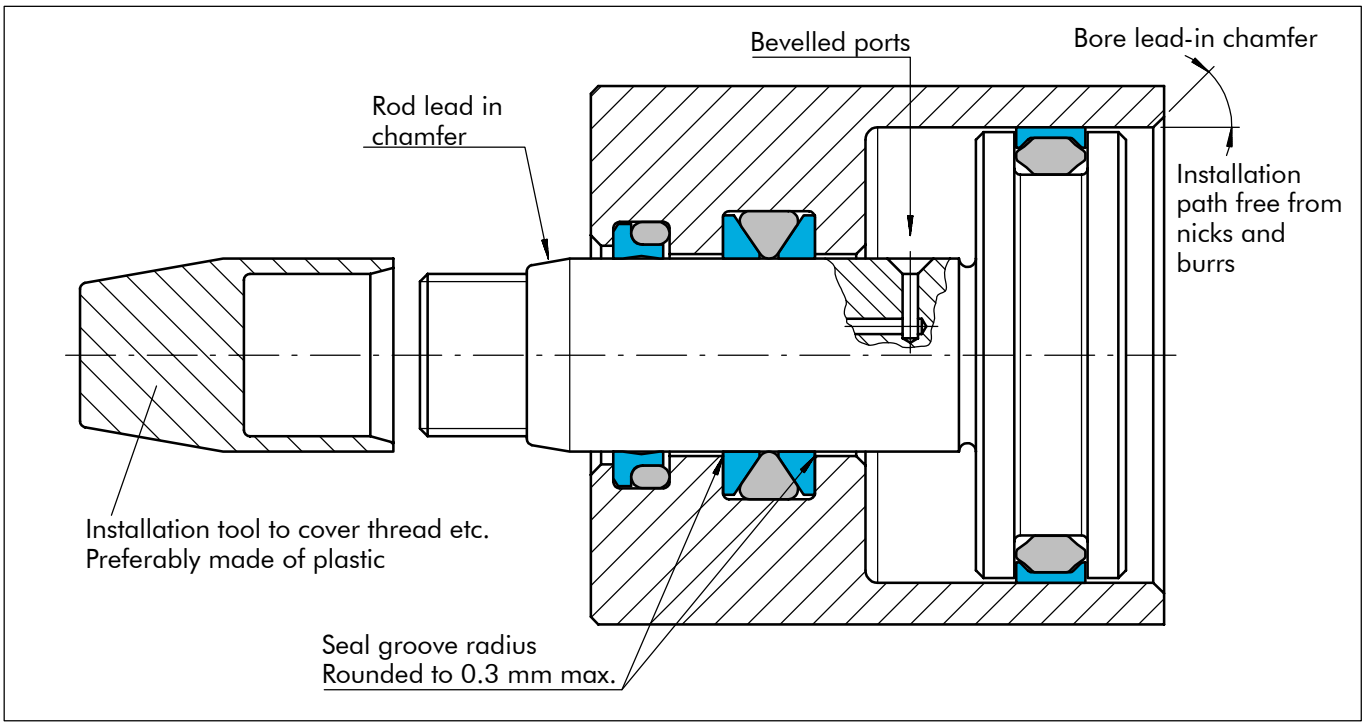


Figure 141 Methods of Hardware Design to Prevent Seal Damage

- The installation path should be kept free of nicks, burrs, scratches, or any sharp edge that could damage the seal.
- Any tool used to install seals should be free of sharp edges. Screwdrivers are especially notorious for damaging sealing lips and should not be used to handle the seals.
- Tools made out of hard plasticlike Delrin or Nylon are preferred.
- In situations where heat is required to soften and expand the Turcon®-seal components, submerse them for a few minutes in hot oil or water (200 °F). Heat should not be required to install elastomer components. Be sure to use compatible lubricant when installing elastomer components.
- Application of a lubricant to surfaces of the seal and hardware reduces the force required to push the seal into a difficult gland such as a solid O-Ring groove.
- Piston seals may be sized by freezing them prior to installing the piston in the bore. A typical situation where this is an advantage is on spool valve pistons.
- A lead-in chamfer on the end of the rod or bore helps during installation. The proper chamfer dimensions are given in the tables found later in this section. This is especially important where seals are to be installed facefirst towards the seal-lip into the gland.
- When seals must be installed across ports, the edges of the ports should be smooth and rounded.
- Design splines or keyways to fall on a smaller diameter than the sealing surface or use a protective sleeve to cover them during installation as illustrated in Fig. 141.
- Avoid glands which require bending the seals during installation. When seals must be stretched or compressed into a difficult gland, be sure to use the recommended tooling described in Fig. 142-144 resize the seals.
- Do not sideload the seals any more than is necessary. Avoid gland situations where a heavy rod or piston bears against one side of the seal.

