

Reinforced all-rubber HSS seals

Reliable protection for large size bearings



Reinforced all-rubber HSS seals

The HSS seals are specially developed by SKF to protect large size bearings under the tough operating conditions in heavy industrial applications such as metal rolling mills, mining equipment or wind turbines. They feature a well-proven sealing lip design and a new concept of reinforcing all-rubber seals.

Improved stability, easy installation

HSS seals offer an excellent combination of high-performance and reliability as well as easy installation and on-site replacement during planned maintenance procedures. The new reinforced all-rubber seals combine high stability with the benefit of an all-rubber seal providing high static sealing performance by its ability to accommodate small imperfections in the housing bore surface. With their limited space requirements, these seals also enable smaller and lighter bearing housings.

Seal materials

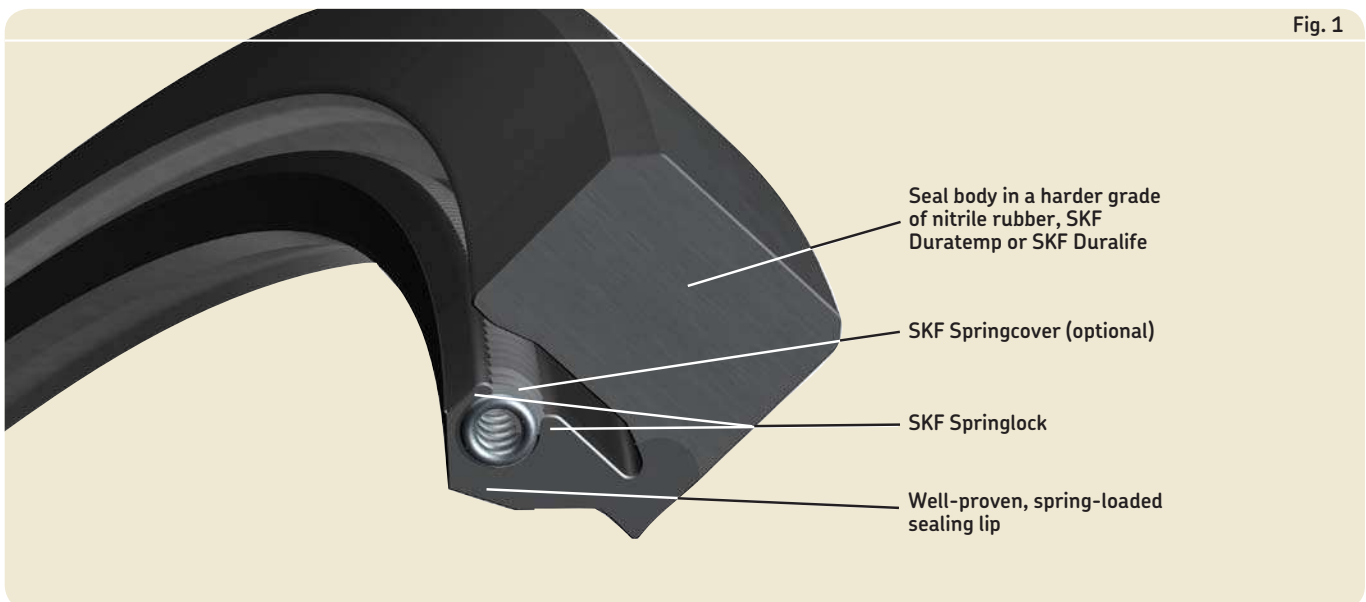
The HSS seals range is available in nitrile rubber (NBR) with very good engineering properties and the two SKF developed materials SKF Duratemp (HNBR) and SKF Duralife (FKM) that successfully have been used for decades in demanding applications.

SKF Duratemp is a hydrogenated nitrile rubber with excellent resistance to wear, ageing, high temperatures and ozone.

SKF Duralife is a fluoro rubber compound, characterized by its very good wear, thermal and chemical resistance.

The standard grade of the materials is used for the sealing lip, while the part of the seal body contacting the housing bore is made from a harder grade (→ **fig. 1**) to provide improved stability in operation and during installation. This concept of reinforcing

the seal allows split designs, which significantly facilitates onsite installation and replacement.



Design features

HSS seals constitute a range of seals with a variety of design features and combinations of these, including solid and split versions, SKF Springlock, SKF Springcover, different spring connections and lubrications grooves.