If you feel that your application poses a special problem with installation, your Shamban sales engineer will be pleased to demonstrate installation of seals and scrapers.

Procedure for installation of piston seals

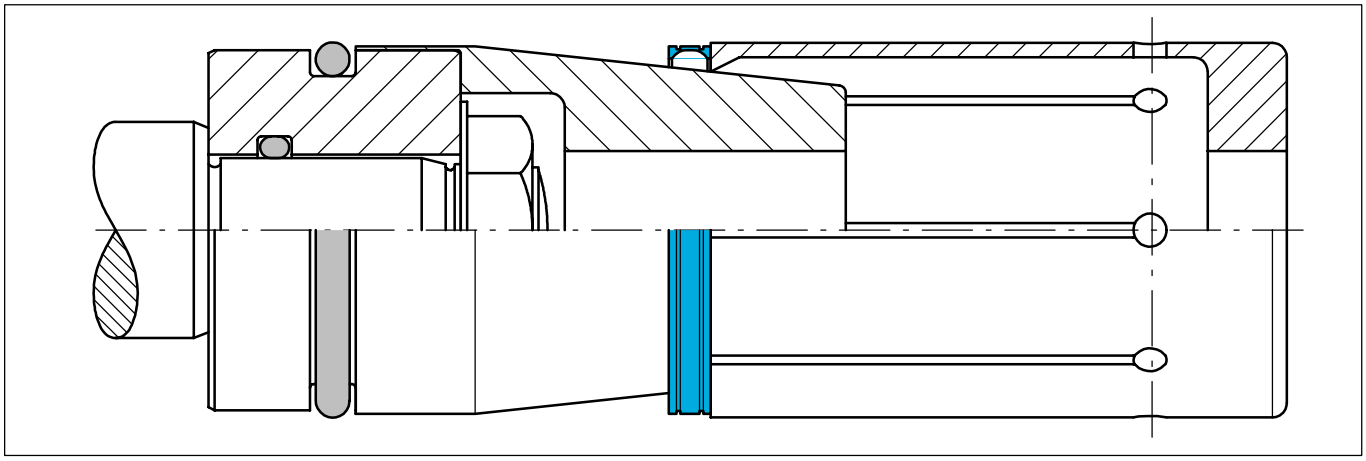


Figure 142 Expanding the Turcon® Sealing Element Using an Expanding Sleeve over the Installation Sleeve

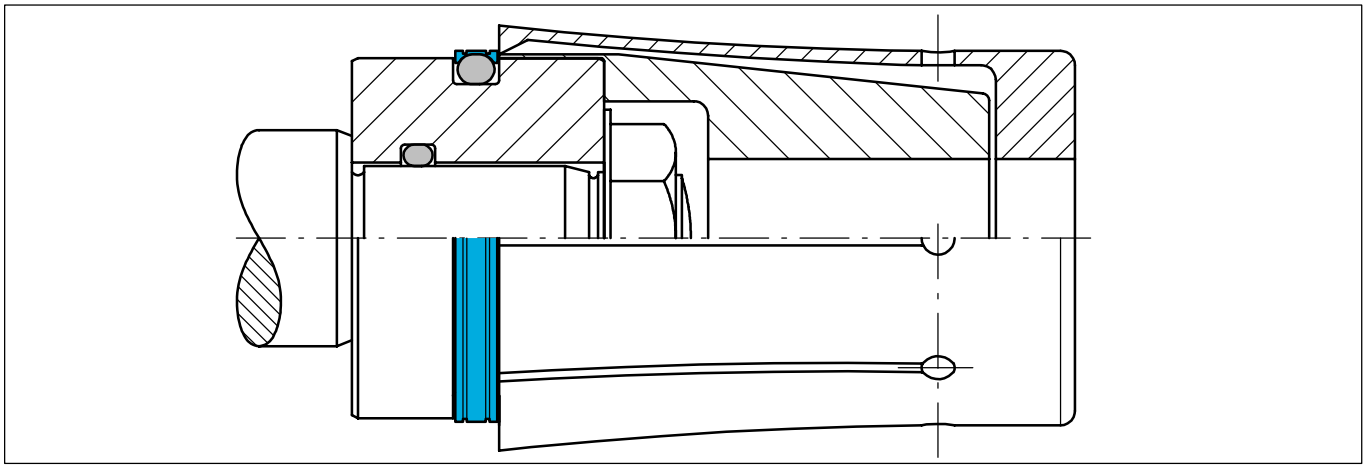


Figure 143 Sealing Element after Snapping into the Groove

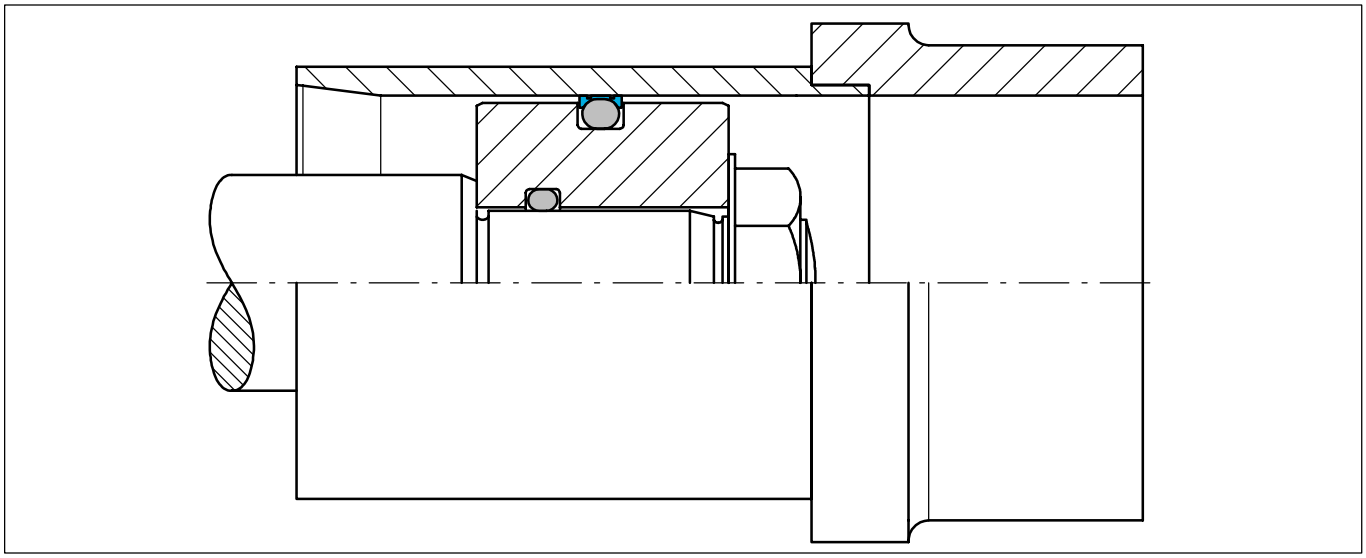


Figure 144 Sizing the Sealing Element with a Sizing Sleeve

For sizes where the Turcon® seal ring is expanded more than 15% (10% for the high filled materials Turcon® T10 and Turcon® T29), a split groove is necessary.