Proven sealing lip design

All HSS seals feature a well-proven, spring-loaded sealing lip design (→ **fig. 1**) with a defined radial load for reliable sealing performance.

Garter spring and connections

The seals are designed with SKF Springlock (→ **fig. 1**), a sealing lip feature that surrounds 270° of the stainless steel garter spring diameter. SKF Springlock helps to hold the spring in position during installation.

For blind installations, where spring displacement may go undetected, the flexible SKF Springcover (→ **fig. 2**) can be specified to further keep the spring in position.

There are different ways to connect the garter springs of HSS seals. A threaded spring connection (→ **fig. 2a**) is used for the solid versions, unless otherwise specified, and for the split versions HSS6 and HSS8 for shaft diameters ≤ 455 mm (18 in.). For bigger sizes, a hook-and-eye spring connection (→ **fig. 2b**) is used.

The split HSS7 seals feature the special control-wire connection (→ **fig. 2c**). The HSS7 seals do not have the same high-performance characteristics of other HSS designs, but are the easiest to install. See **matrix 1** for an overview of the HSS designs and their features.

Lubrication grooves

All HSS seals except the HSS7 can also be equipped with lubrication grooves (→ **fig. 4, page 5**) at the back of the seal to allow the re-greasing between the sealing lips in back-to-back or tandem installations of two HSS seals.

Matrix 1

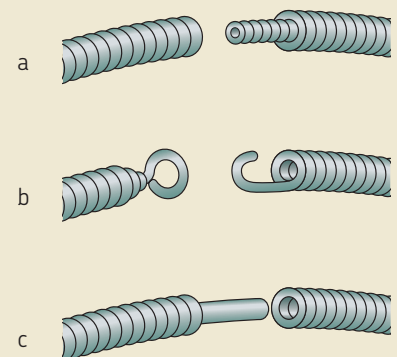
HSS design range	HSS4	HSS5	HSS6	HSS7	HSS8
Solid	✓	✓			
Split			✓	✓	✓
SKF Springlock	✓	✓	✓	✓	✓
SKF Springcover		✓		✓	✓
Threaded connection	✓	✓	✓ ¹⁾		✓ ¹⁾
Hook-and-eye connection			✓ ²⁾		✓ ²⁾
Control-wire connection				✓	
Lubrication grooves	HSS4G	HSS5G	HSS6G	–	HSS8G

¹⁾ Up to 455 mm (18 in.) shaft diameter

²⁾ Above 455 mm (18 in.) shaft diameter

Fig. 2

Spring connections



Installation and size options

All HSS seals are manufactured slightly oversized relative to the housing bore diameter and depth. For proper compression and stability, a cover plate is used.

Cover plates

All HSS seals are manufactured slightly oversized relative to the housing bore diameter and depth. For proper compression and stability, a cover plate is used (→ fig. 3). The cover plate provides axial compression of the seal and stabilizes it in the housing bore to achieve maximum seal performance.

The cover plate must be dimensioned properly to obtain the required fit. It should be thick enough not to bend or distort. Generally, a thickness of 6,35 to 12,7 mm (0.25 to 0.50 in.) is sufficient.

The plate should be fastened with bolts, no more than 150 mm (6 in.) apart, on a

bolt circle located as close to the seal housing bore as practical. The cover plate should be flat and the housing bore depth uniform. Splitting the cover plate at 180° will make seal replacement easier, particularly in confined areas.

To protect the seal from damage from the outside, SKF recommends dimensioning the inside diameter of the cover plate so that it is approximately 6 to 8 mm (0.25 to 0.30 in.) larger than the shaft diameter to accommodate shaft-to-bore misalignment and runout.

For more detailed information, refer to SKF catalogue *Industrial shaft seals*.

Size options

SKF's flexible manufacturing process for the HSS range enables the customization of sizes without minimum quantity and virtually without upper limits for both metric and inch sizes. This flexibility enables the same short delivery times for customized dimensions as for standard seals. **Table 1** lists the shaft and housing bore size options for the HSS seals.