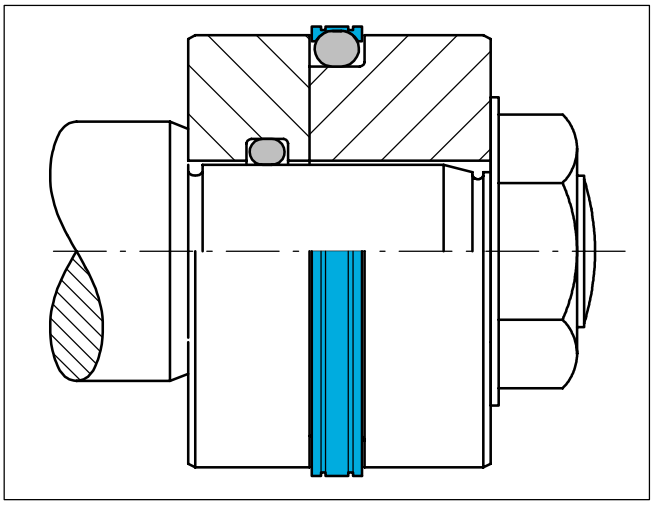


Figure 145 Installation in a Split Groove

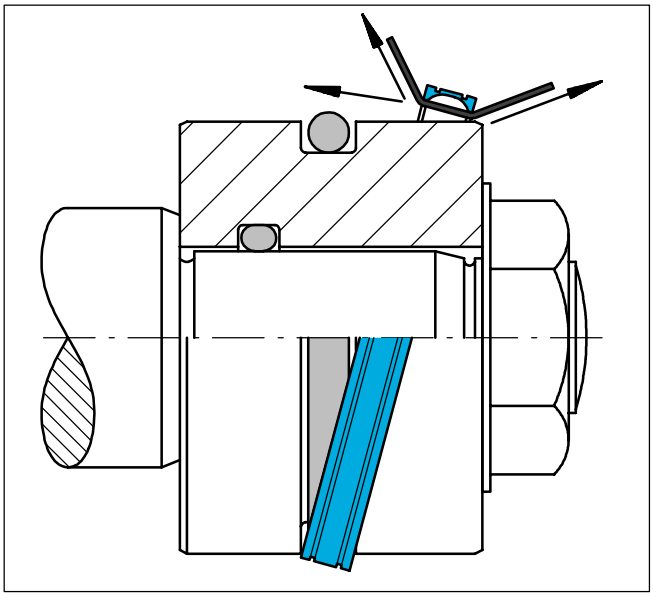


Figure 146 Fitting the Seal Ring onto the O-Ring in the Groove

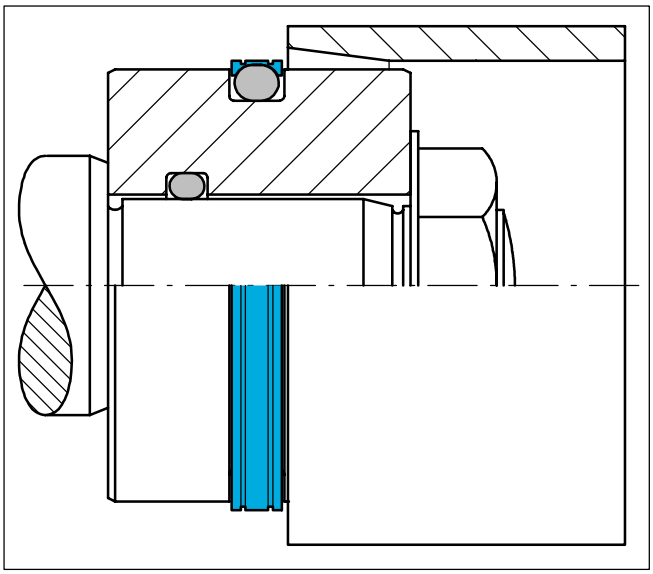


Figure 147 Sizing of the Installed Seal

Procedure for installation of rod seals

- Place the elastomer part into the groove
- Compress the Turcon® part into a kidney shape. The seal must have no sharp bends (Figure 148)! Use a rounded object like a pen to compress the Turcon® part.