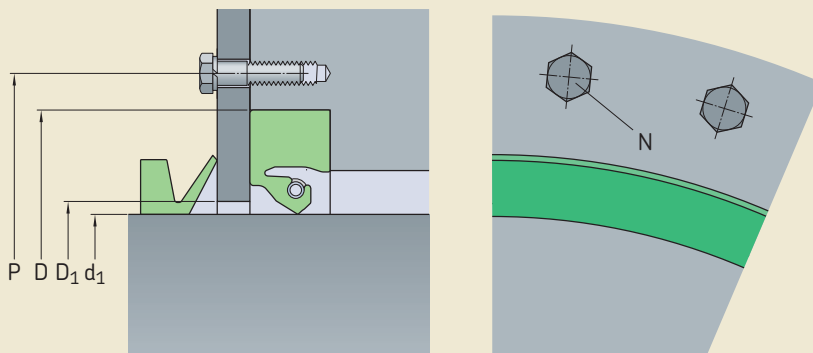
Additional protection

SKF recommends the use of a V-ring as the first barrier for improved contaminant exclusion (→ fig. 3). It is a simple, cost-effective flinger device, available in different designs and sizes to fit in virtually every application.

In fig. 3, the cover plate acts as the counterface surface for the V-ring.

Fig. 3

Cover plate recommendations



Inside diameter of cover: $D_1 \approx d_1 + 6 \dots 8$ [mm]
Pitch circle diameter of screws: $P \approx 1,1 D$ [mm]
No. of attachment screws: $N \approx 0,02 P$

Permissible operating conditions

Temperature

Nitrile rubber (NBR):
 -40 to +100 °C
 (-40 to +210 °F)

SKF Duratemp (HNBR):
 -40 to +150 °C
 (-40 to +300 °F)

SKF Duralife (FKM):
 -40 to +200 °C
 (-40 to +390 °F)

Pressure differential

Solid HSS: max 0,07 MPa (11 psi)
 Split HSS: 0

Shaft surface speed (linear)

Solid HSS:
 NBR max 15 m/s (2 950 ft/min)
 HNBR max 20 m/s (3 930 ft/min)
 FKM max 25 m/s (4 900 ft/min)

Split HSS: max 15 m/s (2 950 ft/min)

Shaft-to-bore misalignment

max 1,6 mm (0.062 in.)

Dynamic runout

max 2,4 mm (0.093 in.)



Fig. 4

HSS seal with lubrication grooves

Table 1

Shaft and housing bore size options for HSS seals

Shaft diameter d ₁		Bore diameter D		Bore depth B		Difference between bore and shaft diameter	
from	to	from	to	from	to	from	to
mm/in.		mm/in.		mm/in.		mm/in.	
165,10 6.500	4 572,00 180.000	195,10 7.681	4 610,10 181.500	12,70 0.500	25,40 1.000	30,00 1.181	63,50 2.500

d₁: Tolerance h11

D: Tolerance H8

B: Tolerance ±0,10 mm (0.004 in.)

HSS5 seals are limited to 1 200 mm bore diameter. Not all cross sections and widths are possible with every shaft diameter. Contact SKF for availability on dimensions at the extreme limits or on sizes outside the standard range.

Housing requirements

To achieve reliable sealing performance and maximum service life, the shaft and housing bore for HSS all-rubber radial shaft seals should meet the requirements outlined below.

Shaft requirements

Tolerances and lead-in chamfers

The diameter of the shaft d_1 at the counterface should be machined to the tolerances provided in **table 2**. Out-of-roundness must be less than 0,005 mm (0.0002 in.) at a maximum of 2 lobes or less than 0,0025 mm (0.0001 in.) at a maximum of 7 lobes.

If the direction of installation is Z, the values of **table 4** ($d_1 - d_2$) should be adhered to. If the direction is Y, the shaft end could be either rounded (r_2) or chamfered ($d_1 - d_2$).

Surface finish

Depending on the direction of rotation, directionality on the seal counterface may cause a seal to leak. Plunge grinding is the preferred machining method to minimize directionality ($0 \pm 0,05^\circ$) on the seal counterface. When plunge grinding, whole number ratios of the grinding wheel speed to the work piece speed should be avoided.

Surface roughness

The surface roughness values of the counterface for radial shaft seals, calculated according to methods described in ISO 4288 (DIN 4768), should be kept within the limits specified in **table 3**.

Hardness

The surface hardness of the seal counterface should be at least 30 HRC. If the counterface surface could be damaged during transport or installation, this value should be increased to 45 HRC.