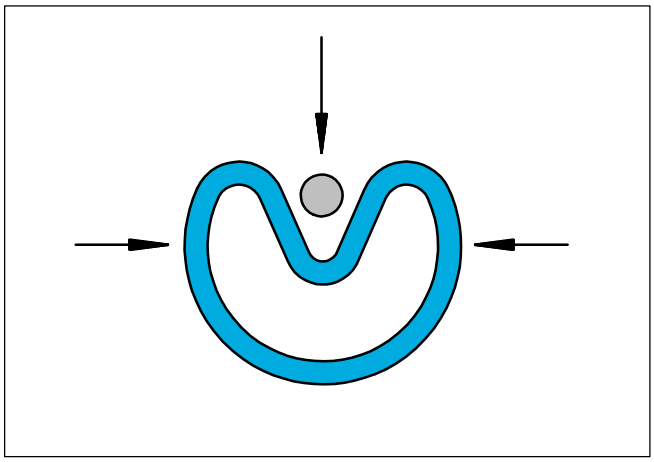


Figure 148 Kidney-Shaped Deformation of the Seal Ring

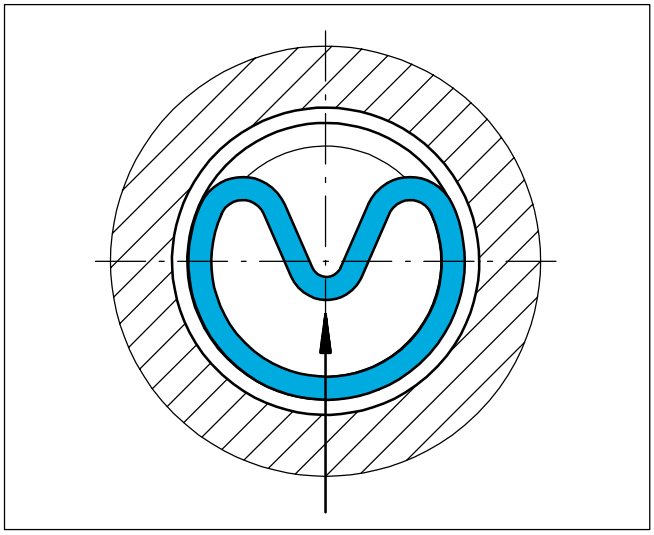


Figure 149 Inserting the Seal Ring into the Closed Groove

- After placing into the groove, form the seal into a ring again by smoothing out the I.D. by hand.
- Finally, size the seal ring using a mandrel which should have a chamfer of 10° to 15° over a length of approx. 30 mm. (Figure 150).

The sizing mandrel should be made from a polymer material (e.g. polyamide) with good sliding characteristics and high surface quality in order to avoid damage to the seals.

The piston rod itself can also be used for calibration, provided it has a sufficiently long lead-in chamfer.

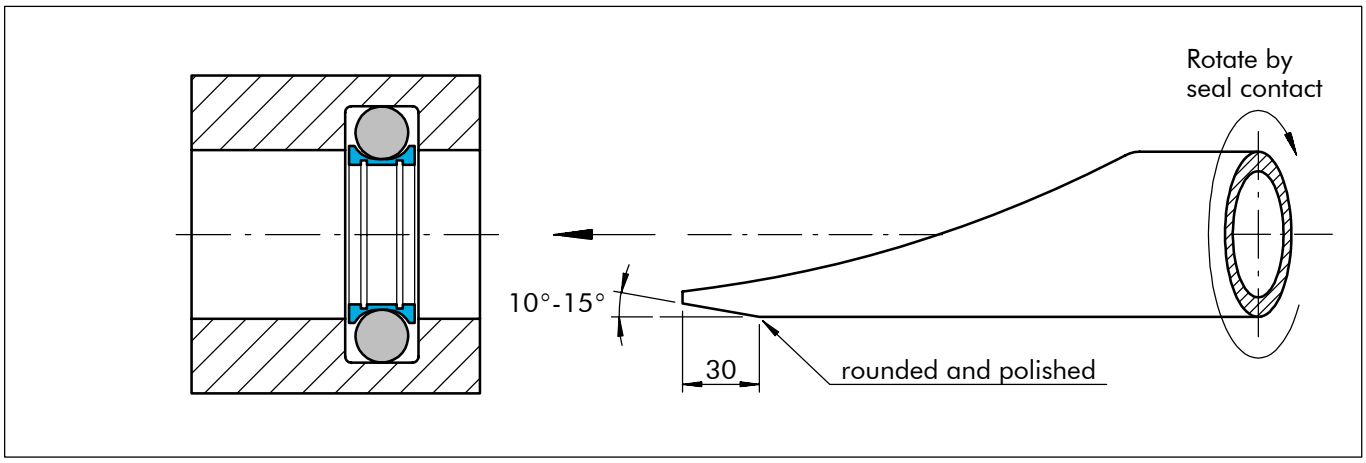


Figure 150 Sizing of the Installed Seal

Note! Should you encounter problems with installation even after following the recommendations in this catalog, additional information is available.