Table 2

Counterface tolerances for shafts

Shaft diameter Nominal d_1				Diameter tolerance ¹⁾ Deviation			
over	incl.	over	incl.	high	low	high	low
mm			in.	μm		in.	
165	180			0	-250		
180	250			0	-290		
250	315			0	-320		
315	400			0	-360		
400	500			0	-400		
500	630			0	-440		
630	800			0	-500		
800	1 000			0	-560		
1 000	1 250			0	-660		
1 250	1 600			0	-780		
1 600	2 000			0	-920		
2 000	2 500			0	-1 100		
2 500	3 150			0	-1 350		
3 150	4 000			0	-1 650		
4 000	5 000			0	-2 000		
		6	10			+0.005	-0.005
		10				+0.006	-0.006

¹⁾ For shaft diameters of 3 150 mm and above, refer to DIN 7172.

Table 3

Recommended shaft surface roughness values

	ISO		DIN		RMA	
	μm	$\mu\text{in.}$	μm	$\mu\text{in.}$	μm	$\mu\text{in.}$
R_a	0,2–0,5	8–20	0,2–0,8	8–32	0,2–0,43	8–17
R_z	1,2–3	48–120	1–5	40–200	1,65–2,9	65–115
R_{pm}	N/A	N/A	N/A	N/A	0,5–1,5	20–50

Housing bore requirements

Lead-in chamfers

To reduce the risk of seal damage during installation, the housing bore should have a 15° to 30° lead-in chamfer. The chamfer should be free of burrs and the transition radius r between the seal seat and shoulder should be in accordance with the recommendations in **table 4**.

Tolerances

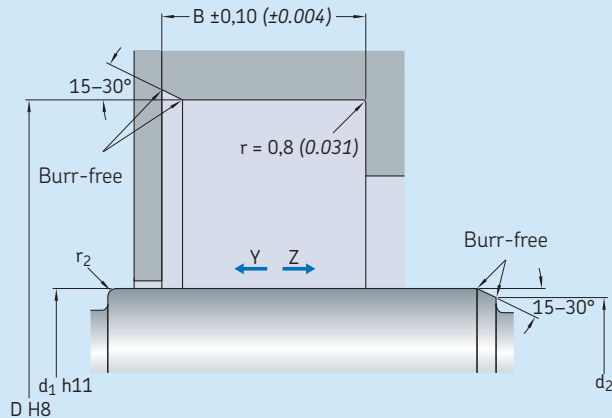
For all-rubber HSS seals, the bore depth tolerance should be 0,10 mm (0.004 in.), see **table 4**.

Surface roughness

The surface roughness (to ISO 4288, DIN 4768 or RMA OS-1-1) of the housing bore should be kept within the limits specified in **table 5**.

Table 4

Lead-in chamfers and radii



Shaft diameter		Nominal d_1		Diameter difference ¹⁾ $d_1 - d_2$		Radii	
over	incl.	over	incl.	mm	in.	r_2 min	
mm	in.	mm	in.	mm	in.	mm	in.
165	240	6.500	9.499	7	0.276	1	0.039
240	500	9.449	19.685	11	0.433	2	0.079
500		19.685		13	0.512	5	0.197

¹⁾ If the corner is blended rather than chamfered, the blended section should not be smaller than the difference in diameter $d_1 - d_2$.

Table 5

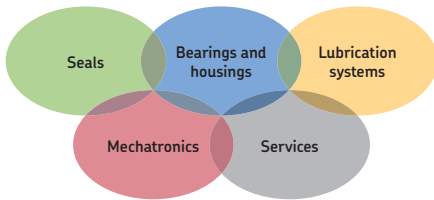
Recommended housing bore surface roughness values

	ISO ¹⁾		DIN		RMA ^{2) 3)}	
	μm	$\mu\text{in.}$	μm	$\mu\text{in.}$	μm	$\mu\text{in.}$
R_a	1,6–3,2	64–128	1,6–3,2	64–128	1–2,5	40–100
R_z	6,3–12,5	252–500	10–20	400–800	N/A	N/A
R_{pm}	N/A	N/A	25	1 000	N/A	N/A

¹⁾ ISO – The housing bore surface roughness may require lower values when metal-cased seals are used, in which case they should be subject to agreement between the manufacturer and user.

²⁾ RMA – If the bore surface texture is greater than 2,5 μm (100 $\mu\text{in.}$) R_a , a sealant should be used.

³⁾ RMA – Turned bores, where a lubricant head of up to 0,20 bar (3.0 psi) is present at the seal. If this texture is maintained and tool removal marks or bore defects are present, no outside diameter leakage should occur.



The Power of Knowledge Engineering

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These competence areas include bearings and units, seals, lubrication systems, mechatronics, and a wide range of services, from 3-D computer modelling to cloud-based condition monitoring and asset management services.

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