Quality Criteria

The cost-effective use of seals and bearings is highly influenced by the quality criteria applied in production. Seals and bearings manufactured by Shamban are continuously monitored according to strict quality standards from material acquisition through to delivery.

Certification of our production plants in accordance with international standards EN ISO 9000 meets the specific requirements for quality control and management of purchasing, production and marketing functions.

Our quality policy is consistently controlled by strict procedures and guidelines which are implemented within all strategic areas of the company.

All testing of materials and products is performed in accordance with accepted test standards and specifications, e.g. random sample testing in accordance with DIN ISO 2859 part 1/ANSI/ASQC Z 1.4-1993/ MIL-STD- 105 E. Inspection specifications correspond to standards applicable to individual product groups (e.g. for O-Rings: ISO 3601/DIN 3771).

Our sealing materials are produced free of chlorofluorinated hydrocarbons and carcinogenic elements.

For Seals and Bearings used in the Aerospace Industry, an "A" must be specified in the 10th digit. In special numbers, the "A" will be in the 5th digit of the number. Customer-specific demands are indicated and monitored with other characters in those positions.

Certificates of Approval

All manufacturing companies have ISO 9001/9002 certification and all marketing companies are certified or will be in the near future.

Storage

(The notes in *italics* only apply to elastomeric sealing materials).

Seals and bearings are often stored as spare parts for prolonged periods. With a few basic simple precautions, the shelf life of these products can be considerably lengthened.

Seals and bearings should be stored where they are safe from damage by external influences. Deformation, in particular, should be avoided during storage.

Under the influence of various external factors e.g. heat, moisture, light, oxygen, ozone and as a result of contact with liquid media, the properties of certain materials may change. For example, deformation, ageing and weathering can cause deterioration of the original mechanical and physical properties, depending on the material and shape of the parts.

Fundamental instructions on storage, cleaning and maintenance of elastomer seal elements are described in international standards, such as:

Storage of rubber products: *DIN 7716/BS 3F68: 1977*

Maximum age limitation:
New seal storage spec.: ARP 5316
MIL-HDBK-695C (Pending on cancellation)
MIL-STD-1523A (Cancelled)
DIN 9088

The individual guidelines give several recommendations for the shelf life of elastomers, depending on the material classes.

The following guidelines should be observed to maintain the optimum physical and chemical values of the parts:

Heat

The ideal temperature for storage is between +5°C/41°F and +25°C/77°F. Direct contact with heaters should be avoided.

Moisture

Parts must be stored dry under normal atmospheric conditions (65% rel. moisture ±10).

Light

To ensure that the properties of the product are maintained, elastomer seals should be stored to avoid exposure to ultra violet or neon light.

Oxygen

To protect elastomers from oxygen, they should be kept in the original packaging or in airtight containers.

Weathering

To protect them against damage, seals and bearings should be kept in the original sealed packaging.

Ozone

Destruction of certain elastomeric sealing materials due to ozone can be caused by the following machines and equipment:

- *Mercury discharge lamps*
- *High voltage equipment*
- *Electric motors*
- *Electric spark sources or discharges*

Customer Approvals

A Abex/Parker/NWL, Control Systems
ABS
AEG
AERO VODOCHODY, a.s.
Aerojet Strategic Propulsion Company
Aerospatiale
Airesearch
Airlines (all major airlines)
Airscrew Howden
Allied Signal/Bendix Engine Controls QP2000
Allied Signal/Bendix Wheels & Brakes QP318
Allison Gas Turbine
Alresearch MIL-I-45208A
Alvis Aerospace & Transmission
Amsco
Anchor Darling Valve Company
ANPK "MIG"
APPH Precision Hydraulics
Argo-Tech
Arkwin
Asdor Filters
Agusta

B Battle of Britain Flight
BF Goodritch
Boeing Company D1-9000
British Aerospace BAe/AG/QC/SC1, Part 3b
British Aerospace
BW/IP International

C Cadillac Gage
Coltax Aerospace
Compania Espanola de Sistemas Aeronauticas,S.A. (CESA)
Construcciones Aeronauticas, S.A. (CASA)

D DAF Special Products B.V.
Daimler Benz Aerospace Airbus GmbH
DLA-DCAS
Douglas Aircraft
Dowty Aerospace
Dräger Hispania S.A.
Dunlop

E EDO
Emco Fluid Systems
E.N. Santa Barbara
Energia
Ericsson Saab Avionics

F Fairey Hydraulics
Fairey Microfiltrex
Fimac
FFV Aviocomp
FFV Aerotech
Flight Refuelling
FLS Aerospace

G Gamesa Aeronautica
Garrett GmbH
GEC Marconi
General Dynamics - Top Gun Supplier
General Electric Aircraft Engine S1000
Grumman MIL-I-45208A (QES0002 - Part I)

H H R Textron
Hamilton Standard
Hispano-Suiza
Hollandse Signaalapparaten B.V.
Honeywell Space Systems
Hunting Aviation
Hughes Aircraft
Hydro-Air
Hymatic Engineering Co. Ltd

I Israel Aircraft/Astra Jet

J JIHLAVAN, a.s.
JIHOSTROJ, a.s.

K Kaman Aerospace MIL-I-45208A
Kombinat "PZL-HYDRAL SA
Kværner

L Liebherr Aerospace Lindenberg GmbH (LLI)
LTV
Lucas Aerospace (all)

M M.L. Aviation
Magnaghi
Martin Baker Aircraft Ltd.
McDonnell Douglas
Meggitt Oxygen Systems
Messier-Bugatti
Messier-Dowty
Microtecnica
MOOG Controls
Moscow helicopter plant "Mil"

N Normalair-Garrett Ltd.
Nuclear Assurance

O Oma

P Parker Hannifin
Pattonair
PHD
Pilatus

R Raytheon
Remco Hydraulics
Rockwell International ST0802GT0002, 20C
Rodina
Rolls Royce (ALL)
Rubin

S SABCA
Sargent Controls MIL-I-45208A
Satair
SHL
Short Brothers
Sundstrand
Swedish Space Agency
Saab Military Aircraft
Saab Aircraft

T Teijin Seiki

V/W Vickers
Volvo Aero Support
Volvo Flygmotor
Voskhod
Westlands (ALL)
Woodward Governor

Z Z.F.
ZAKLAD LOTNICZY "PZL-MIELEC" Sp.z.o.o.
Zvezda

Technical Questionnaire

We would be pleased to send you a technical proposal/quotation to your sealing or bearing application upon receipt of this questionnaire. (Look for address and fax number on the back page of the catalogue).

Name:	Date:
Division:	
Company:	❑ Technical proposal:
Address:	❑ Quotation for pieces
Postal Code:	Annual usage:
Telephone:	❑ Others:
Telefax:	

Please provide relevant dimensions to your application on the drawing shown below, or send us a copy of your hardware drawing.

Service Conditions and Hardware:

Type of component:		Short description of your application or objectives:
Component description:		
Pressure range:		
Operating pressure:		
Temperature range:		
Operating temperature:		
Speed max:	Operating speed:	
Media:		
Movement:		
❑ oscillatory	❑ reciprocating	
❑ rotation	❑ static	
Number of cycles/frequency:		
Maximum stroke:		
Material (housing/countersurface):		
Surface finish:		
Service life required:		

For further information:

Europe	Telephone
FRANCE - Paris	+33 (0) 1 30 86 56 00
GERMANY - Stuttgart	+49 (711) 7 86 40
ITALY - Livorno	+39 (0586) 22 61 11
SPAIN - Madrid	+34 (91) 7 10 57 30
SWEDEN - Jönköping	+46 (36) 34 15 00
UNITED KINGDOM - Ashchurch	+44 (0) 16 84 85 22 11
America	
AMERICAS - Fort Wayne, IN	+1 (260) 7 49 96 31
BRAZIL - Sao Paulo	+55 (11) 33 71 25 70
CANADA - Ontario	+1 (416) 2 13 94 44
USA, Midwest - Lombard, IL	+1 (630) 2 68 99 15
USA, South - N. Charleston, SC	+1 (843) 7 47 76 56
USA, Southwest - Houston, TX	+1 (713) 4 61 34 95
USA, West - Torrance, CA	+1 (310) 3 71 10 25
Asia	
JAPAN - Tokyo	+81 (35) 6 10 18 11

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